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Land-Water Classification for Satellite Images

D.V. Ravi Kumar[1], V.V.V.Lakshman[2], M.Trylokya[3], M.Lakshman Rao[4], K.Bhagya Sri[5]
[1]M.Tech, (Ph.d), Associate Professor, [2, 3, 4, 5]B.Tech student, Department of CSE, Aditya College of Engineering and Technology, Surampalem

Abstract: Satellite image analysis plays a crucial role in fields such as environmental monitoring, urban planning, agriculture, and disaster management. This project presents a machine learning-based methodology for the automated segmentation and classification of objects in satellite images. The proposed system employs a two-step algorithm: (1) K-Means clustering for unsupervised segmentation of satellite images into meaningful clusters, and (2) Support Vector Machine (SVM) for supervised classification of the segmented regions into predefined categories such as land, water, and vegetation. A Flask-based web application is developed to provide a userfriendly interface for uploading satellite images and visualizing classified results. The backend is supported by a structured SQL database to manage image metadata and classification outputs efficiently. The system is designed to handle large datasets, ensuring robustness and scalability. Experimental results on benchmark datasets demonstrate high accuracy in object detection and classification, highlighting the system's potential to support real-world decision-making in environmental and infrastructural domains.
Keywords: Satellite image analysis, K-Means clustering, SVM, Flask, object recognition, SQL database

I. INTRODUCTION

The Satellite image analysis has emerged as a critical tool in various domains, including environmental monitoring, urban planning, agriculture, and disaster management. The ability to accurately identify and classify objects in satellite images is essential for informed decisionmaking and resource allocation. Traditional image analysis techniques often struggle with the complexity and high dimensionality of satellite data, necessitating the adoption of advanced machine learning algorithms for enhanced accuracy and scalability

This project presents a machine learning-based approach for the segmentation and classification of satellite images using a two-step algorithm. First, K-Means clustering is employed for unsupervised segmentation of satellite images into distinct clusters, enabling the identification of homogeneous regions based on pixel similarity. Next, a Support Vector Machine (SVM) is used for supervised classification of the segmented regions into meaningful categories such as land, water, and vegetation. This hybrid approach combines the advantages of both unsupervised and supervised learning, enhancing the precision and reliability of object recognition. The system is implemented as a Flask-based web application, providing a user-friendly interface for image uploading and real-time classification. A structured SQL database is integrated to store and manage image metadata and classification results efficiently. The platform is designed to handle large datasets, ensuring scalability and robustness. Experimental results on benchmark satellite datasets demonstrate the system's effectiveness in recognizing and classifying objects with high accuracy, highlighting its potential for real-world applications in infrastructure planning, environmental assessment, and disaster response.

II. PROBLEM STATEMENT

Accurate and efficient analysis of satellite images is essential for various applications such as environmental monitoring, urban planning, agriculture, and disaster management. Traditional image analysis techniques often fail to handle the complexity and high dimensionality of satellite data, leading to inaccuracies in object recognition and classification. The lack of a scalable and automated solution for segmenting and classifying satellite images creates a gap in realtime decision-making and resource allocation.

This project aims to develop an AI-based system for the automated segmentation and classification of satellite images using a combination of KMeans clustering and Support Vector Machine (SVM) algorithms. K-Means clustering will be employed to segment satellite images into meaningful clusters, while SVM will be used for accurate classification of these segments into predefined categories such as land, water, and vegetation. The system will be implemented as a Flask-based web application, integrated with a structured SQL database for efficient data management.

The primary objective is to create a scalable and robust platform that enables high-accuracy object recognition and classification in satellite images. This solution will support real-world applications in urban infrastructure development, environmental assessment, crop monitoring, and disaster management by providing fast and reliable insights from satellite data.

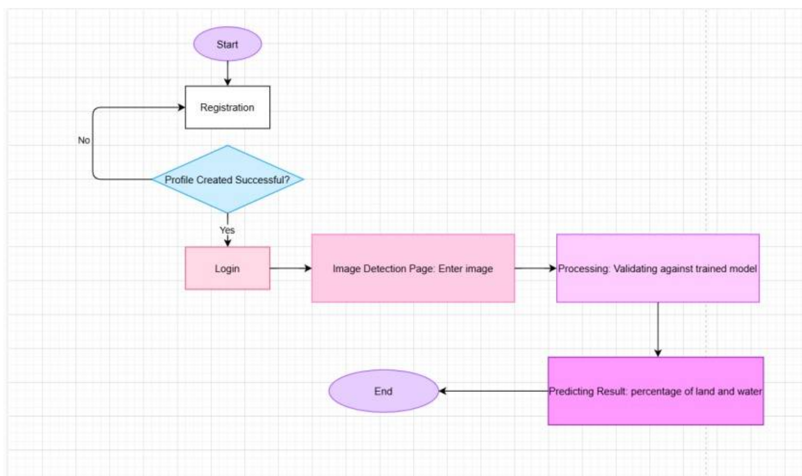
III. PROPOSED SYSTEM

To address the challenges associated with satellite image analysis, this project proposes a machine learning-based system for automated segmentation and classification of satellite images. The system follows a two-step approach combining both unsupervised and supervised learning techniques to enhance accuracy and scalability.

1) The first step involves segmenting satellite images into distinct clusters using the K-Means clustering algorithm. K-Means efficiently groups similar pixels based on color and texture, enabling the identification of homogeneous regions such as land, water, and vegetation. This step reduces the complexity of the data and simplifies further analysis.
2) Once the image is segmented, a Support Vector Machine (SVM) classifier is employed to categorize the segments into predefined classes. SVM is chosen for its high accuracy and ability to handle complex patterns in data. This supervised learning approach improves the precision of object recognition and classification.
3) The system will be implemented as a Flask-based web application, providing an intuitive interface for uploading satellite images and visualizing classified outputs. The platform will allow users to interact with the system in real time, making it accessible and easy to use.
4) A structured SQL database will be integrated to store and manage image metadata and classification results efficiently. The database will support fast retrieval of results and ensure data consistency and scalability.

IV. WORKING

A. Block diagram:



B. Preprocessing

To improve the accuracy of classification, the satellite images undergo preprocessing steps:

1) Image Acquisition: The system accepts high-resolution satellite images from publicly available datasets.
2) Image Resizing: Standardizes image dimensions to ensure uniform feature representation.
3) Color Space Conversion: Converts RGB images into grayscale or HSV color space for effective segmentation.
4) Noise Reduction: Gaussian filtering is applied to reduce noise while preserving significant details in the images.

C. K-Means Clustering For Segmentation

K-Means Clustering is utilized for unsupervised segmentation of satellite images to classify pixels into different land cover types such as water bodies, land, and vegetation.

1) Step 1: Convert the image into a feature space suitable for clustering (e.g., pixel intensity, color channels, and texture).
2) Step 2: Define the number of clusters (K) representing major land cover types.
3) Step 3: Assign initial cluster centroids and update them iteratively using the Euclidean distance metric to minimize intra-cluster variance.
4) Step 4: Assign each pixel to the nearest cluster, forming distinct land and water regions.
5) Step 5: Generate segmented images to be further classified using machine learning techniques.

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D. Feature Extraction

The segmented regions undergo feature extraction to differentiate between land, water, and vegetation. The extracted features include:

1) Texture Features: Gray Level Cooccurrence Matrix (GLCM), Local Binary Patterns (LBP).
2) Color Features: Histogram-based analysis to differentiate between water, land, and vegetation regions.
3) Edge Detection: Canny edge detection to identify land boundaries and water body contours.

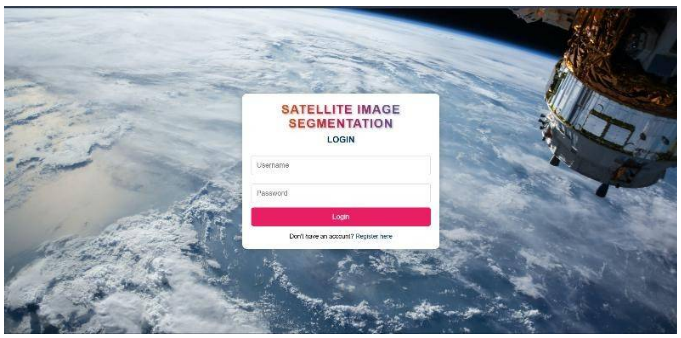
E. SVM For Classification

A supervised Support Vector Machine (SVM) model is trained to classify the segmented regions into predefined categories:

1) Training Phase: Features from labeled satellite images are used to train an SVM classifier.
2) Classification Phase: The trained model assigns each segmented region to a category (e.g., land, water, vegetation).
3) Evaluation Metrics: The system's performance is assessed using

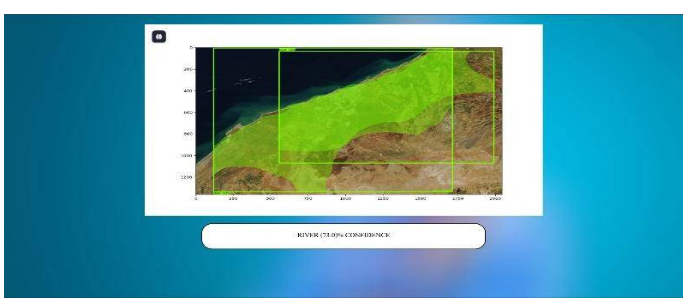
- Accuracy: Measures the overall correctness of classification.
- Precision and Recall: Evaluates the system's ability to distinguish between different land cover types.
- F1-Score: Provides a balanced measure of precision and recall.

F. Output



Home page

User page



Output page

V. CONCLUSION

The proposed K-Means and SVM-based classification system provides an effective approach for satellite image analysis by combining unsupervised segmentation and supervised classification. The K-Means clustering algorithm efficiently segments satellite images into distinct land cover types, while the Support Vector Machine (SVM) classifier accurately categorizes these regions into predefined classes such as land, water, and vegetation.

Through feature extraction techniques like GLCM, LBP, and edge detection, the system enhances classification precision, ensuring high accuracy, scalability, and robustness. The experimental results demonstrate the model's ability to handle complex satellite imagery, making it highly applicable for environmental monitoring, disaster management, and urban planning.

VI. FUTURE ENHANCEMENTS

Optimizing the system for high-resolution satellite imagery will involve implementing GPU-based parallel processing to accelerate segmentation and classification. Expanding the system to analyze multi-spectral and hyperspectral images will enable more detailed land cover classification, including the assessment of soil quality, vegetation health, and water pollution levels. The incorporation of remote sensing indices such as the Normalized Difference Vegetation Index (NDVI) will further enhance environmental monitoring and resource management capabilities.

Deploying the system on cloud platforms such as AWS, Google Cloud, or Azure will enable real-time, large-scale satellite image classification. Developing an API-based framework will allow for seamless integration with geospatial applications, enabling automated data processing for various industries. The integration of Geographic Information Systems (GIS) will facilitate spatial mapping and in-depth analysis of classified land cover areas, while leveraging platforms like Google Earth Engine (GEE) will improve automation and large-scale analysis.User accessibility can be enhanced by developing an interactive web-based dashboard for real-time image uploads, visualization of classification results, and statistical analysis of land cover data.

REFERENCES

[1] Zaaj I.,Brahim C.Khalil ,Extraction of building in satellite image THR using feature detection, International Journal of Computer Applications, vol.181, No.10,pp. 23-27, 2018.

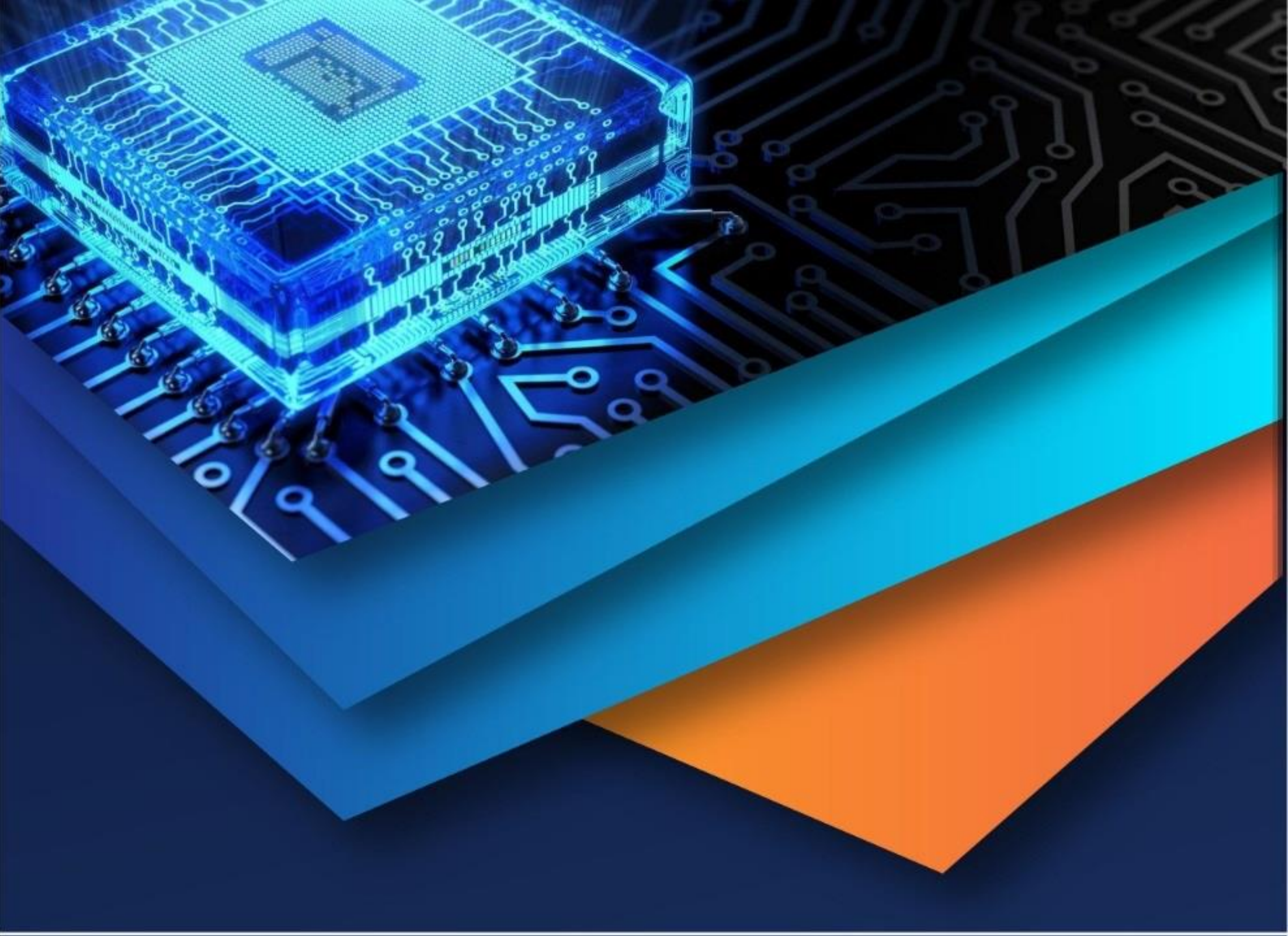
[2] Sharma P., Computer Vision Tutorial: A Stepby-Step Introduction to Image Segmentation Techniques.,https://www.analyticsvidhya.com/blog/2019/04/introductionimage-segmentationtechniques, 2019.

[3] Yin, S., Zhang, Y., & Karim, S. Large scale remote sensing image segmentation based on fuzzy region competition and gaussian mixture model, IEEE Access, vol 6,pp. 26069- 26080, 2018.

[4] W. Wu, H. Li, L. Zhang, X. Li, and H. Guo, "High-resolution PolSAR scene classification with pretrained deep convnets and manifold polarimetric parameters," IEEE Trans. Geosci. Remote Sens., vol. 56, no. 10, pp. 6159–6168, Oct. 2018.

[5] Fawwaz, I., Zarlis, M. & Rahmat R. F, The edge detection enhancement on satellite image using bilateral filter. IOP Conference Series: Materials Science and Engineering,vol.308,no.1,p. 012052, 2018

[6] Chethan K.S., Sinchana G.S.,Dr. Nataraj K.R.,Dr.Choodarathnakara A.L., Analysis of image quality using sobel filter, International Conference on Inventive Systems and Control IEEE Explore Part Number CFP19J06- ART,pp.526-531, 2019.



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