AI-Based Fake Currency Detection Using AI with Full stack web development

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ABSTRACT- ***The proposed system tackles the challenge of counterfeit currency detection by leveraging advanced image analysis and deep learning techniques. Utilizing a Convolutional Neural Network (CNN), the system automatically examines currency note images for critical visual features such as texture, edges, and embedded security elements to classify notes as real or fake. To enhance user trust and model interpretability, Explainable AI methods like Grad-CAM are integrated, visually indicating which parts of the note influenced the classification decision. This transparency aids users in understanding and validating the model's predictions. The implementation employs Python-based technologies including TensorFlow and Keras for building and training the CNN, OpenCV and NumPy for image preprocessing, and Flask combined with HTML/CSS to create an accessible web interface. Users can upload images of currency notes and receive instant verification results. This solution offers a practical, scalable, and cost-effective alternative to traditional manual or hardware-dependent counterfeit detection, contributing to improved economic and financial security.***

Keywords: ***Fake Currency Detection, Deep Learning, Convolutional Neural Network (CNN), Explainable Artificial Intelligence (XAI), Grad-CAM, Image Processing, Computer Vision, Python Full Stack Development, TensorFlow, OpenCV.***

INTRODUCTION

The circulation of counterfeit currency has become a serious problem affecting economic stability and financial security. Traditional methods of detecting fake currency rely on manual inspection or expensive detection machines, which are often time-consuming and less accessible. With the advancement of artificial intelligence and computer vision, automated systems can be developed to improve the accuracy of currency verification. The proposed system focuses on Image-Based Fake Currency Detection

using Explainable Artificial Intelligence and Python Full Stack technologies. The main objective is to automatically identify whether a currency note is real or fake using deep learning techniques. A Convolutional Neural Network (CNN) is used to analyze important visual features such as texture, edges, and security elements present in currency notes. Image preprocessing is performed using OpenCV and NumPy to enhance the quality of the input images. The deep learning model is implemented using TensorFlow and Keras for accurate classification. A web interface developed using Flask, HTML, and CSS allows users to upload currency images and view prediction results. This system provides an efficient, automated, and user-friendly solution for detecting counterfeit currency and preventing financial fraud.

LITERATURE REVIEW

Several research works have been carried out in the field of counterfeit currency detection using image processing and deep learning techniques. One important research paper titled “Counterfeit Currency Detection Using Image Processing” by M. Hassanpour, A. Yaseri, and G. Ardeshir proposed a method that analyzes currency notes using image processing techniques. The system extracts features such as color patterns, edges, and texture information from currency images and compares them with genuine note features. Another research paper titled “Fake Currency Detection Using Convolutional Neural Networks” by J. Patel and R. Shah introduced a deep learning-based approach for identifying counterfeit currency notes. The authors used a Convolutional Neural Network (CNN) model to automatically learn distinguishing features from currency images.

A third research paper titled “Grad-CAM: Visual Explanations from Deep Networks via Gradient-Based Localization” by R. R. Selvaraju, Michael Cogswell, Abhishek Das, Ramakrishna Vedantam, Devi Parikh, and Dhruv Batra presented the concept of Explainable Artificial Intelligence. The Grad-CAM technique generates heatmaps to highlight the regions of an image that influence the deep learning model’s prediction.learning, and explainable AI techniques can significantly improve the accuracy and reliability of fake currency detection systems.

RELATED WORK

Several studies have explored the use of image processing and deep learning techniques for counterfeit currency detection. These approaches focus on analyzing visual characteristics of currency notes to identify whether they are genuine or fake.

One research work titled "Counterfeit Currency Detection Using Image Processing Techniques" focuses on extracting important visual features from currency images such as color patterns, edges, and texture details. The study demonstrates that image processing methods can assist in detecting counterfeit currency with improved accuracy compared to manual inspection.

Another study titled "Fake Currency Detection Using Convolutional Neural Networks" proposes the use of deep learning models for automated currency verification. The system uses a Convolutional Neural Network (CNN) to automatically learn distinguishing features from currency images without requiring manual feature extraction. Technologies such as Python, TensorFlow, and Keras are used to train the model using datasets containing real and fake currency images.

A more advanced approach integrates Explainable Artificial Intelligence (XAI) techniques into the detection system. Research on Grad-CAM-based visualization methods explains how deep learning models make predictions by highlighting important regions of the input image. By combining CNN models, image processing libraries like OpenCV, and web technologies such as Flask, these systems provide automated and transparent solutions for currency authentication.

Overall, these studies demonstrate that combining computer vision, deep learning, and explainable AI technologies can significantly improve the efficiency, accuracy, and reliability of fake currency detection systems.

EXISTING METHOD

Existing fake currency detection systems mainly rely on traditional image processing techniques and basic machine learning models to identify counterfeit notes. One of the commonly referenced research works, "Counterfeit Currency Detection Using Image Processing" by M. Hassanpour et al.focuses on extracting visual features such as color patterns, edges, and texture details from currency images to determine authenticity. Although this approach improves the detection process compared to manual inspection, it has several limitations. The system depends heavily on manually designed feature extraction methods, which may fail when counterfeit notes are created with advanced printing technologies. In addition, traditional image processing techniques may not effectively capture complex visual patterns present in modern currency notes. Another limitation is that these systems do not provide explanations for the prediction results,

making them difficult for users to trust or understand. Furthermore, many existing methods lack automation and require controlled image conditions for accurate detection. As a result, these approaches may produce inaccurate results when dealing with real-world images captured from different devices or environments. Therefore, there is a need for more advanced approaches using deep learning and explainable AI techniques to improve accuracy and transparency in fake currency detection systems.

PROPOSED METHOD

The proposed system improves the limitations of existing fake currency detection methods by integrating deep learning and explainable artificial intelligence techniques. Unlike traditional systems that rely on manual feature extraction using basic image processing methods, the proposed approach uses a Convolutional Neural Network (CNN) to automatically learn important visual features such as texture patterns, edges, and security elements from currency note images. The system also integrates Explainable AI techniques like Grad-CAM to highlight the regions of the image that influence the prediction, improving transparency and user trust. The implementation uses Python along with advanced technologies such as TensorFlow and Keras for deep learning model development and OpenCV and NumPy for image preprocessing. A web-based interface is developed using Flask, HTML, and CSS to allow users to upload currency images and receive instant verification results. This approach provides a more accurate, automated, and scalable solution for detecting counterfeit currency.

SYSTEM ARCHITECTURE

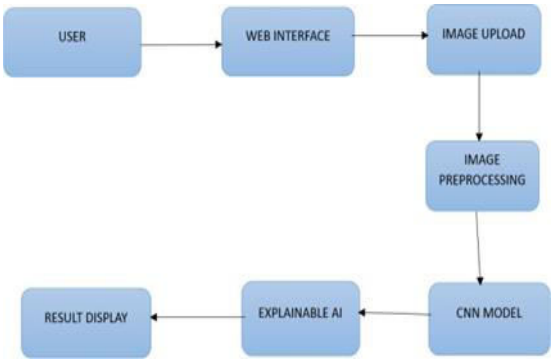

Fig 1: System Architecture

METHODOLOGY DESCRIPTION

The methodology of the Image-Based Fake Currency Detection System using Explainable AI ensures accurate detection, automated analysis, and user-friendly verification of currency notes. The system architecture follows multiple stages that process currency images step by step to determine whether a note is real or fake.Image Acquisition (User Input Layer): Users upload images of currency notes through a web-based interface. The system accepts images captured using mobile cameras or digital devices and prepares

them for further processing.Image Preprocessing (Image Processing Layer): The uploaded image undergoes preprocessing using OpenCV and NumPy. Operations such as image resizing, normalization, and noise reduction are performed to improve image quality and maintain consistent input dimensions for the model.

Feature Extraction (Deep Learning Layer – CNN Model): A Convolutional Neural Network (CNN) is used to automatically extract important visual features from the currency image. The CNN identifies patterns such as edges, textures, colors, and security elements that distinguish genuine notes from counterfeit ones.

Currency Classification (Prediction Layer): The extracted features are processed through the trained CNN model using TensorFlow and Keras.The model analyzes the learned patterns and classifies the uploaded currency note as REAL or FAKE with prediction confidence.

Explainable AI Visualization (Grad-CAM Layer): To improve transparency, Grad-CAM (Gradient-weighted Class Activation Mapping) is applied to highlight the important regions of the currency image that influenced the model's prediction. This helps users understand how the decision was made.Web Application Interface (Flask-Based GUI Layer): The system integrates the deeplearning model with a Flask-based web application developed using HTML and CSS. Users can upload currency images, view prediction results, and observe visual explanations.

Result Display and Verification (Output Layer)Finally, the system displays the detection result along with the uploaded currency image and visual explanation. This structured workflow ensures reliable, efficient, and transparent counterfeit currency detection for practical applications.

RESULTS AND DISCUSSION

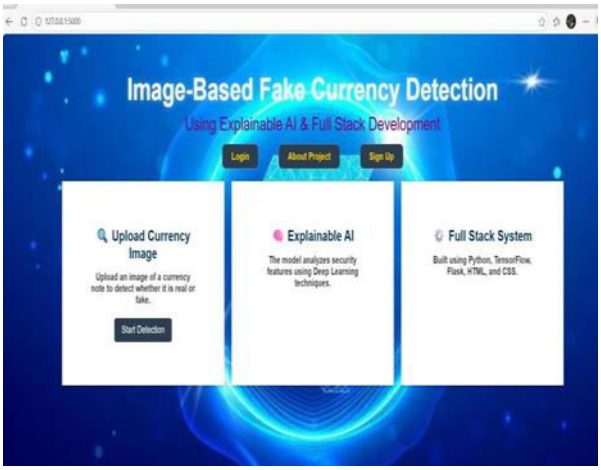

Fig2: Home Page

The figure presents the home page of the Image-Based Fake Currency Detection System, developed using Explainable AI and Python Full Stack technologies. It provides a user-friendly interface for uploading currency images, accessing

system features, and understanding the AI-based detection process.

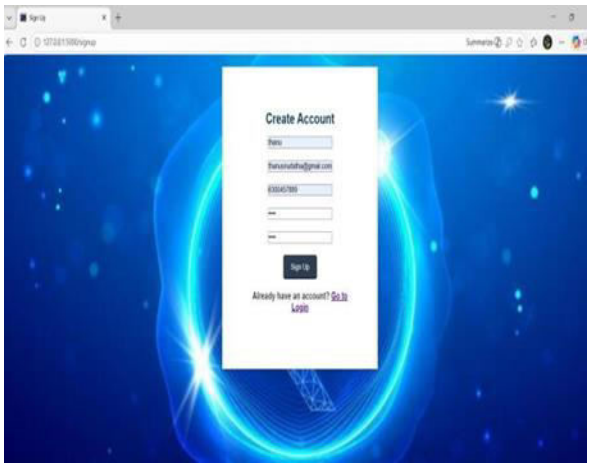

Fig 3: Sign Up Page

The figure illustrates the Sign-Up page of the Image-Based Fake Currency Detection System, allowing new users to register by entering their personal details. It provides a secure interface for account creation and includes an option for existing users to navigate to the login page.

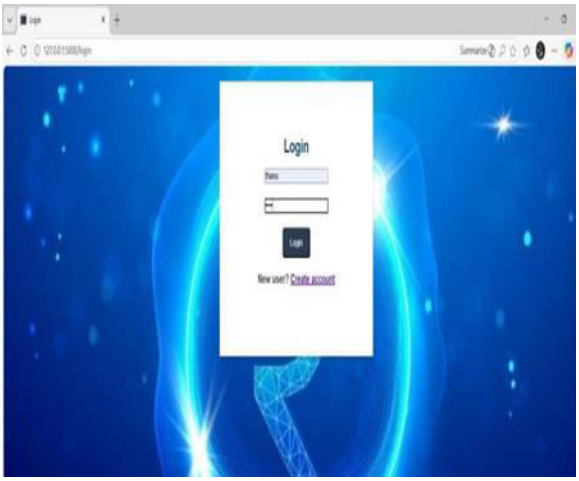

Fig 5: Image Upload Page

The figure illustrates the Login page of the Image-Based Fake Currency Detection System, where registered users can securely access the application using their username and password.It also provides an option for new users to create an account through the Create Account link.

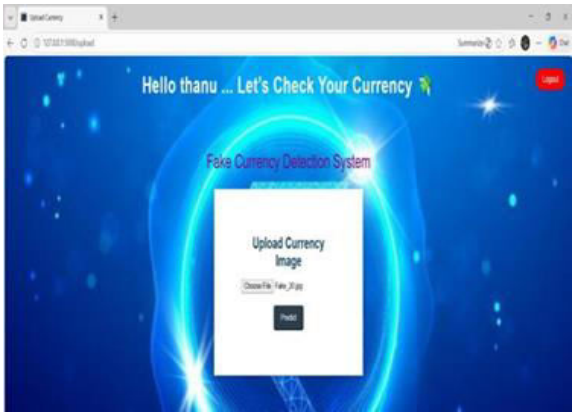

Fig 5: Image Upload Page

The figure shows the currency image upload page of the Fake Currency Detection System, where users can upload a currency note image for verification. After selecting the image, the system processes it and predicts whether the currency is real or fake using the trained deep learning model.

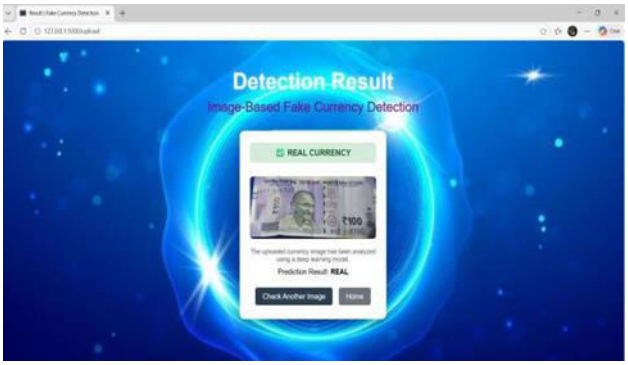

Fig 6: Detection Page of Real Currency

The figure shows the detection result page of the Image-Based Fake Currency Detection System, where the uploaded currency image is analyzed by the deep

learning model.The system displays the prediction result indicating whether the currency is real or fake, along with the analyzed image.

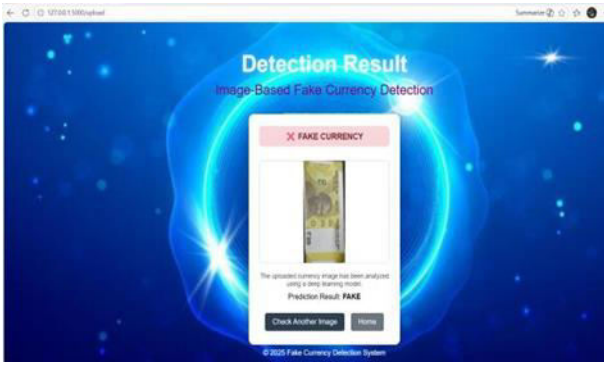

Fig 7: Detection Page of Fake Currency

The figure shows the detection result page of the Image-Based Fake Currency Detection System, where the uploaded currency image is analyzed by the deep learning model. The system identifies the note as fake currency and displays the prediction result along with the uploaded image.

CONCLUSION

The proposed Image-Based Fake Currency Detection System uses deep learning and image processing techniques to identify counterfeit currency notes. A Convolutional Neural Network (CNN) with Explainable AI analyzes currency images and highlights important features influencing the prediction. The system is implemented using Python full stack technologies to provide a user-friendly interface for currency verification. The results show that the system can accurately classify currency notes as real or fake. This approach helps reduce human errors and improves the reliability of currency authentication.

FUTURE SCOPE

The system can be improved by integrating advanced deep learning models such as ResNet or EfficientNet to increase detection accuracy. It can also be extended into a mobile application with real-time camera scanning for instant currency verification. Additionally, deploying the system on cloud platforms with multi-currency support can enhance scalability and accessibility.

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