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VISUAL CURRENCY VALIDATOR: AN ANDROID APP EMPOWERING THE VISUALLY IMPAIRED WITH IMAGE PROCESSING AND DEEP LEARNING FOR FAKE CURRENCY DETECTION

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Abstract

In today's digital world, it is crucial to ensure financial security and independence for everyone, including individuals who are visually impaired. One of the challenges that visually impaired people face when managing their finances is the ability to identify different Indian Rupee (INR) denominations. The use of machine learning technology is a significant step towards improving the accessibility of financial services for visually impaired people. This model not only recognizes different Indian rupees (INR) denominations but also processes the currency is real or fake in real-time. This feature ensures that visually impaired people can quickly and easily verify the authenticity of the currency they receive, giving them the confidence to manage their finances independently. This proposed model used in Android Application works as first recognizing the currency type and then processing it. Once the currency is processed, the application uses text-to-speech technology to speak out the denomination. This feature enables visually impaired people to verify the authenticity of the currency and avoid falling victim to counterfeit money. If the application gives intensity above 75% then detected currency is real otherwise it is counterfeit. Android application is a significant step towards ensuring financial security and independence for visually impaired people. By utilizing machine learning technology, the application accurately recognizes different INR denominations and speaks out the denomination, providing a dependable tool for visually impaired individuals to manage their funds and protect themselves against fake money. The application promotes financial inclusion and independence, empowering visually impaired people to manage their finances with confidence.

Keywords – Machine Learning, Feature Extraction, Indian rupees (INR), Image Processing, Edge Detection

1. Introduction

Fake currency is imitation currency produced without the legal sanction of the state or government. Producing or using fake currency is a form of fraud or forgery. Over the past few years, as a result of the great technological advances in colour printing, duplicating and scanning, counterfeiting problems have become more and more serious. Therefore, the issue of efficiently distinguishing counterfeit banknotes from genuine ones via automatic Fake currency detection system has become more and more important [1]. India experienced one of the biggest financial operations ever executed after the country's independence in late November 2023. This operation carried out

by the Indian Federal government was targeted at the massive flow of 'black money' in the Indian market economy. It has been reported that up to INR 400 crores of fake currency was circulating in the Indian cash economy. This fake currency was found to be mostly of higher denomination notes which are INR 500 and 2000 [2].

Commonly used methods to detect fake currency are Traditional method, Digital image processing method. In traditional method, where a common man employs features like Security thread, Serial Image, Latent Image, Watermark, Identification mark, Fluorescence, optically variable ink, Micro lettering, Intaglio printing etc. in identifying fake currencies. All of these features can be clearly identified by an ordinary person. This method would not assure 100% accuracy. The other anti-counterfeit device for the money is an Ultraviolet counterfeit detection scanner. Best used in highly lit point of sale locations, the UV detector identifies the ultraviolet security features present in most currencies. By simply placing the note in the detector, counterfeit currency is immediately identified, without the need for an employee to closely examine the note. This Ultraviolet counterfeit detection scanner is costly which ordinary man cannot afford and above traditional method doesn't give accuracy of 100% [3].

To overcome this problem, we have proposed a system in which first step involved is inputting an image done either by scanning or by capturing through a camera with good resolution. The scanned image is a R-G-B (colour) image which will be converted to a grayscale image for ease in feature extraction. Now only those regions of the currency which we are interested to analyse (ROI – Region of Interest) will be cropped and calculate their intensities. If the intensity of the extracted regions greater than 75% then the currency is real otherwise it is fake. The output will be shown in an audio that the currency is real or fake [4].

2. Related Work

Currency and fake currency detection is proposed for Indian paper currency system. Using this model, blind people can use this application to identify the currency effectively & efficiently. The proposed model has low processing time and is cost effective. Hence it is very reliable for real-time applications.

In some of system MATLAB is used which extracts the features of the currency but it needs the high level to match the template. There is a detection of counterfeit currency using deep learning CNN model by examining the image of currency in which results are plotted in the form of graph. Convolutional Neural Network (CNN): It is a type of deep learning model that is particularly well-suited for processing grid-like data, such as images. It works by applying a series of filters to the input data, which help to identify patterns or features such as edges, shapes, and textures [5]. Table 1 shows various methods & limitations of existing system.

SR. NO.	YEAR	REFERENCE	METHOD	LIMITATIONS
1	2019	[6]	Proposes an approach that will detect fake currency note being circulated in our country by using their image.	Store the data of currency cloud storage is used.
2	2019	[7]	The application areas of feature extraction and are face, character and object recognition and also convert it into grayscale image.	Large dataset and proper coordinates for feature extraction.
3	2020	[8]	Identify active objects within the dataset of aerial images using CNN.	Large dataset is required to train the model.
4	2021	[6]	Method for fake currency recognition using K-Nearest Neighbor followed by image processing.	Result is limited as the data set used was quite small.
5	2021	[9]	Convolutional Neural Network technique and open cv are used	Large dataset is required.
6	2022	[10]	Machine learning algorithm to train the model and accuracy increase.	Colour detection, Segmentation, Edge Detection.
7	2022	[11]	Random Grouping, Image Processing, CNN models: SVM used	Images requires as per the stages.

Table 1. Methods & Limitations of existing system

3. Methodology

3.1 CNN

CNN stands for Convolutional Neural Network, which is a type of deep learning algorithm inspired by the organization and functioning of the human visual cortex. CNNs are particularly well-suited for tasks such as image recognition, object detection, and classification in computer vision applications. Each convolutional layer applies a set of learnable filters or kernels to the input data. These filters perform convolution operations across the input image, extracting features such as edges, textures, and patterns.

A type of neural network that is commonly used for image recognition tasks. CNNs are designed to automatically and adaptively learn spatial hierarchies of features from images, which makes them particularly effective for image classification tasks. The pre-processed images were

then fed into a Figure 1 Convolutional Neural Network (CNN) structure, which included several convolutional layers, pooling layers, and fully connected layers. This model was trained using a labelled dataset containing images, with labels assigned based on their quality levels [12]. CNNs have revolutionized the field of computer vision and have been instrumental in achieving state-of-the-art performance in tasks such as image classification, object detection, facial recognition, and more.

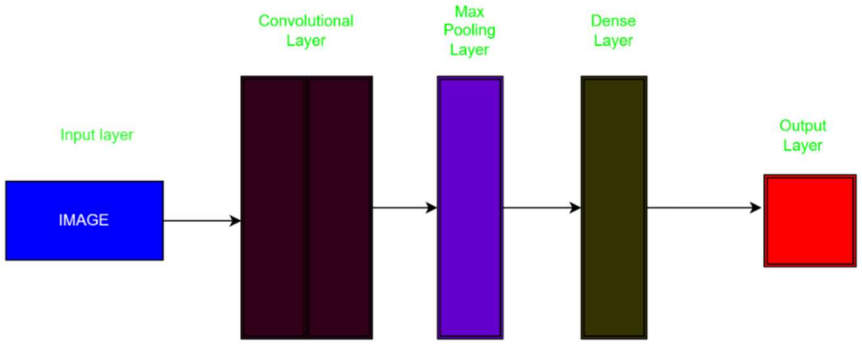

Figure 1. Convolutional Neural Network

3.2 Image Processing –

Image processing for fake currency detection involves a combination of image acquisition, pre-processing, feature extraction, classification, and verification techniques to accurately identify counterfeit banknotes and ensure the integrity of the currency system. Image processing is a field of computer science and engineering that focuses on analysing, manipulating, and interpreting digital images using algorithms and techniques. It involves the transformation of images to extract meaningful information or enhance certain features for various applications.

The process of manipulating and analysing digital images to extract meaningful information or to enhance the quality of the images. Image processing techniques can include filtering, segmentation, feature extraction, and image enhancement. These techniques can be used to improve the quality of the images or to extract relevant features from the images for analysis [6].

3.3 System Architecture –

Our system captures images upon tapping anywhere on the screen. Once captured, the RGB image is converted to grayscale to facilitate feature extraction, as extracting features from RGB images poses difficulties. Following the conversion to grayscale, features such as security marks, watermarks, identification marks, and serial marks are extracted, and their intensities are then calculated. If the intensity of all these extracted features exceeds 75%, the currency is deemed genuine; otherwise, it is classified as counterfeit. Subsequently, an audio output confirms the authenticity of the currency along with its type. This concept is depicted in the figure 3.

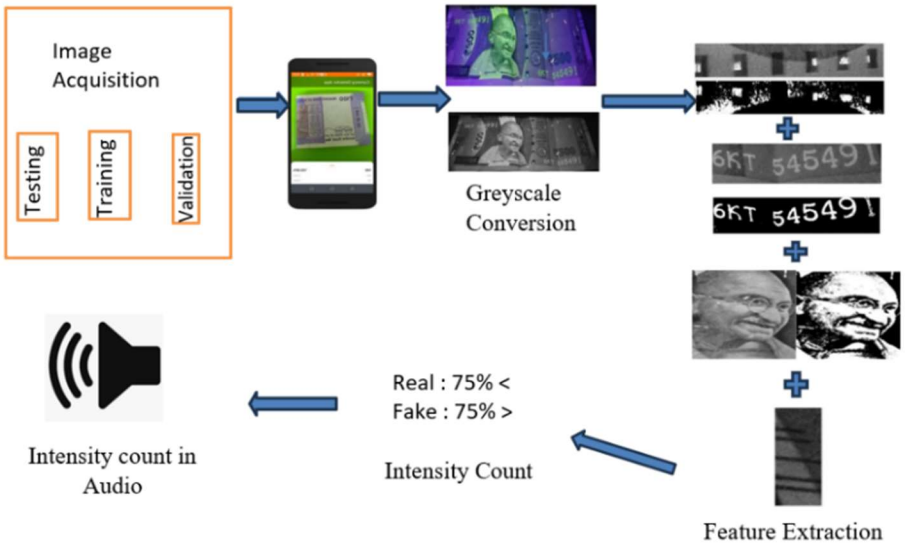

Figure 2. System Architecture

The process begins with acquiring digital images from various sources such as cameras, scanners, satellites, or medical imaging devices. These images can be in the form of photographs, video frames, or digital scans. These images serve as input for further analysis.

Pre-processing involves enhancing the quality of the acquired images to improve the effectiveness of subsequent processing algorithms. Pre-processing techniques may include image normalization, contrast adjustment, and image resizing. Image enhancement techniques are used to improve the visual quality of images by emphasizing certain features or removing unwanted artifacts. Examples include sharpening, blurring, histogram equalization, and dynamic range compression.

Image restoration techniques aim to recover or reconstruct the original image from degraded or distorted versions. This may involve removing noise, restoring missing or damaged parts, or correcting geometric distortions caused by imaging equipment or environmental factors [13]. Greyscale Conversion involves converting the images from their original color format to grayscale. This might be done for simpler processing or to emphasize certain features of image. Grayscale images often require less memory and computational resources compared to their color counterparts, making them more efficient for certain applications. Intensity Count involves analyzing the intensity levels of the images. In the context, there are intensity count values for both real and fake images. If the intensity is greater than 75% then the note is real and if it is less than 75% then it is fake.

Features relevant to currency authentication are extracted from the pre-processed image. These features may include security features such as watermarks, holograms, microprinting, and special patterns unique to each currency. Intensity Count involves analyzing the intensity levels of the images and it will be intimated through the **Audio.** It will generate voice message like “Real note of rupees 500” and so on.

3.4 Software Development Life Cycle (SDLC) -

In Requirement Gathering the requirement for the fake currency detection system are gathered. This includes understanding the features of the currency notes, the expected accuracy of the system, and any regulatory requirements. Feasibility Study contains a study which is conducted to determine the practicality of developing the system. This includes assessing the availability of data, the required resources, and the potential risks. In design the system architecture is designed. This includes selecting the appropriate machine learning algorithms and image processing techniques, and designing the user interface. Implementation system is developed according to the design specifications. This includes training the machine learning models, implementing the image processing algorithms, and integrating the various components.

In testing phase, the system is tested to ensure that it meets the specified requirements. This includes testing the accuracy of the fake currency detection, the performance of the system, and the user experience. In deployment, once the system has been tested and validated, it is deployed in the target environment. This includes installing the system, configuring the settings, and training the end-users. In maintenance, the system is maintained to ensure that it continues to function correctly. This includes fixing any bugs, updating the machine learning models, and adding new features.

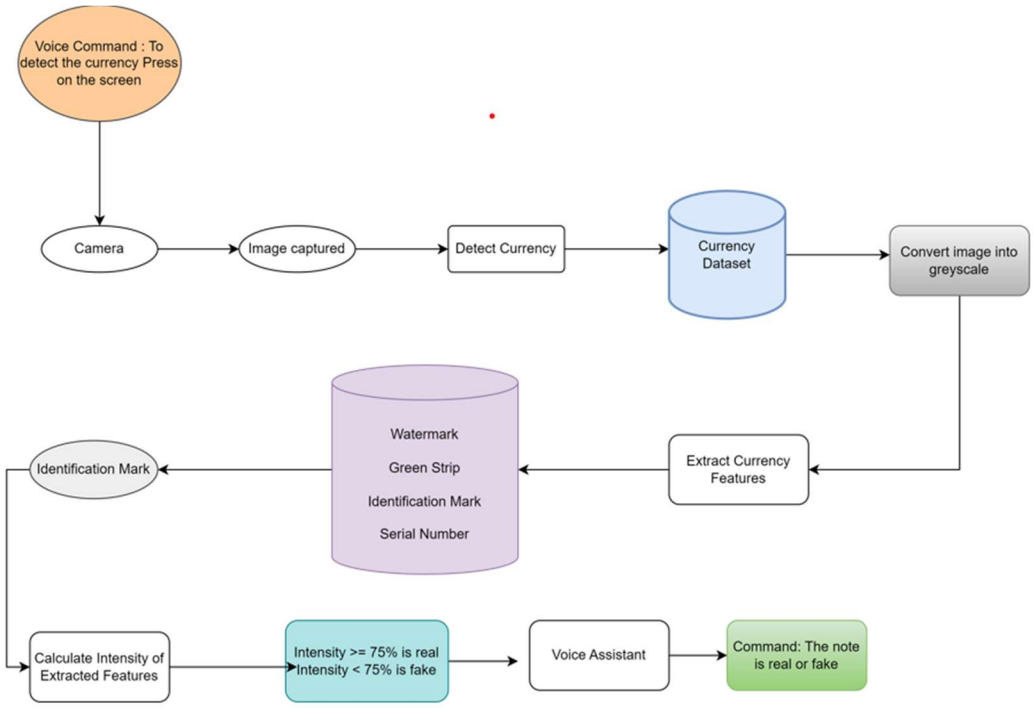

Figure 3. SDLC Model

In the context of the Software Development Life Cycle (SDLC), this process can be considered

as a system or application that has been developed to solve a problem which is fake currency or real currency.

4. Project Scope

The complete methodology works for Indian currency notes. The method is very simple and easy to implement. This technique is very adaptive to implement in real time world. The process begins from image processing and end at comparison of features. This type of automation applications can be used to help physically challenged people like blind and visually impaired people, as they can't see anything it is difficult for them to recognize any currency. In order to avoid this type of problems and their dependency on others, there is a requirement of a system that can help them to identify currency. Using this model, blind people can use this application to identify the currency effectively & efficiently. The proposed model has low processing time and is cost effective. Hence it is very reliable for real-time applications

In Dependence on Image Quality ML models for currency detection rely heavily on the quality of input images. Poor image quality, such as low resolution, blur, or distortion, can degrade detection accuracy, making it challenging to distinguish between genuine and fake currencies accurately. False Positives and Negatives produces false positives, incorrectly identifying genuine currencies as fake, or false negatives, failing to detect counterfeit currencies. Balancing between minimizing false positives and false negatives is challenging and may require extensive tuning and optimization [6]. As counterfeiters evolve their techniques, ML models need to adapt to new counterfeit features and patterns. However, the process of updating the models to recognize new counterfeiting methods can be time-consuming and may lag behind the emergence of new counterfeit currency designs [9].

4.1 Mathematical Model

In mathematical model we have taken 500 real note & fake note and calculated the intensity.

$$\text{Min Intensity} = \min_{i,j} (\text{Pixel Value}_{i,j}) \quad \text{……..(1)}$$

Here,

$\text{Pixel Value}_{i,j}$ represents the pixel value at position (I,j) in the image. The minimum intensity is the smallest pixel value across all the pixels in the image.

Intensities of all remaining features were also calculated for different notes of 500.

Table 2

Features	Intensity
Serial Number	20%

Security Thread	19%
Mahatma Gandhi Potrait	20%
Identification mark	21%
	80%

Table 2 shows the intensity of currency 80%, so we conclude that the currency is REAL.

Table 3

Features	**Intensity**
Serial Number	15%
Security Thread	14%
Mahatma Gandhi Potrait	12%
Identification mark	19%
	60%

Table 3 shows the intensity of currency 60%, so we conclude that the currency is FAKE.

5. Result

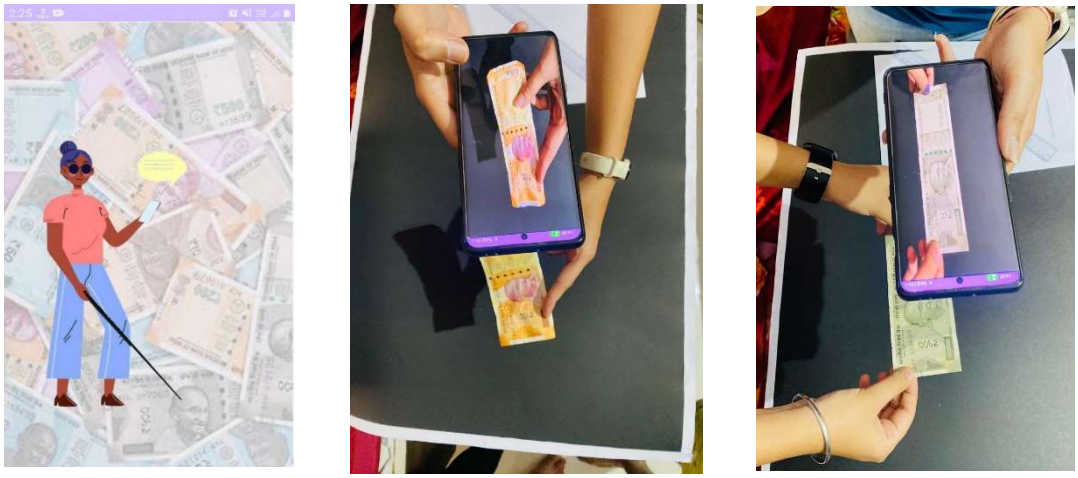

Figure 4. Demonstration of Application

Figure 5 shows how application will look after opening immediately and audio clip will be play as “To Detect the currency press on the screen”. In android application currency will be captured after tapping anywhere on the screen and result will be in audio clip like the “Currency is real or fake with type of currency” i.e. (10,20,50,100,200,500). If currency is not available in the hands of blind people after tapping on screen it will notify to user that currency is not detected. To detect the currency in sequence we have to follow all steps over again.

6. Conclusion

The proposed Android application that uses machine learning technology to recognize and authenticate Indian Rupee (INR) denominations is a significant step towards ensuring financial security and independence for visually impaired individuals. By accurately recognizing different INR denominations and processing the currency in real-time, the application provides a reliable tool for visually impaired people to manage their finances and avoid falling victim to counterfeit money.

The application's use of text-to-speech technology also enables visually impaired people to easily verify the authenticity of the currency they receive, giving them the confidence to manage their finances independently. This application not only promotes financial inclusion but also empowers visually impaired people to be more self-reliant and secure in their financial transactions. Overall, this application is a great example of how technology can be used to improve accessibility and create a more inclusive society.

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