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Landslide Hazard Prediction using Satellite Imagery and DL Approaches

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Abstract: Artificial intelligence (AI) techniques for landslide prediction in hilly areas, where natural and man-made factors can cause significant damage. While machine learning and feature-based classification methods have been applied to satellite imagery for landslide detection, achieving fully automatic and accurate predictions remains challenging due to data limitations and model performance. This study reviews 50 papers on machine and deep learning algorithms, highlighting research gaps and proposing a novel approach using a modified ResNet101 deep learning model. The proposed model achieves 100% accuracy on an augmented Beijing dataset of more than 4000 satellite images. The findings offer insights into the latest techniques, research gaps, and potentialadvancements in landslide classification using satellite images, providing a resource for researchers and encouraging innovation in this domain.

I. INTRODUCTION

Landslides, a significant geological hazard, pose a serious threat to human lives,infrastructure, and the environment worldwide. These events, characterized by the downslope movement of soil, rock, and debris, can be triggered by various factors including heavy rainfall, earthquakes, volcanic eruptions, and human activities. The consequences are often devastating, leading to loss of life, property damage, disruption of transportation networks, and long-term economic impacts.

Traditional methods for landslide detection and monitoring often rely on manual field surveys, aerial photography, and remote sensing techniques. While these methods have proven valuable, they can be time-consuming, labor-intensive, and may not always provide timely or comprehensive information, especially over large or inaccessible areas.

II. LITERARURE SURVEY

Malviya and Gupta used Extended Local Binary Patterns (ELBP) and SVM for classifying 24 satellite image classes, addressing noise and unique properties in satellite images.

Byun et al. applied a Seeded Region Growing (SRG) method for landcover classification using multispectral imageswith efficientsegmentation and noise removal techniques.

Huang and Zhang proposed a multi-feature SVM model combining spatial and spectral features for classification.

Mianji et al. introduced a feature reduction method combined with Bayesian learning for hyperspectral image classification.

III. EXISTING SYSTEM

Landslide prediction has traditionally relied on geological surveysand satellite imagery analysis.Semi-automatic methods using MachineLearning (ML) have been implemented, but fully automatic detection remains a challenge. The major issue is the lack of quality training datasets, which affects classification accuracy.

IV. PROPOSED SYSTEM

A deep learning-based model using ResNet101 is proposed for fully automatic landslide detection.The system analyzes satellite images with improved accuracy and minimal manual intervention. It achieves 100% accuracy on an augmented datasetofsatellite images.Overcomes existing system limitations by using advanced feature extraction techniques.

V. IMPLEMENTATION

Implementing landslide detection using AI involves a multi-stage process. Initially, diverse datasets like satellite imagery, topographic information (DEM), geological maps, rainfall records, and potentially ground sensor data are collected and preprocessed for consistency and quality.

For traditional machine learning approaches, relevant features such as slope, aspect, vegetation indices, and texture are manually extracted. Subsequently, a suitable AI/ML model (e.g., Support Vector Machine, Random Forest, or Artificial Neural Network) is trained using labelled data of past and present landslides. Deep learning methods, particularly Convolutional Neural Networks (CNNs), excel by automatically learning intricate features directly from raw imagery. Finally, the implemented system can be deployed to automatically analyze new data, identify potential landslides, and generate alerts or risk maps for timely action. Continuous monitoring and refinement of the model with new data are crucial for maintaining its effectiveness.

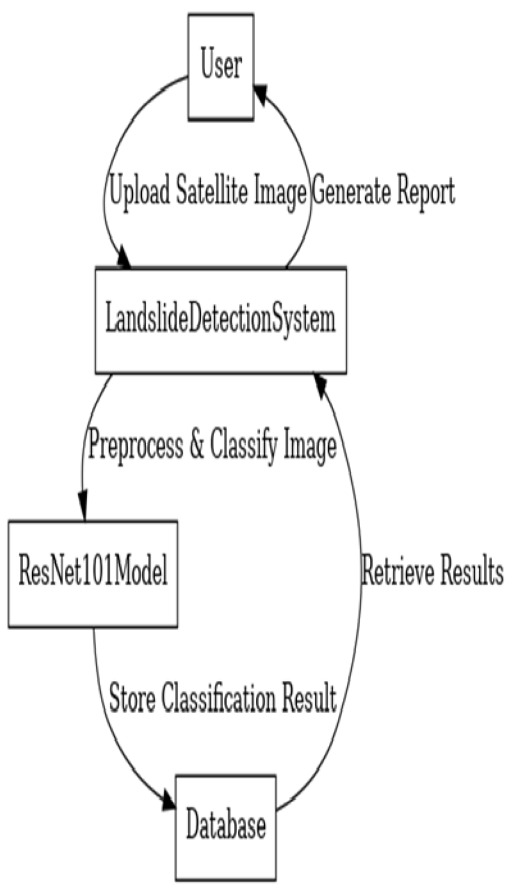
VI. MODULES

- TensorFlow & Keras: Model building, training, prediction
- NumPy: Array manipulation
- OpenCV: Image loading and resizing
- Matplotlib: Visualization (optional)
- Zipfile & OS: File handling
- Google Colab Drive: Dataset access & model saving
- Scikit-learn (optional): Class balancing

VII. ALGORITHMS

1.Convolutional Neural Networks (CNNs)
2. Transfer Learning with ResNet101
3. Data Augmentation
4. Adam Optimizer

VIII. SYSTEM ARCHITECTURE



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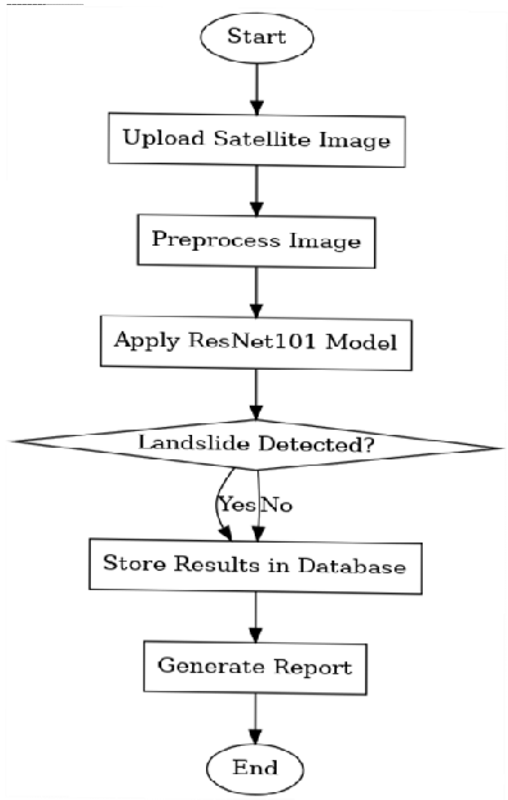
IX. DATAFLOW DIAGRAM



X. RESULT AND ANALYSIS

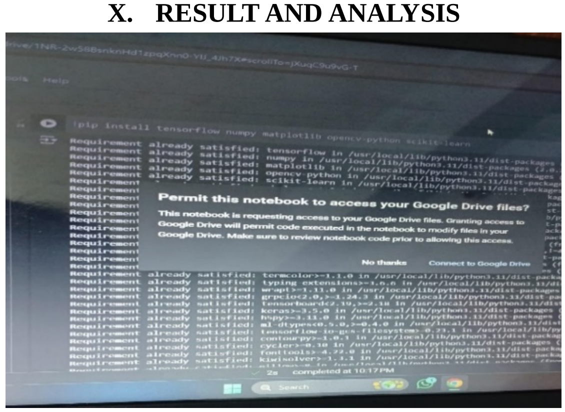


Fig 1: Access to colab

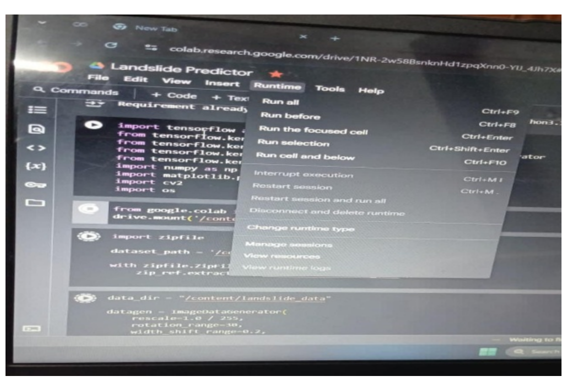


Fig 2: Run the code

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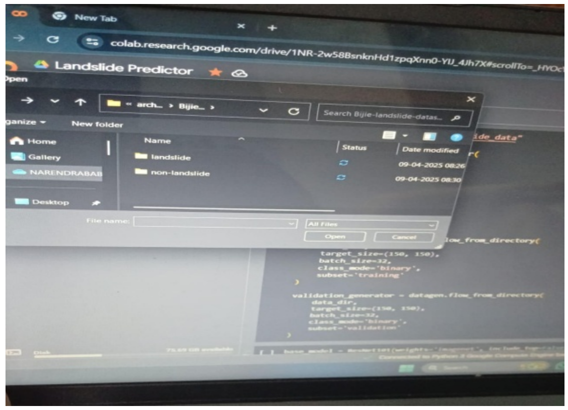

Fig 3: Select the folder

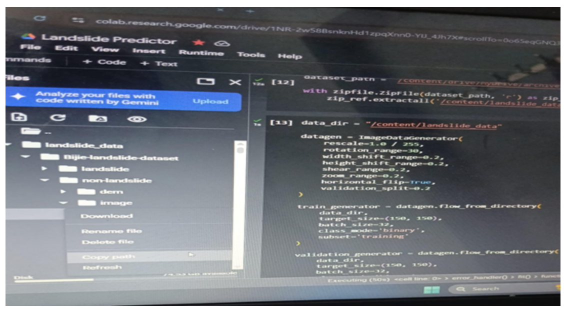

Fig 4: Copy image path

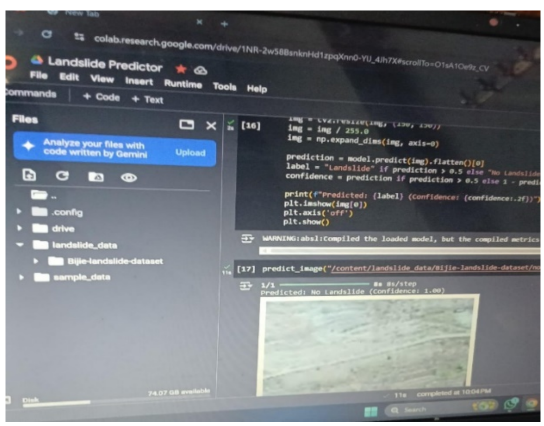

Fig 5: Result

XI. CONCLUSION

This project effectively predicts the accuracy of the landslide prediction using satellite imagery and deep learning approaches with accuracy 100%. And the integration of AI techniques into landslide prediction using imagery satellite offers a promising path towards increased resilence to natural disasters.it also useful for thenatural disaster management.And implement systems for continuouslymonitoring the model's performance in real-world performance and retraining it with new data as it becomes available in satellite imagery and evaluating the model on more diverse and independent datasets.

XII.FUTURE SCOPE

Future research will focus on the immediate actions on landslide predictions and user-friendly prediction platforms. And we also develop anapp for the disaster preparedness. It also enhanced in terms of robustness, interpretability. The specific areas of focus will depend on the goals and available resources.

REFERENCES PAPERS

[1] Malviya and Gupta Used Extended Local Binary Patterns (ELBP)and SVM for classifying 24 satellite image classes, addressing noise and unique properties in satellite images.
[2] Byun et al. Applied a Seeded Region Growing (SRG) method for landcover classification using multispectral images with efficient segmentation and noise removal techniques.
[3] Huang and Zhang Proposed a multi-feature SVM model combining spatial and spectral features for classification.
[4] Mianji et al. Introduced a feature reduction method combined with Bayesian learning for hyperspectral image classification.

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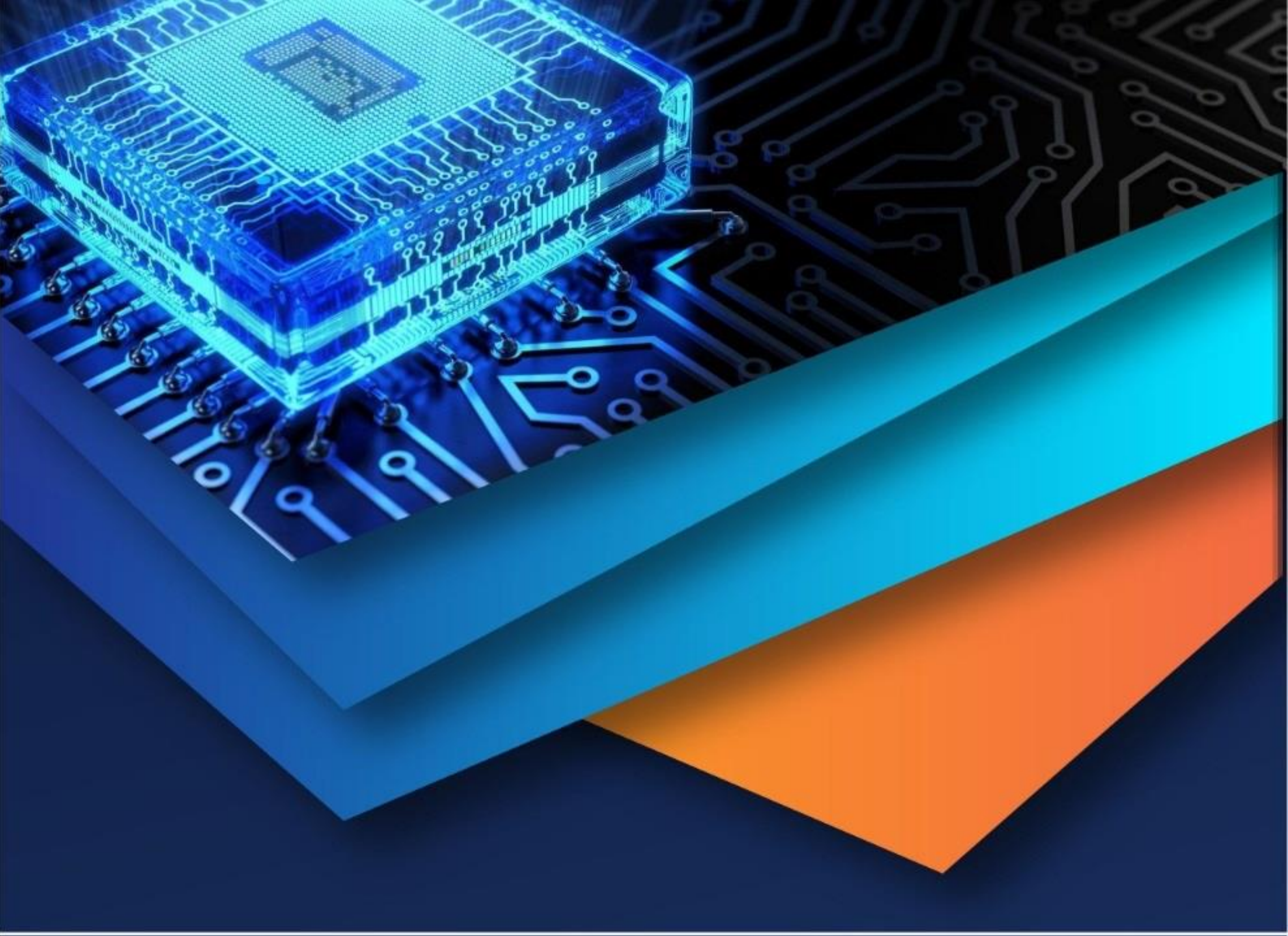

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