AN EFFICIENT METHOD TO DETECT FAKE INDIAN CURRENCY USING ARTIFICIAL NEURAL NETWORK AND SUPPORT VECTOR MACHINE

C.Kiruthigadevi M.Sc., Department of computer Science Mphil scholar

G. RAJA RAJA CHOLAN M.C.A., M.Tech. M.Phil.,(Ph.D),Asst.prof

Department of computer science. Prist Deemed to be University,

Thanjavur, India

Abstract : Fake currency is an impersonation of currency created without the lawful authorize of the government or any state. Delivering or utilizing fake currency is a type of falsification or fraudulent activity. In recent years, the immense innovative advancements in printing, shading, copying and examining leads to the issues of the fake currency that have turned out to be increasingly genuine. A lot of illegal counterfeiting fake note currency is printed and at the same time manufacturers and sellers of fake currencies has been increased as well, which have caused great loss, damage and unbalanced economy of our society. Thus it is imperative to be able to detect fake currency using existing systems as they are not accurate and costly. In this paper, proposed a new approach to spot fake Indian notes using their images. A currency image is scanned and processed using a hybrid approach called improved image processing technique. Based on certain features and characteristics of the currency, the matched key points between the two images can be recognized in an efficient manner. By the acquisition of image from real-time, feature extraction is applied to extract the needed feature. After the feature extraction, improved image processing technique is applied to predict the counterfeit currency.

IndexTerms **- Fake currency, fake currency detection, Artificial Neural Network, Support vector machine, currency image representation.**

I. INTRODUCTION

Currency notes were used as the medium of exchange for any kind of goods and for any services. Human error is a huge apprehension in cases where large amounts of cash transactions are conducted that leads to a push for an increase in automation of transactions in the banking sector. Currency duplication and distribution is also known as counterfeit currency distribution. This kind of distribution is a vulnerable threat to the economy. Surplus of fake currency is now a general phenomenon due to advanced printing and scanning technology and equipments. To get rid of the fake notes in markets, various fake note detection methods were found around the world and most of these are hardware based and costly. The method of Automatic recognition system of fake Indian currency note is important in many of the applications namely automated goods tellers machine and automated goods seller machine. This system is worn to identify the valid Indian currency note among the counterfeit notes [1]. Automatic counterfeit currency identification machines were more helpful in banks because the banking sector faces the problem of counterfeit currency notes or destroyed notes in everyday transaction. The machine makes note recognition progression as a simpler and systematic process. Automatic machine is more significant to identify fake currency note in every country. This system is designed to check the Indian currency (200, 500 and 2000 rupees) note's originality. The Reserve bank of India has approximation that there is at least Rs.2 trillion of fake rupees note in circulation in the society throughout India. The bank staffs are particularly trained to identify counterfeit notes but the problem starts once such notes are penetrated into the market and circulated through common people.

Nowadays, counterfeit notes even received from ATM counters have also been reported at some of the places. The improvement of modern banking services, automatic methods for currency recognition become significant in many applications such as in ATM and Automatic Goods Seller Machines. Indian paper currency consists of six major denominations (₹10, ₹20, ₹50, ₹100, ₹200, ₹500, ₹2000), with each having distinguishing features, such as size, prominent colour, identification mark. The development of sophisticated printing techniques, counterfeit currency has become a considerable concern. The consequences of counterfeit note usage on society tends to reduction in the value of real money, raise in prices due to more money being circulated in the economy and reduces in acceptability of money. To avoid the circulation of counterfeit notes, a well sophisticated system is needed to detect the fake notes must be developed. Notes with the authorized sanction of the government hold certain security descriptions such as intaglio printing, fluorescence and watermark. So far, numerous different approaches have been proposed to resolve the problem of paper currency recognition and verification system. The trade-off between accuracy, complexity and response time becomes the main hurdle to overcome [2].

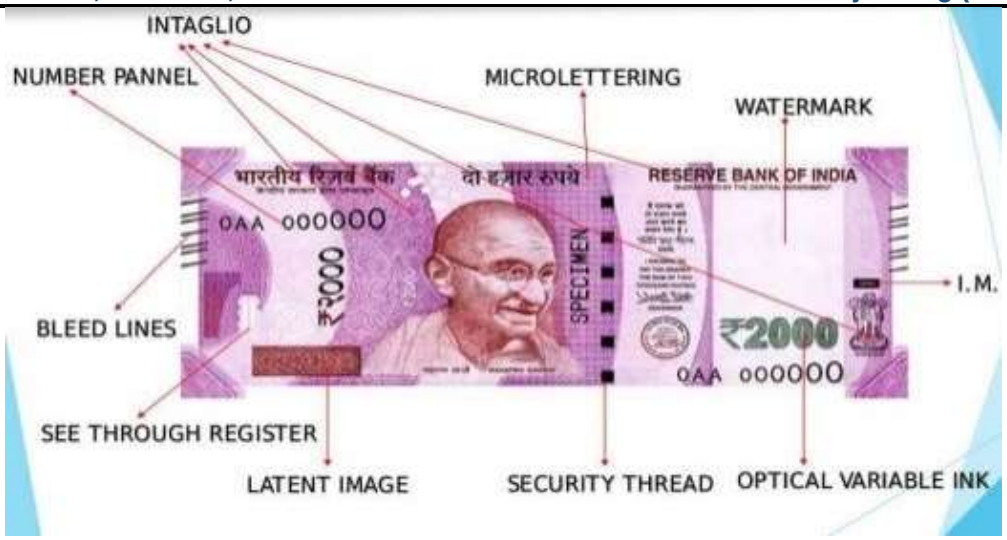

figure 1. two thousand rupees indian currency with its features [3]

II. FEATURES OF INDIAN CURRENCY

The RBI says that the number of the fake notes in the year 2018 has increased by 20% and the number attained up to 7.62 lacks by the estimation. The denomination of 500 and 2000 rupees has the maximum number of fake notes. In order to make the awareness among the general public, several security features related to the currency notes were published. So that, duplicates notes can be identified by the general public. The Reserve Bank of India (RBI) is the highest monetary authority in India.

- **Security Thread:** The security thread shown at the left of the portrait of Mahatma. Features of security thread are a plain, non-readable fully entrenched in to the security thread. Since October 2000, the Rs.2000 currency notes holds a readable, windowed security thread alternately visible on the frontage with the captions 'Bharat' (in Hindi), '2000' and 'RBI'. All the currency notes of India contain a security thread. When notes whispered against the light, the security thread on Rs.2000, Rs.500 and Rs.100 can be seen as one incessant line.
- **Watermark:** Bank notes with Mahatma Gandhi series contain the water mark of the Mahatma Gandhi with a light and shade effect and multi-directional lines in the watermark window.
- **Micro-Lettering**: Micro Lettering is appears between the vertical band and portrait of Mahatma Gandhi. It includes the word of 'RBI' in Rs.5 and Rs.10. The currency notes of Rs.20 and above also have the micro-letters of denominational value of the notes. This feature can be seen well with the help of a magnifying glass.
- **Latent Image:** On the front side of Rs.2000, Rs.500, Rs.100, Rs.50 and Rs.20 notes, a vertical band which is on the right side of the portrait of Mahatma Gandhi poses a latent image showing the respective denominational value in the numeral. The latent image of the vertical band is able to be seen only when the note is held horizontally to the eye level.
- **Intaglio Printing**: One of the special features in our currency is intaglio printing which is added in the bank notes for the expediency of the blind peoples. The emblem of the Ashoka Pillar is placed on the left, portrait of Mahatma Gandhi, and the Reserve Bank seal. It is also added with the guarantee and promise clause, RBI Governor's signature is printed in intaglio. This printing is available in diverse shapes for various denominations i.e. Rs. 20 have in Vertical Rectangle, Rs.50 in Square, Rs.100 in Triangle and Rs. 500 in Circle.
- **Optically Variable Ink or Colour-Changing Ink:** Optically Variable Ink or Colour Changing Ink incorporated in the Rs.500 and in Rs. 2000 notes as well. The colour of the numeral 2000/500 emerges green when the note is held flat but would transform to blue when the note is held at certain angle.
- **See through Register:** This feature will show up relevant currency number when the note is held against the light. The small design of flora is printed both on the front and back of the note in the middle of the vertical band next to the Watermark has an accurate back to back registration in the note.
- **Fluorescence:** Number panels of the currency notes are printed in fluorescent ink and also have optical fibres. Both can be seen when the notes are placed in front of the ultra-violet lamp or ultra-violet light.

The Ministry of Finance and Reserve Bank of India are trying hard to make sure that the Indian notes could not be counterfeited. The government is a success in its efforts up to some extent but these security features could not prevent the tradition of printing and making fake notes in the country [1].

III. LITERATURE REVIEW

Ying Li Tian [4], describes an Effective Component-based Banknote Recognition for the Blind. In this methodology, for the detection of forged notes it needs to identify the denomination every time they use the device which consists of ultraviolet light. The bank employees keeps the paper currency note on the device and try to find whether the watermark identification, serial number and other characteristics of the notes are proper to get the denomination and check its authentication. Nayana Susan Jose and Shermin Siby [5] introduced an Android Based Currency Recognition System for Blind people . This philosophy is for the most part worked to help them and make them simpler to become acclimated to the monetary standards too. Here, the creator proposed an android based application for perceiving monetary forms of various nations and furthermore their groups for the most part for outwardly debilitated people.Mirza and Nanda [6] built up a strategy called acknowledgment of paper cash with the assistance of computerized picture handling methods. The qualities extraction is performed on the picture of the money and it is compared with the characteristics of the genuine currency. Mohammad H Alshayeji [7] elaborates a technique to Detection Method for Counterfeit Currency Based on Bit-Plane Slicing Technique. Another methodology is found in this paper utilizing the bit plane cutting system to remove the most critical information from fake banknote pictures with the use of an edge indicator calculation.

IV. A HYBRID PROPOSED APPROACH

Artificial Neural Network

Artificial Neural Networks (**ANN**) is the pieces of a computing system intended to simulate the way the human brain analyzes and processes information that is needed. They are the basics of Artificial Intelligence (AI) and solve problems that would confirm impossible or difficult by human or statistical standards. Artificial Neural Network can be used for classification, regression or clustering. Stages of image processing are divided into pre-processing, feature extraction and classification. In the later stage it can be applied. Input to ANN should be features and output should be classes [10].

Support Vector Machine

Support-vector machines are supervised learning models used for classification and regression analysis. SVM is fundamentally based on a binary classification algorithm. It falls under the umbrella of machine learning. In a nutshell, both are different concepts from two different fields of study (SVM being from Machine Learning and Image Processing a subset if Signal Processing). Image Processing is mostly done prior to SVM [11].

Pre-Processing

In some recognition and verification systems, a pre-processing step is the initial and most required before the feature extraction and representation of an image. This can improve the performance of the verification system efficiently. In order to recognize worn, torn, and noisy currency along with the clean banknotes, pre-processing is helpful for further processing [12].

Feature Extraction

Feature extraction and representation is an important step of any type of image recognition and verification system. Due to the presence of a vast amount of information in an image, it is not desirable to process the whole image for comparison. Rather, a selected set of features is extracted from the image that is only some important features extracted. The presentation of verification systems is very much reliant on the appropriate selection of features and representation process [13].

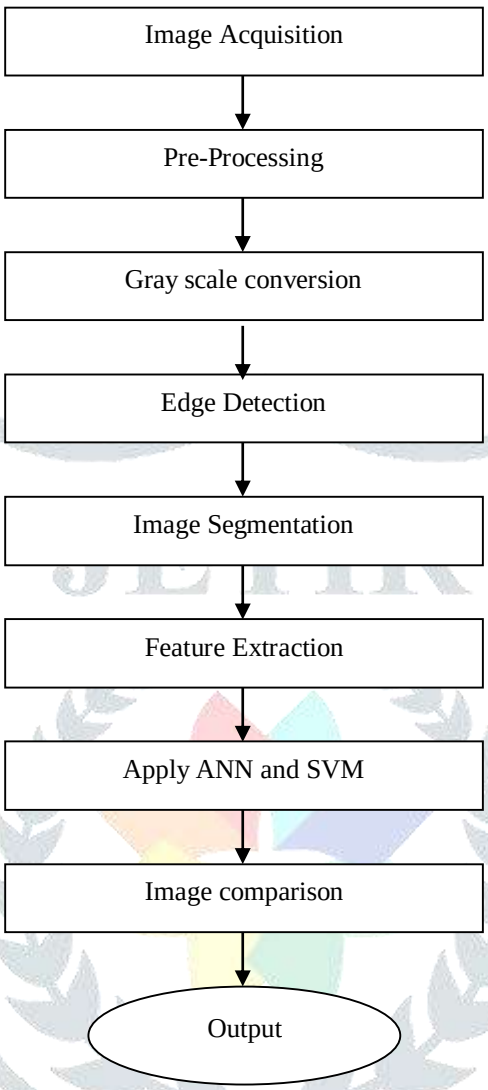

Figure 2. Flowchart

V. RESULT AND DISCUSSION

In this section counterfeit image detection is done for both fake and original currency. To evaluate the performance of SVM and ANN with SVM algorithms, an experiment is conducted. Both the algorithms were implemented in Matlab and executed in a machine with 3.20 GHz CPU. Features of currency note like security thread, serial number, Identification mark, Mahatma Gandhi portrait were extracted from the original note. The process starts with image acquisition to the calculation of the intensity of each extracted feature of the original image. The proposed algorithm is capable of extracting features even if the note has scribbles in it. The extracted features were compared with other notes to detect the counterfeit note.

Figure 3. Input Image

Figure 4. Black and White Conversion

Figure 5. Gray scale Conversion

Figure 6. Edge detection

Table 1. Recall, Precision and accuracy values

Algorithms	Recall	Precision	Accuracy
SVM	83.09	86.65	89
ANN and SVM	93.87	96.23	95

The table 1 holds the values of the performance measures of the existing and proposed algorithms. From the observation it is found that the proposed algorithm outperforms the existing algorithm.

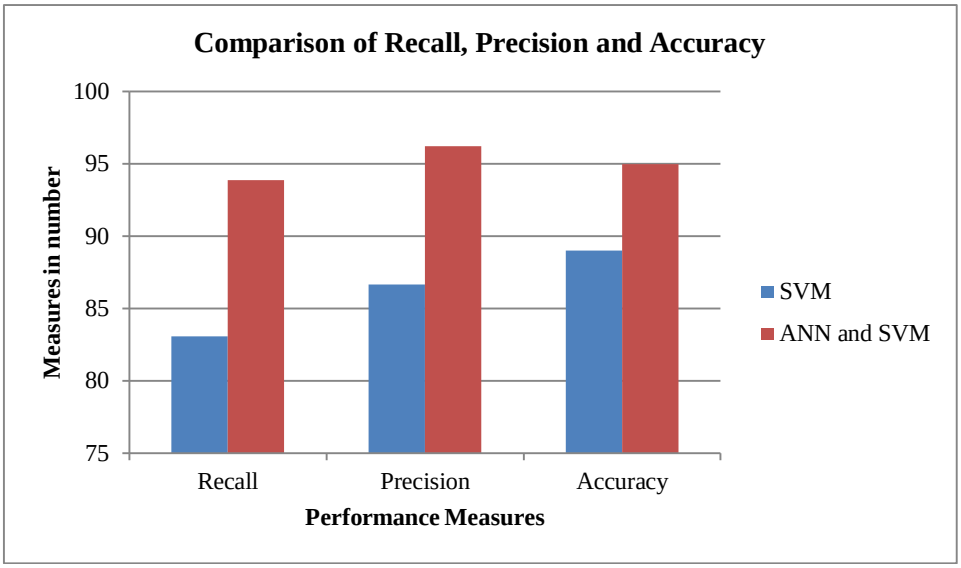

Figure 7. Comparison existing and proposed algorithm's performance measures

VI. Conclusion

After the analysation of various methods used to detect forged banknotes, this paper presents a banknote authentication system using ANN with SVM. In order to recognize the banknote as genuine or fake by using image processing techniques has shown in this paper. Some of the security features of currency note like Identification mark, security thread, serial number, Mahatma Gandhi portrait were extracted from the original note. The processing of image starts from image acquisition to calculation of the intensity of each extracted feature of the original image. The extracted features were compared with other notes to detect the counterfeit note. The result shows an artificial neural network with support vector machine outperforms support vector machine and gives a 100% success rate. These techniques are efficient methods of solving the problem for all banking-machines that accept all types of notes. In future, this work can be extended by categorizing the notes into different categories as Genuine, Inappropriate currency, Low-Quality forgery and High-Quality forgery.

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