



BOOK OF ABSTRACTS

IV International Symposium on Applied Geoinformatics

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ARTIFICIAL INTELLIGENCE

Machine Learning Approaches for Evaluating Forest Fire Impacts on Sentinel-2 Satellite Imagery across Ukraine

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Introduction

This study explores the utilization of machine learning techniques to detect the impacts of forest fires through the analysis of satellite imagery. The objective is to address the pressing need for improved forest fire monitoring systems by harnessing the capabilities of advanced machine learning models. The study specifically aims to assess the accuracy of convolutional neural networks (CNNs) in identifying fire-affected areas from Sentinel-2 satellite images of Ukrainian forests.

Data and Method

The research encompasses Ukrainian forest territories affected by wildfires. The dataset employed consists of Sentinel-2 satellite images, utilizing the true colour composite (Bands 2, 3, and 4), selected for their spectral characteristics in differentiating between burned and unburned forest areas. These images, 100 in total, each with a resolution of 128x128 pixels, were annotated by experts to create a reference for training a CNN model. The machine learning approach involved the CNN learning from these labelled image patches, adjusting its internal parameters through iterative training to minimize classification errors and improve its predictive accuracy.

Results

The trained CNN model achieved an impressive 97% accuracy rate in correctly classifying pixels corresponding to undamaged forest areas. However, the model identified burned areas with a moderate accuracy of 55% only. These quantitative results demonstrate the model's robust capability in general forest fire detection while also highlighting the need for improvements in accurately detecting areas affected by fires.

Conclusion

The research shows the potential of machine learning, and CNNs in particular, as an effective instrument for the remote assessment of forest fire damage via satellite imagery. The study confirms that neural networks are adept at processing spatial data, providing critical insights for environmental surveillance and aiding in the management of forest resources. To further enhance the model's detection accuracy, future research should investigate other architectures and loss functions, expand the dataset, and incorporate additional relevant spectral bands to better distinguish between burned and unburned areas.

Keywords

Forest Fire Detection, Machine Learning, Convolutional Neural Networks, Spectral Bands, Ukraine Forests

Forecasting of Solar Power Plant's Capacity Utilization Factor in Ukraine using Satellite Data and Random Forest Regression

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Introduction

Ukraine, supporting the Green Deal, needs scientifically grounded solutions for the successful restoration of solar energy development, which was interrupted by the war.

In this research, we propose a regression model based on satellite data on climate and topography to predict the annual Capacity Utilization Factor (CUF) for solar power plants.

We aim to verify the suitability of this approach for assessing the potential of solar energy production in different locations of Ukraine and restoring its green course.

Data and Method

In this study, we used data from the Global Power Plant Database (2013-2017) for 21 solar power plants placed in different locations of Ukraine and calculated the annual CUF for each.

Additionally, we collected satellite data on climatic variables (accumulated annual Global Horizontal Irradiance, accumulated annual hourly temperature > 25°C, total annual precipitation, average annual wind speed) from the ERA5-Land dataset and topographic indicators (elevation, slope) from the Shuttle Radar Topography Mission database.

We constructed a Random Forest regression model using satellite data and installed plant capacity as predictors to forecast the CUF. To assess model accuracy, we applied cross-validation using data from one year as testing and the other for training, and averaged the results.

Results

The calculated CUF for the investigated solar power plants varies between 15.2-19.2%. According to the regression analysis, the averaged R^2 is 0.64 with averaged RMSE of 0.45 and MAE of 0.36. The average relative error is about 2%.

Conclusion

Our study demonstrates the feasibility of using satellite data and machine learning to predict the CUF of solar power plants with high accuracy. This approach can help identify the best locations for the construction of cost-effective solar power plants and promote the development of green energy in Ukraine.

Keywords

Solar power, Capacity factor forecasting, Satellite data, Machine learning.

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Graph-Based Modeling of Village Infrastructure Development

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Introduction

This study introduces a framework for village classification, quality benchmarking, and infrastructure enhancement strategy formulation using clustering and grouping techniques. It aims to achieve next objectives: creating a computationally efficient method for village analysis, establishing a classification system for village infrastructure quality assessment and implementing Graph Convolutional Networks (GCN) to evaluate village infrastructure quality based on descriptive graph analysis.

Data and Method

This study uses geospatial data from OpenStreetMap (OSM) to evaluate village infrastructure quality. Key indicators include locations and descriptions of various infrastructure elements such as cities, parks, banks, churches, educational institutions, hotels, kindergartens, libraries, medical facilities, and shops. The data is represented in two forms: tabular identifiers (distances to infrastructure objects) and descriptive graphs with parameterized connectivity. Constraints are applied to the graph data, limiting distances to 50km or 30km for different infrastructure types and setting a maximum of five objects per type. After that data is being categorized and processed with clustering and deep learning techniques.

Results

The main result of this study is the methodology for computing villages' infrastructure development level using graph data engineering. This method clusters villages in Ukraine by infrastructure quality and identifies imbalances in local amenities like schools, clinics, and shops. The model is applicable to various countries and infrastructure indicators, enabling the identification of areas for improvement across different development stages. In the research, we have proven that in Ukraine, libraries are less accessible than kindergartens, while shops, medical facilities, and educational access are comparatively similar.

Conclusion

The method has been tested and works well for evaluating village infrastructure using easily accessible geospatial data. The advantage of graph-based deep learning approach is its ability to be customized to local conditions and expanded to incorporate new data types. Future studies will include the cost-effectiveness of the recommended improvements to village infrastructure.

Keywords

Spatial Data Analysis, Machine Learning, Clustering, Graph Convolutional Networks, Geoinformatics, Village Classification

Symbiotic Artificial Intelligence and Satellite Imagery for Rapid Assessment of War-Induced Agricultural Damage in Ukraine

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Introduction

The ongoing conflict in Ukraine has transformed agricultural lands into high-risk areas. The Russian military incursion has inflicted severe harm on the agricultural sector, disrupting the infrastructure crucial for food production. The intensity of the conflict and the threat to human life make traditional monitoring methods impossible. Therefore, the creation of innovative remote techniques for assessing field conditions during wartime is needed.

Data and Method

In addressing this challenge, we propose an adapt method for detecting damaged fields combines of Symbiotic Artificial Intelligence with human oversight. This approach focuses on detecting anomalies in damaged fields using the most informative spectral bands (B2, B3) and vegetation indices (NDVI, GCI). By integrating Symbiotic AI, we can dynamically adjust parameter indices based on human input, enhancing the accuracy of our analysis. Differential analysis identifies anomalies or deviations, signalling potential field damage. A human-set threshold factor allows the method to be tailored to specific study areas, time periods, and satellite image characteristics.

Results

Our symbiotic AI approach demonstrates that a positive GCI index effectively identifies shallow craters, while a negative GCI index highlights deeper ones. Additionally, traces of military equipment on densely vegetated fields create anomalies in both NDVI and GCI indices. An evaluation of these indices risks overestimating the extent of damage. However, intersecting abnormal pixel values from both indices, as guided by Symbiotic AI with human adjustment, accurately pinpoints war-affected areas.

Conclusion

By combining anomalies from vegetation indices and spectral bands, and leveraging Symbiotic AI guided by human expertise, our method effectively identifies various types of agricultural damage. It offers a comprehensive assessment of the impacts of military operations on fields at different vegetation stages. This innovative approach uses varied spectral ranges and indices, enabling the detection of diverse damage types through simultaneous anomalies, further enhanced by human-controlled parameter setting.

Keywords

Symbiotic artificial intelligence, Human interaction, Agricultural field anomaly detection, Remote sensing, Agricultural damage.

Transfer Learning Models for Oil Spills Detection Based on Satellite Data

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Introduction

The HORIZON Europe project iMERMAID is devoted to the development, implementation, and demonstration of innovative strategies for preventing, monitoring, and mitigating toxic and enduring chemical pollution in the Mediterranean Sea. A key focus of this study is oil spill detection based on free satellite data, which aligns with the iMERMAID project's main goals. Literature analysis makes clear that the most informative and accessible source of information is Sentinel-1 SAR data. However, the most significant constraint is the lack of available training data for the pilot territory. This study solves this problem via a transfer learning neural network technique.

Data and Method

A transfer learning approach for an oil spill detection model utilizes ~270 Sentinel-1 fragments, an open dataset from Marine Pollution Surveillance Reports for the Atlantic Ocean from 2018-2020, 2022-2023 for training and 2021 for testing. The model employs the LinkNet semantic segmentation network and its ability to generalize SAR imagery for the pilot region. For the Mediterranean Sea, coordinates with oil spills from CleanSeaNet reports are available, but only the accident year is indicated, without date specification. This 2022 information was used for model testing in the region near Cyprus.

Results

The model achieved an F1-score of 0.721 and IoU of 0.564 on the validation set. The results also indicate applicability of the proposed approach and its effectiveness for the independent Atlantic and Mediterranean regions. The transfer learning strategy demonstrates potential for automated expansion of oil spill monitoring to new areas lacking training data.

Conclusion

With further refinement, similar systems could provide actionable information to stakeholders working to mitigate environmental damage from oil spills. We plan to continue this research by expanding the dataset diversity, exploring model extensions, and conducting tests on larger geographic areas.

Keywords

Oil spill detection, Mediterranean Sea, remote sensing, Satellite imagery, SAR Sentinel-1, Deep learning, Transfer learning.

Investigating the use of artificial intelligence and data from UAV for wheat crop height and yield estimation

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Introduction

This research aims to address the pressing need for accurate and efficient methods of wheat crop height and yield estimation through the integration of Artificial Intelligence (AI) and Unmanned Aerial Vehicle (UAV) data. The practical problem at hand revolves around the limitations of traditional crop monitoring techniques, which often lack precision and require significant time and resources. The research question centres on how the fusion of AI and UAV technology can improve agricultural practices and resource allocation.

Data and Method

In this study, we employed a research method focused on the utilization of 5 multispectral bands captured by a DJI Phantom over a winter bread wheat bread fields in Beauvais, France on May 15-16th, 2024. Wheat was at the booting stage. The research involved processing and interpreting the multispectral imagery using advanced Artificial Intelligence algorithms to estimate wheat crop height and predict yield. Validation was performed by comparing real height and yield at harvest stage on 51 points of the parcel.

Results

The analysis of multispectral imagery acquired revealed promising results in the estimation of wheat crop height and yield. Employing Artificial Intelligence algorithms, our study demonstrated a high level of accuracy in predicting crop height based on the processed multispectral data. Correlation coefficient shows reasonable values with an R^2 over 0.7. Additionally, the integration of UAV technology and AI facilitated reliable yield predictions, showcasing the potential for precision agriculture applications.

Conclusion

In conclusion, our research establishes that the integration of Artificial Intelligence with UAV-acquired multispectral data, particularly from UAV platforms, significantly improves the precision of wheat crop height estimation and yield prediction in agricultural fields. Further research could explore the scalability of this approach across diverse agricultural landscapes and crops, ensuring its applicability on a broader scale

Keywords

Unmanned aerial vehicle, NDVI, Machine learning, Wheat, Remote sensing.

Semantic Segmentation using Segformer for Precise Building Damage Identification: A Study of the Marrakech Earthquake

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Introduction

This study addresses the urgent need for accurate assessment of building damage in the recent aftermath of the earthquake of Al Haouz region in Marrakech, Morocco. The aim of this study is to improve the efficiency and rapidity of house damage investigations by utilizing UAV images and advanced deep learning algorithms for image recognition.

Data and Method

In our study, we used an orthophoto from UAV images. We applied the vision Transformer architecture to classify post-earthquake UAV imagery into damaged and undamaged buildings. Our methodology included preparing an annotated dataset, dividing it into training (60%), validation (30%), and test sets (10%), and using the cross-entropy loss function with class balancing techniques. The model was initialized with pre-trained weights, fine-tuned using SGD optimizer, and augmented for dataset diversity.

Results

This approach effectively classified building damage, with evaluation metrics showing an accuracy rate of 0.9708, precision of 0.9200, F1 score of 0.9110, mean intersection over union (mIoU) of 0.9068, and a recall rate of 0.8742.

Conclusion

The experimental findings have demonstrated the effectiveness of our approach in identifying building damage. Moreover, it provides valuable insights that assist local authorities in assessing the extent of destruction and identifying severely affected areas. These results have significant implications for disaster response strategies and urban development planning, establishing our method as a benchmark for similar disaster assessments and aid initiatives.

Keywords

Haouz, Marrakech, Earthquake, UAV, Transformer, Classification, Building damage, Disaster response, Urban planning.

Utilizing Remote Sensing and Artificial Intelligence for Effective Monitoring of Deforestation: A Case Study in the Attica Region, Greece

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Introduction

The pressing need to monitor deforestation amid the ongoing climate crisis arises from various contributing factors, including wildfires, floods, and unsustainable land use practices. These factors have exacerbated the rate of forest loss, underscoring the urgency for effective monitoring strategies. This study, realised under the context of Horizon Innovation Action IMPETUS.

Data and Method

This study is employing remote sensing datasets, such as Sentinel 2 products, in conjunction with geospatial datasets like CORINE Land Use/Land Cover (LU/LC) and ESA WorldCover. By leveraging machine learning (ML) and artificial intelligence (AI) classification methodologies, the study aims to identify and provide continuous monitoring of areas undergoing deforestation. This study's approach integrates Sentinel 2 products, CORINE LU/LC, and ESA WorldCover datasets to monitor and identify deforestation hotspots. The region of interest has been selected to be the Attica Region, Greece. ML and AI classification methodologies are applied to analyse these datasets, enabling the identification of areas experiencing forest degradation. Ground truth data derived from both CORINE LU/LC and ESA WorldCover datasets are used to validate and ensure the robustness and consistency of the results.

Results

The results obtained from this study demonstrate the efficacy of the ML and AI classification methodologies in identifying degrading forest areas. The findings were consistent and reliable when validated against ground truth data from CORINE LU/LC and ESA WorldCover datasets. This approach provides a robust means of monitoring deforestation, offering a valuable tool for stakeholders in making informed decisions.

Conclusion

This study presents a promising monitoring tool for addressing deforestation in the face of the climate crisis. By integrating remote sensing and geospatial datasets with ML and AI techniques, the study offers a comprehensive approach to identifying and tracking forest degradation. The application of this study as a monitoring tool or as an integrated service can aid stakeholders in making informed decisions to combat deforestation in areas particularly susceptible to the direct and indirect impacts of the climate crisis.

Keywords

Remote Sensing; Deforestation; Forest Monitoring; Machine Learning; IMPETUS Project

Predicting Post-Wildfire Soil Characteristics Using Remote Sensing and AI: A Case Study in Central Greece

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Introduction

The aftermath of a wildfire event poses significant challenges for soil restoration efforts, necessitating accurate assessment of soil characteristics in burned areas. Remote sensing, particularly datasets acquired through aerial means, can be a valuable tool for identifying soil characteristics shortly after a wildfire. This study, realised under the context of Horizon Innovation Action TREEADS, aims to leverage remote sensing imagery and AI Deep Learning classification networks to predict soil characteristics in burned areas, thereby facilitating informed decision-making for tailored restoration practices.

Data and Method

The methodology proposed involves the analysis of remotely sensed images, specifically datasets acquired from a Light Maned Aircraft (LMA) equipped with a Sequoia multispectral camera. Images from four different burned areas in the prefecture of Central Greece were utilized for this study. Ground samples collected from two of these sites were analyzed in a laboratory to train and validate the methodologies. Various soil characteristics, including pH, EC, Soil Texture, and CaCO₃, were predicted using AI classification.

Results

The results of this study demonstrate the potential of remote sensing and AI techniques in predicting soil characteristics in burned areas. The proposed methodology resulted predictions of the soil characteristics that show great variability. This is mainly due to challenges such as image mosaic artifacts, cloud shadows, and hill shade in the acquired images, but also natural challenges such as cover of ash or recovered vegetation. Overcoming those challenges the dataset generated can serve as a valuable resource for stakeholders, enabling them to assess soil health after a wildfire event and determine appropriate restoration practices tailored to each specific case study.

Conclusion

This study highlights the utility of remote sensing and AI techniques in assessing soil characteristics in burned areas shortly after a wildfire event. By predicting soil characteristics, stakeholders can make informed decisions regarding restoration practices, thereby promoting effective soil rehabilitation and ecosystem recovery. The methodology and results presented in this study contribute to the body of knowledge aimed at enhancing post-wildfire soil management strategies.

Keywords

Remote Sensing; Wildfire; Soil Health; Soil Characteristics; Machine Learning; TREEADS Project

Machine Learning For Urban Traffic Prediction: Towards Intelligent Urban Planning Case Study : Casablanca

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Introduction

Urban planning faces unprecedented challenges in optimizing traffic flow and enhancing mobility within metropolitan cities. Lack of efficient traffic management and holistic urban planning strategies lead to congestion compromising city mobility and citizen well-being. This study addresses the diverse factors associated with traffic patterns, contributing to the identification of problematic zones within metropolitan areas.

Data and Method

Our case study focuses on the city of Casablanca in Morocco, serving as an example of metropolitan areas in emerging economies. By employing different Machine Learning (ML) algorithms, such as: Random Forest RF, Artificial Neural Network ANN, Support Vector Machine (SVM), and K-nearest neighbors (KNN), we developed a predictive model that leverages multi-source urban data. The dataset used includes Waze data metrics (traffic incidents, traffic flow rate, real-time traffic conditions...), GIS data (road network, land use patterns, population density...), and other urban indicators.

Results

These algorithms have been compared in order to select the best one, aiming to anticipate traffic patterns, optimize urban planning strategies, and propose intelligent solutions for better mobility, reduced congestion, and enhanced accessibility. Random Forest (RF) and Artificial Neural Network (ANN) emerged as the best-trained models, exhibiting the highest level of accuracy in this pursuit, with respectively an AUC of 0,884 and 0,808.

Conclusion

This study not only contributes to the development of a predictive model for urban planning but also provides actionable insights that can be utilized by road authorities and urban planners for effective decision-making, in the city of Casablanca.

Keywords

Mobility, Traffic, Machine Learning, Intelligent Urban Planning.

Enhanced Comparative Analysis: LIME Integration with Multiresolution Segmentation (MRS) and Simple Linear Iterative Clustering (SLIC) Algorithms for Support Vector Machine (SVM) Classification in Sentinel-2 Imagery

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Introduction

Recent advancements in remote sensing technology help to acquire multispectral imagery at higher spatial resolution. In response to this rapid technological evolution and the subsequent surge in data volume, the paradigm of Object-Based Image Analysis (OBIA) has emerged as a crucial approach.

Data and Method

This study aims to conduct land use and land cover (LULC) analysis on Sentinel-2 imagery and compare the accuracy of the Support Vector Machine (SVM) classifier on different segmentation results, produced by Multiresolution Segmentation (MRS) and Simple Linear Iterative Clustering (SLIC). While MRS operates by clustering pixels based on similar color and intensity characteristics of objects, SLIC is a quadratic grid-based segmentation algorithm dividing the image based on pixel similarities. The selected study area, covering 53,010.50 km² in the Marmara region, mainly includes seven LULC classes (i.e., water, road, forest, meadow, soil, white roof, and red roof). Upon executing the OBIA, the overall accuracy of the thematic map produced by the SVM with SLIC-based segmentation was 90.81% and the Kappa coefficient was 0.89.

Results

Besides, the thematic map produced using the SVM with MRS-based segmentation produced an overall accuracy of 95.95% and a Kappa coefficient of 0.95. In the class-based accuracy analysis, the water class had the highest F-score accuracy above 99% for both segmentation algorithms, while the lowest F-score value was calculated for the road class in both algorithms. The findings demonstrate the superior performance of the MRS segmentation algorithm. This high accuracy holds significant promise in delivering more dependable and precise outcomes for planning processes.

Conclusion

In addition, the integration of explainable AI (XAI), in particular Local Interpretable Model-Agnostic Explanations (LIME) algorithm, has shown significant promise for improving the transparency and understandability of the classification analysis in the OBIA framework at the local scale. This integration contributes to increased transparency and provides more informed and reliable decision-making processes.

Keywords

Image Segmentation, LIME, Multiresolution Segmentation, Object-based Image Analysis, Simple Linear Iterative Clustering

Global-Scale Explainable AI Assessment of Classification Algorithm Effectiveness in Object-Based Image Analysis using Random Forest and Support Vector Machine

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Introduction

Over the last decade, Object Based Image Analysis (OBIA) has become an emerging and widely used method to produce Land Use/Land Cover (LULC) maps.

Data and Method

A SPOT 6/7 image covering the Pyrénées-Orientales region of France was segmented using the Multi-Resolution Segmentation (MRS) algorithm, and then Random Forest (RF) and Support Vector Machine (SVM) classifiers were used for the classification task, considering the features of the image objects. The accuracy of the thematic maps was analysed using conventional metrics of overall accuracy (OA), Kappa coefficient (KC) and F-score (FS). The accuracy analysis of the thematic map generated by the RF algorithm resulted in an OA of 81.06% with a KC of 0.77, while the thematic map generated by the SVM algorithm achieved an OA of 91.50% and a KC of 0.90. In the class-based accuracy analysis, the highest F-score value in the thematic map generated by the SVM algorithm belongs to the red roof class with 96.90%, while the lowest F-score value belongs to the road class with 81.24%. On the other hand, in the thematic map generated by the Random Forest Classifier, the white roof class has the highest accuracy with an F-score value of 95.37%, while the road class has the lowest F-score value with 63.91%.

Results

These results highlight the difference in classifier performance and show that SVM outperforms RF in terms of classification accuracy. Compared to RF, the SVM algorithm produced a thematic map with approximately 10% higher classification accuracy.

Conclusion

The incorporation of eXplainable Artificial Intelligence (XAI) algorithms not only improved the interpretability of machine learning models, but also fostered greater trust, accountability, and acceptance in decision-making processes. Thus, SHAP analysis was used to evaluate the global explainability of machine learning algorithms, and the findings provided significant clues for studies, including the integration of XAI and OBIA.

Keywords

Multi-Resolution Segmentation, Object Based Image Analysis, Random Forest, XAI, Support Vector Machine

Mapping the Future: The Integration of Artificial Intelligence in Cartography and Map Design

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Introduction

In the rapidly evolving domain of cartography, Artificial Intelligence (AI) has emerged as a transformative force, particularly in the realm of map design. This paper reviews the burgeoning body of literature on AI applications in cartography and presents current AI technologies enhancing map design practices.

Data and Methods

Our methodology is rooted in a systematic literature review, encompassing academic journals, conference papers, and technological reports that document AI's integration into cartographic science. The paper catalog the array of AI tools and systems currently in use, assessing their functionalities and contributions to map design. The discussion extends to evaluating the potential of these technologies to address traditional challenges in cartography and to set new benchmarks for efficiency and accuracy.

Results

The literature reveals a suite of AI technologies that have been effectively harnessed for map design. Neural networks have been employed to automate the stylization of geographic features, while machine learning algorithms are used to optimize map layouts for enhanced user experience. AI's proficiency in processing large geospatial datasets has resulted in maps of higher detail and accuracy. Additionally, AI-driven tools for tasks such as feature detection, pattern recognition, and predictive modeling have been instrumental in advancing cartographic techniques, enabling more sophisticated visualizations of complex spatial data.

Conclusion

The review underscores the substantial impact of AI on cartography and map design. By integrating AI technologies, cartographers are able to transcend traditional limitations, achieving greater levels of detail, accuracy, and design quality. The potential for AI to further revolutionize the field is significant, with ongoing research likely to yield even more advanced applications. As AI technology continues to advance, its role in shaping the future contours of cartography becomes increasingly pivotal, promising a new era of map-making that is both intelligent and intuitive.

Keywords

AI, Cartography, Map Design, Geovisualization

Deep Learning based Marine Debris Segmentation from Sentinel-2 Imageries

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Introduction

Marine environments play a crucial role in sustaining biodiversity, regulating climate, and supporting human life. However, marine environments are increasingly threatened by climate change, transportation activities and pollution from various sources. Sustainable monitoring and managing marine pollution are vital for safeguarding marine ecosystems. In this regard, this study aims to detect marine pollution using Sentinel-2 satellite imagery with integration of deep learning algorithms.

Data and Method

This paper explores the application of deep learning techniques to monitor marine debris pollution using Sentinel-2 imagery using Dilated U-Net and FC-DenseNet architectures and open access MARIDA dataset. MARIDA is an open-access dataset that allows to explore the spectral behaviour of specific floating objects, sea state characteristics and water types, to develop and evaluate deep learning architectures. Although MARIDA dataset contains 15 classes, only “Marine Debris” class was selected for train and evaluate the used models. Two sub-datasets have been generated with 256x256 (Dataset A) and 128x128 (Dataset B) patch sizes. After applying flip and rotate augmentation, a total amount of 950, 82, and 101 image subsets have been used training, validating, and testing, respectively.

Results

Adam optimization algorithm was used with the initial learning rate of 0.0002 and the Dice function was chosen as loss function. The number of epochs and batch size were determined as 100 and 2, respectively. The deep learning models have been implemented using Python Keras deep learning library using Tensorflow backend. Accuracy assessment of marine debris semantic segmentation has been realized by using accuracy, intersection over union (IoU). The calculated IoU scores for Dilated U-Net and FC-DenseNet were 0.6830 and 0.6972 from 256x256 image patches, 0.7385 and 0.7174 from 128x128 image patches, respectively.

Conclusion

This study shows that Sentinel-2 imagery can be exploited to detect marine pollution. The accuracy results reveal that even though sufficient IoU metric has been achieved, the results can be still improved using more state-of-the-art deep learning architecture and extending the used dataset. SMARTPOL (Autonomous network system with specialized and integrated multi-sensor technology for dynamic monitoring of marine pollution) is an MarTERA ERA-NET Cofund project has received funding from the Turkish National Funding Authority (TUBITAK) under grant agreement No 122N065.

Keywords

Marine Pollution, Artificial intelligence, Remote Sensing, Dilated U-Net, FC-DenseNet, Sentinel-2

ENGINEERING SURVEYING, BIM and GIS

Peri-Urban Areas - How to Measure the Balance Between Anthropogenic Pressure and Ecological Relevance with GIS Tools?

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Introduction

The role and sustainability of green spaces are particularly important in peri-urban areas, where in many purposes, sprawl is the main type of development. The balance between anthropogenic and investment-free areas is proving to be in danger. The fast-paced anthropogenic pressure and suburbanisation lead to the question of how long green spaces in these zones will remain unchanged. It is the primary goal of this article to devise the index which can measure the sustainability of these areas. The authors developed Green Neighbourhood Sustainability Index (GNSI).

Data and Method

The GNSI was then put to the test in the peri-urban zone of Kraków. The Authors used spatial data (land cover categories, environment protection areas, administrative boundaries) and socio-economic data (demographic structure), which determines anthropogenic pressure. QGIS software was used for the calculations.

Results

In most cases, the suburban areas showed a gradual and smooth transition from the most ecologically significant land cover types to the most anthropogenic ones, leading to a well-balanced neighbourhood of natural areas. Authors noticed also such green areas that are not clustered, but occur as single sites surrounded mainly by anthropogenic areas. They are at risk of transformation. Their sustainability is not guaranteed. They are in danger of being absorbed by surrounding built-up areas. Arable land was found to be the most vulnerable to transformation, while forested areas are the most sustainable.

Conclusion

The structure of land use types in the peri-urban zone of Kraków is well balanced. The GNSI can be among the aids used by decision-makers to take science-informed strategic spatial planning decisions to ensure the sustainability of green spaces in peri-urban areas.

Keywords

Geoinformation, Sustainability of green spaces, Kraków suburban area, Sustainability determinant, Spatial analyses

Low-distortion-projections (LDP) for point clouds in BIM projects – a practical demo

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Introduction

Building Information Modelling (BIM) is essentially based on three-dimensional Cartesian coordinates. However, the 3D authoring and coordination software does not support curved and scaled geodetic coordinates used in geographic information systems (GIS) and planning software. This leads to systematic deviations when georeferencing BIM models, as the curvature of the earth is not taken into account by the BIM software. In order to minimise these deviations, a coordinate reference system optimised for small-scale applications is defined. This practical demonstration compares the differences in the registration of a laser scan in Low Distortion Projection (LDP) and in other coordinate reference systems. This is done on a bridge in the city of Dresden.

Data and Method

The basis was a BIM model derived from the construction plans. A fixed-point network was established around the bridge, and tachymetric and static GNSS measurements were conducted to determine the coordinates of the fixed points in the ETRS89/UTM33 coordinate reference system. Additionally, control points were recorded with total station for the subsequent laser scanning of the bridge. The fixed points and control points were then transformed into the RD83/GK5 and ETRS89/LDP systems. The structure was laser scanned from multiple viewpoints and registered in the three reference systems utilized by the software solutions Scene from Faro and Scantra from technet. For comparison purposes, the calculated position coordinates from ETRS89/UTM33 and RD83/GK5 were transformed to ETRS89/LDP using three parameters.

Results

The residuals of the standpoint coordinates after the transformations exhibit systematic distortions in the centimetre range, which are present in both coordinate reference systems and the software used in this project. Furthermore, the scale distortions in the ETRS89/UTM33 system are dependent on the route length, as evidenced by the comparison of distances between measured control points in different directions. Deviations are also observed in the reference system RD83/GK5. The point distances in the LDP system closely match the actual measured values.

Conclusion

Systematic differences between the residuals of the position coordinates from the laser scans can be identified. These differences are due to the scale distortion; therefore, it is recommended to use the LDP for registration. This approach resulted in achieving high accuracy for the overall point cloud of the bridge. Additionally, it is necessary to deliver point clouds in a distortion-free coordinate reference system for 3D modelling in BIM projects. The value added is significantly greater than the additional effort required for the control point transformations.

Keywords

BIM, Low-distortion projection, laser scan, registration, distortions, residuals

Variants for demand-oriented CityGML-2-IFC ETL processes with FME

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Introduction

Building Information Modelling (BIM) facilitates collaboration through the creation and sharing of digital models. Geospatial data plays a crucial role in the different stages of BIM projects as buildings exist within the built environment. Therefore, it must be seamlessly integrated into these processes. To achieve this integration, openBIM projects rely on open standards such as the Industry Foundation Classes (IFC) developed by BuildingSMART International (bSI) or CityGML, developed by the Open Geospatial Consortium (OGC). However, transforming geospatial data into IFC is complex due to the different model intentions of BIM and GIS. They use different paradigms for semantics, geometric representation and georeferencing. In recognition of this difficulty, Safe Software Inc.'s Feature Manipulation Engine (FME), an Extract-Transform-Load (ETL) software application, is used to perform these tasks.

Data and Method

To study an automated FME process, we created a workflow for transforming 3D CityGML data of IFC. We tested the approach in a medium size railway BIM project in the district of Bad Kleinen, Germany. This process is intended to serve as a basic framework for the general conversion from openGIS to openBIM. The workflow is structured to load CityGML files via a reader, along with an optional JSON configuration file, storing the variants, according to project specific BIM information requirements (IR). The data is processed through various transformers before finally being exported as IFC. In general, the workflow can be described by the following steps: input data management and configuration file handling, attribute management and generation, georeferencing preparation, coordinate conversion to BIM project coordinates, classification into IFC classes, geometry processing, Propertyset creation, and output data management.

Results

Our research results in the development of a customisable and extensible workflow for GIS-BIM integration using FME. This workflow is designed to generate IFC4 files from CityGML data, providing the flexibility to represent the building either as its individual components (walls, roofs, floor slabs) or as an unified IfcBuildingElementProxy or IfcGeographicElement. The adaptability of the workflow allows the user to tailor the representation to specific requirements, providing a diverse solution for handling different BIM scenarios.

Conclusion

In conclusion, our research focuses on the transformation of 3D building and city models into openBIM using FME, with an emphasis on geometry, topology and semantics, as well as correct georeferencing in IFC. Implemented in FME Flow, the automated workspace generates various IFC4 datasets from CityGML files, demonstrating FME's ability to seamlessly integrate complex 3D models into the IFC4 data format. All CityGML attributes are mapped to IFC, preserving this information in IFC Propertysets. This adaptability, according to specific BIM IR is a pivotal feature for using geospatial information in BIM projects.

Keywords

BIM, GIS, BIM-GIS-Integration, FME, IFC, CityGML, 3D city model

Green3dScan - an open source tool to create and use adaptive point cloud segments BIM projects

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Introduction

When modelling CAD/BIM objects with point clouds as geometric reference or comparing scan versus BIM, it is usually not desirable to load the entire point cloud. This is computationally expensive, for both, data storage and data transfer. We are investigating methods how only a selected range of point clouds can be loaded the modelling CAD/BIM software. In addition, if a BIM model already exists, the point cloud can be segmented into a set of small point clouds using the buildings components. The entire point cloud to be stored on a server and for the client to send a request with only the required area. This section of the point cloud is then returned in response. As part of the research project, the tool will be used for monitoring. A robotic platform with a scanner is to navigate as autonomously as possible through a hall and scan it. These scans are then analyzed on a mini-computer and the resulting point clouds are segmented and stored.

Data and Method

Partially oriented 3D bounding boxes from Revit or IFC are used. These boxes are saved as a simple CSV file and can be buffered with an editable value if required. Segmentation is performed using the open source Point Cloud Library. The test dataset is a university building in the form of a large hall with many test setups, which already has a BIM model. In addition to walls, columns and floor slabs, the model also includes ventilation shafts, pipes and steel beams. A component-segment index is created to manage and accelerate the accesses. In addition to the index, each component segment also receives a small metadata file containing information about which overall point cloud it belongs to, how many points it contains, and the status of the BIM model.

Results

The small tool was successfully tested with IFC and Revit 3D-models. The point cloud can be intelligently filtered using information from the BIM model. As a side effect, temporary points in the point cloud for which there is no component need not be processed (e.g. building materials on site). A useful value for buffering was found to be 5 cm. It is important to note that the metadata file is written even if no points could be assigned to the component. This means that the area of the component was not scanned or the component was covered by other objects. The advantage of IFC is that fully oriented bounding boxes can be determined. Revit, on the other hand, only stores boxes that are parallel to the coordinate axes. We have improved these boxes so that they can be rotated around the Z axis.

Conclusion

The developed tool works as a Revit plug-in or as an executable command line for IFC files. This means that it is not always necessary to load the entire point cloud. As the storage requirements of point clouds can quickly reach terabytes, it will be necessary in the future to investigate whether the segmentation is working efficiently. The index may need to retrieve the floor or room first, and then the component being searched for.

Keywords

BIM, point cloud, segmentation, laser scanning

Just another CAD to BIM process? First experimental results with semantic graphs and 2D-space partitioning

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Introduction

This presentation provides an overview of our current research project “Hypokeimenon”, which aims to automatically convert sets of 2D-CAD plan views into a 3D BIM model. The two-year research project is funded by the German Federal Ministry for Economic Affairs and Climate, because the energetic refurbishment of existing buildings is a major contribution to reduce carbon dioxide emissions.

Data and Method

The first step of the presented algorithm is to analyze the existing CAD files (in DXF format) according to filename, layers, and DXF-entity and blocks. Secondly, a semantic synthesis is conducted on both, the imported graphical data (DXF) and supplementary databases (SQLite), resulting in a semantic graph that displays the mutual relationships between the identified pieces of information in a Graph database (Neo4J). The following – and rather unusual step - step involves a space partition model merging the many imported geometric entities (Lines, Polygons, ...) in a unified topological model. This model possesses unique characteristics, including gapless, overlap-free, and complete modelling of the building's space. Additionally, the input coordinates are converted into integers, and any intersections are represented by rational positions on edges, to achieve computational robustness. The information obtained from the semantic graph then is used to enrich the space partition model. References in the form of globally unique identifiers are assigned to the topological elements of the space decomposition model, including vertices, half-edges, and faces. The model is stored in a relational database (SQLite) on a building-by-building basis for further component detection. Eventually the identified components are stored in a structured IFC file for each building.

Results

Even at the beginning of the two-year term, real CAD models from Hamburg housing associations were always used. The automated CAD-2-BIM process should also work with complex floor plans and difficult building geometries. The presentation shows the first interim results of the programming, the exported building models, the test scenarios with individual CAD models and discusses the open problems.

Conclusion

The presentation shows both the relevance and necessity of converting two-dimensional CAD floor plans into consistent 3D building models. In the approach presented, particular emphasis is placed on the consistency of geometry, topology and semantics.

Keywords

Facility Management, CAD, BIM, Space Partitioning, Geometry, Topology

Possibilities of Developing Maps of Sight-Aesthetic Attractiveness of Underwater Landscapes of Lakes Using the Point-Valuation Method and Spatial Interpolation Methods

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Introduction

The aim of the study is to test the point-valuation method for assessing the sight-aesthetic value of lakes in terms of potential for tourist exploration. The results are presented in the form of maps, resulting from spatial interpolation methods based on a random measurement network. The main research questions concern the feasibility of using interpolation algorithms for assessment using the point-valuation method in different types of lakes. The research shows the possibilities of using the proposed methodology in the study of underwater landscapes, comparing results, and determining applicability under various environmental and geographical conditions.

Data and Method

State: Natural water bodies (lakes) of Poland

State: Point-valuation scores obtained during underwater surveys

State: Diving equipment, underwater scooters, underwater navigation, Geographic Information System

An assessment of the sight-aesthetic attractiveness (underwater inventory) of underwater landscapes was conducted using an original method based on a survey among divers (400 questionnaires). Measurement points were designated as a regular (random) network. Based on the observation results, attractiveness maps were created using selected interpolation algorithms.

Results

The possibility of implementing the methodology for assessing the sight-aesthetic value of terrestrial landscapes for underwater landscapes of lakes was demonstrated. The result is clear and easy-to-analyse maps showing the distribution of the phenomenon under study. They can serve as a tool for protection and planning of development and tourist use of lakes. Dedicated spatial interpolation methods for this type of assessment map were identified. The methodology is universal and can be applied, with appropriate modifications, in various types of water bodies (lakes).

Conclusion

Successful implementation of point-valuation methods and interpolation algorithms for assessing the sight-aesthetic attractiveness of underwater landscapes of lakes has been achieved. These are pioneering studies in the field of underwater landscape perception and cartographic presentation methodology. This contributes to the development of principles for protection, tourist use (qualified tourism – diving), and channelling tourist traffic in places attractive to users.

Keywords

Sight-aesthetic value, Underwater landscape, Point valuation, Interpolation, Scuba diving

Quantitative Analysis of Different SLAM Algorithms for Geomonitoring in an Underground Test Field

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Introduction

Quantitative and reliable information provided by geomonitoring helps identify hazards and adopt appropriate measures timely. However, this job inherently exposes monitoring staff to hazardous environments, especially in the field of underground geomonitoring. Since 2000, robots have been widely applied in various fields, many studies have focused on the establishment of automated robotic systems as well as underground navigation and mapping. Only a few studies have conducted quantitative evaluations of the proposed or used methods, and almost none have provided systematic and comprehensive assessment of suitability of mapping robot for underground geomonitoring areas. In this study, the accuracy and precision of two selected Simultaneous Localization and Mapping (SLAM) methods (HDL Graph SLAM and RTAB-Map), implemented on a designed robot system, were systematically and quantitatively evaluated.

Data and Method

In order to assess accuracy, an underground test field was developed, which includes a 20 m long tunnel for accuracy analysis using control points and an 80 m natural ring area for accuracy analysis of points, line segments, and planes using artificial targets. A series of repeated experimental measurements was performed in this test field using a robot equipped with various sensors in conjunction with the selected SLAM. The resulting point cloud was compared with the reference data measured by a total station and a terrestrial laser scanner. The accuracy and precision of the selected SLAM methods as well as the verifiability and reliability of the results were evaluated and discussed by analysing quantities such as the coordinates of control points, cloud-to-cloud distances between the test and reference point cloud, normal vector, centre point coordinates and area of the planar objects.

Results

The results demonstrate that the HDL Graph SLAM achieves satisfactory precision, accuracy, and repeatability with a mean cloud-to-cloud distance of 0.12 m (with a standard deviation of 0.13 m) in an 80 m closed-loop measurement area. The measurement results from RTAB-Map reveal instability and inaccuracy.

Conclusion

We conclude that using LiDAR based SLAM for underground geomonitoring and mapping is very promising.

Keywords

Underground geomonitoring, robot, Simultaneous Localization and Mapping, HDL Graph SLAM, RTAB-Map, Accuracy and precision

Modelling Malaria Suitability: A case study of Chiredzi District in Zimbabwe

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Introduction

This study delves into the intricate dynamics of malaria transmission in Chiredzi, Zimbabwe, with a focus on climate change. Emphasizing the roles of Plasmodium parasites and Anopheles mosquitoes, we explore the spatiotemporal nuances of disease transmission in the region. Our integrated approach aims to identify targeted strategies for effective control and mitigation, considering the impact of climate change on malaria prevalence.

Data and Method

In Chiredzi Rural District, Zimbabwe, diverse parameters spanning 2010 to 2020 were analyzed. Climatic data, obtained from the World Bank Climate Change website, included temperature records and precipitation information. The World Bank's datasets on waterbodies and demographic distributions from the Zimbabwe Census website enriched our dataset. Humanitarian Data Exchange details on health facilities and data from reliable sources like Landsat 7 and 8 were incorporated. A multicriteria GIS suitability map was developed using the Analytical Hierarchy Process and risk mapping to analyse environmental factors affecting malaria transmission.

Results

The GIS suitability map highlighted heightened malaria susceptibility in the south of Chiredzi, especially in Malipati and surrounding areas. Factors contributing to increased risk included localized water channels, elevated temperatures, and low altitudes. Conversely, the northern regions exhibited lower susceptibility due to the absence of hydro-temperature coupling.

Conclusion

Our research advocates for targeted interventions in the identified high-risk areas in the south of Chiredzi for enhanced malaria control. Understanding spatiotemporal dynamics is crucial for effective disease management. Further research could explore specific strategies to minimize environmental factors contributing to disease transmission.

Keywords

Analytical Hierarchy Process, Climate Change, GIS, Malaria, Suitability mapping.

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Temporal changes in building concentration - an attempt to measure sprawl ISAG2024, Wroclaw, Poland May 9-10, 2024

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Introduction

Assessing and monitoring settlement concentration and dispersion in areas with diverse topography is crucial for effective urban planning and sustainable development. This study addresses the lack of a standardised method to measure the concentration. It also examines the suitability of the C Kostrubiec Index for evaluation of settlement dispersion in the Orawa region. The research contributes insights into refining methodologies for understanding built-up area dynamics in regions facing similar challenges with various patterns of development.

Data and Method

We have tested the C Kostrubiec Index on the 14 villages comprising Polish Orawa. The region is subjected to dynamic development as it is located in a picturesque cross-border area that is attracting both businesses and tourists. The analysis was made using BDOT10k data for 2014 and 2021. Calculations were conducted both separately for each village and for the entire region. To obtain the synthetic concentration index we have used a 250 m grid. The sums of buildings for each column and each row of the grid were presented in the form of edge-built histograms for all examined areas.

Results

We have obtained 30 maps with the edge-built histograms that show temporal changes in building concentration. The analysis for the whole region has shown that built-up areas expanded between 2014 and 2021. The values of the index differ among the villages. In addition, the more detailed analysis for each village shows that building concentration was decreasing in 13 out of 14 villages.

Conclusion

C Kostrubiec Index is an effective measure that may support spatial planning practices in dynamically developing regions. Further implementations and testing of the method can provide implications for effective urban planning strategies.

Keywords

Settlement dispersion index, Orawa, Sprawl

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The impact of hexagonal grid size on the uncertainty of spatial entropy mapping

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Introduction

The study of land use and land cover (LULC) changes requires often to analyse these phenomena regardless of existing administrative boundaries. Therefore, grids of basic spatial unit in the form of hexagonal grids are often used in spatial analyses due to their geometric properties. Unfortunately, to the best of our knowledge, there are no studies that consider the impact of hexagon size on land use and cover mix (LUM) measures using currently available LULC data sets and taking into account their minimal mapping units. In this study, we analysed the effect of the hexagon size on the determination of spatial entropy values when using pan-European available LULC data.

Data and Method

The research focuses on selecting the optimal size of hexagons dedicated to working with data from the Urban Atlas (UA) and Corine Land Cover (CLC) projects for the years 2006, 2012 and 2018. Analysis was carried out using the QGIS program and R Project. The study determined the impact of changing the size of hexagons on the values of selected LUM measures. Hexagons with sizes 0.5 km², 1 km², 2 km², 3 km², 4 km² and 5 km² were considered. The research covered the functional urban areas (FUA) of the Polish capital. The FUA boundaries determined with the OECD methodology was used. Based on the values from each hexagon a spatial pattern of uncertainty of spatial entropy value was developed.

Results

Analysis show that the size of the hexagon must be appropriately selected for the spatial data used and their mapping accuracy. The optimal size of hexagons for determining spatial entropy values using UA and CLC data was proposed.

Conclusion

The incorrect selection of the size of the hexagon increases the uncertainty of the determined values of LUM measures, and thus may lead to incorrect conclusions based on changes in the spatial entropy.

Keywords

Hexagon grid, LUM measures, Spatial entropy, Land use and land cover

Integrated Geospatial Analysis for Rural Development Metrics

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Introduction

This study presents a comprehensive framework for analysing village infrastructure, focusing on statistical correctness, unbiasedness, and diversity in data representation. The primary goal is to establish a detailed, data-driven description for the development of all Ukrainian villages, utilizing freely accessible data sources. This approach aims to provide a robust foundation for understanding and improving village infrastructure at a granular level.

Data and Method

Our analysis leverages geospatial data from OpenStreetMap (OSM) to assess the quality and extent of village infrastructure. This includes examining the locations and specific features of various infrastructure elements, such as urban areas, parks, financial institutions, religious establishments, educational facilities, accommodations, early childhood education centres, libraries, healthcare services, and retail outlets. By applying statistical tools to this data, we aim to create a nuanced description of infrastructure development for each village, highlighting both strengths and areas needing improvement.

Results

A key outcome of this study is the development of a comprehensive methodology for constructing a dataset that accurately describes the level of infrastructure development in villages. This dataset integrates geospatial data with information from independent sources and private companies, including postal services and telecommunications providers. The combination of these diverse data sources results in a rich, multi-dimensional view of village infrastructure, offering insights into various aspects of community development.

Conclusion

Focusing on villages in Ukraine, this study has successfully categorized and described each type of accessible data. The resulting comprehensive dataset provides a valuable resource for future research endeavours. It lays the groundwork for more targeted and effective strategies to enhance village infrastructure, considering the unique characteristics and needs of each community.

Keywords

Geospatial Infrastructure Analysis, Statistical Data Integration, Rural Development Metrics, Open Data Utilization

Robust Neighborhood Solutions for Facility Location Problems with Uncertainty

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Introduction

There are various uncertainties in facility location planning in the real world. A method is, therefore, needed that not only optimizes a specific objective function, but also can flexibly deal with the presence of uncertain factors. The purpose of this research is to develop a method that can support facility location planning while assuming the existence of uncertainty.

Data and Method

In order to deal with the above problem, we constructed a mathematical method that increases the degree of freedom in facility location planning by determining the facility location as a neighborhood solution obtained by setting a tolerance range for the value of the objective function. We also performed numerical analysis using GIS data related to real urban space, and discussed the effectiveness and potential of the proposed method while comparing with existing optimization methods.

Results

- Solutions derived by traditional optimization methods (p -center problem, p -coverage problem, p -cover problem) are vulnerable to uncertainty.
- The proposed method has high robustness and can flexibly respond to the uncertainties that exist in the real world.
- The proposed method can also be used when adding new facilities to existing facilities.

Conclusion

When planning the location of urban facilities, decisions must be made based on a wide variety of evaluation indicators, considering the various values held by many stakeholders. In such a process, it is difficult to discuss based on a single optimal solution, and in some cases, it may become an obstacle to smooth discussion. Using the method of finding neighborhood solutions proposed in this study, multiple candidate site candidate sets can be extracted and can be effectively utilized in the actual facility location planning process.

Keywords

Facility location problem, Optimization, uncertainty, Neighborhood solution, Facility planning

3D Gaussian Splatting for UAV night photogrammetry

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Introduction

Images taken at night under artificial lighting are still rare in the field of photogrammetry, although their potential allows new details to be extracted or some to be enhanced. Traditionally, photogrammetric software has been adapted to process images taken during the day, so standard algorithms are vulnerable to changes in lighting, consequently degrading the quality of the final model. In this paper, the authors analyzed and evaluated a new 3D Gaussian Splatting spatial modelling method for modelling objects from night-time images.

Data and Method

The study conducted a comparative analysis of methods designed to reconstruct spatial models made from night images. The images were taken with a small commercial UAV. The object of measurement from the UAV was Gediminas Tower in Vilnius. Spatial models made with the 3D Gaussian Splatting method and traditional algorithms implemented in popular photogrammetric software were developed and compared. Geometric and radiometric analysis of the developed models was conducted.

Results

The analytical results presented in the paper show that the new method is very promising especially for modelling objects from night-time images. The data processing time is much shorter than with traditional methods, and the geometric and radiometric conditions are fully preserved. The model is more complete, with no significant data gaps, allowing accurate model development for artificial illumination analyses.

Conclusion

The new method not only improves calculation time and achieves a faster result, but the result itself is more complete. The data does not contain significant gaps in the surface, which allows it to be used for further analyses, e.g. lighting quality, artificial light pollution. The new method can be successfully applied to work that does not require precise geometry, but at the same time provides more data especially in areas where traditional methods can no longer manage.

Keywords

Photogrammetry, night, 3D, Gaussian, Splatting

GIS Based Decision Support Tool for Assisting Parcel Locker Field Operations ISAG2024, Wroclaw, Poland May 9-10, 2024

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Introduction

The increasing prevalence of e-commerce has escalated the demand for deliveries, making the last-mile delivery the most expensive, inefficient, and environmentally detrimental segment of the entire logistics chain. Alternative methods such as centralized multi-deliveries and 24/7 service-enabled smart lockers, known as parcel lockers, have been developed. The accurate placement of parcel lockers plays a crucial role in their successful utilization. Geographical Information Systems (GIS) provide effective tools for solving multi-criteria spatial decision-making problems. This study aims to introduce local requirements for parcel locker location selection and create a GIS-based location selection model for decision-makers.

Data and Method

Potential criteria effecting site selection process were identified through a literature review and local demands. Required data were collected for five districts of Istanbul and processed using ArcMap software. A model as a decision support tool focused on hexagonal grids 500 meters of side length and it was developed using the Model Builder to create an automated tool which determines the suitability of the hexagonal grids for parcel locker operations for the use of decision-makers.

Results

According to the results of the application conducted in five districts of Istanbul, it was determined that hexagonal grids suitable for the parcel locker were concentrated in the districts of Kadıköy, Üsküdar, and Ümraniye, categorized as most suitable, suitable, and moderately suitable.

Conclusion

This study, which establishes a GIS-based decision support mechanism for the location selection of parcel lockers, is instructive in its approach to concepts, examinations of e-commerce delivery methods, and parcel locker service reviews. The developed location selection criteria and model provide guidance for future studies. This study holds a general applicability, whether in Istanbul or different regions of Turkey. To promote the widespread utilization of parcel lockers, similar studies should be conducted in the e-commerce sector, academic realm and public domain planning processes.

Keywords

Parcel Lockers, Multi-Criteria Spatial Decision-Making, GIS, Site Selection

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Measuring Integration and Accessibility Levels of M7 Yıldız-Mahmutbey Metro Line

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Introduction

Cities are expanding spatially with the increasing urban population leading to a rise in demand for urban transportation and spatial accessibility. Consequently, it is imperative to integrate various modes of public transportation within cities and enhance access to public transit. An integrated public transportation system reduces the number of private vehicles in traffic, mitigates air pollution from fossil fuel consumption, enhances urban sustainability and quality of life, reduces social exclusion, and promotes spatial justice through increased spatial accessibility.

Data and Method

This study aims to assess the level of integration and accessibility between the stops of the M7 Yıldız-Mahmutbey metro line and other public transportation stops. Initially, an index was developed using the PTAL index criteria which measures spatial accessibility. Subsequently, using GIS software, service area analysis was conducted considering the M7 Yıldız-Mahmutbey metro line stops as the origin and a walking distance of 5-10-15 minutes. All public transport stops within the service area were scored based on the established index criteria to evaluate M7 metro stops and determine their integration and accessibility levels. The study utilized open-source data that are the locations of rail systems, metrobus and bus stops, roads, the number of public transportation vehicles passing through stops, and their departure times.

Results

The findings indicate that the integration and accessibility of M7 metro line stops are higher in the city center compared to those farther away. Analysis of the data also revealed that stops closer to the city center have higher volumes of public transportation vehicles and shorter average waiting times.

Conclusion

The spatial distribution of roads and stops, transportation modes, and average waiting times at stops directly influence integration and accessibility levels.

Keywords

Integrated public transportation systems, PTAL index, spatial accessibility, GIS

The role of terminological postulates at the core of geoinformatics definition Geoinformatics ISAG2024, Wroclaw, Poland May 9-10, 2024

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Introduction

The aim of this research is a structured evaluation and valorisation of existing geoinformatics definitions using terminological postulates to redefine/improve the existing definition. To this end, a study of the evolution of the structure of spatial data and the software used to process this data was carried out, the terminological analogy method was used, and in addition, job surveys were analysed, and based on a literature review, the nomenclature used to define the field of spatial data research was analysed. As a result of the research, terminological postulates were developed according to which limitations and indications for the content of the revised geoinformatics definition were formulated.

Data and Method

One of the research methods was to look for patterns in the texts of the definitions of the concepts under study. This involved extracting text fragments with identical or similar meanings and then valorising them. Research methods based on a classic literature review were also used, as well as conducting our own simple experiments related to testing selected software functions and analysing data structures on our own test bench. Further statements were made based on research methods used in semantics: syntactic analysis, conceptual unambiguity, and terminological analogy. The study was concerned with comparing definitions that are similar in terms of vocabulary, names that refer to other research fields and the concept itself.

Results

Geoinformatics is primarily a technical science, being a part of the Computer Science area, and may be defined as follows:

“The geoinformatics is the programming of applications, spatial data structures, and analyses of objects and space-time phenomena referred to the Earth surface, together with designing, developing, and maintaining the software and web services intended for modelling and analysing the spatial data”.

A geoinformatics is primarily a computer scientist (and this is his/her basic education), who has knowledge of the software architecture and computer networks. He/she has the skills of designing, programming, and maintaining IT systems, and only next, he/she learns the specific nature of computer science application for spatial data processing, spatial information modelling, and analyses used in this field.

Conclusion

The definition of geoinformatics that has been formulated is closer to the concept of computer science than any previously formulated definitions of this kind. This definition develops Echlers' idea that geoinformatics is part of computer science and concretises it.

Keywords

geoinformatics; spatial database; GIS; spatial data

Regression Approach to transform GRACE Mascon TWS-L3 data into groundwater-induced displacements in the Türkiye Region

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Introduction

The GRACE (Gravity Recovery and Climate Experiment) satellite mission has been successfully employed for nearly two decades to monitor hydrological events on Earth's surface. The gravity monthly solutions provided by GRACE satellites are available in the form of L2 (Level 2) spherical harmonic coefficients data or ready-to-use L3 data, typically representing Total Water Storage (TWS) hydrological variations. Notably, L3 data, such as GSFC-Mascon TWS data, includes essential corrections like post-glacial rebound and signal leakage, encompassing river basin systems. This facilitates a focused examination of the time-series of TWS changes associated with river basins or specific Earth locations without the need for additional physical corrections. However, as L3 data is preprocessed, certain geopotential changes, such as vertical displacements induced by groundwater changes, comparable to GPS-derived displacements, along with temporal but non-tidal geoid height changes and gravity anomaly variations formulated as harmonic expansions, are not directly obtainable.

Data and Method

To address this, one must transform L3 data into monthly harmonic coefficient solutions for evaluating these geopotential changes. While this alternative may not be easily adaptable due to its computational demands compared to directly adapting L2 data with necessary corrections for geopotential changes, the question arises: How can L3 data for TWS be transformed directly into any other potential change? In this study, we propose a regression approach in the Türkiye region, comprising approximately a hundred GSFC Mascon blocks on land, to convert TWS into groundwater-induced displacement data.

Results

The transformation parameters are estimated by considering the outcomes of L2 data (specifically selecting DDK2-filtered data for its convenience) in the region. The ratio between displacement and TWS for each Mascon obtained from L2 data is modelled by a quadratic function based on TWS magnitudes, enabling the transformation of TWS data into displacements. However, upon investigating the residuals from this model over time, a clear time-dependent dependency is observed. The residuals consist of a quadratic part and a signal part. A second regression is applied to the residuals to model this time-dependent aspect.

Conclusion

Ultimately, it is demonstrated that the transformation from TWS to displacements can be achieved by applying two types of regression. The root mean square after applying these regressions is approximately half a centimeter, which is highly satisfactory for transforming TWS data into displacements in the region.

Keywords

GRACE, Mascon, TWS, Groundwater-induced displacements, Türkiye

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Investigation of the Impact of Slot Geometry on Brushless DC Motors

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Introduction

The brushless direct current motor (BLDC) proposed in this study is designed to improve performance and efficiency. Following climate change, the demand for sustainable technologies increases in various sectors. Foremost among these sectors are energy and transportation. Developing environmentally friendly devices such as vehicles will have a positive impact on reducing carbon emissions and improving climate change impacts. Environmentally friendly vehicles most important component is the motor of the vehicle.

Data and Method

Utilizing the finite element method in two dimensions with the ANSYS Maxwell program, this study designed a Brushless Direct Current motor and subsequently modified its stator slots. Four different slot structures were examined, and the study presents an analysis of efficiency, torque, torque density, torque ripple, iron losses, and harmonic content for each slot geometry, obtained through the Fast Fourier Transform method.

Results

Efficiency analysis of BLDC motors with various slot geometries revealed significant effects stemming from variations in stator geometry, iron losses, and stator flux density. Key performance parameters, including torque and torque ripple, were assessed alongside an analysis of air gap harmonic content and its impact on torque ripple.

Conclusion

In conclusion, this study contributes to ongoing efforts to address environmental challenges through the development of brushless direct current devices. By reducing environmental impact and increasing employment and productivity, the findings of this study are consistent with the broader objectives of promoting sustainable development and combating climate change is met going forward, further R&D in this area will play an important role in developing environmentally friendly technologies and reducing carbon footprint.

Keywords

Brushless Direct Current Motor, Machine Design, Finite Element Method, Fast Fourier Transform

WebGIS map of landform transformations in a lignite post-mining area. Case study of the Babinamine (W Poland)

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Introduction

The Muskau Arch, is a moraine structure formed by the multi-stage impact of the Scandinavian Ice Sheet and is included in the UNESCO Global Geopark Network. The area was intensively mined by underground and open pit mining, which ended about 50 years ago. These activities have caused various anthropogenic changes in the region. Secondary ground deformation and other post-mining processes continue in the region even though mining activities have long since ended. The main aim of the study was to document and visualize the extent and types of anthropogenic transformations at the "Pustkow" site of the former "Babina" lignite mine in the Muskau Arch region using the web-based GIS.

Data and Method

Landscape transformation map was created using the ESRI ArcGIS Online application. The map was created using open data and results of the research projects in this area. The content of the map consists of thematic layers representing: the extent of glaciotectonic transformations, location and types of open pit and underground mining objects, e.g.: external and internal waste dumps, abandoned pits, anthropogenic lakes, remnants of surfacemining infrastructure such as: railroad tracks, shafts, extent of continuous and discontinuous ground deformation from underground mining. Furthermore, the current land development (built-up area, road network, stream network) against the background of the land elevation. Lastly, the new tourist development of the reclaimed post-mining area is presented. The selected layers contain attribute information that can be accessed by the user via a pop-up window. Additionally, images of some objects have been added as pop-ups for the benefit of the user.

Results

The study has made a valuable contribution to the documentation and understanding of post-mining landscape evolution in the Muskau Arch region. The web-based Map can be used for educational purposes and to effectively manage the region, as it contains information about the history and location of mining infrastructure. In addition, one of the advantages of web-based GIS is that the map is accessible to everyone, which allows the map to be used for touristic purposes for the region, which has been opened to touristic activities and educational purposes.

Conclusion

Web GIS offers many benefits over traditional GIS, such as viewing, querying, and analyzing geographic data, managing layers, sharing maps, mobile compatibility, and real-time data updating. In addition, it provides easy access and use not only for professional users, but also for other users. It is possible to mention the production of maps with the Web-GIS method and the practicality of the use of these interactive maps in comparison with the classical methods.

Keywords

Web GIS, Anthropogenic Changes, Secondary Deformation

ENVIRONMENTAL MONITORING

Exploring the Influence of LST and NDVI on Real Estate Values in Turkish Cities Through Regression Analysis

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Introduction

In this research, we employed regression analysis to examine the relationship between average housing sale prices in the central districts of Ankara, Istanbul, Izmir, and Mersin, Türkiye, and corresponding Land Surface Temperature (LST) and Normalized Difference Vegetation Index (NDVI) values derived from Landsat-8 satellite images during the summer of 2021. The objective was to understand variations in NDVI and LST across cities with diverse land use and climatic conditions and how these variables contribute to differences in real estate market prices.

Data and Method

Average housing sale prices for neighbourhoods were manually collected from open access Endeksa.com, while NDVI and LST values were obtained from Landsat-8 imagery on the Google Earth Engine platform. After aligning images with administrative boundaries in QGIS, we calculated average pixel values for each neighbourhood. Regression analysis was conducted to assess the relationship between housing sales values and NDVI/LST, with R^2 scores and p-value tests computed for each district in the four cities.

Results

Strong influences of NDVI and LST on housing sale prices were noted in specific districts of Istanbul, including Eyüp, Bahçelievler, and Çekmeköy ($R^2 > 0.7$). In Ankara's Çankaya and Izmir's Buca, a milder influence was observed. Mersin showed a higher impact in the Yenişehir district compared to others. Furthermore, quartile-based analysis revealed that, except for Mersin, NDVI and LST had a more pronounced impact on areas with the highest average sales values.

Conclusion

In conclusion, the study found that the influence of NDVI and LST on housing sales values varies across neighbourhoods and cities. This effect is particularly distinct in Istanbul, while cities with less greenery, like Mersin and Izmir, showed less distinctive patterns. The results suggest a need for increased green spaces in warmer climate cities to link housing sale prices with urban thermal comfort.

Keywords

Thermal comfort, NDVI, LST, Remote sensing, Housing sale prices

Sentinel-1 Backscatter Analysis of Ratoon Rice Crops: Example from Ratooning Practice in the Philippines

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Introduction

Ratooning is a common rice crop management practice where the plant is left to regrow from post-harvest stubble, providing a low-input second crop. There is rising interest and use of rice ratooning in Asia to increase productivity on the same amount of land hence an accurate ratoon rice detection is important for monitoring rice production and productivity. Synthetic Aperture Radar (SAR) time series have been widely used for rice crop monitoring but there is little research on detecting ratoon rice practice in rice cropping systems. Hence, this study aims to (1) investigate the temporal SAR backscatter signatures of ratoon rice crops compared to those of the main rice crop and (2) determine if the ratoon rice signature is consistent in irrigated and rainfed rice systems.

Data and Method

Farmers' interviews and field surveys were conducted in four provinces of the Philippines, where rice ratooning was reported in the dry, wet, and very wet growing seasons of 2018-19. Four bands of backscatter information (VV, VH, VH/VV, and the radar vegetation index (RVI)) were obtained from the multi-temporal Sentinel-1A and B data with a six-day repeat cycle. We determined which band and which period of the season showed significant differences between the main rice and ratoon rice crops.

Results

Our results show that ratoon rice significantly differed from the main rice crop during the peak of the growing season in the VH, VH/VV, and RVI bands. We also found that the signature of ratoon rice was the same (no significant difference) for irrigated and rainfed rice systems.

Conclusion

These findings suggest that Sentinel-1 time series data is suitable for detecting ratoon rice in lowland irrigated and rainfed rice systems. Given the increased interest in rice ratooning, detecting ratoon rice and its expansion is important for monitoring rice management practices and rice production.

Keywords

Ratoon rice, time series, Synthetic Aperture Radar (SAR), second harvest, Philippines.

Farmland boundary extraction in plain based on contour hierarchical detection

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Introduction

Accurate information on agricultural field boundaries is important for precision agriculture and can serve as a basis for farmland monitoring and protection. Though previous works have shown promising results, automatic extraction of agricultural field boundaries remains a nontrivial task. Hierarchical contour detection combines multiple local cues into a globalization framework based on spectral clustering and presents a high contour detection performance on nature image datasets. Due to the similarity of physical shape and spatial location in UAV remote sensing images, hierarchical contour detection extracts the boundary information of farmlands, but also including these boundaries of roads, ditches and so on simultaneously.

Data and Method

In this research, we investigate a feature integration approach based on hierarchical contour detection for the extraction of agricultural field boundaries in Jiangnan Plain. On the one hand, the field boundaries have an obvious color contrast with the internal parts of the farmlands. We integrate suitable bands of remote sensing image to filter the boundary information of the non-farmlands. On the other hand, the internal parts of most farmlands are homogeneous. Standard deviation is used to distinguish crops in different fields.

Results

Experimental results show that the proposed method achieves a specificity, accuracy, sensitivity and F-scores of 0.9944, 0.9730, 0.0768 and 0.1171 respectively.

Conclusion

We conclude that the proposed method is able for accurate discrimination of the farmland boundary class.

Keywords

Hierarchical Contour detection, Feature integration, Farmland boundary extraction, UAV remote sensing images, Agricultural application

Geographic Information System-Driven Decision Support System for Assessing Multiple Hazards in Post-Mining

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Introduction

Mining regions face multiple post-mining, natural and technology hazards after closer mines. This paper presents a Geographical Information System (GIS)-based Decision Support System (DSS), as part of the European research project titled "Post-mining Multi-Hazards Multi-Assessment for Land-Planning (POMHAZ). The objective of the GIS-DSS tool to help stakeholders to better manage the post-mining regions.

Data and Method

Utilizing predominantly open-source tools like PostgreSQL, Geoserver, Leaflet and Python-Libraries, the DSS aims to tackle the intricate challenges posed by post-mining hazards in European coal mining regions. Its primary objective is to furnish a functional web-based tool tailored for EU administrative units, ensuring a comprehensive evaluation of various hazards that impact their territories.

In the context of post-mining landscapes, conventional environmental policies often encounter challenges due to the lack of operational and accessible tools. The proposed DSS seeks to bridge this gap by catering to a diverse potential user base, including citizens, scholars, associations, and various decision makers.

Results

The DSS streamlines the acquisition, management, and processing of both static and dynamic data, providing web-accessible data visualization.

Customized for post-mining multi-hazards, this tool contributes to enhanced decision-making by generating data, statistics, reports, and maps for various EU areas of interest.

Conclusion

This paper showcases the practical application of a spatial GIS-DSS with sample data reflecting the potential threat posed by closed mining structures offering valuable insights to address the challenges associated with post-mining hazards.

Keywords

Multi-hazard, Post-mining, Assessment, DSS, GIS

Residual Attention Downscaling Model on the Japanese 55-year Reforecast for Hydrological Applications

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Introduction

This study explores the application of attention-based neural networks to weather downscaling, leveraging the success observed in image upscaling. We developed the Residual Attention Downscaling Model (RADM) and trained it on the Japanese 55-year Reanalysis (JRA-55). The resulting model is capable of generating climate data for hydrological applications on a 10 times denser spacial grid than the original JRA-55.

Data and Method

The original data was produced by the Japanese operational data assimilation system and distributed under the name Japanese 55 Years Reanalysis with a spatial resolution of 55 km and a temporal resolution of 3 hours. As a reference of data, Dynamically Downscaled Japanese 55 years Reanalysis (DSJRA-55), which was produced until 2012, was used with a resolution of 5 km and 1 hour, respectively. The deep residual attention-based neural network is designed to augment the resolution of surface-level atmospheric variables, encompassing temperature, total precipitation, relative humidity, air pressure, wind velocity, total cloud coverage, and received solar radiation.

Results

A comparison of RADM and traditional downscaling methods, such as inverse distance weighting and spline interpolation, was performed to determine the best approach to emulate DSJRA-55 data. It was discovered that RADM showed an error up to twice lower than interpolation when comparing with DSJRA-55 across all accounted variables and locations. The most substantial improvements are observed in high-altitude regions (more than 500 meters from mean sea level), with notable enhancements in sea-level regions.

Conclusion

In conclusion, RADM demonstrates the ability to capture spatial patterns in reanalysis maps. The model's effectiveness suggests its potential use in extending the DSJRA-55 dataset beyond its termination period (2012). Furthermore, the proposed model architecture holds promise for downscaling applications with other datasets, such as the Japanese Reanalysis for Three-Quarters of a Century (JRA-3Q).

Keywords

Artificial Neural Networks, Attention model, Weather Downscaling, Reanalysis

Assessment of River Basin Water Budget Estimation Using Remote Sensing Observations and GIS Techniques

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Introduction

This research addresses the challenge of river basin water budget estimation, emphasizing the use of GIS techniques and remote sensing observations. The study responds to the need for accurate and comprehensive water balance assessments in large basins, aiming to improve our understanding of hydrological processes. By leveraging advanced technologies, this investigation seeks to enhance the precision of water budget components, crucial for effective river basin management.

Data and Method

The study focuses on a broad perspective applicable to various large basins. Utilizing remote sensing data and GIS techniques, we conducted a thorough analysis of water budget components in the Kizilirmak River Basin. Our approach involved extracting valuable insights from satellite observations and employing advanced geoinformatics tools. The research method employed ensures a comprehensive evaluation of precipitation, evapotranspiration, runoff, and terrestrial water storage change, contributing to a holistic understanding of the basin's hydrological dynamics.

The water budget components derived from remote sensing observations were also compared with the GLDAS model outputs, and statistical analysis were performed.

Results

Our analysis reveals significant findings related to water budget components. Remote sensing observations, particularly from GPM IMERG, MODIS, and GRACE, demonstrate temporal variations in precipitation, evapotranspiration, and terrestrial water storage change. Notably, the study highlights the challenges in accurately estimating runoff from remote sensing data alone, emphasizing the need for complementary approaches.

Conclusion

In conclusion, the research highlights the importance of integrating GIS techniques and remote sensing observations for robust water budget estimation. Despite the inherent uncertainties within GLDAS and remote sensing datasets, these data sources prove invaluable in assessing seasonal and interannual variations in water components and facilitating effective river basin management, especially in regions with limited data availability. This work, constituting a partial result of an ongoing PhD thesis, contributes to advancing the field of hydrological modeling and offers practical implications for river basin management.

Keywords

Remote Sensing, GLDAS, GRACE, Water Budget, River Basin Monitoring

Geometric Analysis of WorldView-2 Geo-referenced Image Containing Mostly Sea

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Introduction

A WorldView-2 (WV2) GeoTIFF image was ordered for the bathymetry work around the Tavsan Island which is the smallest island of Istanbul (previously known as Prince Islands) located in the Sea of Marmara, southeast of Istanbul city. Image itself includes just a very small part of the land, but some islands. The geometric definition of the GeoTIFF image was not clear and therefore needed to be investigated. The image was provided along with Rational Polynomial Coefficients. For the orientation the RPC-solution, 3D-affine transformation and the direct GeoTIFF with Ground Control Points (GCP) from Google Earth were analysed. We realized that the correct handling requires orientation through 3D-affine transformation.

Data and Method

For marine application, a geolocation accuracy corresponding to topographic maps, of about 2m is required. Based on own experience in other areas, the relative accuracy of Google Earth was in the range between 1.5 m and 2 m in an area covering the entire WV-2 scene. Due to the lack of detail in the GeoTIFF images, the above mentioned 3 orientation methods had to be tested.

Results

There were 17 GCP with a height between 1m and 6m and 3 GCP with 24m, 31m and 26m. The mean nadir angle of the scene is 29.5° , which corresponds to an angle of incidence of $\sim 33.6^\circ$. This results in a ground sampling distance of 49cm to 59cm.

	SX	SY	Number GCP
Direct use of GeoTIFF	5.11 m	6.64 m	20
Direct use of GeoTIFF only 17 GCP	2.32 m	2.27 m	17
RPC all GCP	4.86 m	6.64 m	20
RPC only 17 GCP	1.09 m	1.59 m	17
3D-affine transformation	1.30 m	1.23 m	20

The table above clearly shows that the direct use of the GeoTIFF geometry and the RPC are strongly influenced by the elevated GCP. That means that the scene is simply projected onto a plane of constant height. This geometry requires a 3D-affine transformation that takes the height of the GCP into account.

Conclusion

The RPC-solution is the correct mathematical model for original satellite images, but not for GeoTIFF geometry. The standard deviation of 1.30m for X and 1.23m for Y achieved by the 3D-affine transformation meets the requirement.

Keywords

Marine Environment, WorldView-2, satellite orientation, GeoTIFF geometry

European-wide High-fidelity Forest Type Maps

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Introduction

The forest system of our planet is significantly influenced by rapid climate change, the demand for wood, and various objective and subjective factors. Given the importance of monitoring forest health, it is important to have up-to-date forest maps. Therefore, there is a pressing need for the timely and cost-effective creation of contemporary forest maps, particularly those that classify European forests by type.

Data and Method

The forest type classification maps were created for European countries. A time series of Sentinel-1 and Sentinel-2 satellite data for 2022 and the prefiltered open data set LUCAS Copernicus 2018 were used for train and testing the Random Forest model in Google Earth Engine cloud platform (GEE).

Results

The forest type map for all European countries was created with 10 meters resolution and with overall accuracy 93%. A comparative forest area analysis of the existing Forest type 2018 product with our product for 2022 showed a coefficient of determination of 0.96 for coniferous and deciduous forests. The product is available in GEE by the link

<https://code.earthengine.google.com/5874048ea778501b60d67c353ab6a9d2>.

Conclusion

A significant advantage of the created forest type map compared to existing analogues is that it is for 2022, has distributions for different types of forests, and also covers some countries that, for example, are not covered by the Forest Type 2018 product (for example, Ukraine or Turkey). The work solves the problem of the lack of ground data for some countries for training the machine learning model (Turkey, Serbia, Albania, Norway and other). The resulting areas compared with existing 10-meter global products (Forest Type 2018 and WorldCover 2021), the accuracy assessed based on independent dataset. The created map will be used in the future to monitor forest diseases, identify wind damage and other damage to forests.

Keywords

Forest monitoring, Satellite monitoring, Machine learning, Forest diseases, Windthrow

Remote sensing-based Analyses of multi-temporal and multi-seasonal changes of Land Surface Temperatures in the Greater Graz area from 1985 to 2021

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Introduction

Urban heat islands can be identified by air temperature on the one hand and surface temperature on the other. With the help of TIR satellite images the “Surface Urban Heat Islands” (SUHI) is often recorded with a mono-temporal approach, only. The comparison of so-called multi-temporal and multi-seasonal image data can provide conclusions about the development, distribution of the SUHI compared to surrounding rural regions over a long period of time.

Data and Method

The study area (700km²) extended around the city of Graz. Land surface temperatures were calculated from Landsat-5,7 and 8 scenes with typical autochthonous weather conditions. The Google Earth Engine was used for further processing the approximately 200 scenes. In addition, pixel-by-pixel seasonal averages from all years were calculated for spring, summer, autumn and winter and were assigned to the different land cover types.

Results

The results of the study are visualised in maps and statistics. They show a clear heat island effect in the city of Graz compared to the rural surrounding area. There is also a significant increase in surface temperatures from 1985 up to 2021, which, on the one hand, corresponds to the development in the official climate statistics and, on the other hand, is reinforced by the increasing sealing (increase in the UHI) of the city of Graz. This effect is particularly noticeable in the summer months, but is somewhat weaker in autumn and spring. The winter development depends very much on the existence of a snow cover, which makes it difficult to compare with the other seasons.

Conclusion

By analysing multi-seasonal thermal images from the Landsat series over a period from 1985 to 2021, a method was developed that reflects signals from climate change in this period and the study area and also illustrates increasing sealing. The method can also be implemented in comparable (climatic) regions with newer satellite systems (e.g. Sentinel).

Keywords

Surface Urban Heat Island, Multi-temporal and multi-seasonal Analyses, Landsat TIR

Beach macroplastic debris detection from high-resolution RPAS images.Alessandra Capolupo^{1,#}, Marco Lonero², Eufemia Tarantino³

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Introduction

One of the most pressing challenges that must be addressed nowadays is the pollution of the coastal/marine environment by macroplastics, with approximately 80% becoming an important part of these ecosystems, endangering the health of both the marine and human ecosystems. Recognizing and monitoring the geospatial distribution of macroplastics is critical for maintaining the coastal ecosystem. While various geolocation and classification approaches have been explored, the majority relies on in-situ surveys, resulting in high costs and considerable time investment for data acquisition. To address these restrictions, the emphasis is turning to the use of Remotely Piloted Aircraft Systems Services (RPAS), offering cost-effective high-resolution images and tailored monitoring programs for study areas. Thus, the main goal of this research is to assess the potential of high-resolution photogrammetric RPAS images in identifying the quantity and composition of macroplastics on beaches.

Data and Method

The methodology was tested along the Brindisi coastline. Despite being sparsely populated, this coastal site exhibits a significant presence of macroplastics. The survey mission lasted 9 minutes and was conducted using a DJI MAVIC MINI drone equipped with an RGB camera (f=4.49 mm, sensor size = 6.17 x 4.55 mm). To enhance the accuracy of the photogrammetric products, ground control points were surveyed using the integrated GNSS in the GARMIN Forerunner 245. A total of 66 photos were taken and then processed into Metashape environment. This aided in the production of an accurate digital elevation model and a highly detailed orthophoto. Such products were used as input data to manually classify the macroplastic and to compute the abundance and plastic cover maps.

Results and conclusion

The area covered by plastic waste was found to be 16.8 m², located on a sandy area of 521.3 m², with 1154 items. High-density polyethylene was the most common polymer, followed by low-density polyethylene (LDPE) and expanded polystyrene (EPS). The combination of information supplied by abundance and plastic cover maps was useful in determining the amount and type of discovered components.

Keywords

Marine litter contamination, Beach Environment surveillance, Coastal ecosystem sustainability

The role of training data in identifying land cover classes from Sentinel 2 satellite imagery

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Introduction

The aim of the study was to investigate the role played by spatial data as training fields for training machine learning algorithms. The main research problem was to determine whether different results can be obtained in the case of samples with ambiguous purpose or interpretation doubts. In the case of this research, the problem of a series of datasets with unstable spatial continuity was developed, experiments were carried out on how machine learning algorithms deal with ambiguous data from satellite imagery in the case of multispectral data.

Data and Method

The area of interest is the issue of the quality of classification of data from satellite imagery in the field of land cover. The relationship was identified on the basis of two sets of training fields, differing from each other by a certain group of interpretatively uncertain objects. Two types of data were used to solve the problem: original data Sentinel-2 and data processed with Super-Resolution algorithm with adaptive edge detection. This allowed them to obtain high-quality imagery and perform a quality analysis of the land cover classification on fairly accurate material.

Results

The effects of the approach to training a model with different sets of inputs are clear, but not spectacular. Particular differences could be observed in regions with fragmented result classification. Areas with larger surface areas remained independent of the input factor. On the basis of the experiments carried out, the weaknesses of this method were also discovered.

Conclusion

It can be concluded that in the case of areas with fragmented and changing land cover structure, properly prepared training data is a key element in the process of classifying satellite images using machine learning. The spatial resolution of the analyzed satellite imagery is of secondary importance.

Keywords

Satellite imagery, Sentinel-2, Machine learning, Training grounds, Land cover

Greenery in times of crisis: residents' travel preferences

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Introduction

Do age, form of residence and physical activity influence travel to urban green spaces (UGS)? Previous studies have shown that it is mainly distance or travel time from home that are the most important reasons for using UGS.

The main objective of our study was to investigate the preferences of residents of Krakow (Poland) in choosing UGS in times of uncertainty.

Data and Method

To further identify the impact of travel time on UGS choice, a survey was combined with statistical and geostatistical methods in analyzing residents' travel preferences to UGS.

A survey was conducted with 1,353 respondents using the CAWI technique.

Statistical calculations and analyses were carried out in the RStudio software environment.

Spatial analyses were based on network distance (routing).

Results

Our analysis showed that there is a relationship between the age and form of residence of respondents and travel time to UGS.

However, it could not be clearly indicated that distance to UGS matters for respondents who practice sports.

It was also shown that there are UGS that are popular among the age groups surveyed, and that travel time does not always affect this popularity.

Conclusion

We concluded that our research, thanks to the survey, enriches the knowledge of the social aspect of preferences for choosing urban green spaces.

Studies of this type are not commonly conducted in Central and Eastern European countries, as evidenced by their novelty, and this is also confirmed by a search of bibliometric databases conducted.

Keywords

Green areas, Open spaces, Survey questionnaire, Crisis, Accessibility

Transfer Learning Model for Chlorophyll-a Estimation Using Satellite Imagery

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Introduction

This research focuses on evaluating water quality parameters in the Mediterranean Sea, with an emphasis on chlorophyll-a concentration. Utilizing transfer learning techniques, the study adapts a model initially trained on Sentinel-2 satellite imagery and ground station chlorophyll values from Hong Kong for application in the southern coastal region near Limassol, Cyprus, as part of the iMERMAID Horizon Europe project.

Data and Method

The study leverages the Multilayer Perceptron (MLP) model, initially trained with Hong Kong in-situ data provided by the Environmental Protection Department Marine Water Quality as of 2020. This model, along with various specifically trained MLP architectures, underwent adaptation for the Mediterranean context using data processed and stored via Google Earth Engine (GEE). Model validation employed referenced data from the global dataset Coriolis data selection 2.0.

Results

A significant outcome is the high Pearson correlation observed between the GCOM-C/SGLI L3 Chlorophyll-a Concentration V2/V3 and Sentinel-2 data for both the Hong Kong and Cyprus regions, using the same pre-trained model and in-situ data. The study noted a lower correlation for Cyprus, possibly due to the 4638 m resolution of GCOM-C/SGLI data, which may limit the model's effectiveness when applied to the Cyprus dataset.

Conclusion

The findings highlight the potential limitations of using lower-resolution satellite data for chlorophyll-a concentration estimation in the Mediterranean. The research advocates for the exploration of higher-resolution satellite data sources, such as Sentinel-3 with a 300 m resolution, to enhance model accuracy. Future studies are recommended to investigate the transferability of models across different marine environments and the impact of high-resolution satellite data on improving chlorophyll estimation accuracy.

Keywords

Water Quality, Mediterranean Sea, Chlorophyll-a Concentration, Transfer Learning, Sentinel-2 Satellite Imagery, Multilayer Perceptron (MLP).

Multi-frequency SAR utilization in mountainous regions in Bulgaria for forest boundaries determination with impact of seasonality

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Introduction

This study focuses on an accuracy assessment of the forest boundary determined by preliminary elaborated “Forest/Non-forest” masks of mountainous forest located in the north-west part of Bulgaria, based on a different SAR data and methods. The objective is accuracy assessment of the forest boundaries determined via three different SAR bands – X, C and L, and which method gives highest accuracy in respect to the different seasonality in a temperate mixed forest.

Data and Method

A polarimetric, interferometric and time series SAR methods were utilized with the fully POL-SAR images from ALOS PALSAR (ESA/JAXA), bistatic InSAR data from TanDEM-X (DLR), and ESA’s Sentinel-1, for the time span of four years. The POL-SAR and InSAR imagery were available in different seasonal time frame, thus a seasonality was also examined. Validation was performed in QGIS with a 60 points randomly generated. Overall Accuracy (OA) and Kappa Hat were calculated to represent accuracy of the masks.

Results

Strong influence of the seasonality was observed because of the higher ground contribution during forest leafs-off. Frequency also plays major role in the accuracy. Supervised and unsupervised classifications was elaborated to determine forest classes. A Wishart unsupervised classifier was used for POL-SAR data. Assessment showed highest OA above 90%, of the C-band time series forest mask. The L-band mask also showed high accuracy with OA above 89%. Least accurate forest mask with overall accuracy of 68%, belongs to the X-band bistatic InSAR measurement in the winter.

Conclusion

In conclusion, the SAR time series from Sentinel-1 showed highest feasibility in the forest boundaries determination. The polarimetric SAR utilizes better for the purpose of the study. Accuracy is higher for the summer periods when scattering phase centers are higher from the ground, and volume scattering is better delineated from the ground contribution.

Keywords

Forest, accuracy assessment, multi-frequency SAR, seasonality, POL-SAR

Empowering Sustainable Manufacturing with the PSM Tool: A Leap Towards Circular Economy Integration

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Introduction

This study investigates the implementation and impact of the Process Simulation and Modelling (PSM) tool within the Plooto project, emphasizing its role in enhancing the integration of Secondary Raw Materials (SRMs) into manufacturing processes. The research focuses on the PSM tool's ability to comprehensively map material flows throughout various production stages, aligning with circular economy principles.

Data and Method

Utilizing data from three industrial pilot projects within the Plooto project, the study thoroughly evaluates the PSM tool's impact on manufacturing efficiency and sustainability. The analysis focuses on the tool's advanced simulation capabilities and detailed process modelling functionalities.

Results

The findings reveal that the PSM tool, through its dynamic and interactive models, significantly improves resource optimization and waste reduction and can be effective on calculating the relevant Key Performance Indicators (KPIs). This development is attributed to the tool's comprehensive approach to modelling material, data, and energy flows. The PSM tool's multifaceted features, including graphical model design, detailed flow specifications, and comprehensive KPI generation, facilitate strategic decision-making for sustainable manufacturing practices.

Conclusion

The research underscores the PSM tool's crucial contribution to the Plooto project as a driver of sustainable & circular manufacturing innovation. It highlights the tool's effectiveness in implementing and integrating circular economy practices within industrial operations, demonstrating a shift towards more sustainable manufacturing concepts. The study promises for broader application and exploration of the PSM tool's capabilities across diverse manufacturing settings to fully exploit its potential in promoting sustainable manufacturing solutions.

Keywords

Process Simulation and Modelling, Plooto Project, Secondary Raw Materials, Circular Economy Integration, Sustainable Manufacturing Innovation

Enhancing Manufacturing Sustainability through Integrated Digital Product Passports and the Sustainability Balanced Scorecard

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Introduction

This research explores the integration of the Sustainability Balanced Scorecard (SBSC) into Digital Product Passports (DPPs) within the Plooto project. The study addresses the need for incorporating circular economy principles into manufacturing processes to enhance sustainability and resource efficiency.

Data and Method

The research focuses on one industrial pilot case under the Plooto initiative. It investigates the SBSC's role in systematically measuring and improving the implementation of circular practices, such as waste minimization, efficiency optimization, renewable input utilization, and safe material degradation. This analysis is complemented by the traceability and lifecycle insights provided by DPPs.

Results

The findings demonstrate significant advancements in manufacturing practices, particularly in resource utilization and waste reduction. These improvements are attributed to the strategic application of the SBSC, coupled with the comprehensive lifecycle data and transparency offered by DPPs. This combined approach drives both environmental and economic benefits within the manufacturing sector.

Conclusion

The study concludes that integrating the SBSC with DPPs within the Plooto project presents a transformative approach for manufacturing operations. This integration fosters a more sustainable and circular manufacturing environment, contributing to broader goals of environmental protection and operational efficiency. This research encourages further exploration of this integrated approach across diverse industrial settings to fully leverage its potential in promoting sustainable manufacturing practices.

Keywords

Sustainability Balanced Scorecard, Digital Product Passports, Circular Economy, Manufacturing Sustainability, Photo Project

Advancing Livestock Management through ICT: Insights from the CHAMELEON Project in Greece

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Introduction

This study investigates the application and effectiveness of Information and Communication Technology (ICT) for livestock monitoring within the CHAMELEON project, specifically focusing on the Greek pilot case. The research aims to address the challenges of animal welfare and management in the context of climate change.

Data and Method

The study utilizes data collected from a livestock herd (sheeps) in Greece participating in the CHAMELEON project. Advanced ICT tools, including innovative UAV technology equipped with thermal imaging cameras, were employed for non-intrusive data collection on animal health and behavior. The research methodology involves remote scanning for stress-free herd monitoring, movement modeling to identify health-related behavioral anomalies and posture issues, and a real-time alert system to notify herd owners of potential health concerns or straying livestock. Additionally, position monitoring via GPS tracking is utilized for accurate livestock location tracking, particularly crucial during emergencies.

Results

The results demonstrate significant improvements in livestock management efficiency and animal welfare. Remote scanning and thermal imaging can help to effectively identify and monitor health conditions within the herd. Movement modeling enables early detection of potential health issues through behavioral analysis, allowing for timely intervention. The alert system to-be-facilitated prompt communication of anomalies to herd owners, while position monitoring ensures precise and efficient tracking of livestock.

Conclusion

The CHAMELEON project's integration of ICT-driven tools in the Greek pilot showcases the transformative potential for modernizing livestock monitoring practices. The use of technologies like UAVs and Computer Vision (Machine learning), the project contributes to sustainable agricultural adaptation in response to environmental changes, promoting food security and ecosystem sustainability. This study emphasizes the crucial role of digitalization and technological innovation in advancing agricultural practices to effectively address the challenges posed by climate change.

Keywords

ICT in Agriculture, Livestock Monitoring, Thermal Health Monitoring, Movement Modeling, UAV Technology, CHAMELEON Project

Study of Impact of Anomalous Refraction on Digital Zenith Camera Measurements by using Meteorological Data

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Introduction

Atmospheric anomalous refraction is a part of astronomical refraction that cannot be explained by the radial-symmetric refraction model. Research suggests that anomalous refraction most likely results from tilted atmospheric layers of equal density caused by pressure and temperature gradients occurring in the horizontal direction. Absolute ground-based astrometric observations are significantly affected by anomalous refraction, as it causes additional irregular angular displacements of observed stars. In this study, anomalous refraction strongly affects the deflection of vertical (DoV) measurements obtained by digital zenith cameras (DZC) in the field of geodetic astronomy. DZC measurements involve taking star images near the zenith area. DoVs characterize Earth's gravity field as the angle between the reference ellipsoid normal and the geoid normal (or plumb line).

The objective of this study is to investigate impact of anomalous refraction on DZC measurements.

Data and Method

To understand the effect of anomalous refraction, a meteorological sensor recording temperature, pressure, and humidity was set up on a drone (UAV) and lifted to a height of up to 100 meters during DoV measurements. Additionally, meteorological sensors were set up on a DZC and several 5–6 meter high masts around the observation site. The obtained data set provides information about the spatial temperature, pressure, and humidity gradients around the DoV observation site and the lowest atmospheric layers above it.

Results

Current results show the necessity to perform calibration of meteorological sensors, as well as to isolate the sensor from the body of the UAV, otherwise heat from the UAV distorts temperature readings of the sensor.

Conclusion

Calibration of the meteorological sensors may provide more reliable results. Consequent overnight test sessions will be performed to obtain meteorological data during DZC measurements. Additionally, tropospheric parameters could be estimated from simultaneous GNSS observations to evaluate atmospheric conditions during DZC observations.

Keywords

Digital zenith camera, anomalous refraction, Earth's gravity field, deflection of vertical

Digital Intelligent Services in Industrial Wastewater Treatment to Mitigate Climate Change

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Introduction

Water depletion issues affect most of the EU countries, even though the water abstraction rate from natural resources has decreased in the last two decades. In view of resource depletion and rapid industrialization, SDG #9 – Industry, Innovation and Infrastructure has been set, aspiring to open the way for a sustainable industrial sector through innovative solutions. Hence, the scope of this study is to investigate the potential of advanced and smart digital tools and services implementation in the process industry, targeting water recovery, reuse and recycling of secondary raw materials and by-products, emissions reduction as well as energy and waste minimization.

Data and Method

A literature review was carried out focused on diverse digital tools and services to be deployed across the value chain of water-intensive process industries. Wastewater treatment was studied since it constitutes a valuable source of water and nutrients that can be re-incorporated into the production chain, instead of disposed to the environment.

Results

Digitalization in process industries actualizes enhanced water circularity, closed-water loop adoption, and energy-efficient and environmentally friendlier solutions. Digital twins of processes and systems encompass real-time monitoring, modelling, simulation, data analysis, optimization and life cycle assessment tools to build a virtual representation of the physical system, being directly interconnected with each other.

Conclusion

Digital tools and services are capable of providing and visualizing real-time data from diverse sources, predicting and optimizing the performance of the system in terms of raw materials, chemicals and energy, assessing the alternative strategies and selecting the most beneficial for higher production yield, lower energy requirements and waste generation that facilitates the decision-making of the operators and results in a more sustainable wastewater treatment sector.

Keywords: wastewater treatment, industry, digital tools, climate change

Integrated geoinformation modelling to support community adaptation to climate change

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Introduction

One of the biggest challenges of our time is the process of global climate change, which directly affects all spheres of life. Therefore, to meet the adaptation needs of individual communities, it is necessary to develop information systems that can cover large, diverse data sets not only in the field of climatology, but also in the social, economic, environmental, governance and security domains. These tasks are solved through the creation of geographic information systems (GIS) with distributed databases. The study was carried out for the Zakarpattia region of Ukraine.

Data and Method

The study used data from global and regional climate change modelling in the Zakarpattia region for the period up to 2030 using various climate models and scenarios. The study also used data on the administrative division, land cover and relief monitoring, statistics on natural hazards and socio-economic monitoring. Data analysis was based on modelling and overlaying data layers with unified spatial and temporal resolution. The main result of the modelling is to predict changes in the main parameters of the socio-economic and environmental state of the territory and to identify the most promising adaptation measures.

Results

The result of the use of GIS is the development of mathematically sound proposals for the formation of a climate change adaptation strategy in the Zakarpattia region of Ukraine for the time horizon up to 2050, based on the use of a set of analytical tools and geospatial databases.

Conclusion

Based on the results of the research, an applied tool was developed to analyse the impact of climate change on the development of all components of sustainable regional development with the formation of appropriate recommendations for mitigating and preventing negative consequences in the foreseeable future.

Keywords

Climate change, Zakarpattia region, geoinformation modelling, strategy

Forest Fire Analysis with Landsat Satellite Images: 2023 Gökçeada Forest Fire Deniz Bitek¹, Füsün Balık Şanlı², R. Cüneyt Erenoğlu³

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Introduction

Forest fires have an important place among the disasters that occur in the world when evaluated in terms of their effects on the environment. Temperature increases as a result of climate change and the increase in the frequency of heat waves are among the important reasons for the increase in forest fires. It is seen that forest fires have been on an increasing trend in our country in recent years due to natural and natural causes.

Data and Method

Geographic Information Systems and Remote Sensing methods are frequently preferred in monitoring, imaging, and analyzing these fires. In this paper, the forest fire that occurred in Gökçeada district of Çanakkale on 16.07.2023 was analyzed using Landsat satellite images. The burned areas were identified and burn maps were created using satellite images before and after the fire. dNBR (Differenced Normalized Burn Ratio) and dNDVI (Differenced Normalized Vegetation Index) indices were used. The impact area of the forest fire was calculated as 336.51 ha. The accuracy of the areas calculated using the indices was evaluated. 4 different statistical values were used in the evaluation.

Results

As a result of the study, it was seen that the dNBR index reached higher statistical values in determining the areas affected by fire.

Keywords

Forest fire, Gökçeada, satellite imagery, remote sensing, spectral indices

Calculating the Carbon Footprint of Industrial Induction Motors via Life Cycle Analysis

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Introduction

This study addresses the urgent need to reduce greenhouse gas emissions, particularly for industrial power plants, as set out in the European Commission's proposals for a 55% reduction by 2030. The aim of the study is to analyze the emissions of electrical equipment over their lifetime, . In response to the need to increase energy efficiency and sustainability in the industrial sector.

Data and Method

Area of Interest: This research focuses on analyzing the environmental sustainability of power plants, especially their carbon footprint throughout their life cycle.

Use of data-sets: The study uses the latest research, regulations and reports on social assessment and carbon footprint calculations. In addition, motor product material inventories and associated system components are analyzed to determine manufacturing processes and product properties.

Instrumentation: Life cycle analysis (LCA) methodology is an important tool for analyzing the environmental impact of electrical equipment. This involves collecting data from various phases of the motor life cycle and applying established LCA frameworks and software tools for analysis

Results

The study reveals a significant relationship between CO₂ emissions and the various stages of electrical equipment manufacturing and operation. Notably, there is a strong correlation between the carbon footprint and motor power levels, power outputs and materials.

Conclusion

This study highlights the critical importance of considering the entire life cycle of electrical equipment in sustainability efforts. Identifying the main sources of carbon emissions and emphasizing the need for renewable energy and environmentally friendly practices.

Keywords

Electrical motors, Industrial Induction motors, Life Cycle Analysis, Carbon footprint, Climate change, Sustainability

The Changing Landscape of the Automotive Industry: Impacts on Vehicle Wiring Harnesses

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Introduction

The automotive industry is constantly changing and developing from the past to the present, electric and hybrid alternatives replacing traditional internal combustion engine vehicles. Additionally, vehicles are becoming smarter and more complicated in construction with significant implications for vehicle harness structures. As the complexity of the harness increases, it becomes progressively challenging to manage and navigate. This study investigates the effects of continuing developments in the automotive sector on the automotive harness structure as well as analyses how the having a simulation can effects to have an optimal harness design.

Data and Method

In this research, low and high voltage installations of an electric passenger vehicle were analysed in terms of voltage drops and suitability of selected cable cross-sections. It was seen what effects increasing the voltage had on the low voltage installation.

Results

The analysis conducted demonstrates that utilizing a simulation helps to validate the harness design. Optimal cable selections were identified, resulting in decreased harness weight and increased efficiency. This study aims to provide insights into the reliability and efficiency of electrical systems in modern vehicles. In addition, the study highlights the importance of voltage drop analysis in terms of increasing productivity, reducing costs, reducing equipment weight, and ensuring overall efficiency.

Conclusion

To conclude, this research imparts important knowledge about the intricacy of electrical connectivity in cars within an ever-progressing automotive realm. As the industry confronts the troubles and possibilities brought about by transitions in the automobile sector, comprehending the far-reaching effects of ecological sustainability becomes crucial. Merging green engines with concerted efforts to minimize carbon emissions presents the potential to mitigate the severity of global warming and safeguard diverse ecosystems. Hence, this research underlines the significance of weaving sustainability concepts into the fabric of policies revolving around vehicle design and advancement.

Keywords

Electric vehicles, wiring harness, low voltage, high voltage, voltage drop analysis, cost reduction, power management

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Analysis of Wet Deposition of Microplastics with Rainwater on Different Landscapes of Poland: Case Study of Wrocław

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Introduction

Microplastics have been identified almost everywhere on the earth including remote areas. Atmospheric washout with rain could be a potential source of microplastics deposition on different kinds of landscapes. The current research study focuses on the presence, characteristics and quantification of atmospheric microplastics in agricultural and urban areas of Wrocław, Poland. The aim of this study is to assess the wet deposition of microplastics on different landscapes including agricultural residential, and traffic areas of Poland.

Data and Method

The novel methodology has been used in this research combined with using few sample collection protocols designed by NOAA and PCT/IB 2019 /051,838 of March 7, 2019, that is the code of the submitted request granted an international patent extension in several countries worldwide, together with the accepted Italian patent number 102,018,000,003,337 on March 7, 2018. The sampling duration was 6 months from October 2023 to March 2024. Sample preparation, digestion, vacuum filtration and extraction were done in the mineral processing.

Results

Screening Electron Microscope (SEM) used for data interpretation. Results shows high concentration of microplastics in rainwater samples from each location with majority in agricultural and residential area. The results categorized according to the identified particle sizes, colors, and shapes.

Conclusion

In conclusion, the study found sufficient amount of microplastics in rainwater on different landscapers. This research study has linkage with SDG 15 and 3. The methodology and findings of this research can be used to assess microplastics impacts on livelihood, ocean and mountains worldwide and will help to plan strategy to achieve sustainable development goals.

Keywords

Microplastics, Food chain, Landscapes, Wet deposition, Rainwater

LAND MANAGEMENT and CADASTER

The Problem of Overlapping Cadastral Boundaries Cases and Proposed Solutions

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Introduction

Objective of the Algerian cadaster is to unify cadastral plans in a single database and to assemble these plans in a single geographic system. The problems experienced included overlap and duplication; Their presence in the thematic information layers of the cadaster affects not just the metric quality of parcels and islands, but also the results of queries, thereby diminishing quality of cadastral information. Goals of study the problems of interconnection of communal boundaries in the wilaya of Oran and propose Solutions for the Correction of overlapping inter-communal boundaries.

Data and Method

Cadastral plans: these are unique plans that represent the municipal territory at the scale of islands and parcels. Ground control points: The crosses of the planes cadastral or points observed in the field by GNSS. Tie points: tie-points common details between planes. The first proposal, an affine transformation to adjust cadastral plans individually, and the second, a simultaneous adjustment of all cadastral plans by commune, were programmed in python.

Results

After analyzing the results of the affine transformation, it was found that overlaps are still present between the commune boundaries.

Three neighboring communes were chosen as a test area for block adjustment, and applied different tests:

- Adjustment by commune: each commune's boundary is adjusted independently.
- Global adjustment, adjusting the three communes at the same time.
- Calculating residuals in X, Y, RMS and distance deviations, we found that:
- Adjustment by municipality the deviations are minimized; we noticed visually that the offset was minimized, but not totally.
- Global adjustment that deviations are minimized and that all deviations are tolerable and visually that the offset has been well minimized.

Conclusion

After these tests, it was noted that the fit depended on the quality of the support and connection points used, and their distribution. After these results, we decided to test with points observed in the field by GNSS. From the results obtained, we can conclude that global adjustment using GNSS ground control points gives better results.

Keywords

Cadastral plans, Affine transformation, Simultaneous adjustment, Communal boundaries, GIS.

A Novel Vector Cellular Automata Model for Modelling Urban Growth: Preliminary Findings

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Introduction

The Raster data, which reduces geospatial entities into regular units, was frequently used in cellular automata-based urban growth simulation models. However, lands are irregular and cannot be exactly represented by a raster data model. Representing land parts in the vector data can provide more accurate and precise models. This study tackles this limitation by proposing a novel VCA-based UGSM that leverages the flexibility of vector data to create more accurate and detailed simulations.

Data and Method

Unplanned urban sprawl poses a significant threat to *forests and agricultural areas in the Istanbul, selected as the study area to test the model. The concept of CA consists of five essential components: grid network, state, neighborhood, transformation rules, and time. The structure of the CA's principal components was flexed in the study to be compatible with the vector structure. CORINE LULC data produced by the EEA were used as input for 1990, 2000, 2006, 2012, and 2018. The accessibility data were obtained from the OSM web-server. Also, the required slope were created from SRTM-DEM data.*

Results

The VCA-based UGSM has predicted potential urban growth areas for 2050. *Change detection analysis was carried out between 2018 and 2050. According to the results, urban areas increased by 73,537 hectares between 2018 and 2050. Of this amount, 39,367 hectares of agricultural land and 34,169 hectares of forest land were transformed. The validation of the model was measured with metrics, and 83% accuracy was achieved.*

Conclusion

In this study, the CA components have been transformed and reimagined to a vector structure that can more accurately represent the LULC change. Our findings demonstrate the potential of VCA-based UGSMs to provide valuable insights for sustainable urban planning by predicting future LULC changes with high accuracy.

Keywords

Urban Growth, Vector Cellular Automata, Simulation, LULC Change

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Towards Formalization of Thematic Tactile Mapping Representation

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Introduction

Tactile mapping refers to the process of creating spatial representations enabling individuals and especially people with visual impairments (PVI) to perceive and interact with environments through the sense of touch. This field of cartography, attempts to transform visual-based geospatial data into tactile-based features, allowing PVI to perceive and interpret the corresponding representations. Tactile mapping has been utilized in various applications which are mostly focused on navigation aid or 3D digital terrains transformation to a tangible maps. In this study, a methodology for thematic tactile map generation is proposed which aspires to standardize the automatic transformation of a thematic map to a legible tactile representation.

Data and Method

One of the main issues of the thematic cartography is the transformation and symbolization of thematic to tactile features, legible by PVI. Thus, a survey is conducted aiming to derive feedback by the PVI about the desired resolution and suitable symbolization of a thematic tactile map. Based on that feedback, several rules and constraints are established, generating a correlation between most common thematic symbols and the corresponding haptic features.

Results

For the evaluation of the methodology, an extended experimentation was conducted, focused on the following two components:

- AI (Artificial Intelligence) architectures such as image segmentation models, were implemented aiming to automatically extract features from a thematic map.
- Cartographic generalization algorithms were tested and utilized in order to avoid conflicts including overlapped symbols or heterogenous data.

Conclusion

In this study, a methodology for semi-automatic thematic tactile mapping system is proposed, using feedback by the PVI, cartographic generalization algorithms and AI. The system can be used in education (e.g schools, museums, etc), in civil protection authorities, etc, extending the spatial intelligence through the sense of touch, to a higher level.

Keywords

Tactile mapping, thematic maps, AI-based feature extraction

PHOTOGRAMMETRY and REMOTE SENSING

Flood Dynamics Evaluation Using Sentinel-1 SAR Intensity and Coherence for Mapping Extent and Depth Estimation

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Introduction

Floods are among the most devastating natural disasters, posing significant threats to human lives, infrastructure, and economies worldwide. The dynamic and rapidly evolving nature of floods can pose safety risks to ground observers, making it challenging to collect real-time data in hazardous conditions. Conventional flood monitoring methods, including ground-based observations and the use of optical imagery, have demonstrated limitations in delivering timely and accurate assessments during significant disasters. To address these limitations, advanced remote sensing technologies like Synthetic Aperture Radar (SAR) offer promising solutions. SAR systems, such as Sentinel-1, provide all-weather capabilities and can penetrate cloud cover, operate day or night, and offer unparalleled insights into flood dynamics.

Data and Method

The Interferometric SAR (InSAR) method, renowned for its capability to monitor ground movements resulting from a spectrum of phenomena such as earthquakes, volcanic activity, land subsidence, and flooding, offers profound insights into surface dynamics across extensive spatial scales. In the InSAR processing, pairs of Sentinel-1 SAR images were utilized, with one serving as the pre-flood dataset and the second as the post-flood dataset. Coherence images were generated to evaluate the fidelity of interferometric measurements, identifying regions exhibiting low coherence indicative of alterations in surface characteristics like flooding. Furthermore, intensity values were gleaned from the SAR data to complement the interferometric analysis for flood extent investigation and flood depth estimation.

Results

Coherence values derived from SAR data offer insights into changes in surface characteristics, enabling accurate flood extent mapping. Lower coherence values indicate changes such as flooding. The analysis of SAR intensity offered valuable insights into estimating flood depth in the study region, underscoring the correlation between intensity values and flood depth for flood assessment. When the post-flood intensity value decreases compared to the pre-flood intensity, it indicates a darker pattern, signifying water presence where signals are absorbed or attenuated.

Conclusion

This study underscored the effectiveness of SAR data analysis in assessing flood dynamics, providing critical insights into flood extent mapping and preliminary depth estimation. It also emphasized the vital importance of robust flood monitoring and mitigation strategies to safeguard lives and infrastructure. SAR data, offers distinct advantages over other methods, providing valuable insights for post-disaster response and recovery efforts.

Keywords

SAR applications, Coherence, Backscattering, Flood mapping and monitoring, Risk mitigation

Advances in Engineering Surveying: A Comprehensive Accuracy Assessment of UAS Photogrammetry and Structure from Motion

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Introduction

This study explores the accuracy of Unmanned Aerial Systems (UAS) photogrammetry and Structure from Motion (SfM) in engineering surveying. It addresses crucial factors influencing accuracy and presents a synthesis of findings from 16 photogrammetric projects, which include cross-flights. These projects were processed with various Ground Control Point (GCP) configurations, and detailed statistical analysis was conducted on the results. To meet the increasing demand for rapid and cost-effective surveying solutions, this research focuses on UAS-SfM, investigating its applicability and accuracy in diverse engineering surveying scenarios.

Data and Method

The study focuses on the application of UAS-SfM in engineering surveying, with the study area encompassing Eskisehir Technical University campus. Utilizing UAS photogrammetry datasets from 16 projects, the research centers on the accuracy assessment of UAS-SfM in surveying, mapping, and 3D modeling. Various instrumentation, including fixed-wing and multirotor UAS, was employed for aerial surveys. The research methods involved quantitative analysis, statistical assessments, and comparisons with terrestrial laser scanner (TLS) data.

The examination included an in-depth analysis of the influence of flight height on the accuracy of UAS-SfM-derived products, emphasizing the significance of GCP configurations for achieving reliable and precise results.

Results

The analysis demonstrated notable correlations between flight height, GCP configurations, and processing software, impacting the geometric accuracy of UAS-SfM-derived products. The study revealed the influence of flight height on vertical accuracy, emphasizing the importance of GCPs for reliable results.

Moreover, the findings indicate that integrating images from different flight heights contributes to reduced outlier values, demonstrating the potential for enhancing accuracy through thoughtful flight planning.

Conclusion

This research affirms UAS-SfM as a viable and cost-effective alternative for engineering surveying applications. The obtained accuracies, especially in 3D modeling and volumetric calculations, highlight the potential of UAS-SfM for precise and rapid data acquisition. Recommendations for cross-flight image acquisition and further research in processing software evolution are discussed.

This paper was extracted from an MSc thesis entitled “Accuracy Analysis and Evaluation of UAS Photogrammetry and Structure from Motion in Engineering Surveying.”

Keywords

Accuracy Assessment, Engineering Surveying, 3D Modeling, Structure from Motion, UAS Photogrammetry

Farmland boundary extraction based on improved Mean Shift from UAV remote sensing images

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Introduction

Farmland parcels are the basic units on which humans engage in agricultural activities using land resources. Accurate information of farmland parcels is the basis and core information required for digitalization and informatization in modern agriculture. Unmanned aerial vehicle (UAV) remote sensing system has unique advantages in large-area agricultural applications, because of its maneuverability, low cost and high-resolution image acquisition. For existing methods of farmland boundary extraction, artificial vectorization is time-consuming and labor-consuming. The over-segmentation is also a common problem in the research field.

Data and Method

Aiming at the difficulty of farmland boundary extraction, we propose an automatic extraction process of farmland boundary based on the improved Mean Shift from UAV remote sensing images for agricultural applications. According to the global characteristics of farmland parcels and the local characteristics of the crops in the farmland parcels, the method takes into account the pixel position information and the image color information.

Results

The results show that the improved Mean Shift method can achieve good results in the farmland boundary extraction from UAV agricultural remote sensing images.

Conclusion

The proposed method provides support and inspiration for other researchers to study the farmland boundary extraction.

Keywords

Farmland boundary Extraction, Mean Shift, UAV remote sensing images, Agricultural application

Delineation of debris-covered glaciers with multi-temporal UAV images (Gössnitzkees glacier, Schober Group /Austria)

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Introduction

Glacier variations in length, area and volume serve as important climate indicators in high mountain research because of their relatively fast response to changing environmental conditions. However, clear demarcation of glaciers from the proglacial area becomes increasingly difficult, as their strong retreat and increased production of debris in their catchment areas lead to excessive debris coverage and many smaller glaciers in the Alps appear to be drowning in debris. Difficulties in glacier demarcation and different assessment approaches may therefore imply large variations in the quantitative determination of this important climate indicator. This study examines the possibility of automated demarcation using bitemporal UAV flights by analysing height changes and displacement vectors at the glacier margins.

Data and Method

The Gössnitzkees glacier has been monitored annually using edge measurements and longitudinal glacier profiles as part of the glacier measurement service of the Austrian Alpine Club since 1982. In addition, aerial photo evaluations in 1954, 1983, 1997, 2006 and 2012 exist. In summer 2018, the first UAV flight with a DJI Phantom 4 was performed. This was repeated in 2019 and 2023. For precise georeferencing, control point targets were evenly distributed in the flight area and measured using RTK-GNSS. Since the glacier is completely covered with debris, it is almost impossible to visually distinguish the glacier from the proglacial area. However, this information is a prerequisite for quantitative change estimates. Ground-based investigations, such as excavations, are difficult due to the thick and coarse debris cover. Therefore, we examined local elevation changes and displacement vectors around the edge of the glacier to separate relatively stable proglacial areas from changes on the glacier. Thereby, different point-cloud and image correlation techniques using co-registered images are presented.

Results

We show that displacement vectors and height changes derived from bitemporal UAV flights facilitate the delineation of heavily debris-covered glaciers from proglacial areas, leading to a consistent recording of glacial parameters.

Conclusion

We conclude that the presented methodology allows accurate delineation of debris covered glaciers and pro-glacial areas, enabling increased accuracy and standardization of glacier monitoring.

Keywords

UAV, Debris covered glacier, Feature tracking, Glacier monitoring

Accuracy of forest road Digital Terrain Models captured using Airborne and Mobile Light Detection and Ranging Technology and Photogrammetry

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Introduction

Forest roads are important for sustainable forest management, and information about them is necessary for decision support. Accurate recording of the road surface is required for this task. Several methods can record it with various accuracy and effectivity by creating digital elevation models (DEMs). Two basic ways to create point clouds can be considered: photogrammetry and laser scanning (LiDAR), both mobile and airborne versions. In this study, we assessed and evaluated the accuracy of the generated DEMs using three different remote sensing techniques on three types of forest road surfaces.

Data and Method

As a sample data, we used the forest road located in Vígľaš, Central Slovakia. The road surface is constructed from asphalt, concrete road slabs, and paving stones (“cat heads”). We evaluated the vertical accuracy of the DEMs produced by mobile laser scanning (MLS, Leica Pegasus, 840 pts/m²), airborne laser scanning (ALS, Leica ALS 70, 9 pts/m²), and aerial photogrammetry (Leica RCD 30, 10 pts/m²). Overall, 700 points were measured on 50 m long road sections. DEMs were generated with a final resolution of 0.5m using the IDW method. The accuracy of DEMs was assessed by comparing them with the reference dataset (measured by combining the GNSS and total station).

Results

Regarding road surface capture quality, subsequent terrain generation, and the number of points per m², the MLS method dominates. Depending on the road surface type, it provides the RMSE values from ± 0.01 m to ± 0.03 m. The ALS method provided balanced RMSE results irrespective of surface type (RMSE ± 0.04 m to ± 0.05 m). The aerial imaging has the highest variability on all surface types (RMSE ± 0.12 m to ± 0.22 m).

Conclusion

In the case of aerial images, the decimetre-level accuracy is not sufficient for construction and maintenance purposes. This method provided the largest blunders at the edges of roads closest to the forest stands. ALS, with its ability to partially penetrate the forest canopy, can provide complex information about forest roads for inventory purposes. MLS provided the best spatial accuracy, enabling both construction and maintenance works. In any case, the advantage is that these data types can be combined. Future research should also focus on the impact of forest stands on DEM accuracy.

Keywords

Forest road, Photogrammetry, Airborne laser scanning, Mobile laser scanning, Digital elevation model

Automatization of 3D Point Cloud Semantic Segmentation Using PointNet++ Algorithm

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Introduction

With the advancements in hardware and software, research efforts on large-scale data processing have significantly increased. Consequently, the application areas have expanded proportionally. Among the prominent sources of dense data, 3D points cloud finds extensive use in various fields such as healthcare, automotive, defense industry, and the film sector. Analyzing and interpreting point clouds, which are inherently dense and complex, entails solving substantial and intricate problems. Therefore, manual interpretation of these data sets not only introduces the possibility of operator errors but also results in substantial time and cost losses. This study focuses on the automatic segmentation and analysis of 3D dense and complex point clouds using artificial intelligence.

Data and Method

The primary dataset selected for this research comprises open-source DublinCity LIDAR 3D point cloud data. The DublinCity dataset was created in 2015 in the city of Dublin, the capital of Ireland, using the Aerial Light Detection and Ranging (A/LiDAR) method. The dataset was generated through the collection and labeling of LiDAR data on a city-wide scale. It consists of 13 classes hierarchically organized. These classes are further divided into four main categories: building, vegetation, ground, and undefined. Within these main categories, there are subcategories such as window, door, tree, and others. One of the most popular contemporary approaches employed is the PointNet++ algorithm to automatically analyze point cloud data. PointNet++ is an advanced 3D deep learning algorithm designed for point cloud data processing. Building upon the success of the original PointNet algorithm, PointNet++ introduces a hierarchical neural network architecture that captures hierarchical features from local to global scales.

Results

Within the scope of this study, segmentation results were generated using the PointNet++ algorithm on DublinCity LIDAR data for different class numbers, and class-specific analyses were conducted. The analyses revealed accuracy values reaching ~90%.

Conclusion

This hierarchical approach enables PointNet++ to effectively handle complex structures within point cloud data. One key innovation of PointNet++ is its use of a set abstraction and feature propagation module. The set abstraction module allows the network to efficiently sample informative points and capture local patterns, while the feature propagation module facilitates aggregating local features into global representations. This multi-scale feature extraction makes PointNet++ particularly robust for tasks such as point cloud segmentation and object recognition, enhancing its overall performance in handling intricate 3D data.

Keywords

Point cloud segmentation, Artificial intelligence, 3D data processing, PointNet++

Remote Sensing-Based Identification of Tree Species in Degraded Forest Areas: A Methodology for Targeted Restoration in the Attica Region, Greece

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Introduction

The escalating climate crisis and the alarming rise in forest loss areas have underscored the urgency for immediate action and effective restoration practices. One critical aspect of restoration efforts is the ability to recognize different tree species in specific forest areas. This study, realised under the context of Horizon Innovation Action IMPETUS, addresses this need by providing a methodology to identify tree species in degraded forest areas, using remote sensing datasets, aiming to facilitate more targeted and effective restoration practices.

Data and Method

The study area focuses on the Attica region, Greece, where remote sensing products such as Sentinel 1 & 2 are utilized. Ground truth data is derived from the LUCAS dataset, providing essential reference information. Machine learning (ML) and artificial intelligence (AI) learning methodologies are employed to identify tree species in degraded areas using remote sensing images captured before and after forest land degradation. The methodology developed in this study demonstrates its effectiveness in identifying tree species in degraded forest areas.

Results

By leveraging remote sensing products and ML/AI techniques, the study achieves robust classification of tree species, providing valuable insights into the composition of degraded forest areas. Importantly, ground truth data from the LUCAS dataset holds can have a significant potential for both training and validating datasets, in this case, tree species classification. This study presents a methodology to address the need for identifying tree species in degraded forest areas, particularly in the context of the climate crisis and increasing forest loss.

Conclusion

By utilizing remote sensing products and ML/AI methodologies, the study offers a practical approach to support restoration efforts. The information generated from this study serves as an advisory tool for stakeholders and forestry experts, empowering them to implement targeted and effective restoration practices to mitigate the adverse impacts of forest degradation.

Keywords

Remote Sensing, Deforestation, Species Recognition, LUCAS, Sentinel 2, Machine Learning; IMPETUS Project

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Designing low-cost Virtual Reality walk throughs for Cultural Heritage Management

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Introduction

In times of digital humanities research, interdisciplinary approaches and processes and their tools for the digitization and virtualization of objects are increasingly becoming the focus of interest. Several problems arise in this context: Which database is suitable to cover the needs resulting from a given thematic context in the most versatile way possible? How should the collaboration between different disciplines, methods and tools be organized to achieve the desired result? Finally, in view of the expected effort, the question of possible optimization potential also arises. The aim of this paper is to develop a workflow for the creation of a database suitable for the purpose mentioned and to test it using a practical example; in doing so, the material and time expenditure associated with such a data acquisition process should be kept as low as possible.

Data and Method

The Hanfelden Castle in the Austrian province of Styria served as the subject of the investigations, which proved to be a very useful demonstration object in terms of architecture, building history and restoration. Regarding the digital building documentation that was the focus of the study, the creation of a VR-compatible data basis was defined as the goal. This requirement made it necessary to completely re-record the approximately 50m x 50m object, whereby the creation was carried out based on 360° spherical panoramas in HiRes quality in order to minimize effort and costs.

Results

After cleaning up any artifacts, the data obtained in this way was compiled into virtual walk-throughs as the result of the described workflow, with particular attention being paid to the highest possible flexibility (i.e. free combinability of the available locations into any path). Furthermore, by selecting appropriate exchange formats, an attempt was made to ensure a wide range of options for utilizing the results without simultaneously driving up the follow-up costs.

Conclusion

The final evaluation of the results showed a thoroughly satisfactory result, considering the relatively low expenditure of time and resources compared to alternative methods; the quality of the visualization proved to be good enough to be able to identify details of the building fabric as well as damage and its changes. The preferred presentation options are either self-sufficient file solutions or variants integrated in html.

Keywords

Building documentation, cultural heritage, visualization techniques, virtual reality, digital humanities

"Spatial Realities: Bridging Digital Heritage, Geoinformatics, and Sustainable Development"

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Introduction

Cultural heritage is a non-renewable, unique, and irreplaceable resource. Digital technologies and geoinformatics specifically act as a power multiplier in culture. However, integrating digital heritage that uses geoinformation into the dialogue concerning sustainable development is an ongoing and long-term challenge. This paper investigates the different geoinformatics technologies that have been applied to the basic domains of DH (documentation, representation, and dissemination). It also examines the triple role that digital heritage plays in cultural sustainability, namely how it mediates the other three pillars of sustainability (society, economy, environment), how it develops and operates alongside the other three pillars, and how geoinformatics is embedded in digital heritage.

Data and Method

The study uses a methodological approach of literature review and case study analysis to explore the integration of geoinformatics and digital cultural heritage in sustainable development, aiming to inform policy and practice in heritage conservation.

Results

Geoinformatics, a multidisciplinary field integrating geospatial technologies and information science (such as Participatory Geographic Information Systems), has emerged as a powerful tool in the conservation, management, and promotion of cultural heritage. Digital heritage itself also faces issues such as data security, distribution, interoperability, cost, simplification, and speed problems for applications. It is also challenging to open access and increase the ease of understanding.

Conclusion

The integration of geoinformatics into the realm of digital heritage marks a significant advancement in cultural heritage conservation. This interdisciplinary approach not only provides powerful tools for documentation, spatial analysis, and decision-making but also fosters public engagement in preserving our shared heritage. Moving forward, stakeholders must continue collaborating in leveraging geospatial technologies and information science to safeguard our cultural legacy while ensuring the sustainability of socioeconomic and environmental processes vital for human equity, diversity, and prosperity. This concerted effort is essential for securing a sustainable future for generations to come.

Keywords

Digital Heritage, Geoinformatics, Sustainable Development

Comparative Accuracy Analysis of Algorithms Used in Automatic Detection of Power Lines From LiDAR Data

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Introduction

Power lines are essential for distributing electricity to households, industries, healthcare facilities, and other areas. In densely vegetated areas, power line disruptions and contact with forest fuel can result in forest fires, which can cause loss of life, environmental catastrophes, and infrastructural devastation. Airborne LiDAR systems can be used in difficult-to-access or hazardous areas, in contrast to terrestrial methods. In recent years, automatic detection algorithms have become increasingly popular for accurately and quickly detecting power lines on airborne LiDAR point clouds. This study investigates the automatic power line detection performance of different detection algorithms on a LiDAR point cloud.

Data and Method

In this study, the Robust Railroad Infrastructure Detection Framework developed by Eötvös Loránd University (ELTE) Geoinformatics Laboratory was used to automatically detect power lines from an airborne LiDAR point cloud of an area with different land cover classes, including power lines, buildings, roads, and vegetation. To accomplish this task, five algorithms including Above, AngleAbove, AngleGroundAbove, VoronoiAbove and VoronoiGroundAbove were applied separately and their accuracies were compared by adopting accuracy metrics such as precision, recall, and F₁ score.

Results

When results were investigated, Above algorithm has the lowest precision at 0.50, compared to the others which have values between 0.98 and 0.99. For recall values, AngleAbove and AngleGroundAbove have the lowest values at 0.51, compared to the others which range between 0.89-0.91. When investigating F₁ scores, the VoronoiAbove algorithm has the highest value at 0.94. The overall performance results show that the VoronoiAbove algorithm is superior to the other algorithms, while the VoronoiGroundAbove algorithm performed similarly.

Conclusion

In conclusion, when accuracies of the applied algorithms were compared in terms of F₁ scores, the VoronoiAbove algorithm has the highest value at 0.94, followed closely by VoronoiGroundAbove at 0.93, while the other algorithms scored between 0.64-0.68. Overall, VoronoiAbove performed better than the other algorithms in automatic power line detection.

Keywords

Automatic power line detection, LiDAR point cloud, Above, AngleAbove, AngleGroundAbove, VoronoiAbove, VoronoiGroundAbove, Accuracy.

An Assessment of The Potential Use of Sentinel-2 Imagery and Water Indices in Monitoring Water Quality: A Case Study of Sakarya River

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Introduction

Rivers are vital components of global aquatic systems, but they face significant threats mainly caused by agricultural and anthropogenic activities that negatively impact water quality. Remote sensing technologies have been widely used as an essential tool for monitoring and protecting aquatic ecosystems. This study investigates the relationship between in-situ water quality parameters and satellite image-derived water indices during maize plant growth.

Data and Method

In this study, the Sentinel-2 imagery and derived water indices, Normalized Difference Chlorophyll Index (NDCI), Normalized Difference Aquatic Vegetation Index (NDAVI), and Automated Mucilage Extraction Index (AMEI) were used to monitor water quality level of the Sakarya River during the growth periods of maize plant. For this purpose, water quality parameters were calculated based on water samples collected during field campaigns and correlated with satellite imagery.

Results

As a result of the study, the Pearson correlation between the nephelometric turbidity unit (NTU) parameter and the NDCI index was 91%, while the correlation between the NDAVI index and suspended solids (SS), chemical oxygen demand (COD), biochemical oxygen demand (BOD), and total Kjeldahl nitrogen (TKN) parameters was above 90%. Furthermore, time series analyses based on NDAVI and normalized difference vegetation (NDVI) indices for the time interval covering the maize plant growth period using Sentinel-2 imagery showed significant changes in water quality parameters with plant growth.

Conclusion

This study discusses the relationship between Sentinel-2 images and different water indices derived from these images and water quality parameters. Sentinel-2 images correlated highly with water quality parameters (i.e., EC, NTU, SS, COD, and BOD). Second, the strong correlations were calculated between the three spectral water indices and water quality parameters (i.e., NTU, SS, BOD and COD). Third, significant changes in water quality occurred during the period of highest plant vitality, namely, the flowering season, and this trend continued until after the harvest.

Keywords

Water quality, Spectral water indices, Sentinel-2, Maize plant, NDAVI, NDCI.

AIR2SEA, A Synergy of Unmanned Aerial and Sea Surface Systems for Search and Rescue

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Introduction

Unmanned aerial systems (UAS) are increasingly being used in various applications, but their use remains essentially limited. Similarly, there is limited correlation between unmanned systems operating in different environments, (terrestrial, underwater sea surface). Air2Sea, realizes the cooperative link between a UAS and an Unmanned Sea Surface System (USSS). The purpose of this synergy is multidimensional and can be crucial in multiple scenarios including search and rescue missions where a holistic approach is extremely critical, the assessment of accidents with an environmental impact, and the monitoring - surveillance of marine infrastructure and transport.

Data and Method

Through an analysis of current advancements in relevant fields, including object recognition algorithms such as YOLO v7, we identified key interface requirements and designed an efficient air-sea cooperation infrastructure. This synthesis ensures seamless integration and interoperability between UASs and USSS. Making use of commercially available components and employing rapid prototyping techniques (3D printing), both aerial and maritime systems were constructed or modified. Meticulous platform assembly, programming utilizing ROS and an GPU-enabled embedded system, and rigorous testing, ensured the system's robustness and effectiveness.

Results

The marine section consists of a rigid hull inflatable boat, outfitted with an electric outboard engine steered with a purpose-built, custom-made control unit, consisting of an electric motor, gear pair and steering angle control unit. The aerial part consists of a drone with an imaging system, and an integrated data processing unit while finally the sea-air interface is realized by wireless transponders. Several parts of both the aerial and the marine equipment have been constructed using 3D printed components.

Conclusion

Air2Sea combines the advantages of UAS and USSS using deep learning architectures and ROS-based development. It enhances the capabilities of civil protection, emergency assistance, etc, having a critical role in marine applications.

Keywords

UAS, USSS, deep learning, Search & Rescue

UP42 platform - the comprehensive solution that facilitates access to different geospatial data for scientific and commercial projects

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Introduction

The Earth Observation and Remote Sensing sector has been evolving over the past 5 years with a speed never seen before. The New Space movement is enabling the launch of hundreds of new sensors every year and the availability of data, as well as its proper access and management, is proving to be one of the new challenges to be solved. When dealing with complex multi sensor projects and conducting scientific research, we are often combining the best and proven source of data and tools that will help us extract relevant information and find answers to the questions posed. Regardless of the area in which we work, whether it is geology, agriculture or spatial management, it is necessary to leverage datasets obtained using various devices and sensors at different heights. The process of finding the right data and adjusting tools is often time-consuming.

Data and Method

One of the solutions that enables a comprehensive, but also easy and quick, access to data from many sources is the UP42 platform. It is a rich repository of very high resolution commercial imagery, offered by such providers as eg. Airbus, BlackSky, SIIS, Capella Space or ICEYE. In addition, the platform also includes medium and low resolution imagery like Axelspace, Geosat or Copernicus Sentinel constellations, as well as aerial imagery and other geospatial data, such as Digital Terrain Models. The listed products are available to be explored in an integrated catalog or users can also place an order when the project requires a specific dedicated acquisition over an area of interest.

Results

The UP42 platform is also a suite of tools necessary to explore and automate processes using the API and Python SDK, which can be connected to your own applications. In addition, the platform is integrated with Esri's ArcGIS Pro software. Access to the UP42 data resource and prepared projects is possible in ArcGIS thanks to a special add-in. All these elements significantly affect the improvement of work.

Conclusion

The UP42 platform, combining data and tools in one environment, supported by the power of cloud computing, is a comprehensive solution that facilitates and accelerates the implementation of scientific and commercial projects.

Keywords

satellite imagery, earth observation, geospatial data

POSTERS

15202

Changes in the coordinate time series based on PPP solutions using innovative polygon trend analysis

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Introduction

The purpose of this research is practical verification of the existence of monthly seasonal correlations in the time series of coordinates of GNSS reference stations located in Europe.

Data and Method

Area of interest were permanent GNSS stations' daily time series based on PPP solutions. For each station's components trend regions were determined based on IPTA (innovative polygon trend analysis) method. This is modified version of the ITA method which is usually used for analysis air temperature or precipitation data. The IPTA method was employed separately for both arithmetic mean and standard deviation. The authors looked for potential relationships between seasonal changes in coordinate components on a monthly basis and their geographic location.

Results

The authors divided the time series for each station into two equal groups and compared the trends for each month. This type of phenomenon was seen only for the altitude component. For example, in case of the GNSS stations: JNSK (Joniškis, Lithuania) and KRAW (Krakow, Poland) stations in Up component, IPTA method reveals decreasing of this component for 10 months and 5 months respectively.

Conclusion

We concluded that IPTA method reveals seasonally dependent months for part of analysed set of data and part of their coordinate components.

Keywords

seasonality, time series, GNSS, permanent stations, building height

Dependence of seasonal phenomena in coordinate time series on GNSS antenna mounting height

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Introduction

In the research presented here, the authors undertook an analysis of the potential correlation between the magnitude of the seasonal amplitude and the height of the GNSS antenna mounting above the ground.

Data and Method

The area of interest was daily coordinates time series of more than 20,000 reference stations globally distributed, authors use a PPP solution provided by NGL. For each coordinate, the component was fitted with an annual periodical function to determine the amplitude of the seasonal component. Moreover, for each station based on the EGM2008 geoid model and terrain model was determined the height of the pillar/building/etc. of GNSS antenna. The authors looked for a potential correlation between the height of the antenna mounting above the ground and the seasonal effect of coordinate changes

Results

Analysed set of the data partly proves existence of dependency between building height and magnitude of amplitude. For example, pair of stations SIN1 (Singapore, building height 45 m) and ANMG (Selangor, Malaysia, 11 m), and this is evident in the magnitude of the amplitude of the fitted seasonal function is 4 mm and 2 mm respectively for an Up component. In case of the North and East components this phenomenon is much more lower.

Conclusion

It has been shown that there is a relationship, between the height of the building and value of the amplitude of the periodic function, but this does not happen in every case. This is due to the characteristics of the technical structure of the building, as well as the type of foundation material on which it is founded. We found a partial correlation between analysed time series and GNSS antenna height and the strongest dependence appears in the Up component.

Keywords

GNSS, GNSS antenna, coordinate time series

Boreal Forest Diversity Through In Situ and Laboratory Spectral Measurements of Understory Elements

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Introduction

Improving our knowledge about the spectral properties of forest elements is essential to interpret airborne and satellite-borne remote sensing data. Spatially explicit determination of forest diversity through, for example, physically-based reflectance models require extending existing spectral libraries to include also forest understory elements. The aim of this study is to investigate the spectral properties of understory elements in boreal forests through close-range hyperspectral measurements.

Data and Method

We conducted two field campaigns in June and July 2023 in Finland to acquire spectral measurements for forest understory elements. We measured ferns, decaying wood, common wood sorrel and May lily, in situ, and leaves from European fly honeysuckle, alder buckthorn and common hazel in a laboratory. Spectral measurements were performed at wavelengths from 350 to 2500 nm using an ASD FieldSpec 4 spectrometer and associated with the description of the target and its immediate environment. We analyzed the preprocessed spectral signatures and made them available as two open spectral libraries.

Results

Our analysis showed strong spectral variations in decaying woods with reflectance factors continuously increasing from 350 to 1300 nm. Highest intra-species variations in the spectral signatures were observed in the near-infrared region for decaying wood and ferns, and in short-wave infrared (> 2000 nm) for bush leaves. We found low spectral intra- and inter-species variations across the sampled leaves from the different bush species. Near-infrared reflectance factors decreased from ferns, to wood sorrel and finally to May lily, while they showed similar visible and short-wave infrared reflectance.

Conclusion

We conclude that spectral properties could help to discriminate classes of bush, decaying wood, fern, and herb, thus allowing diversity indicators to be developed. Further research is needed to link the spectral intra-species variation present in understory elements to their physiological and environmental conditions.

Keywords

Hyperspectral, Boreal Forest, Understory, Spectral measurements

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Design of a Coastal Zone Monitoring System Using an Unmanned Vessel

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Introduction

The main purpose of the article is to present preliminary research for the project of a coastal zone monitoring system using an unmanned vessel. The system is funded by the National Centre for Research and Development of Poland and aims to create a prototype of the system working in real conditions. State-of-the-art sensors mounted on the Hydrodron unmanned vessel are used for data acquisition: for underwater data, MBES and sonar, while for the ground part, a laser scanner and metric camera. The proposed system, in addition to being able to integrate data from different sensors, create a multidimensional and multi-temporal knowledge base of a given coastal zone, will allow visualization of data from the form of a spatial map.

Data and Method

In the course of the work, a methodology was developed for the use of an unmanned vessel for the implementation of measurements in the coastal zone, including the configuration of equipment and devices, how to transmit information, guidelines for conducting measurements and routes of travel. The following sensors were installed on the Hydrodron vessel: the PING DSP 3DSS-DX-450 interferometric echosounder, the Velodyne VLP-16 LiDAR, the Blackfly S GigE metric camera, and the auxiliary systems: the Ekinox2 Subsea positioning system, the Garmin 18 GPS PPS, and the AML SV Xchange and AML SVP Base X2. Detailed parameter, setting and configuration requirements for each sensor for proper system operation are also specified.

Results

The architecture of the proposed system is based on four modules: acquisition module, underwater data processing module, surface data processing module and operations/visualization module. These modules represent the characteristics of the components of the integrated data and data fusion module. Each of them has been studied and implemented in detail. Another challenge was to develop a model for a multi-dimensional and multi-temporal knowledge base on the coastal zone. A database model was prepared, as well as guidelines and standards for storing data in this database. A new spatial data model MMTDEF (Multidimensional and Multi-Temporal Data Exchange Format) has been designed for the project. The MMTDEF spatial data model consists of four main classes representing templates for the representation of bathymetric, sonar, lidar and imagery data.

Conclusion

In building the system, two main technologies were used: Python 3.1x and Postgres. Their use allows for easy startup of the application, the ability to place the database on the server and run an application that will communicate with the database through the network, scalability of the database, sharing of data by multiple applications and centralization of the data used. The system is characterized by automation of operation, which forces the end user only to place the measurement data in the appropriate directories. Data will be collected in a single pass and then integrated into a single model. The benefits of implementing the results of the work may include, for example, monitoring the coastal zone, inventorying the condition of navigation markings, waterways, shoreline fortifications, movement of bottom debris, wharf inspections, checking the capacity of the waterway, updating flood risk maps.

Keywords

Monitoring system, data fusion, seafloor mapping, coastal zone, spatial big data

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Detection of Land Use and Land Cover Changes in Cottbus City and Spree-Neisse District, Germany in the Last Three Decades using Machine Learning Approaches

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Introduction

Regular detection of Land use and Land cover (LULC) changes with high accuracy is essential for natural resources management and sustainable urban planning. The produced LULC maps also enable the demonstration and detection of the transformation of the respective landscape over time. The selected study area from southern Germany, Cottbus City, and the Spree-Neisse district have developed over the past few decades due to several factors, including urbanisation and industrialisation; also, the landscape has changed in some areas for post-mining activities. Identification of LULC changes that have been taken over the past years thus plays a vital role in quantifying the impact of these factors while improving the knowledge of these developments and supporting the city planners or urban management officials before implementing further long-term development initiatives for the future.

The main aims of the study are (i) to generate improved LULC maps to the available traditional survey dataset (from the Federal and state offices) using a supervised machine learning (ML) algorithm for 1992 and 2022 to consider changes over a 30-year period, and (ii) to analyse the LULC change for the selected region. The newly produced classified maps will then be validated with the available survey data from the Federal and state offices (RDB) and with the Dynamic World (DW) near real-time (NRT) 10m global LULC data set powered by artificial intelligence (AI).

Data and Method

The study area is Cottbus city and Spree-Neisse district, which are situated in the southern part of Germany under the Brandenburg state and cover a total area of 1822.6 km². As of 31 December 2022, the population of Cottbus city and Spree-Neisse district is 99,502 and 112,493, respectively.

To identify the LULC changes, Random Forest (RF) ML classifier on Google Earth Engine (GEE) through Landsat satellite imageries, i.e., Landsat 5 MSS/TM for 1992 and Landsat 9 OLI-2 / TIRS-2 for 2022 is applied. The training samples were taken from the high-resolution satellite imagery on the GEE through a visual inspection, with 70% of the samples used for training and the remaining 30% for validation. For accuracy assessment, three factors were considered, i.e., "true" land cover types, intended usage of the classification, and other possible subsets of data resident in a GIS. Also, the error matrix or confusion matrix method is applied to the GEE to determine the Kappa Index (KI).

Results

The results showed a highly accurate classification, especially for Landsat 9 satellite imagery in 2022. Further, the RF classifier demonstrated a validation accuracy of 91% with a Kappa Index of 78%, where the Training Overall Accuracy (TOA) was 100% for both years, 1992 and 2022. Overall, the validation database from the AI-generated DW NRT 10 m global LULC mapping and RDB was similar to the produced LULC mapping 2022 on GEE API.

Conclusion

The study produced an improved LULC map for 1992 and 2022 using the GEE API and ArcMap 10.8.2. Overall, the two maps produced on GEE give us a clear overview of the LULC changes over the last 30 years in Cottbus city and Spree-Neisse district into four distinct land cover classes.

Keywords: LULC, Random Forest, Landsat, Google Earth Engine, highly accurate classification

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Weight of evidence exploration of the built-up area changes in the rural setting

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Introduction

The system of spatial planning in Poland sets the rules for land development. The possibility of an open space being built-up depends on the existence of local spatial development plan. In many cases the plan is absent which often leads to a chaotic development. To prevent such chaotic development, it is crucial to determine which areas are more prone to being developed.

Data and Method

The chosen test area is community of Limanowa (voivodeship małopolskie). The spatial planning in the test area is based on the study of spatial planning conditions and directions. The research was based on the analysis of the legal regulations, and such physiographic features as landform, the existence of landslides, and land use type. The weights have been assigned to each criterion based on the actual land development between 2013 and 2022 with the weight of evidence method (van Westen, 1997). All the criteria have been later overlaid to show synthetic suitability of the land.

Results

The factors that influence the suitability of land to be developed are terrain slope, landslides, and land use type. It has been determined that such factors as proximity to developed plots, public road access, and quality of land do not impact the probability of the land being developed. Multicriteria analysis resulted in a suitability map of the whole test area showing which areas could be developed in the future.

Conclusion

On the basis of legal regulations and literature, it was possible to identify factors that allow for the forecasting of development in an area which lacks a local development plan. However, the method can be successfully applied to another area, taking into account the conditions prevailing in it.

Keywords

Development of built-up areas, Rural areas, Weight of evidence method

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Ground-based remote sensing in earthquake monitoring

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Introduction

In this presentation we propose to enhance geophysical investigations with other remote sensing methods, such as infrared photography combined with 3D data, to create a 3D model of the exposed or partially uncovered geological structures in the analysed region.

Data and Method

The area studied is located between the villages of Stare Bystre and Rogoznik on the left bank of the Rogoznik Wielki Creek. For analyses were used four different methods:

- a) infrared thermography
- b) seismic tomography
- c) geophone sensors setup
- d) terrestrial laser scanning

Results

This experiment shows that all used methods are complement each other. For example, not often used in such objects 3D thermal model can be used as a support for geological, geomorphological and geophysical investigations of remote and unsafe to access area. Since thermography and terrestrial laser scanning is one of the remote sensing methods that do not involve entering the object they can be of great use for filling the blanks in data obtained via other, more direct methods.

Conclusion

The joint use of infrared thermography, seismic tomography, geophone sensor configurations and terrestrial laser scanning enables comprehensive earthquake monitoring and analysis. Infrared thermography can detect temperature changes that can indicate areas of geological or structural damage. Seismic tomography can accurately locate the epicentre of an earthquake and analyse the geological structure. The configuration of geophone sensors makes it possible to monitor seismic activity in real time and respond quickly to potential hazards. Terrestrial laser scanning after an earthquake enables rapid assessment of infrastructural and structural damage, speeding up the process of recovery and restoration of normalcy. By integrating these methods, a comprehensive picture of the earthquake can be obtained, which contributes to better hazard assessment and faster rescue efforts.

Keywords

point cloud, 3D thermal model, infrared thermograph, terrestrial laser scanning, geophone, earthquake

The impact of the CEEMD method boundary errors on the estimation of oscillation periods detected in GNSS time series

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Introduction

Time series of GNSS station positions provide valuable information for geodesy as well as modeling of geophysical and geodynamic phenomena. Therefore, it becomes important to properly analyze the GNSS time series, aimed at, among others, to model periodic signals occurring in them, the characteristics of which may change over time. For this purpose, the Complementary Ensemble Empirical Mode Decomposition (CEEMD) method can be used, which is dedicated to the analysis of non-stationary and non-linear signals. However, the CEEMD method has the problem of boundary errors, which may result in inaccurate estimation of the detected seasonal oscillations.

Data and Method

Due to the possibility of occurrence of boundary errors in the CEEMD method, its impact on the estimation of the period of detected oscillations was examined. For this purpose, the recommended extension of the signal at its ends with a soft fading function was used. Then, it was compared whether there was a significant difference in the periods of detected oscillations as a result of CEEMD decomposition with and without such extension. The research used selected daily time series of GNSS station position residuals provided by EPN (EUREF Permanent Network).

Results

The research provided information on the impact of the boundary errors occurring in the CEEMD method on the periods of detected seasonal oscillations in GNSS time series using CEEMD decomposition.

Conclusion

The boundary errors occurring in the CEEMD method, as well as their elimination by extending the time series at the ends, may affect the changes in the periods of the detected oscillations. In further research, other methods of extending the signals at the ends should be considered in order to properly eliminating the impact of the CEEMD method boundary errors on the periods of the determined signals.

Keywords

GNSS, CEEMD, time series, annual oscillation

Monitoring artificial light pollution using a multispectral camera

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Introduction

Studying the adverse phenomenon of artificial light pollution requires systematic monitoring based on various methods. One commonly used technique involves assessing the intensity of light reflected from surfaces using different types of digital cameras at various measurement levels. However, such an approach doesn't always fully allow for understanding the characteristics of the light source. In our study, we focused on the potential application of the multispectral camera, designed for mounting on a drone (UAV), to evaluate the spectrum of the light source.

Data and Method

We conducted laboratory measurements using the Micasense Dual RedEdge-MX multispectral camera. Recording scenes representing both the light source and reflected light, we also took reference measurements using a spectrometer. Employing classical methods of image analysis and mathematical analysis, we verified the potential for assessing the spectral characteristics of light sources. Based on the results, we developed a concept and conducted tests for monitoring light pollution using multispectral cameras mounted on drones.

Results

Our research emphasizes challenges related to photogrammetry and remote sensing under night conditions. The short exposure time of the camera shutter significantly limits the registration of data necessary for creating orthomosaics using multispectral cameras. An alternative solution was found through correlating data with a classic nocturnal orthomosaic and point analysis of registered clusters of bright pixels in images used to assess the characteristics of light sources.

Conclusion

Our studies indicate a significant potential for using multispectral cameras to monitor artificial light pollution. Expanding the range of data recorded in small spectral ranges allows for a more accurate assessment of this phenomenon, which is crucial in identifying sources that may have a negative impact on the environment, such as flora, fauna, or even humans.

Keywords

Light pollution, night photogrammetry and remote sensing, UAV, night orthomosaic, environmental protection

Potential of Hyperspectral Vegetation Indices for Assessing Nitrogen Content in Potato, Maize, and Grassland

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Introduction

To mitigate environmental pollution stemming from agricultural activities, there's a pressing need for a dependable indicator to gauge the nitrogen status of crops, facilitating precise fertilization management tailored to specific sites within agricultural fields. Conventional approaches like soil testing, plant nutrient analysis, and SPAD metering demand numerous point samples to delineate nitrogen's spatial variability across extensive fields. Remote sensing methodologies offer promise in assessing this variability across large agricultural expanses at a reduced cost compared to traditional, resource-intensive methods.

Data and Method

This study aimed to: (a) assess the efficacy of hyperspectral vegetation indices in estimating nitrogen content, and (b) develop and validate straightforward regression models correlating these indices with in situ measurements. Hyperspectral data were collected for grassland, potato, and maize crops across 10 fields in Noord-Brabant, the Netherlands, utilizing the Airborne Prism Experiment (APEX) sensor.

Results

Various vegetation indices were calculated based on the original APEX bands. In the regression model linear and exponential relationships were investigated. On the subject of nitrogen estimation in grassland the best performance was achieved by REP model ($R^2 = 0.61$ linear and $R^2 = 0.71$ exponential); in potato by MTCI ($R^2 = 0.65$ linear and $R^2 = 0.75$ exponential); in maize there were no significant correlation for any of the tested indices.

Conclusions

This research is focused on the need for precise nitrogen assessment in agriculture and examines remote sensing's potential using hyperspectral data from the APEX sensor. While vegetation indices and regression models show promise in estimating nitrogen content in grassland and potato crops, challenges persist in maize. This research indicates the viability of remote sensing for nitrogen evaluation but suggests further exploration to enhance its applicability across different crops.

Keywords

Remote sensing, APEX sensor, Hyperspectral VIs, nitrogen content, crops

Comparison of Hyperspectral and Broad-Band Vegetation Indices for Estimation of Nitrogen Content in Grasslands

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Introduction

The role of nitrogen in ecological and agricultural systems is pivotal due to its influence on essential ecosystem processes and primary production rates. Nitrogen availability significantly impacts plant growth and crop yield, making it a crucial determinant among major plant nutrients. While artificial nitrogen supplementation is integral for optimizing crop productivity, mismanagement and over-application can lead to detrimental effects, profoundly altering the global nitrogen cycle.

Data and Method

This study explores the utility of hyperspectral vegetation indices derived from APEX hyperspectral data and simulated spectra from Sentinel-2 and Landsat TM. Regression analysis was employed to assess the effectiveness of these indices in estimating nitrogen content, investigating linear and exponential relationships in the regression models.

Results

Our findings reveal comparable correlations between vegetation indices based on Sentinel-2 and those derived from APEX, highlighting the potential of Sentinel-2 for nitrogen estimation. Moreover, the study highlights the significance of red-edge bands, which are absent in Landsat TM, showing limitations in nitrogen estimation using Landsat TM-derived indices.

Conclusions

This study underlines nitrogen's central role in ecological and agricultural systems and the challenges of its management. It explores remote sensing's potential, comparing hyperspectral data from APEX and Sentinel-2 with Landsat TM. Findings suggest Sentinel-2's effectiveness in nitrogen estimation, emphasizing the importance of red-edge bands absent in Landsat TM for accurate assessment of vegetation nitrogen content in grasslands.

Keywords

Remote sensing, APEX sensor, Hyperspectral VIs, nitrogen content, grasslands

SATELLITE IMAGE PROVIDERS

Unlocking New Horizons: Harnessing the Power of Worldview Legion and Umbra Radar Data for Comprehensive Earth Observation

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Introduction

In the rapidly advancing field of Earth observation, the integration of high-resolution optical and synthetic aperture radar (SAR) data has become essential for a comprehensive understanding of our dynamic planet. This presentation introduces a groundbreaking approach to Earth observation by synergizing data from the Worldview Legion optical satellite constellation and the advanced Umbra radar technology. The convergence of optical and SAR data presents an unprecedented opportunity to overcome limitations associated with traditional observation methods and revolutionize our ability to monitor and analyse Earth's diverse ecosystems.

Data and Method

The Worldview Legion constellation has exceptional spatial resolution of 0.3m and multispectral capabilities of 8 Bands with this it offers a wealth of information for monitoring land cover changes, vegetation health, and urban development. Concurrently, the integration of Umbra 0.25m radar data introduces a unique dimension to Earth observation, allowing for day-and-night, all-weather imaging with high penetration capabilities. By combining these two complementary datasets, a more comprehensive and timely understanding of environmental phenomena, natural disasters, and anthropogenic activities can be achieved.

Results & Conclusion

Combining VHR optical data with SAR data not only provides a more comprehensive understanding of the Earth's surface but also offers several other advantages:

1. **Nighttime imagery:** VHR optical data are limited to daylight conditions, but SAR data are independent of daylight and can capture imagery day or night.
2. **Weather independence:** Optical data are heavily influenced by weather conditions such as clouds, haze, and fog, while SAR data can penetrate through these atmospheric disturbances, providing consistent and reliable imagery regardless of weather conditions.

By integrating VHR optical data with SAR data, users can:

- **Enhance mapping accuracy:** The combination of optical and SAR data enables more accurate and detailed mapping of the Earth's surface, capturing both surface features and terrain characteristics.
- **Improve monitoring capabilities:** The integration of these data sources facilitates better monitoring of environmental changes, such as urban expansion, deforestation, and agricultural practices, over time.
- **Facilitate environmental analysis:** The complementary nature of VHR optical and SAR data allows for more in-depth environmental analysis, including land cover classification, vegetation monitoring, and soil moisture estimation.

Overall, the combination of VHR optical data with SAR data provides a powerful tool for various applications, including mapping, monitoring, and environmental analysis, while overcoming limitations such as nighttime imaging and weather dependence.

Keywords

VHR, Optical Satellite Data, WorldView, SAR, UMBRA, EUSI

Setting the SAR Benchmark with 24/7 Global Insights

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Introduction

Capella Space is the first US-based owned and operated commercial SAR (COMSAR) provider, providing access to high-resolution up to 25 cm imagery. The Capella constellation provides a high-revisit and low latency tasking and delivery system that allows for highly reactive tasking through their Console UI and API that connect users to a fully-automated constellation scheduling operations interface.

This presentation

The requirements for remote sensing data providers in terms of spatial and temporal resolution are growing with the technical capabilities of modern small satellite constellations. Through their fully automated scheduling system clients of Capella can easily, quickly, and effectively task Capella VHR SAR data, which can subsequently be downloaded directly via Capella's image tasking platform Console and API. This service enables near-real-time tasking of the constellation with no human in the loop, translating into full automation of task scheduling, secure and private customer operations, and speedy data processing and delivery to enable access to global monitoring where and when you need it.

During this presentation it will be explained in detail what is meant with:

- High-Quality - Very high resolution and low noise leads to enhanced image clarity
- Timely - Rapid fully-automated order-to-delivery means faster speed to insight
- Frequent - Increasing high-cadence revisit timeframes as our constellation grows
- Accessible - Intuitive online platform with self-serve catalog search, ordering and tasking Capella's high-resolution SAR satellites are matched with unparalleled infrastructure to deliver reliable global insights that sharpen our understanding of the changing world – improving decisions about commerce, conservation, and security on Earth.

Capella SAR data is used for time-critical applications in, among others, the D&I, disaster management, and maritime monitoring domains. Especially Capella's focus on building a SAR satellite constellation using a mixture of mid-inclined and polar orbits provides unique opportunities for customers to image at any time during day or night, in any weather conditions. Additionally, Capella offers a diverse range of analytics based on its own data, ranging from Change Detection to Object Identification.

Keywords

Very-High Resolution, Synthetic Aperture Radar (SAR), New Space, Small Sats

Space within Your Reach - AXELSPACE Corporation Services Introduction

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The global competition to develop microsatellites was triggered by the successful launch of a microsatellite developed by Japanese university students in 2003. Convinced that microsatellites offered future promise, a few space enthusiasts have established a commercial company named Axelspace in 2008. Since the launch of Weathernews' WNISAT-1 satellite in 2013, nine satellites have been launched and operated by March 2021 in total. Not only that, we launched the AxelGlobe business in 2015, and we are also deeply involved in an Earth Observation domain providing services based on our own satellite constellation. AXELSPACE is the first and only Japanese company providing optical data with a nearly daily revisit rate.

AXELSPACE Corporation has been established in 2008 by University of Tokyo and Tokyo Institute of Technology alumni/former members who recognized their chance in starting the commercial activity related to space and satellite development. As students and scientists, our founders have been involved in research projects in the space domain and these activities have strengthened their self-confidence that “space is within their reach” not only as an experimental, but also as a commercial and profitable activity. Since its foundation, AXELSPACE has been involved in many commercial projects where we have been responsible for consulting, design, development, assembly, launch and, in many cases, operational part of the project. Some of our milestone projects are the following: in 2013 and 2017 we delivered WNISAT-1 and WNISAT-1R, commercial Earth Observation (EO) satellites for Weathernews Inc developed and launched in order to observe sea ice in the Arctic Ocean. Both satellites improved Weathernews business services for maritime applications. In 2014, in cooperation with the University of Tokyo, we have developed Hodoyoshi-1 - equipped with an optical sensor capable of taking images with a ground resolution of 6.7m and an observation width of approximately 28km, observing the earth from a sun-synchronous orbit at an altitude of 500km.

Our experience gathered during these successful projects motivated the team to launch our own investment in a project named AxelGlobe, where our motivation was to start a low cost and highly efficient earth observation satellite constellation. In 2018, we have launched our first satellite from AxelGlobe's GRUS-1 fleet providing images in panchromatic (GSD: 2.5 m) and multi-spectral (5.0 m, 5 bands) modes. The first GRUS, named 1A, proved the concept and then, in 2021, the next 4 siblings joined the constellation providing 2 days revisit rate over the majority of our Globe. All data captured by the GRUS-1 constellation is accessible via our own platform: Axelglobe.com, where each registered user is able to check our archives and order data.

In 2019 AXELSPACE has been selected by JAXA (Japan Aerospace Exploration Agency) as a service provider for the development and operation of RAPIS-1, which served JAXA to finalize 7 technology demonstration projects. RAPIS-1 was the first case when JAXA outsourced development and operation to an external organization.

In AXELSPACE we continue our development, and soon we will launch new EO constellation precursor which will open the next chapter of our AxelGlobe services and will improve our capacity.

Pixxel: High-Resolution Hyperspectral Satellite Imagery

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Introduction

Hyperspectral Imagery has its genesis in medical imaging and astronomy, allowing for the detection of diseased tissue in laboratory environments, or classifying distant planets, stars, and constellations from telescopes. It has been adapted and utilised in the remote sensing industry from airborne platforms and drones widely for the detection of minerals, chemicals and contaminants, more discriminate habitat and species classification, and precision agricultural use cases. These platforms however, lack scalability and regularity. A gap has existed in the availability of hyperspectral from space. Pixxel is seeking to fill this gap, by launching 5-metre, 250-band imagery with a daily revisit.

Data

Pixxel is launching two distinct satellites and sensors. The Firefly constellation will carry a VNIR hyperspectral sensor, with a 5-metre spatial resolution and over 150-bands between 470nm-900nm to select from. The Honeybee constellation will carry both a 5-metre VNIR and a SWIR sensor, covering 470nm-2500nm, offering over 250-bands to select from. We will be launching satellites from July 2024, aiming to have daily VNIR by the end of the year (commissioned) and daily SWIR by the end of 2025.

Conclusion

Hyperspectral data is the next epoch in space, enabling more detailed understanding of our environment, rapidly and with high accuracy. We are able to go further through hierarchical habitat schema, enabling biodiversity measurement at scale, we are able to detect minerals and chemicals/contamination from space, and determine detailed biochemical signals from vegetation enabling precision agriculture and spotting disease before it takes hold.

Keywords

Hyperspectral, Narrowband Indices, Satellite, Spatial, Spectral.

Introducing Pléiades Neo and OneAtlas

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Introduction

In this presentation we will discuss how space based remote sensing impacts daily activities on earth and showcase how increased resolution coupled with a high-end accessing mechanism to data provides tangible improvements in various market verticals.

In this case, specifically, we will showcase the capabilities of the Pléiades Neo constellation and the OneAtlas platform.

Data and Method

Data provided by various satellite constellation may be used for comparison, however, in this case, we choose to focus exclusively on the merits of Pléiades Neo and OneAtlas without providing a comparison but rather offer a qualitative approach which aim to showcase the qualities of the systems discussed.

Results

Two years from the launch of the mentioned above systems it clearly shows, by the high demand for the 30 cm resolution class imagery provided by Pléiades Neo that the systems' capabilities have a substantial impact on various market segments and users which traditionally uses space based remote sensing data.

Conclusion

In conclusion, the increased capabilities provided by Pléiades Neo along with the flexibility of OneAtlas brings true value to end users globally.

Keywords

Pléiades Neo, OneAtlas, Remote sensing, Satellites, imagery

Abstract by Session and Date/Time

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4	Satellite Image Providers	Sat	09/5/24	10:15
5	Satellite Image Providers	Sat	09/5/24	10:15
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14886	Engineering Surveying, BIM and GIS	s1.3	09/5/24	13:00
14893	Engineering Surveying, BIM and GIS	s1.3	09/5/24	13:00
14894	Engineering Surveying, BIM and GIS	s2.3	09/5/24	16:30
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15195	Land Management and Cadastre	s4.3	10/5/24	10:45
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15198	Artificial Intelligence	s4.2	10/5/24	10:45
15199	Environmental Monitoring	s5.1	10/5/24	13:15
15200	Photogrammetry and Remote Sensing	s1.2	09/5/24	13:00
15201	Environmental Monitoring	s5.1	10/5/24	13:15
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15208	Environmental Monitoring	s2.1	09/5/24	16:30
15209	Engineering Surveying, BIM and GIS	s1.3	09/5/24	13:00
15210	Photogrammetry and Remote Sensing	s1.2	09/5/24	13:00
15211	Engineering Surveying, BIM and GIS	s5.3	10/5/24	13:15
15214	Artificial Intelligence	s5.2	10/5/24	13:15
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15223	Poster session	Poster	09/5/24	14:30
15224	Environmental Monitoring	s2.1	09/5/24	16:30
15225	Environmental Monitoring	s5.1	10/5/24	13:15
15228	Photogrammetry and Remote Sensing	s1.2	09/5/24	13:00
15231	Poster session	Poster	09/5/24	14:30
15232	Engineering Surveying, BIM and GIS	s3.3	10/5/24	09:00

15233	Poster session	Poster	09/5/24	14:30
15234	Engineering Surveying, BIM and GIS	s3.3	10/5/24	09:00
15235	Engineering Surveying, BIM and GIS	s5.3	10/5/24	13:15
15237	Poster session	Poster	09/5/24	14:30
15238	Photogrammetry and Remote Sensing	s1.2	09/5/24	13:00
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15244	Poster session	Poster	09/5/24	14:30
15245	Poster session	Poster	09/5/24	14:30
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15252	Artificial Intelligence	s4.2	10/5/24	10:45
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15254	Environmental Monitoring	s3.1	10/5/24	09:00
15255	Artificial Intelligence	s4.2	10/5/24	10:45
15260	Artificial Intelligence	s5.2	10/5/24	13:15
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15264	Photogrammetry and Remote Sensing	s3.2	10/5/24	09:00
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15272	Artificial Intelligence	s6.1	10/5/24	15:00
15275	Environmental Monitoring	s3.1	10/5/24	09:00
15276	Artificial Intelligence	s6.1	10/5/24	15:00
15277	Photogrammetry and Remote Sensing	s2.2	09/5/24	16:30
15278	Artificial Intelligence	s6.1	10/5/24	15:00
15279	Environmental Monitoring	s3.1	10/5/24	09:00
15280	Environmental Monitoring	s3.1	10/5/24	09:00
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15283	Engineering Surveying, BIM and GIS	s5.3	10/5/24	13:15
15284	Poster session	Poster	09/5/24	14:30
15287	Photogrammetry and Remote Sensing	s2.2	09/5/24	16:30
15288	Photogrammetry and Remote Sensing	s2.2	09/5/24	16:30
15290	Photogrammetry and Remote Sensing	s3.2	10/5/24	09:00
15293	Environmental Monitoring	s4.1	10/5/24	10:45
15294	Engineering Surveying, BIM and GIS	s3.3	10/5/24	09:00
15296	Engineering Surveying, BIM and GIS	s6.2	10/5/24	15:00
15297	Environmental Monitoring	s4.1	10/5/24	10:45
15298	Poster session	Poster	09/5/24	14:30
15301	Artificial Intelligence	s6.1	10/5/24	15:00
15306	Poster session	Poster	09/5/24	14:30
15308	Land Management and Cadaster	s4.3	10/5/24	10:45
15310	Engineering Surveying, BIM and GIS	s5.3	10/5/24	13:15
15311	Photogrammetry and Remote Sensing	s1.2	09/5/24	13:00
15312	Photogrammetry and Remote Sensing	s3.2	10/5/24	09:00
15313	Artificial Intelligence	s5.2	10/5/24	13:15
15315	Artificial Intelligence	s6.1	10/5/24	15:00
15318	Engineering Surveying, BIM and GIS	s3.3	10/5/24	09:00
15325	Photogrammetry and Remote Sensing	s3.2	10/5/24	09:00

15326	Land Management and Cadaster	s4.3	10/5/24	10:45
15327	Environmental Monitoring	s4.1	10/5/24	10:45
15328	Photogrammetry and Remote Sensing	s2.2	09/5/24	16:30
15330	Artificial Intelligence	s5.2	10/5/24	13:15
15334	Poster session	Poster	09/5/24	14:30
15335	Engineering Surveying, BIM and GIS	s6.2	10/5/24	15:00
15336	Poster session	Poster	09/5/24	14:30
15342	Photogrammetry and Remote Sensing	s2.2	09/5/24	16:30
15348	Artificial Intelligence	s4.2	10/5/24	10:45
15350	Environmental Monitoring	s4.1	10/5/24	10:45
15356	Environmental Monitoring	s1.1	09/5/24	13:00
15359	Engineering Surveying, BIM and GIS	s2.3	09/5/24	16:30
15360	Environmental Monitoring	s2.1	09/5/24	16:30
15362	Engineering Surveying, BIM and GIS	s6.2	10/5/24	15:00
15366	Environmental Monitoring	s4.1	10/5/24	10:45
15555	Environmental Monitoring	s2.1	09/5/24	16:30

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