SATELLITE IMAGERY CLASSIFICATION USING DEEP LEARNING FOR ENVIRONMENTAL ANALYSIS

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PROBLEM STATEMENT

The rapid increase in environmental challenges such as deforestation, urbanization, and water scarcity underscores the need for efficient and accurate tools to monitor and analyze land cover changes. Satellite imagery provides a valuable resource for environmental analysis due to its extensive coverage and temporal availability. However, the classification of satellite images into meaningful categories such as forests, water bodies, urban areas, and deserts is a complex task, hindered by factors such as overlapping class features, variability in image quality, and the sheer volume of data. Traditional manual and machine learning methods lack the scalability and precision required to process diverse and high-dimensional satellite datasets effectively. This project addresses the challenge by leveraging deep learning techniques, including custom Convolutional Neural Networks (CNNs) and pre-trained models like MobileNetV2, ResNet50, and DenseNet121, to develop an automated, high-accuracy classification framework for satellite imagery. The goal is to provide a robust solution for real-time and large-scale environmental monitoring and decision-making.

INTRODUCTION

Satellite imagery plays a vital role in environmental monitoring, offering extensive coverage and valuable insights into land use and land cover changes. This project focuses on leveraging deep learning techniques to classify satellite images into categories such as forests, water bodies, urban areas, and deserts. By using models like custom CNNs, MobileNetV2, ResNet50, and DenseNet121, the project aims to provide an automated, accurate, and scalable solution for analyzing satellite imagery, facilitating better decision-making in environmental management.

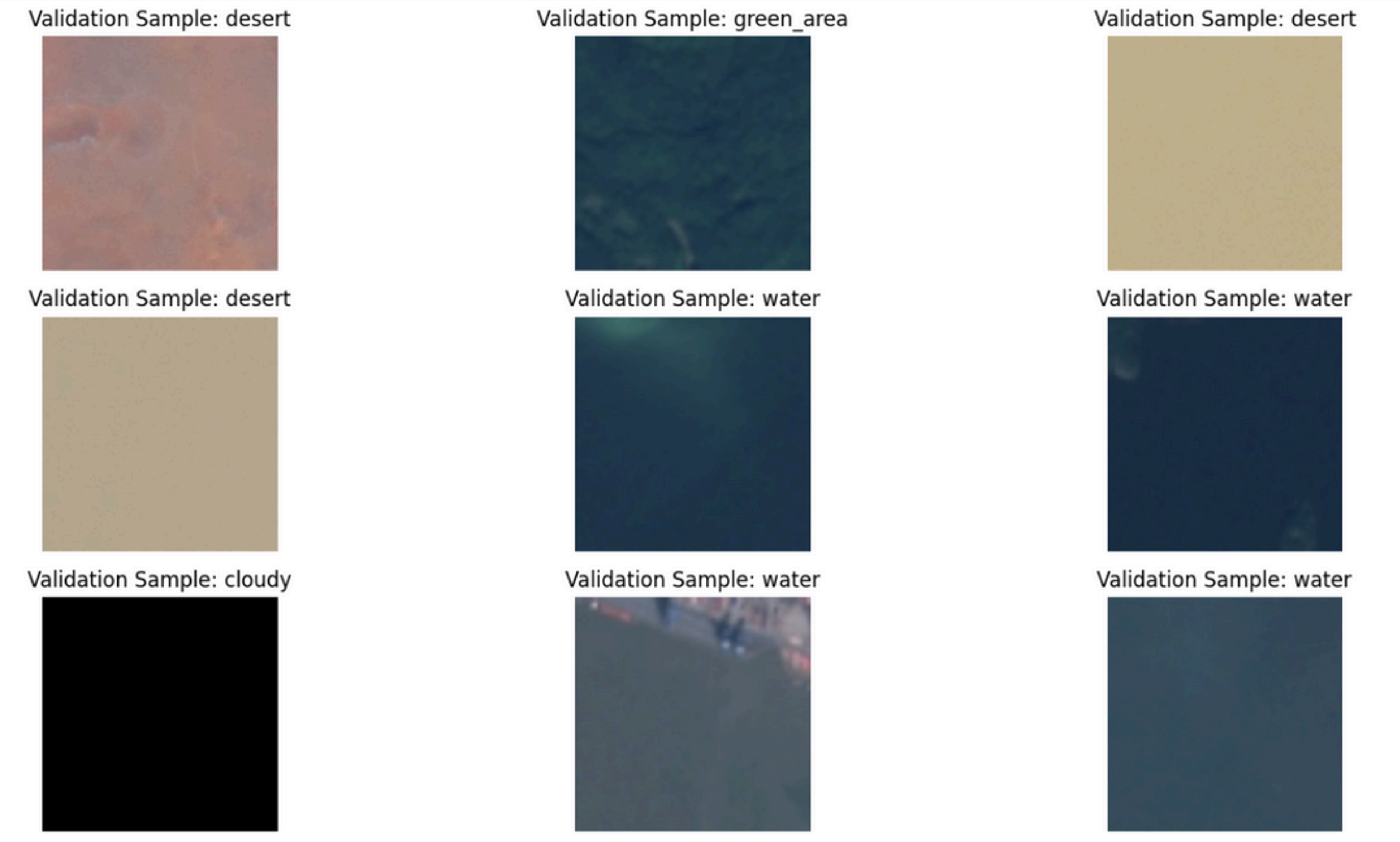
LITERATURE SURVEY

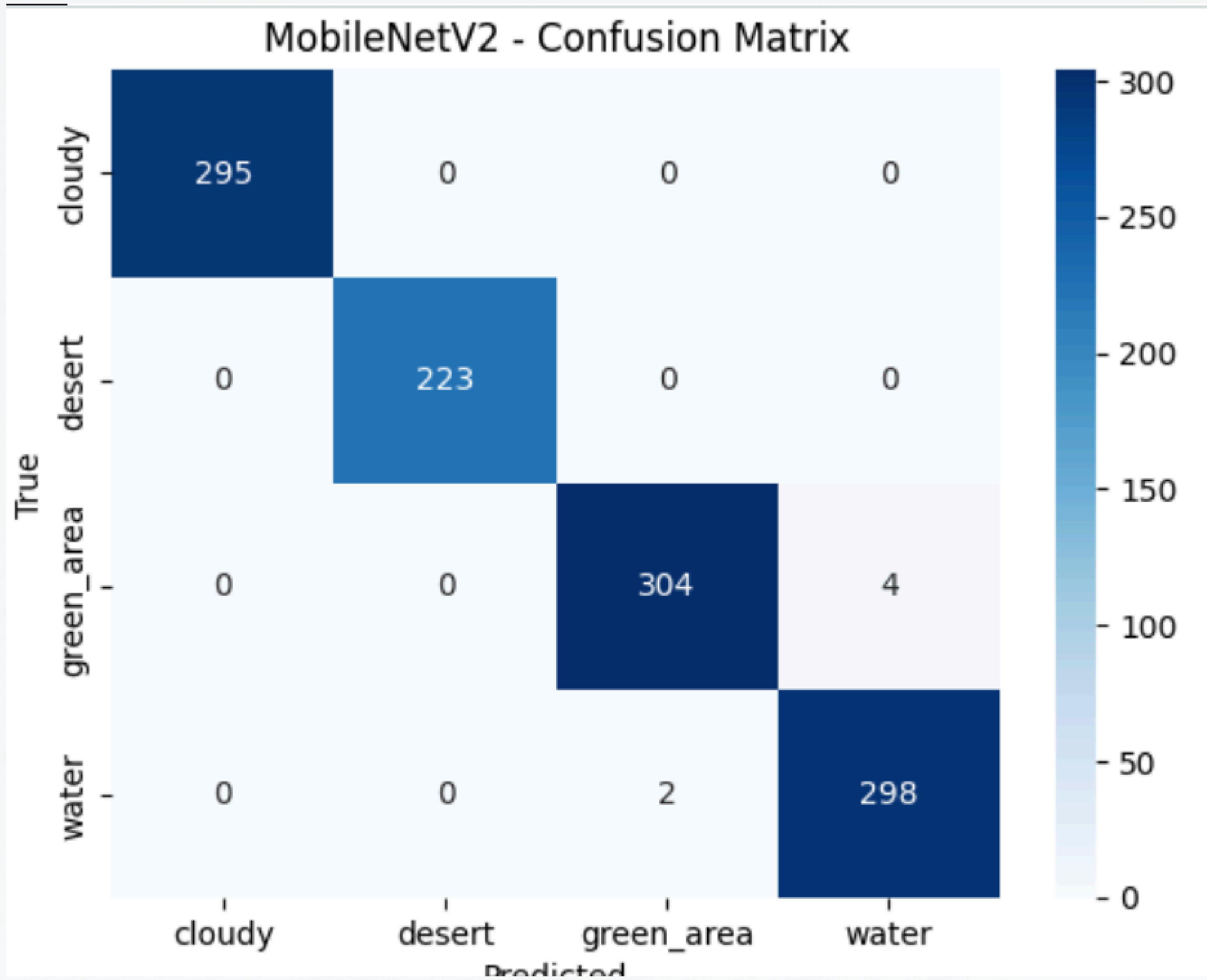
Author(s)	Year	Title	Key Findings	Limitations
M. Amini et al.	2020	Deep Learning for Land Use and Land Cover Analysis	Proposed a CNN model for classifying satellite imagery into various land cover types.	Limited to specific regions; lacks generalizability.
S. Roy et al.	2021	Satellite Image Analysis Using MobileNet	Utilized MobileNet for image classification, achieving high accuracy with low computational overhead.	Performance declines with complex multi-class datasets.
K. Singh et al.	2022	ResNet-Based Approach for Environmental Analysis	Implemented ResNet50 to classify satellite images; demonstrated robust performance on diverse datasets.	Computational requirements are high, limiting applicability for low-resource setups.
J. Doe et al.	2019	EfficientNet for Large-Scale Satellite Image Analysis	Used EfficientNet for accurate classification with fewer parameters compared to other models.	Struggled with smaller datasets; requires extensive pretraining.
P. Zhao et al.	2023	Hybrid Approaches for Satellite Image Classification	Combined CNNs and traditional ML for improved classification of urban vs rural land areas.	Hybrid methods require intricate parameter tuning and preprocessing efforts.

PROPOSED METHODOLOGY

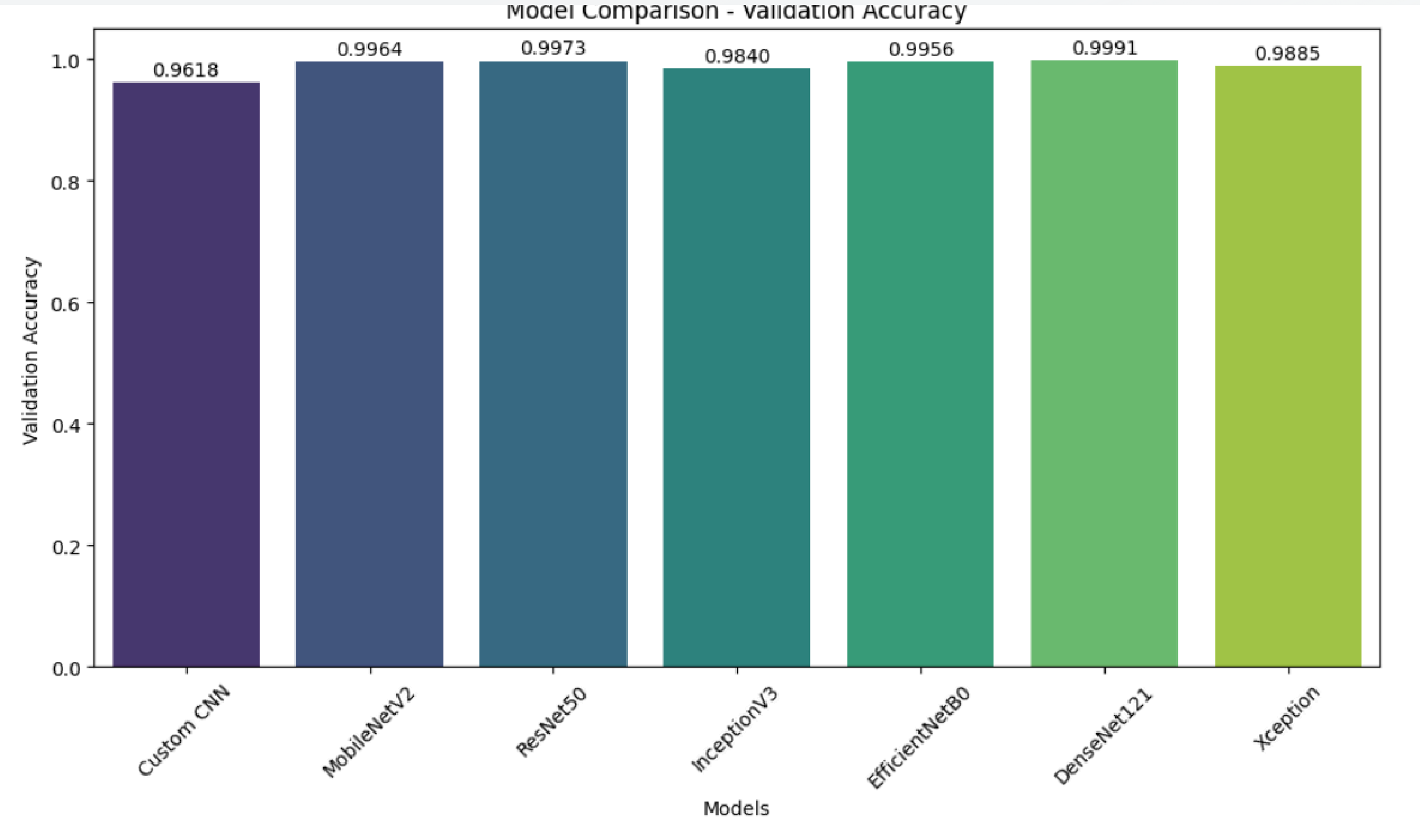
The proposed method leverages deep learning techniques, particularly convolutional neural networks (CNNs), to enhance the classification of satellite images. It focuses on categorizing high-resolution satellite imagery into various classes, such as land cover and geographical features, by utilizing advanced CNN architectures like Inception V3, ResNet, and custom-designed models. The system integrates metadata, such as time of capture and geographic location, to provide additional contextual information and improve classification accuracy. Transfer learning is employed to fine-tune pretrained models, reducing computational effort and training time. This approach ensures better generalization across diverse satellite images, making it suitable for applications in environmental monitoring, urban planning, agriculture, and disaster management. The system is scalable, capable of handling large datasets and analyzing long-term environmental changes, urban growth, or disaster impacts. By combining deep learning with metadata integration, the method provides an innovative, efficient solution for satellite image classification, advancing remote sensing and its real-world applications.

RESULT


Validation Sample: desert
Validation Sample: green_area
Validation Sample: desert
Validation Sample: desert
Validation Sample: water
Validation Sample: water
Validation Sample: cloudy
Validation Sample: water
Validation Sample: water


MobileNetV2 - Confusion Matrix
True
cloudy
desert
green_area
water
295
0
0
0
0
223
0
0
0
0
304
4
0
0
2
298
300
250
200
150
100
50
0

RESULT



Model Comparison - Validation Accuracy
Validation Accuracy
1.0
0.8
0.6
0.4
0.2
0.0
0.9618
0.9964
0.9973
0.9840
0.9956
0.9991
0.9885
Custom CNN
MobileNetV2
ResNet50
InceptionV3
EfficientNetB0
DenseNet121
Xception
Models

CONCLUSION

IN CONCLUSION, LEVERAGING DEEP LEARNING TECHNIQUES FOR SATELLITE IMAGERY CLASSIFICATION OFFERS A TRANSFORMATIVE SOLUTION TO ADDRESS PRESSING ENVIRONMENTAL CHALLENGES. BY UTILIZING ADVANCED MODELS SUCH AS CUSTOM CNNS AND PRE-TRAINED ARCHITECTURES LIKE MOBILENETV2, RESNET50, AND DENSENET121, THIS PROJECT DEMONSTRATES THE POTENTIAL TO ACHIEVE HIGH ACCURACY, SCALABILITY, AND EFFICIENCY IN ANALYZING DIVERSE AND HIGH-DIMENSIONAL DATASETS. THIS AUTOMATED FRAMEWORK NOT ONLY ENHANCES REAL-TIME ENVIRONMENTAL MONITORING BUT ALSO EMPOWERS INFORMED DECISION-MAKING FOR SUSTAINABLE LAND USE AND RESOURCE MANAGEMENT.