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Smart Currency Authentication: Real-Time Fake Note Detection Using CNN and Flask

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Abstract: *Counterfeit currency has become a significant problem affecting financial institutions, businesses, and individuals worldwide. Fake currency circulation can cause economic instability and financial losses. Traditional manual detection methods are often inefficient and require trained personnel. Therefore, an automated system for currency authentication is essential. This project proposes a Smart Currency Authentication System that detects counterfeit currency in real time using Deep Learning techniques, specifically Convolutional Neural Networks (CNN). The system analyzes currency note images captured through a camera or uploaded by the user and identifies whether the note is genuine or fake based on trained patterns and security features.*

INTRODUCTION

Currency plays a vital role in the economic system of every country. However, the circulation of **counterfeit currency notes** has become a growing concern globally. Fake currency affects the financial system, reduces trust in cash transactions, and leads to significant financial losses. Traditional methods of fake currency detection involve **manual inspection of physical security features** such as watermarks, security threads, micro-printing, and color-shifting ink. These methods require trained experts and specialized machines, making them less accessible for everyday users.

PROJECT OVERVIEW

The circulation of counterfeit currency has become a serious issue affecting financial stability and public trust in monetary systems. Fake currency notes can cause economic loss to individuals, businesses, and financial institutions. Detecting counterfeit notes manually requires expertise and specialized equipment, which may not always be available to the general public. Therefore, there is a need for an intelligent and automated system that can quickly verify the authenticity of currency notes.

OBJECTIVE

The primary objectives of this project are:

- To design and develop a **deep learning-based system for detecting counterfeit currency notes**.
- To use Convolutional Neural Networks (CNN) for feature extraction and classification of currency images.
- To build a web-based interface using Flask for easy user interaction.
- To enable real-time authentication of currency notes using uploaded images or camera input.

LITERATURE SURVEY:

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4. Laavanya, M., and V. Vijayaraghavan [3], Counterfeit currency notes pose a significant threat to the economy

of a country, necessitating the development of reliable detection systems. In this research, Ayush Antre et al. propose a system that employs Convolutional Neural Networks (CNNs) for accurately distinguishing between real and fake currency notes. The system operates in real-time, processing images of currency notes to determine their authenticity. Agasti, Tushar, Gajanan Burand, Pratik Wade, and P. Chitra [4], the paper addresses the challenges faced by visually impaired individuals in identifying Indian currency notes, especially after the demonetization initiative in India. It proposes an automated system based on Convolutional Neural Networks (CNNs) to assist visually impaired individuals in currency recognition. Tele, Gouri Sanjay, Akshay Prakash Kathalkar, Sneha Mahakalkar,

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System Analysis

The existing system architecture for fake currency detection consists of several important modules that work together to identify whether a currency note is genuine or counterfeit. The first module is the input module, which captures the currency image either through a camera or by allowing the user to upload an image file. Once the image is received, it is sent to the image preprocessing module, where operations such as image resizing, noise removal, and feature enhancement are performed to improve image quality. After preprocessing, the feature extraction stage uses a Convolutional Neural Network (CNN) to automatically identify important visual features such as edges, textures, and patterns present on the currency note. These extracted features are then passed to the classification module, where the CNN model classifies the note as real or fake. Finally, the Flask web interface displays the prediction result to the user in a simple and accessible format.

Proposed System

The proposed system introduces a Deep Learning-based Fake Currency Detection System developed using CNN and Flask. This system is designed to provide accurate and efficient image-based currency authentication. Its key features include image-based currency detection, CNN-based deep learning classification, real-time prediction, a web application interface, and easy accessibility for users. The working principle of the system begins when the user uploads an image of the currency note. The system then preprocesses the image to make it suitable for analysis. Next, the trained CNN model extracts visual features from the note and classifies it as real or fake. The final result is displayed to the user through the Flask web interface.

Requirement Specifications

The software requirements for the system include an operating system such as Windows 10 or later, Linux, or macOS for development and deployment. Python is used as the primary programming language for implementing the deep learning model and backend logic, while HTML, CSS, and JavaScript are used to create the web interface. Deep learning frameworks such as TensorFlow or Keras are used to build and train the CNN model for image classification. OpenCV is used for image preprocessing tasks such as resizing, noise removal, and feature enhancement. Flask is used as the web framework to create an interactive interface that enables users to upload currency note images and receive predictions. Data handling libraries such as NumPy and Pandas are used for managing datasets, performing numerical computations, and preprocessing data. Scikit-learn may also be used for dataset splitting, model evaluation, and performance measurement. Optionally, databases such as SQLite or MySQL can be used to store prediction results, image datasets, or system logs. Development tools such as Jupyter Notebook, Google Colab, or Visual Studio Code can be used for model development, training, and testing.
The hardware requirements include a minimum Intel i5 processor or equivalent for efficient image processing and model inference. At least 8 GB RAM is recommended to ensure smooth execution of deep learning operations. A dedicated GPU such as an NVIDIA GTX series card is optional but beneficial for faster training of the CNN model. A webcam or smartphone camera can be used to capture images of currency notes for real-time detection. The system also requires a minimum of 50–100 GB of free storage to store datasets, trained models, and project files. A standard monitor or display device is needed to visualize uploaded images and prediction results.

System Design

The architecture of the Smart Currency Authentication System is composed of several modules that function together to detect fake currency notes using deep learning techniques. The input module accepts currency note images from users through file upload or camera capture. The

image preprocessing module performs operations such as resizing, normalization, and noise removal to prepare the image for model analysis. The feature extraction stage uses the CNN model to automatically identify critical visual elements such as edges, textures, shapes, and patterns present in the note. The classification module then analyzes these extracted features and determines whether the currency note is genuine or fake. The Flask web application serves as a user-friendly interface that allows users to upload images and view prediction results. The output module displays the final result clearly, indicating whether the uploaded currency note is real or fake.

Modules

The system contains several functional modules. The input module allows users to upload currency note images through the web interface. The image preprocessing module improves image quality through processes such as resizing, normalization, noise removal, and enhancement. The CNN model module is responsible for learning patterns and features from the currency note images during the training phase. The prediction module uses the trained model to determine whether the currency note is genuine or counterfeit based on the learned patterns. The web interface module, developed using Flask, enables users to interact with the system and easily obtain results.

Implementation

The implementation of the fake currency detection system is carried out in multiple stages. Initially, a dataset containing real and fake currency note images is collected from publicly available sources or through manually captured images. These images are then preprocessed by cleaning, resizing, and normalizing them so they can be effectively used for model training. After preprocessing, the Convolutional Neural Network is trained using the prepared dataset to learn distinguishing features of genuine and counterfeit notes. Once training is completed, the model is tested using unseen currency images to evaluate its prediction accuracy and performance. Finally, the trained CNN model is integrated into a Flask web application that allows users to upload currency images and obtain real-time prediction results through a simple web interface.

RESULT ANALYSIS

The performance of the fake currency detection system is evaluated using several metrics. Accuracy

The CNN model achieves high classification accuracy in distinguishing between real and fake currency notes. Precision

Precision measures how many detected fake notes are actually counterfeit. Recall

Recall evaluates how effectively the system detects all counterfeit notes in the dataset. Confusion Matrix

A confusion matrix is used to visualize the model's classification performance between real and fake notes. Experimental results show that the proposed system provides reliable and fast fake currency detection, making it suitable for real-world applications.

FUTURE SCOPE .

The future scope of the **Smart Currency Authentication System** is extensive and offers many opportunities for improvement and expansion. One important enhancement is the integration of **advanced deep learning models** such as improved Convolutional Neural Networks or hybrid models to increase detection accuracy and handle more complex counterfeit patterns. The system can also be expanded to support **multiple currencies from different countries**, making it useful for international financial institutions and currency exchange centers.

Another potential improvement is the development of a **mobile application** that allows users to detect fake currency using their smartphone cameras in real time. This would make the system more accessible to the general public. Integration with **banking systems and ATMs** could also help automate currency verification processes in financial institutions.

Future research can also focus on **real-time video-based currency detection**, where the system continuously scans currency notes through a camera. Additionally, using **larger and more diverse datasets** will help improve model robustness and reduce misclassification. The system may also include advanced features such as **detection of damaged notes, denomination identification, and counterfeit pattern analysis**.

With continuous improvements in artificial intelligence and computer vision technologies, the system has the potential to become a **powerful tool for preventing counterfeit currency circulation and strengthening financial security**.

CONCLUSION

In conclusion, the **Smart Currency Authentication System** provides an effective solution for detecting counterfeit currency notes using **deep learning and image processing techniques**. By utilizing a **Convolutional Neural Network (CNN)** for image classification and integrating it with a **Flask-based web application**, the system enables real-time verification of currency notes in a simple and accessible manner.

The proposed system successfully analyzes visual features of currency notes and classifies them as genuine or fake with high accuracy. The user-friendly interface allows individuals, businesses,

and financial institutions to easily upload currency images and obtain instant authentication results. his project demonstrates how **Artificial Intelligence and Machine Learning** can be applied to improve financial security and reduce the circulation of counterfeit currency. Although the system shows promising performance, future enhancements such as larger datasets, improved models, and mobile application integration can further increase its effectiveness.

Overall, the proposed system contributes to the development of **intelligent and automated counterfeit detection solutions**, supporting safer and more reliable financial transactions.

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