

## An Image-Based Fake Currency Detection System Using ORB Feature Extraction and Edge Analysis

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### ABSTRACT

Counterfeit currency poses a significant threat to economic stability and financial systems worldwide. With the advancement of printing technologies, counterfeiters have become increasingly capable of producing high-quality fake notes that are difficult to distinguish from genuine ones through manual inspection. This necessitates the development of automated and intelligent systems capable of detecting counterfeit currency accurately and efficiently. The proposed system presents an image-based fake currency detection approach using computer vision techniques and machine learning-inspired feature extraction. The system utilizes OpenCV-based image processing techniques to analyze currency notes uploaded by the user through a graphical user interface (GUI) built using Tkinter. The uploaded image is first converted to grayscale and resized for standardization. Edge detection is performed using the Canny Edge Detection algorithm to identify structural boundaries and fine details in the currency note. Additionally, ORB (Oriented FAST and Rotated BRIEF) feature extraction is employed to detect key points and descriptors that represent unique visual patterns of the note. The number of detected key points plays a crucial role in determining the authenticity of the currency. Genuine notes typically contain intricate patterns, textures, and micro-details, resulting in a higher number of detectable key points. In contrast, counterfeit notes often lack such complexity, leading to fewer key points. A threshold-based classification mechanism is implemented, where the note is classified as genuine or fake depending on whether the number of key points exceeds a predefined threshold. The system provides visual feedback by displaying the uploaded image along with edge-detected and key point-highlighted images. The final classification result is presented clearly to the user. This approach offers a simple yet effective solution without requiring complex deep learning models, making it computationally efficient and suitable for real-time applications. Although the system demonstrates promising results, it has limitations such as dependency on image quality, lighting conditions, and threshold tuning. Future enhancements may include integrating deep learning techniques such as convolution neural networks (CNNs) for improved accuracy and robustness. Overall, the proposed system contributes to the development of low-cost and accessible counterfeit detection solutions, especially useful for small businesses and individuals.

**KEYWORDS:** Fake Currency Detection, Computer Vision, ORB (Oriented FAST and Rotated BRIEF), Edge Detection, Image Processing, Feature Extraction, Pattern Recognition, OpenCV, Tkinter GUI, Digital Image Authentication

## I. INTRODUCTION

Currency plays a vital role in facilitating economic transactions and maintaining financial stability. However, the circulation of counterfeit currency has become a growing concern across the globe. Fake currency not only leads to financial losses but also undermines trust in monetary systems. Traditional methods of detecting counterfeit notes often rely on manual inspection, which requires expertise and can be prone to human error. With the advancement of digital technologies, there is an increasing demand for automated systems that can efficiently identify counterfeit currency. In recent years, computer vision and image processing techniques have gained significant attention in the field of document authentication. These techniques enable systems to analyze visual patterns and extract meaningful features from images. Currency notes contain various security features such as watermarks, micro printing, security threads, and intricate designs, which can be analyzed using digital image processing methods. The proposed system aims to develop a user-friendly and efficient fake currency detection system using image processing techniques. The system leverages the power of OpenCV for feature extraction and analysis. A graphical user interface (GUI) is developed using Tkinter, allowing users to upload images of currency notes easily. The system processes the input image by converting it to grayscale and resizing it to a standard dimension to ensure consistency in analysis. One of the key components of the system is edge detection, which helps in identifying the structural details of the currency note. The Canny Edge Detection algorithm is used for this purpose, as it effectively detects edges while minimizing noise. In addition to edge detection, the system employs ORB (Oriented FAST and Rotated BRIEF) feature extraction, which is a fast and efficient method for detecting key points and computing descriptors. The number of detected key points is used as a metric to determine the authenticity of the note. Genuine notes typically have complex patterns that result in a higher number of key points, whereas counterfeit notes tend to have simpler patterns. Based on this observation, a threshold-based classification approach is implemented. The system is designed to be simple, cost-effective, and easy to use, making it accessible to a wide range of users. It eliminates the need for specialized hardware and can be deployed on standard computing devices. This makes it particularly useful for small businesses and individuals who may not have access to expensive counterfeit detection machines. In summary, the proposed system demonstrates the potential of image processing techniques in addressing the problem of counterfeit currency detection, offering a practical and efficient solution.

## II. LITERATURE SURVEY (WITH EXISTING METHODS)

Several research efforts have been made to address the problem of counterfeit currency detection using various techniques ranging from traditional image processing to advanced deep learning models. Early approaches primarily relied on manual inspection and basic image processing techniques such as color analysis, texture analysis, and edge detection. One of the commonly used methods involves feature extraction using Scale-Invariant Feature Transform (SIFT) and Speeded-Up Robust Features (SURF). These methods are capable of detecting distinctive features in images and are robust to changes in scale and rotation. However, they are computationally expensive and may not be suitable for real-

time applications. With the advancement of machine learning, researchers have explored classification algorithms such as Support Vector Machines (SVM), k-Nearest Neighbors (k-NN), and Decision Trees for counterfeit detection. These methods require a labeled dataset of genuine and fake notes for training. While they offer improved accuracy compared to traditional methods, their performance heavily depends on the quality and size of the dataset. In recent years, deep learning approaches, particularly Convolution Neural Networks (CNNs), have gained popularity in image classification tasks. CNN-based models can automatically learn hierarchical features from images, making them highly effective for detecting subtle differences between genuine and counterfeit notes. Studies have shown that CNN-based systems can achieve high accuracy levels; however, they require large datasets and significant computational resources for training.

Another approach involves the use of texture analysis techniques such as Gray-Level Co-occurrence Matrix (GLCM) and Local Binary Patterns (LBP). These methods analyze the texture properties of currency notes to identify differences between genuine and fake notes. While effective, these methods may be sensitive to variations in lighting and image quality. The proposed system differs from existing methods by utilizing ORB (Oriented FAST and Rotated BRIEF) feature extraction, which is both efficient and computationally lightweight. ORB combines the FAST key point detector and BRIEF descriptor, making it suitable for real-time applications. Unlike SIFT and SURF, ORB is free from patent restrictions and can be implemented easily using OpenCV. Additionally, the system employs Canny Edge Detection to enhance structural feature analysis. A threshold-based classification approach is used instead of complex machine learning models, making the system simple and easy to implement. Overall, the literature suggests that while deep learning methods offer high accuracy, lightweight approaches like ORB-based feature extraction provide a good balance between performance and computational efficiency, especially for practical applications.

### III. EXISTING SYSTEM

Existing systems for fake currency detection primarily rely on manual inspection or specialized hardware devices. Manual methods involve checking physical features such as watermarks, security threads, color-shifting ink, and micro printing. While effective, these methods require expertise and are prone to human error, especially when dealing with high-quality counterfeit notes. Automated systems, on the other hand, often use ultraviolet (UV) light, infrared (IR) sensors, and magnetic ink detection to verify the authenticity of currency notes. These systems are commonly used in banks and financial institutions. Although they provide reliable results, they are expensive and not easily accessible to the general public. In the field of computer vision, several systems have been developed using image processing and machine learning techniques. Traditional approaches use feature extraction methods such as SIFT and SURF combined with classifiers like SVM. These systems require extensive training data and computational resources. More recent systems utilize deep learning models such as Convolution Neural Networks (CNNs) for classification. While these models achieve high accuracy, they are computationally intensive and require large datasets for training, making them less suitable for low-resource environments.

Furthermore, many existing systems lack user-friendly interfaces, limiting their usability for non-technical users. Some systems are also sensitive to variations in lighting conditions, image quality, and background noise. In summary, existing systems either rely on costly hardware or complex algorithms, highlighting the need for a simple, cost-effective, and user-friendly solution like the proposed system.

#### **IV. PROPOSED METHOD**

The proposed system introduces an efficient and user-friendly approach for detecting counterfeit currency using image processing and feature extraction techniques. Unlike traditional hardware-based systems, this model leverages computer vision algorithms to analyze digital images of currency notes and determine their authenticity. The system is designed using Python with integration of OpenCV for image processing and Tkinter for graphical user interaction. The core idea of the proposed system is to extract distinctive visual features from the currency image and use them to classify the note as genuine or fake. Initially, the user uploads an image of a currency note through the graphical interface. The system preprocesses the image by converting it to grayscale and resizing it to a fixed dimension to maintain consistency in feature extraction. Two primary techniques are applied: Canny Edge Detection and ORB (Oriented FAST and Rotated BRIEF) feature extraction. Edge detection helps in identifying structural boundaries and fine details of the note, while ORB detects key points that represent unique patterns and textures present in genuine currency. Research shows that image-processing-based systems analyze features such as texture, edges, and patterns to differentiate fake notes effectively.

The number of detected key points is used as the main criterion for classification. Genuine notes typically have a higher number of key points due to complex patterns, whereas fake notes have fewer distinguishable features. A threshold-based decision mechanism is implemented to classify the note. The system displays the original image along with processed outputs such as edge-detected and key point images. Finally, it provides a clear classification result to the user. This approach ensures low computational cost, real-time performance, and ease of use, making it suitable for practical applications.

#### **V. IMPLEMENTATION**

The implementation of the fake currency detection system is carried out using Python programming language with libraries such as OpenCV, NumPy, and Tkinter. The system is structured into multiple modules to handle image input, processing, feature extraction, and classification. The graphical user interface (GUI) is developed using Tkinter, which provides an interactive platform for users to upload images and view results. The interface includes buttons for uploading currency images and displaying classification outcomes. A canvas is used to render the input image after resizing it appropriately. The first step in the implementation is image acquisition. The user selects an image file (JPEG or PNG format), which is then read using OpenCV. The image is converted into grayscale to simplify processing and reduce computational complexity. Grayscale conversion is essential as it removes color dependency and focuses on structural features.

Next, image preprocessing is performed by resizing the image to a standard size (600×300 pixels). This ensures uniformity across all inputs and improves the consistency of feature extraction. After preprocessing, edge detection is applied using the Canny algorithm. This step highlights important structural features such as lines, contours, and boundaries of the currency note. Following edge detection, ORB feature extraction is performed. ORB is chosen due to its efficiency and robustness compared to traditional methods like SIFT and SURF. It detects key points and computes descriptors that represent important visual features. Studies indicate that feature extraction plays a crucial role in identifying counterfeit patterns in images.

The system then calculates the number of detected key points. A threshold value (e.g., 100 key points) is used to classify the note. If the number of key points exceeds the threshold, the note is labeled as genuine; otherwise, it is classified as fake. This threshold can be adjusted based on experimental results. The processed images, including edge-detected and key point-highlighted outputs, are displayed in the GUI. The final classification result is shown prominently with color indicators (green for genuine and red for fake). The system is tested with various currency images under different lighting conditions to evaluate performance. While the system performs well for clear images, its accuracy may decrease with poor image quality or noise. Overall, the implementation demonstrates a simple yet effective approach for counterfeit detection using image processing techniques.

## **VI. ALGORITHMS**

The proposed system utilizes a combination of image processing and feature extraction algorithms to detect counterfeit currency.

### **1. Canny Edge Detection Algorithm**

The Canny Edge Detection algorithm is used to identify edges in the image. It involves multiple steps including noise reduction using Gaussian filtering, gradient calculation, non-maximum suppression, and hysteresis thresholding. This algorithm effectively detects edges while minimizing noise, making it suitable for analyzing currency structures.

### **2. ORB (Oriented FAST and Rotated BRIEF)**

ORB is a feature detection and description algorithm that combines the FAST key point detector and BRIEF descriptor. It detects key points in an image and computes descriptors that represent local patterns. ORB is computationally efficient and invariant to rotation and scale, making it ideal for real-time applications.

### 3. Key point-Based Classification

The classification algorithm is based on the number of detected key points. The steps include:

- Detect key points using ORB
- Count the number of key points
- Compare with predefined threshold
- Classify as Genuine or Fake

### 4. Image Preprocessing Algorithm

This includes grayscale conversion and resizing:

- Convert RGB image to grayscale
- Resize to fixed dimensions
- Normalize pixel values

Recent studies highlight that combining feature extraction with classification improves counterfeit detection accuracy significantly.

## VII. SYSTEM DESIGN

The system design follows a modular architecture to ensure scalability, maintainability, and ease of implementation. The system consists of four major components: User Interface, Image Processing Module, Feature Extraction Module, and Classification Module.

### 1. User Interface Module

The GUI is developed using Tkinter, providing an interactive interface for users. It includes options for uploading images and displaying results. The interface is designed to be simple and intuitive, making it accessible to non-technical users.

### 2. Image Processing Module

This module handles image input and preprocessing. It reads the image using OpenCV, converts it to grayscale, and resizes it to a standard dimension. Preprocessing ensures that the image is suitable for further analysis and reduces the impact of noise and variations.

### 3. Feature Extraction Module

This module extracts important features from the image using edge detection and ORB. The edge detection component highlights structural details, while ORB identifies key

points and descriptors. These features are essential for distinguishing between genuine and counterfeit notes.

#### 4. Classification Module

The classification module analyzes the extracted features and determines the authenticity of the currency. It uses a threshold-based approach, where the number of key points is compared against a predefined value. The result is then displayed to the user.

#### 5. Data Flow

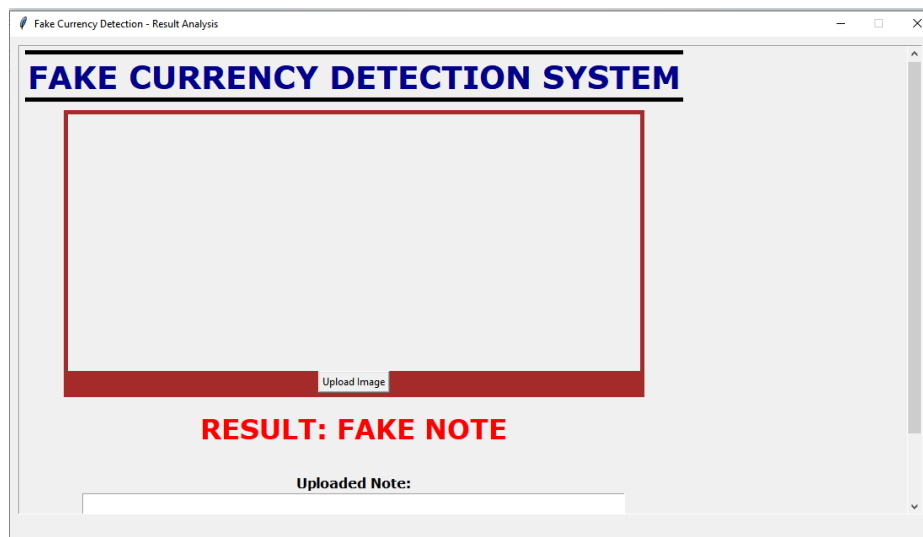
- User uploads image
- Image is preprocessed
- Features are extracted
- Classification is performed
- Result is displayed

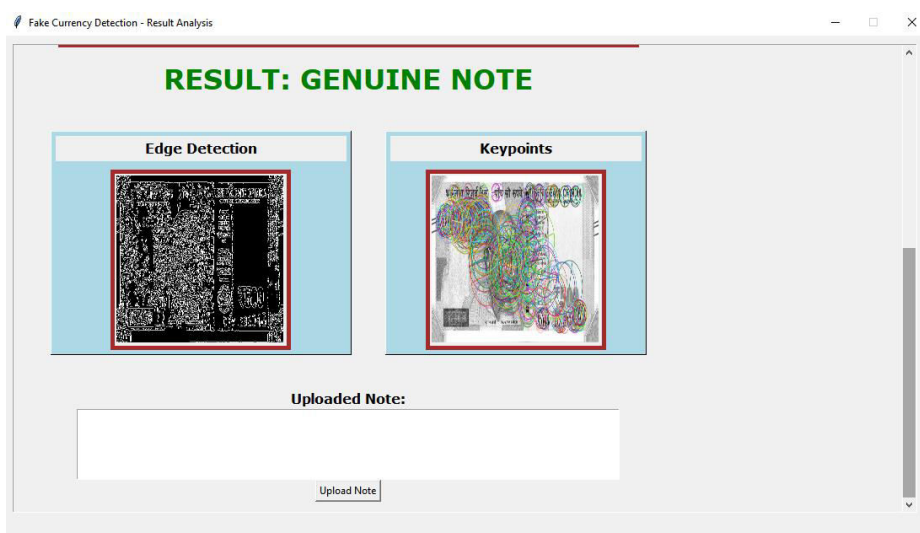
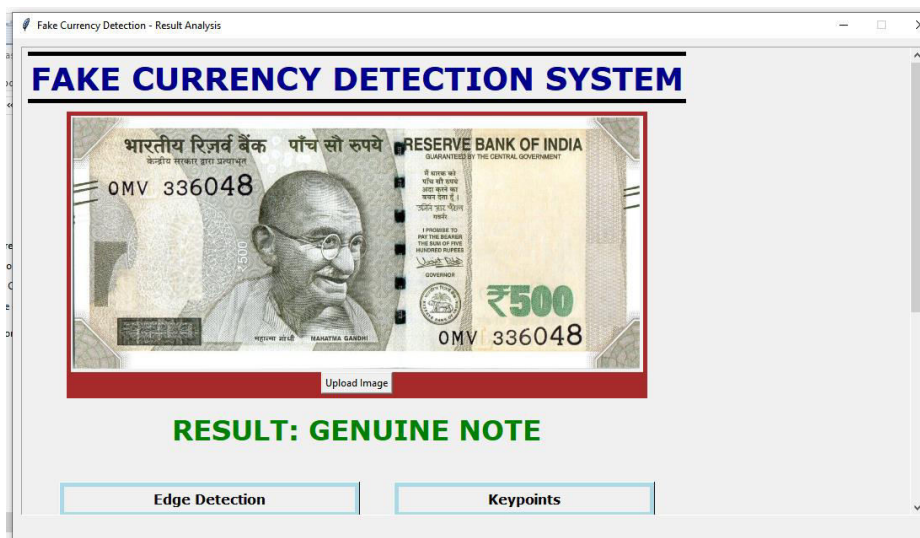
#### 6. Advantages of Design

- Low computational complexity
- Real-time processing capability
- Easy integration with other systems
- User-friendly interface

Modern systems often integrate machine learning for improved accuracy, but lightweight systems like this remain efficient and practical for real-time applications.

### SYSTEM DESIGN IMAGES





## VIII. CONCLUSION

The proposed fake currency detection system demonstrates an effective and efficient approach to identifying counterfeit currency using image processing techniques. By leveraging Canny edge detection and ORB feature extraction; the system successfully analyzes structural and texture-based characteristics of currency notes. The use of a simple threshold-based classification method makes the system computationally efficient and suitable for real-time applications. One of the key advantages of the system is its simplicity and ease of implementation. Unlike complex machine learning or deep learning models, the proposed approach does not require extensive training data or high computational resources. This makes it accessible for small-scale applications and users with limited technical expertise. The graphical user interface enhances usability by allowing users to upload images and view results easily. The system also provides visual outputs such as edge-detected and key point images, which help in understanding the classification process. However, the system has certain limitations. Its performance depends on image quality, lighting conditions, and threshold selection. In cases of poor

image quality or highly sophisticated counterfeit notes, accuracy may decrease. Additionally, the system does not consider advanced security features such as watermarks or infrared patterns.

Future work can focus on integrating machine learning or deep learning models to improve accuracy and robustness. Techniques such as Convolution Neural Networks (CNNs) can be used to automatically learn complex features from images. Research indicates that deep learning-based systems achieve higher accuracy in counterfeit detection tasks. In conclusion, the proposed system provides a cost-effective and practical solution for counterfeit currency detection, with potential for further enhancement and real-world deployment.

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