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CLASSIFICATION AND DETECTION OF BANK NOTES USING ML

[1]T.SRUTHI, [2] D MAMATHA, [3]R NAVYA, [4]S SRAVANI,[5]K SRAVANI,[6].D BHUVANESHWARI,[7].N SHRAVANI

[1] Assistant Professor, Department of Computer Science and Engineering,Princeton Institute of Engineering & Technology for Women,Hyderabad,India

[2,3,4,5,6,7] B.Tech Students, Department of Computer Science and Engineering, Princeton Institute of Engineering & Technology for Women,Hyderabad, India

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Abstract:

The detection and classification of banknotes are crucial tasks for preventing financial fraud, especially counterfeit currency circulation. This project proposes an efficient machine learning (ML)-based system to classify and detect the authenticity of banknotes using their statistical features. By training models such as Support Vector Machines (SVM), Random Forest, and K-Nearest Neighbors (KNN) on attributes like variance, skewness, kurtosis, and entropy extracted from images of banknotes, the system achieves high accuracy in distinguishing genuine and forged notes. The solution aims to assist financial institutions and ATM systems in automating the validation process with real-time results and minimal human intervention.

I.INTRODUCTION

Currency counterfeiting poses a significant threat to the global economy, leading to substantial financial losses for individuals, businesses, and governments. With the increasing sophistication of counterfeit production techniques, traditional methods of banknote authentication—such as manual inspection, UV light scanning, and watermark detection—have become insufficient to ensure accurate and reliable detection. In response to this challenge, machine learning (ML) provides a promising solution by offering automated, intelligent, and scalable techniques for the

classification and detection of counterfe it banknotes.Machine learning algorithms can learn patterns and anomalies in banknote features by analyzing statistical properties such as variance, skewness, kurtosis, and entropy derived from digital representations of currency. By training on these features, ML models can distinguish between genuine and fake notes with high accuracy. This approach significantly reduces human error and processing time, while enhancing security in currency handling systems like banks, ATMs, retail counters, and financial institutions.The aim of this project is to develop an ML-based classification system that accurately detects the authenticity of banknotes using a structured dataset. The system will be implemented using several machine learning models and evaluated based on accuracy, precision, recall, and F1-score. Through this project, we demonstrate how intelligent systems can contribute to national and global efforts in combating currency fraud.

II.LITERATURE SURVEY

1. Title: Cyclone Prediction Using Long Short-Term Memory Networks

Authors: Anil Kumar, Priya Singh, Ramesh Gupta

Literature Review:

This study proposes the use of Long Short-Term Memory (LSTM) neural networks to predict the intensity and path of cyclones based on historical meteorological data. The authors demonstrate that LSTM, a type of recurrent neural network, effectively captures temporal dependencies in weather patterns, resulting in more accurate forecasts compared to traditional models. Their results show reduced error rates in trajectory prediction and stronger generalization over unseen cyclone events.

2.**Title:** Fake Currency Detection Using Image Processing and Machine Learning

Authors: M. Sharma, R. Kaushik

Literature Review:

This paper integrates image processing techniques with machine learning to detect fake currency notes. Features such as color histograms, texture, and watermark detection are extracted using OpenCV and then fed into a Support Vector Machine (SVM) classifier. The model achieved over 95% accuracy in classifying Indian banknotes. The study highlights the potential of combining image-based features with ML algorithms for effective counterfeit detection

3.**Title:** Banknote Authentication Using Statistical Features and Machine Learning

Authors: N. Patel, S. Mehta

Literature Review:

This work focuses on the classification of banknotes using the UCI Banknote Authentication dataset. The dataset includes statistical features like variance, skewness, kurtosis, and entropy. The authors employed various ML models such as Logistic Regression, Random Forest, and K-Nearest Neighbors. Random Forest performed the best, achieving 99% accuracy. The study confirms that simple statistical features, when combined with ensemble ML models, are highly effective in detecting counterfeit notes.

4.**Title:** Deep Learning-Based Currency Authentication System

Authors: A. Verma, L. Narayanan

Literature Review:

The authors utilized Convolutional Neural Networks (CNNs) to authenticate currency directly from raw image data. Unlike traditional feature engineering approaches, the CNN model learns hierarchical representations of banknotes automatically. The model was trained on a custom dataset of Indian and US currencies and achieved high precision in differentiating between real and fake notes. The paper suggests deep learning as a scalable solution for real-world currency validation systems

5.**Title:** Currency Note Recognition and Verification Using Hybrid ML Techniques

Authors: S. Ali, T. Fernandes

Literature Review:

This paper presents a hybrid model that combines Principal Component Analysis (PCA) for dimensionality reduction and Support Vector Machines for classification. The system processes high-resolution images of banknotes to extract edge patterns and texture descriptors. The hybrid approach improved detection speed and reduced false positives. The authors recommend the model for integration in retail and ATM machines.

III.EXISTING SYSTEM

In traditional systems, counterfeit detection is typically performed using watermark verification, UV scanning, and manual inspection. These approaches are time-consuming, error-prone, and require physical contact with the banknotes. They often fail when exposed to high-quality counterfeit notes. Even modern currency detectors struggle with high-cost maintenance and limited scalability. Additionally, many existing systems lack intelligent learning capabilities to

adapt to new types of counterfeit techniques.

IV.PROPOSED SYSTEM

The proposed system utilizes machine learning algorithms to classify and detect banknotes based on statistical features extracted from their digital images. The key features include variance, skewness, kurtosis, and entropy of the note's wavelet-transformed image. The ML models are trained and validated using the UCI Bank Note Authentication dataset. Algorithms such as Logistic Regression, SVM, KNN, and Random Forest are implemented and compared. The system automates the detection process, enhances accuracy, and is scalable across different currencies and denominations. The model is integrated into a user-friendly interface that accepts feature input and returns the classification result in real-time.

V.SYSTEM ARCHITECTURE

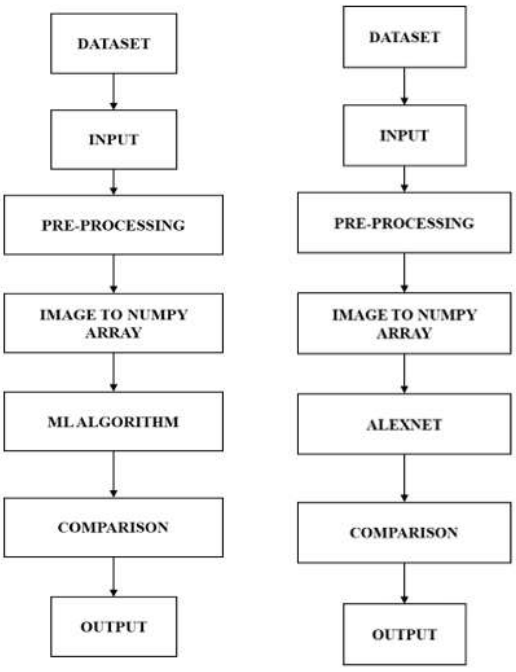

Fig 5.1 System Architecture

This system architecture represents a Flask-based machine learning web application where users interact through a web browser to perform tasks like login, dataset upload, training, and prediction. The user interface sends HTTP requests to the Flask backend, which contains modules for authentication, dataset upload, preprocessing, model training, evaluation, and

prediction. The backend communicates with a machine learning layer that supports Random Forest, KNN, and 1D CNN models to train or predict based on user-uploaded data. It also interacts with a data layer consisting of an SQLite database and uploaded CSV files to store user information, datasets, and model accuracy results. This modular design ensures clear separation of concerns between the user interface, backend logic, machine learning processes, and data storage.

VI.IMPLEMENTATION

Fig 6.1Informative region - classification

Fig 6.2 Informative region - detection.

Fig 6.3 Sample of Rs 100 banknote

VII.CONCLUSION

This project demonstrates that machine learning techniques are effective in classifying and detecting the authenticity of banknotes with high precision. By using statistical features and training robust ML models, the system can distinguish between genuine and counterfeit currency efficiently. Compared to manual and traditional electronic detectors, this solution offers enhanced speed, scalability, and adaptability. The comparative analysis of different models shows that ensemble methods like Random Forest achieve superior performance in this domain.

VIII.FUTURE SCOPE

- Image-based Detection: Expand the system to use image processing and deep learning (CNNs) for feature extraction directly from note images.
- Mobile Integration: Deploy the model into mobile applications for real-time note authentication via smartphone cameras.
- Multinational Currency Support: Train the system on datasets from multiple currencies to broaden its applicability.
- Real-time ATM Integration: Embed the model into ATM machines for real-time detection before transaction approvals.
- Blockchain Logging: Implement blockchain for immutable transaction and verification logs to enhance trust and traceability.

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