Indian Currency Note Recognition System using YOLO v3 Methodology

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Abstract - *A currency note is more like a transferable medium that a government makes, paid on offer to the sender. The Indian currency rupee is the Republic of India's national currency. Falsified currency is the false money created without the Government or the state's legitimate confirmation. Fake currency is one of the biggest revenue transaction issues. This has led to a significant increase in corruption that inhibits development in the Nation. Due to the increasing developments in graphics, monitoring, and able to print, making falsified paper currency using automated hardware and software systems is very convenient for everyone. The manual identification of the falsified notes takes time, which means that an automated technique is required for the money recognition system. In this article, the framework mainly focuses on the identification of various currency notes and also whether the note is fake or original concerning their security features of a particular currency note. For faster identification of currency notes, YOLO V3 architecture has been utilized to extract the features of the new Indian currency note.*

Key Words: Indian currency, YOLO, recognition, features of note.

1. INTRODUCTION

Currency identification is a computer vision application used in the detection of specific nations' currencies. There is also a growing possibility of paper currencies interrelated in different nations. Banknotes must be noticeable from either side and distance by the banknotes detection system. Since certain notes were torn down during transmission, the model frameworks must recognize damaged or worn notes effectively. The world has about Fifty multiple currencies, including one with a unique pattern. For example, the paper size is unique, and the pattern and texture are still there. The people that work in exchange for currency must classify various types of cash and it is not a simple process because the logo of every other foreign currency must be recognized. Any complications could take place, and they will need an effective methodology to incorporate their assigned tasks. Many researchers were tried to persuade to implement the appropriate sustainable and predictable techniques to achieve an automated banking detection framework. In certain frameworks physical reviewing every note in transactions requires quite complicated and untidy regulations and sometimes there is a possibility for ripping during most of the handling of banknotes. Stimulus handling and identification accuracy are typically two necessary preconditions. Automatic methods for such identification of banknotes are also important for various functionalities, including electronic transactions and sales machines. For both the accuracy and performance of the detection algorithm, enough money - related specifications were extracted from the currencies photograph. For application programmers, this is indeed a challenging task. RBI (India reserve bank) encounters manipulated currencies cash or damaged cash every year. Additional difficulties come into play with maintaining massive quantities of bank currency. Thus, it aims to simplify the method of identification of notes utilizing computer systems (autonomous or as help and guidance to human analysts).

Paper currency identification systems must be proficient to accept paper currency with the best accuracy and rapidity. As banknotes become unreliable in both parts, the planned scheme must provide a precise resolution of wrinkled or damaged currency notes in a corruption investigation. The preferred method is to make use for precedence, the measurements and color, and texture of the paper currency, of the easily recognizable opportunities of paper currency. Until now, architecture is intended in many forms for the identification of paper currency. Generally, Holidaymakers and foreign visitors take a lot of paper money in the country. This is a challenging task for traditional bank notes frameworks. That wasn't enough for functional business organizations. Especially after the recent international integration of e-financial money transfers, transactions in actual cash are still very directly applicable to the national market, despite a decline in paper money use[1]. Although actual cash exchanges, money is still widely used in everyday situations, contacting and calculating are fundamental for big and secure money transfers, and that the use of several electronic devices is now becoming extremely important. Automatic currency depositing and withdrawing ATMs, banking transfers and banknotes [2], and coins counters, primarily found in banks, or electronic vending systems in which currency is deposited to buy goods, are part of the automated self-served automatic vending mechanisms. Four basic components should be given for the machines: banknote identification, false currency notes identification, identification of serial numbers, classification of fitness. Information technology performance is attributed to the replication of currency notes, which is not usually recognizable. For making falsified banknotes, automated scanners and innovative customization options have been used.

Fake currency notes can only be managed to slip in actual currency packages since they almost always exchange on the industry worldwide. Business areas such as financial institutions, shopping complexes, and clothing stores have large regular daily payments. These places can afford to purchase devices using UV light and other methods to detect the validity of the currency and can make everything feasible. However, it is very challenging [3] for average citizens to see if the money is bogus or genuine, and in fact, in bank deposits or investments participants may lead to a loss. The framework is built so that anyone can quickly use it and identify the currency appropriateness by using currency visualization features. The falsified note has been one of the greatest barriers to financial transactions for countries such as India. Due to rapid advancements in image technology, inspecting and able to print it is quite convenient for an individual to even use the emerging innovations and equipment for printing fake paper money. The key main purpose of this study would be to get knowledgeable about various security standards which have been applied to new banknotes so that they could still distinguish between counterfeit paper money and real currency note with convenient assessments. Currency identification and authentication have numerous practical implications including banking services, monetary tracking systems. Automatic machines that identify currency notes are frequently distributed in suppliers of modern goods such as treats, bottles of beverages, plane or subway bookings.

The currency identification [4] and authentication engineering are fundamentally designed to distinguish and remove known and unknown currency note characteristics. In this research article, I focused on understanding the Indian banknotes to determine whether that is a real or falsified note. Several software methods have been utilized for the identification of banknotes. It is easy to derive a country's currency security features and then see whether the banknote is real such as the currency color and dimension. But it is difficult to decide whether the banknote is fake or credible depending on the currency's key characteristics, such as watermarking. The daily use of currency notes worsens and damaging the circumstance of paper money. The actual paper money may have a lack of knowledge due to the disruption to the banknotes. The money could be disrupted and the disturbance hard to manage. The money can be checked even if it is replicated or not by using image processing strategies. Some technologies, including photo manipulation, side identification, pattern classification, character segmentation, and color-coordinated frames, are often used for the objective.

This paper is planned as Section II includes the overview of the paper. Section III describes the proposed methodology. Section IV is about results and discussion. Finally, ends with a conclusion.

2. LITERATURE REVIEW

In the research paper [5], where T. Pathrabe and Swapnil. K proposed an innovative methodology for transforming identification and speed of learning on the job to identify the banknotes of the United States and Japan. This distinguishes two input images, series data and power spectrum from Fourier. In all instances, the neural network is specifically used as input variables. They often apply to a modern assessment method. Throughout the printing house, the banknotes are mockup, however, with the assistance of the system and a color printer at the store, it is indeed available for any individual to print replica pound notes. Paper fraudulent documents can be completely separated from the authentic and then using genuine ones through the essential robotic system.

In [6] a new technique based on photos is proposed for the identification of paper currency in Birhani based mostly on a Machine Learning algorithm and a weighted Euclidean utilizing adequateweights. The first thing the scanning method accomplished is the accuracy of the color image of the banknotes is almost 600 pixels. Four types of the picture in color: the binary picture is the grey pixel by Prewitt mask, the grey image by Sobel mask, and the grey image by Canny mask are collected in the preprocessing method. Features have been extracted by modification with each of the captured images with the summation of pixels. For all of the photos, the Euler factor is also determined, and the similarity factor of the source images is computed after transforming to grey. After abstraction of paper money identification, the feed-forward propagation is carried out using the following separate strategies called the Weighted Euclidean Distance (WED) and the Artificial Neural network.

To determine the control of sculpture, a diversity of scholars was implemented a set of techniques. The main emphasis is on the identification system [7] which requires multiple algorithms involving different measures such as the image possession, classification system, and element pull out. The outcome of the categorization promotes identification of the counterfeit money by primarily incorporating Serial Number fishing by the use of OCR. Most of the elements in this method are picture segmentation, edge recognition, image analysis, image contrast, characteristic extraction [8]. On the currency portrait, the characteristic separation was carried out and particularly in comparison to the money characteristics.

A framework for the identification of banknotes consisting of 2 parts, an identification component, and an authentication part, has been proposed in [9]. Few authors implemented an ENN (Ensemble Neural network) currency identification method. Negative correlation modeling is used to train multiple neural networks (NNs). The goal of using negative correlation modeling is to influence individuals in various positions. The picture is transformed into grey and compacted into the target range by various types of notes. An input to the system will be provided to every other pixel of the filtered image. This framework may recognize very noisy or older TAKA pictures. Ensemble network is incredibly useful in classifying multiple currency types. It decreases the probability of mis-qualification as a singular, independently qualified network, and ensemble network [10].

Yifeng Liu [11] has suggested that a Haar Wavelet function be the shortest functioning wavelet and an efficient classification algorithm is the Supported Vector Machine (SVM). This paper proposes a novel pattern that first incorporates Haar wavelet and SVM to address the issue of currency notes with scheduling and superior effectiveness in smaller amounts. The basic outline of this technique is to identify the characteristics of the waveform and incorporate them into predefined virtual support vectors. Now several banknotes have been complimenting a newer and better counterfeit use with more immediate problems. A new camera-based simulation system was developed by Yingli Ti [12] to recognize and classify banking notes for individuals with visually impaired circumstances. The overall assessment is focused on the application of image computation and pattern recognition. The embedded system factors are thoroughly investigated for the identification of counterfeit currency. Actual prototypes are used to validate paper currency in studies that indicate high-precision equipment. The machine efficiency is seen for both reliability and speed of processing. To achieve an accurate measure, the study of the security systems [13] demonstrates some of the issues which should be taken into consideration in the future when developing paper currency. Due to improvements in printers, the use of such new hardware equipment makes it possible to print counterfeit notes. Currency identification processes can also be effectively performed using automation methods to detect counterfeit notes, which would be computationally expensive and frustrating. Many methodologies, HSV color space as well as other computer vision implementations have been suggested about the use of MATLAB. We have a fake note identification system with the MATLAB automated system. These findings suggest that the machine can identify 100% of images properly registered.

A study [14] implemented a system for the ATM DSP framework of real currency notes. It simultaneously identifies USD and EUR with a running time of 54 MS for each note and demonstrates an accurateness of classification of over 99.8%. This technique employs the dense SIFT methodology for object extraction and is a significant step to generate the processing rate of the SIFT implementation more efficient against changes in the size. A study [15] demonstrates the most important inter-class discrepancy on the differential map and GLVQ-base categorization on 65,700 USD billed correctly 99 percent in real-time processing techniques in an embedded platform, responsible for processing 16 MS per note. A study [16] carried out in the DSP Real Conflict was carried out using a classification and deployment methodology of a GA based optimal Mask and an error-free identification rate over 97 percent on 100,000 USD and JPY currencies.

One study [17] conducted with a USD 60,000 money analysis in an actual banknote monitor DSP atmosphere revealed an improvement of 15.6 MS for each bill at a rate of identification of 99.86%. The input banking notes are first categorized in terms of inputs and indications in this experiment and are then classified according to descriptions. Progressive processing based on the number of categories, thereby enhancing the application performance, is the most significant element of this approach.

The Integrated Indian National currencies Denomination Classification Model, which depended upon the Neural Network,[18] proposed that native currencies could be categorized based on the several interesting non-separating characteristics, such as color and indicators, and besides, the identifying symbol referred to RBI regulations. First of all, the prevalent color is segregated from the perception of the banknote. After that, the segment of the note representing a sort of I.D is differentiated. The photocopy is completed. The feature extracting using Fourier Descriptors is completed from all these interconnected image features. Since every note is of a particular kind like the I.D. Descriptions, with the guidance of Neural Network the identification of such outlines is accomplished. The proportions are interpreted to rely on the computation provided after the extraction of the features. [19-24]

3. SECURITY FEATURES IN INDIAN BANK NOTE

In terms of protecting the newly released 2000 currency note from misinterpretation, it has numerous authenticating characteristics. Although it is difficult to accurately duplicate and build similar security features, fraudsters nevertheless attempted to design banknotes to their significant limitations. It is necessary to understand the numerous security mechanisms available in Indian paper currency and in numerous certain documents that incorporate these characteristics to counteract these unethical practices of the counterfeiters, avoiding such misrepresentations and be scammed. In this article, we will first address the different security mechanisms in the new Indian currency note with denomination values of 2000, 500, 100, 200, 50, 10, and those from the scanned and photocopied papers.

3.1 Watermark

Embedded watermarks are indeed the sketches produced by different distributions of textures within the particular area in the paper money able to integrate mostly during the process of manufacturing. The unique watermarks that existed in 2000 note as mentioned in figure 1 are:

i. Watermark of 20000
ii. Electrotype watermark
iii. Portrait of Mahatma Gandhi
iv. RBI watermark
v. Watermark of 2K symbol

Fig -1: Various watermarks of Indian 2000 note

3.2 Micro Lettering

Micro-lettering tends to mean the transcriptions which can be understood only under a magnifying glass or utilizing a hand-lens. "RBI 2000 INDIA" is encoded on the Indian currency note with reference number 2000. The terms INDIAN BHARAT (Hindi) are substitute on the right side and left side of the Mahatma Gandhi outfits near the chest, and the term RBI is engraved within the spectacle structure of Gandhi. Instead, they are printed on the right side and left side of the currency note.

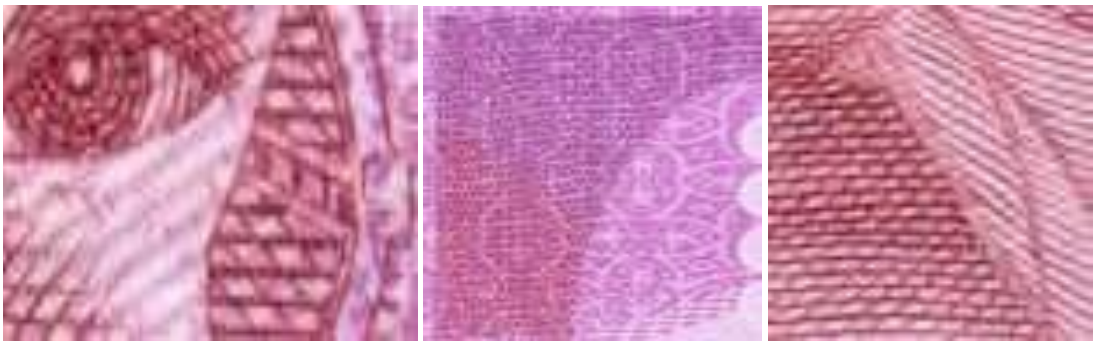

Fig -2: Micro Lettering

3.3 Optical Ink

The decimal amount 2000 on the front is processed with digital ink by the Mahatma Gandhi watermark portal of the 2000 currency note. When seen from different perspectives, the letters and numbers transform their shade.

Fig -3: Optical Ink (Blue, Green)

3.4 Safety Thread

The safety threads in the currency note 2000 is three-meter long, typically six-windows and interprets three terms, specifically "BHARAT", "2000" and "RBI". The safety threads change from blue to green when angled, slanted, and marked on them respectively.

Fig -4: Safety thread viewing from different angles

3.5 Intaglio Print

Inscribed or written narratives may be sensed by contact were made using the Intaglio printing process. Mahatma Gandhi's portrait is written on the Indian paper currency of decimal – 2000, the symbol of the Reserve Bank, assurance and promise provision, Ashoka pillar symbols on the right, the signature of RBI Governor were printed. Some other security features include the latent image, numbering patterns that include the size of the letters also, and identification marks.

Fig -5: Intaglio print

4. METHODOLOGY

Computer vision plays an important role in scenarios of the identification of objects using images or videos. It incorporates the identification of a particular object's presence, and its location in the image or video, and identification of the type of the object in the image or videos. It is a complicated topic that requires relying on strategies for object identification, object localization, and labeling of objects. Deep learning methodologies have achieved state-of-the-art findings for object identification in present scenarios, including on standardized benchmark datasets and various competition for computer vision. Of those methodologies, the identifiable architecture is YOLO. The full form of YOLO is "You Only Look Once", it is based on a convolutional neural network and it is part of the CNN family for the fast object identification learning models. YOLO based on the GoogleNet CNN model in the initial stages and later it was updated using the VGG CNN model. The object detection with the aid of the YOLO network by splitting \each of the input into various grids and object will be identified based on these grids for the classification aspects. The proposed algorithm can be mentioned as follows:

4.1 Dataset and System Description

The dataset considered consists of various new notes such as 10, 50, 100, 200, 500, 2000 images with the size of 78. This dataset is very crucial in the identification of various notes based on various features that can be obtained from the implemented methodology. The system considered for the implemented system on Windows 10 operating system, with the Python programming language and Intel®Core™ i7 – 1160G7 processor upto 4.40 GHz with 11th generation.

4.2 Implemented Methodology

Step 1: Considering a dataset of new Indian currency notes of 2000, 500, 100, 200, 50, 10, along with different scanned copies of those notes. Dataset consists of 78 images of the new Indian currency.

Step 2: Applied Image processing techniques, such that the security features of the note can be identified without noise and blur in the images.

Step 3: As the YOLO architecture is invariant to the input the size of the image, Image resizing must be done for all the currency note images.

Step 4: Splitting the dataset into training and testing datasets, such that the YOLO v3 model can be applied.

Step 5: Importing the YOLO V3 architecture to train the model and to extract the security features of the note with a training dataset up to 6000 epochs.

Step 6: On the trained YOLO V3 architecture, consider a random currency note from the testing dataset to check the accuracy.

4.3YOLO v3 Description

YOLO is a technique used for object localization by CNN. YOLO has been one of the fastest techniques for image classification. Although the image classification model may not be the most powerful, that would be a very viable alternative for real-time identification without losing unnecessary performance. A recognition framework not only predicts class labels and thereby recognizes target positions relative to image classification. So, the picture is not only classified into a group and most objects may also be recognized in a frame. A standard neural network refers to the overall picture of this methodology. This framework splits the picture into areas and estimates boundaries and probability for each area. The expected probability measures their feature vectors. Advanced and more complex architecture for extracting features named Darknet-53 is introduced in YOLO v3. It has 53 deep convolutional levels, each with a batch normalization phase and ReLU activation. No sort of pooling was utilized, and the pattern maps are downsampled with a convolutional framework of stage 2. The above helps avoid the reduction of low-level characteristics often associated with pooling. Yolo recognizes the security features of the currency note and labels them in their sub-region part of the image. As all the security features were identified at an instant time with YOLO architecture, it provides faster results effectively with small architecture.

5. RESULTS AND DISCUSSION

As the new Indian currency notes 2000, 500, 100, 200, 50, 10 of totally 78 images were utilized for the identification of various notes. YOLO v3 architecture based on CNN family architecture is a pre-trained model to obtain the results in a faster mode. So, the considered dataset was utilized on the YOLO V3 architecture. The model trained a large number of epochs to obtain higher accuracy with 6000 epochs with a learning rate of 0.001 for slow learning to stabilize the learning of various features from the currency note images. The model achieved an accuracy of 99.57% along with the training loss of 0.28% that shows the better recognition of the Indian currency notes faster and efficiently.

6. FUTURE WORK AND CONCLUSION

In this research article, I focused on understanding the new Indian paper currency to determine whether that is a real or falsified note. Several software methods have been utilized for the identification of banknotes. But, to recognize a note is counterfeit or real in real-time with better accuracy, a few architectures have been introduced by researchers. The framework mainly focuses on the YOLO V3 architecture that identifies various security features of the currency note at an instant of time and achieved an accuracy of 99.57% with a training loss of 0.28%. The present implemented methods can be extended further by generating an application based on a smartphone with their respective operating systems and web applications that would be helpful for visually challenged people.

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