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A Novel Recognition of Indian Bank Cheque Names Using Binary Pattern and Feed Forward Neural Network

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Abstract: *Automatic processing of bank cheques is getting more popularity and attracting more researchers. This paper proposes an efficient machine leaning techniques to design and develop an algorithm to read and recognize the nationalized Indian bank cheques using optical character recognition technique, in which binary patterns extracted by applying classification level decision using feed forward artificial Neural network(NN). In the proposed methodology the neural network is trained to classify six standard nationalized Indian bank cheques. The accuracy of the system is analyzed by the invariant features such as different font, size and varieties of characters with noise and the experimental results reveal satisfactory result.*
Keywords: *Binary pattern; Bank cheque; Neural network; Optical character recognition*

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I. Introduction

As the population is growing, bank transactions use of huge number of bank cheques daily. A great deal of work has been done on automatic processing of bank cheques like automatic extraction of items, signature verification, recognition of date from the cheque, amount filled by the user etc. The bank name is written always at the top left corner with unique font, any damage in this region will hamper the performance of the proposed system.

The proposed approach automatically segments and recognizes the bank name present at top of the bank cheque, with different character pattern. The proposed approach does not necessitate any prior information and require no human intervention. The system performance is quite promising on large dataset of real cheque images.

The concept of geometrical patterns of a character in a given cheque image includes:

1. The changes in the characters of the bank name represent the different visual patterns of the category of alphabets, fonts, size and colour of the query cheque.
2. The physical characteristics of bank name of cheque image are identified using unique binary patterns for the recognition of name of the bank.

Bank cheques plays a significant role in today's cashless transaction of any organization. Cheque images contains fields like bank name, date, courtesy amount, legal amount, logo, cheque number and signature which gives authenticity of the cheque image. In day to day financial transactions a larger set of bank cheques belongs to different banks is a challenging task to automatically recognizing and detecting bank names.

Many varieties of systems have been developed to perform cheque image recognition. These systems possess some of the common and similar characteristics.

In this approach, an own dataset of bank cheque database is constructed to recognize six nationalized Indian bank chques: Sbi, Canara, Axis, Vijaya, Sbm and Union bank of India. Along with the standard database, hundreds of other cheque images from the internet are also considered. The methodology has two stages.

- *Segmentation of bank name and extraction of characters*
- *Generation of unique binary pattern for each character*
- *Classification and recognition:*

In this proposed work, the classification and character recognition is done by feed forward Artificial Neural Network as shown in Figure-1.

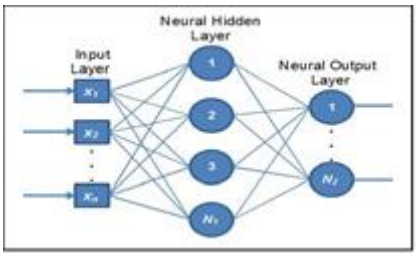


Figure-1 : Simple neural network architecture

A knowledgebase of 52 English characters will be created with appropriate pre-processing like thinning, normalization, resizing to create binary patterns and later used for comparison and classification using artificial feed forward neural network.

In the first stage segmentation of region of interest containing bank name is located, bank name is extracted using binary patterns.

The second stage processing includes, the classification based on the outcome of the Primary level to recognize and classify bank cheque into one of six categories of bank viz sbi, canara, axis, vijaya, sbm and union bank of India using Feed-Forward ANN.

Literature Survey:

Several researchers contributed their work in this field such as Abdul Mueed Hafiz [1] etal proposed robust and efficient classification of Arabic characters, an effort has been made to further boost the recognition capability of HMM Based Arabic Optical Character Recognition Systems, by using a two-tier hybrid classification scheme. Amarjot Singh [2] etal proposed a technique for recognizing handwritten, printed characters using OCR mechanism. Anju K Sadasivan [3] and etal proposed a survey which addresses a comparative study of different techniques available for extraction of characters from complex document images like different fonts, different languages, having surface deformation, poor quality, or even blurred. Ankit Sharma [4] and etal developed 0ff-line strategies for the recognition of isolated handwritten English character (A TO Z) and (0 to 9) using Neural network followed by the Back-Propagation Algorithm which compromises Training. Ashok Kumar. D [5] and etal designed Neural Network model for the signature verification and testing using the Offline Bank Cheque Signature Verification System. The acquired signature from the bank cheque is pre-processed and the Gray Level Co-occurrence Matrix (GLCM) features of the signature are extracted. The extracted features are used to train a Feed Forward Back Propagation Neural Network (FFBPNN). Ahmad Ridwan wahap [6] and etal presents the results from a research to design and develop a bank cheque recognition system for Malaysian banks. The system concentrates on recognizing the courtesy amount and date only.

Asmaa Qasim Shareef [7] etal shows how the use of artificial neural network for an optical character recognition application, while achieving highest quality of recognition and good performance by applying multiple image processing technique, Ayatullah Faruk Mollah etal [8] presents a complete Optical Character Recognition (OCR) system for camera captured image/graphics embedded textual documents for handheld devices. At first, text regions are extracted and skew corrected. Then, these regions are binarized and segmented into lines and characters. Characters are passed into the recognition module also Chinmay Bhurke [9] and etal presented currency recognition aims to search and extract the visible as well as hidden marks on paper currency for efficient classification, worked on 5 currencies and it was found that the proposed algorithm based on color and feature analysis works well for four currencies. Chirag Patel [10] etal made a comparative study of the tool with commercial OCR tool Transym OCR by considering vehicle number plate as input. From vehicle number plate and tried to extract vehicle number by using Tesseract and Transym and compared these tools based on various parameters. Chowdhury Md Mizan [11] and etal proposed algorithm for solving the problem of offline character recognition, given the input in the form of images. The algorithm was trained on the training data that was initially present in the database. Have done pre-processing and segmentation and detect the line.

Dhanalakshmi S [12] and etal presented a technique to detect whether the cheque is valid or not by verifying the signature and account payee which can be validated using binarization and implemented pin generation kit which is designed as a separate hardware component but in later stage this can be developed as an OCR application which can be accessed in smart phones along with OTP. Dileep M R [13] etal presents a novel technique to design a model to classify human facial expressions according to the features extracted from human facial images by applying 3 Sigma limits in Second level decision using Neural Network (NN). G. T. Sutar [14] and etal implemented number plate recognition and algorithm successfully detects the number plate region from the image which consists of vehicle number & then character segmentation, recognition. Henge Santosh Kumar [15] etal This paper proposes the layered approach methodology to recognize the characters, conjunct

consonants, mixed-conjunct consonants and expressed the efficient classification of the hand written and printed conjunct consonants. Hrishikesh Samant [16] etal introduced a methodology for to reduce the human efforts, time and money for automatic processing of cheques.

Lawrence D. Jackel [17] etal discussed technological development that has extended the utility and convenience of ATMs produced by GIS by facilitating check cashing and depositing, as well as direct bill payment, using an on-line system with sophisticated optical character recognition (OCR) technology. M. Abdul Rahiman[18] etal provides an overview of the OCR (Optical Character Recognition) research in South Indian languages. OCR reading technology is benefited by the evolution of high-powered desktop computing allowing for the development of more powerful recognition software that can read a variety of common printed fonts and handwritten texts. M Jasmine Pemeena Priyadarshini [19] etal proposes methodology that verifies a cheque by recognizing and analyzing the major details in a cheque, which includes the account holder's signature. It falls through image capturing, gray scale image conversion, Binarization, Edge detection, which is then localized & the signature is compared.M. Shridhar [20] etal presents document recognition strategies for two important applications : 1) Comprehensive Check Image Reader and 2) Recognition of text document containing multiple lines of text data and describes the challenges in finding and recognizing the fields of interest on the broad document types. The remaining of the paper will focus on handwritten legal line recognition which remains the most challenging field. Mahmud S. Alkoffash [21] presented a technique which presents a brief overview of digital image processing techniques such as image restoration, image enhancements, and feature extraction, a framework for processing images and aims at presenting an adaptable digital image processing method for recognition of characters in digital images.

Maninder Kaur [22] and etal work focuses on research project is to experiment deeply with, and find alternative solutions to the image segmentation and character recognition problems with adaptive SVM scheme using weight based scheme. Mohanad Alata [23] and etal presents an algorithm and software to detect and recognize character in an image. Three types of fonts were under investigation, namely, case (I) : Verdana, case (II) : Arial and case (III) : Lucida Console. Najib Ali Mohamed Isheawy [24] and etal proposed OCR system is based on grid infrastructure, which is a character recognition system that supports recognition of the characters of multiple languages. Namrata Dave [25] presents serves as a guide for people working on the text based image segmentation area of Computer Vision. First, the need for segmentation is justified in the context of text based information retrieval. Then, the various factors affecting the segmentation process are discussed.

Noman Islam [26] etal summarizes an overview of different aspects of OCR and discusses corresponding proposals aimed at resolving issues of OCR, Pallavi Aggarwal [27] presents the recognition of handwritten characters using either a scanned document, or direct acquisition of image using MATLAB, followed by the implementation of various other MATLAB toolboxes like Image Processing and Neural Network Toolbox to process the scanned or acquired image. R. Jayadevan [28] proposed comprehensive bibliography of many references as support for researchers working in the field of automatic cheque processing. R. Palacios [29] etal described in his work uses the scanned image of a bank cheque to check many fields of US based cheques. It includes three main modules that allow for fully automated bank check processing. Raghavendra S P [30] etal proposed a novel technique for segmenting and recognition of india bank cheque number using correlation and template matching technique, Sakchai Tangwannawit [31] and etal presents an algorithm to recognize lottery digits and development of an application to read and check the lottery digits. This is achieved by using the Tesseract OCR engine in a mobile application. Sanjay Kumar [32] etal detect and analyze the handwriting words, proposes a technique to recognize the handwriting of the doctor and try to get some pattern which will be used to guess the most probable prescribed medicine using one can only guess prescribed medicine's name and does not assure the exact name because it is difficult to read the handwriting of doctors for non-medicine personal.

Shreejit Achari [33] etal presents a technique that converts an image to text document which later converts it into an audio file, can be implemented with the translation of language feature and the benefits of this being implemented successfully could affect a lot of people especially blind. Siddharth Manay [34] and etal worked for shapes represented as closed planar contours, we introduce a class of functionals which are invariant with respect to the Euclidean group and which are obtained by performing integral operations. S. Jayapradha [35] etal presents the License plate tracking system is used to provide high speed security as well as monitoring systems. License plate recognition (LPR) is a system where car plate is recognized and identified automatically. Car License plate identification plays very important role in Data Driven Intelligent Transportation System. S P Raghavendra [36] and etal presents the results from a research to design and develop a bank cheque recognition system for Indian banks. Geometrical features of the bank cheque are the one which is the outcome of the type or category of the cheque which belongs to a specific bank using feed forward artificial Neural network. Sumit Sharma [37] and etal tells about OCR system for offline handwritten character recognition which focuses on the detailed discussion about handwritten character recognize and include various concepts involved, and boost further advances in the area.

Sushruth Shastry [38] etal presented an approach for OCR named "i" which aims at a high speed, simple, font independent and size independent OCR system based on a unique segment extraction technique. Swanand Joshi [39] and etal proposed Template matching techniques in optical character recognition (OCR). The proposed system uses template matching for character recognition this system does not require an entire input template to be matched but only the critical part of the input template. Teddy Mantoro [40] and etal proposes a framework of Optical Character Recognition (OCR) on mobile device using server-based processing. Comparison methods proposed by this paper by conducting a series of tests using standalone and server-based OCR on mobile devices, and compare the results of the accuracy and time required for the entire OCR processing. Vikas J. Dongre [41] presents a Devanagari Numerical recognition method based on statistical discriminant functions, 17 geometric features based on pixel connectivity, lines, line directions, holes, image area, perimeter, eccentricity, solidity, orientation etc. are used for representing the numerals, five discriminant functions viz. Linear, Quadratic, Diaglinear, Diagquadratic and Mahalanobis distance are used for classification.

II. Proposed Methodology

This paper proposes an effective method for classification of Indian bank cheques using optical character recognition in order to segment the potential bank name region and there after recognition is accomplished using feed forward artificial neural network. The experimental results of bank cheque recognition are shown in the figure-(2); (3); (4) & (5) as shown below.

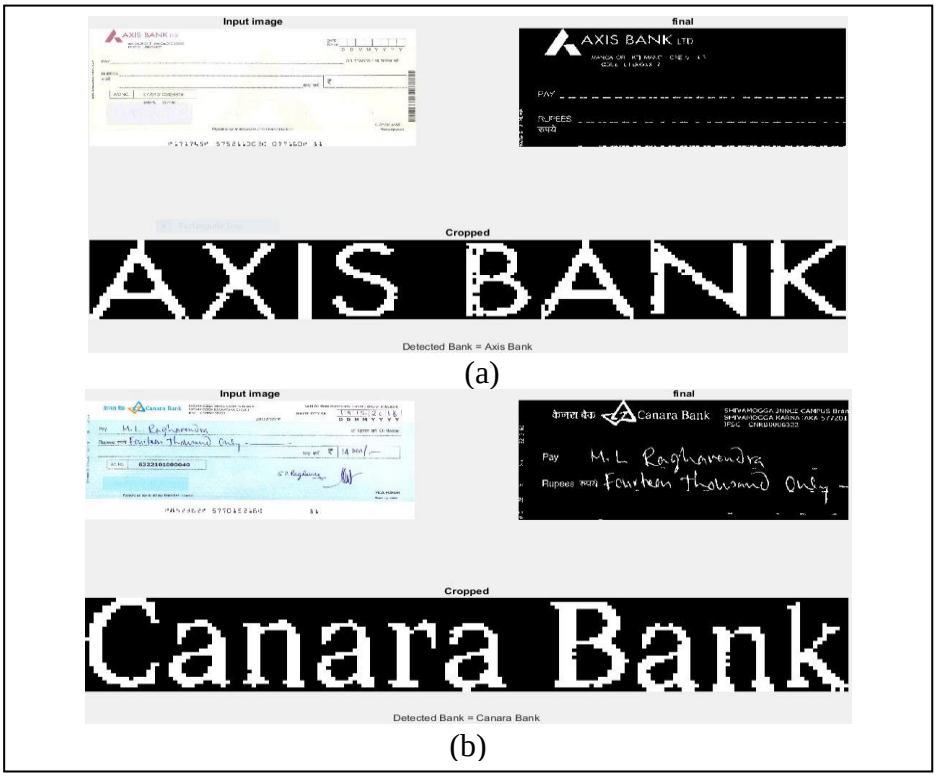


Figure-2 : Sample experimental results : Recognition & Segmentation of (a)Axis ; (b) Canara

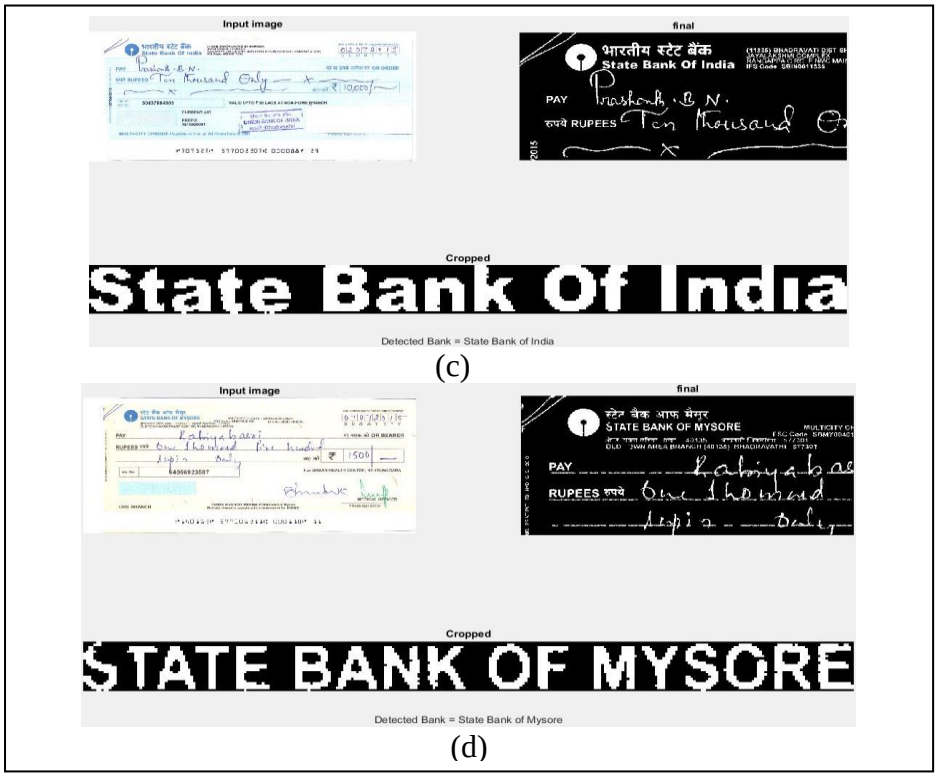


Figure-3 : Sample experimental results : Recognition & Segmentation of (c) State Bank of India ; (d) State Bank of Mysore

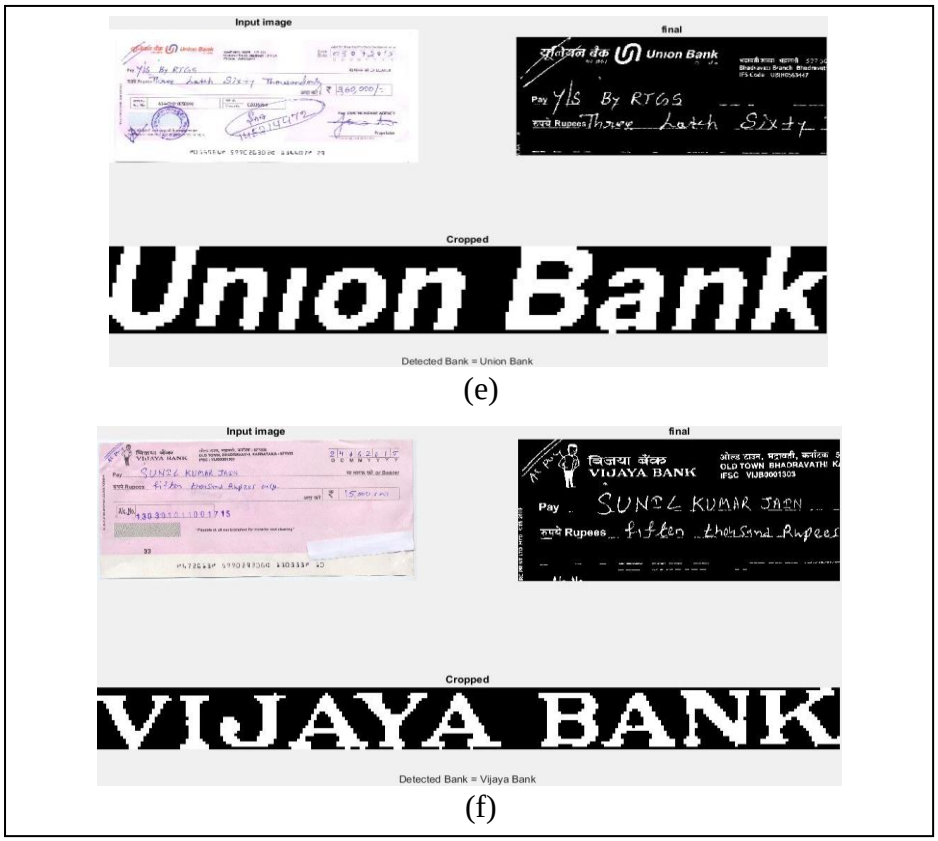


Figure-4 : Sampler experimental results : Recognition & Segmentation of (e)Union Bank ; (f) Vijaya Bank

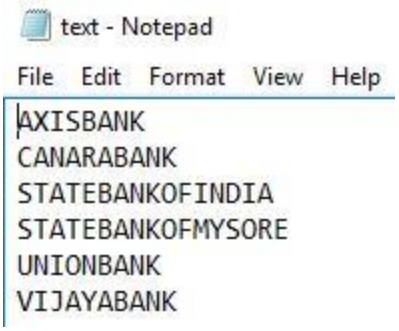


Figure-5 : Sample experimental results : OCR results of above cheques

The Optical character recognition process includes hierarchical tasks such as pre-processing, segmentation, recognition and post processing, the stages are depicted in figure-(6).

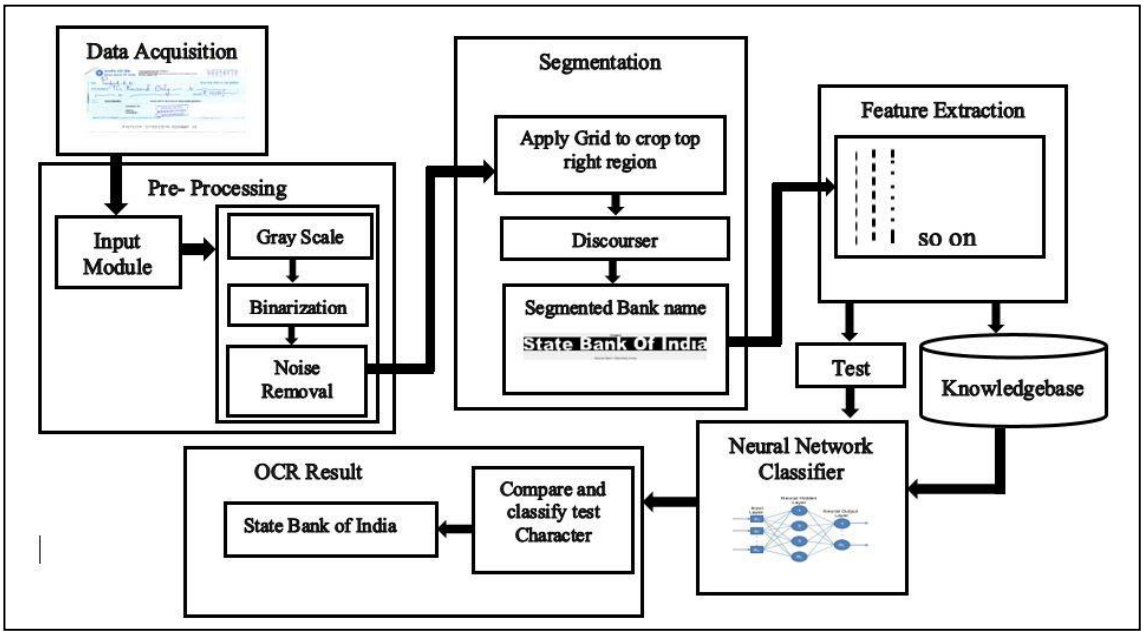


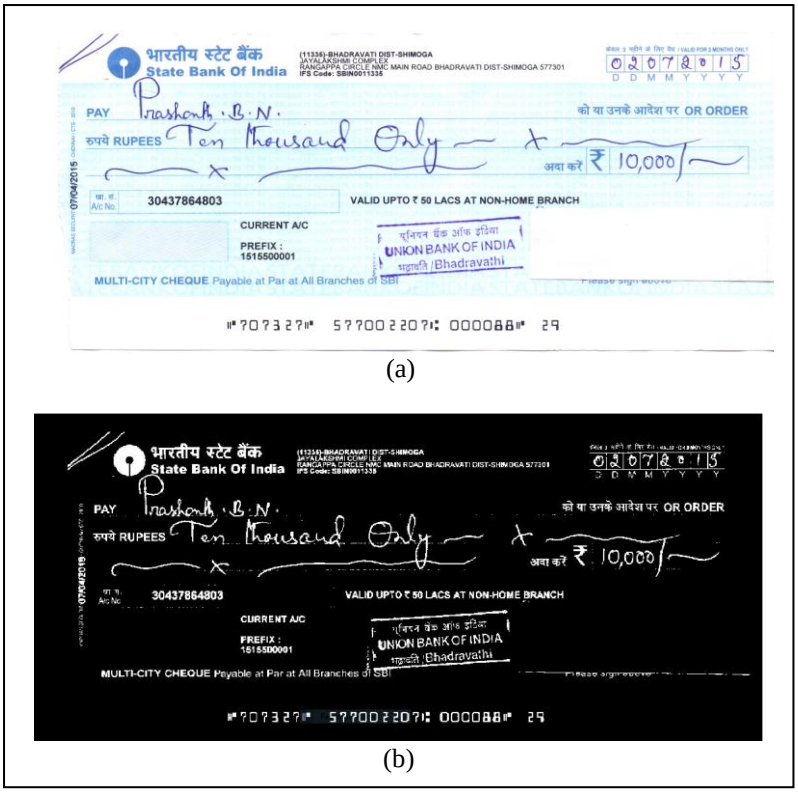
Figure-6 : Block Diagram of the proposed system

Preprocessing :

The cheque data, depending on the data acquisition type, is subjected to a number of preliminary processing steps to make it usable in the descriptive stages of character analysis. Preprocessing aims to produce data that is easy for character recognition system to operate accurately. It covers all functions to produce 'cleaned up' version of original image.

The various steps carried to accomplish the above process is discussed in following steps :

- Consider a bank cheque color image $f(x, y)$ and convert it into binary format $g(x, y)$ as shown below



(a)

(b)

Figure-7 : Sampler Pre-processing results of (a)$f(x,y)$ RGB input image with 200 dpi ; (b) $g(x,y)$ binary image

- Select the left top region of $g(x,y)$ by applying grid, since CTS bank cheques contains the name of the bank only at left top so other regions are ignored,

$$t(x,y) = g\left(\frac{\sum_{i=1}^{x} i}{2}, \frac{\sum_{j=1}^{y} j}{2}\right) \tag{1}$$

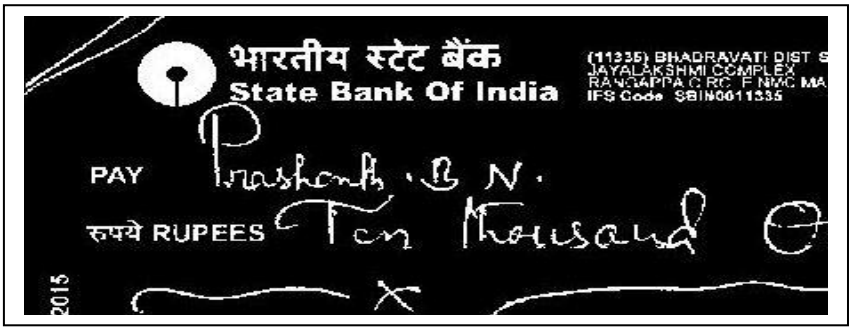


Figure-8 : Sample Pre-processing results on $t(x,y)$ applying equation (1)

- Noise removal will be done by removing the unnecessary pixels and small regions with area 4 times less than the characters to be clipped using region properties of all connected components. Fix a threshold and remove all those regions which are less than the given threshold.

$$t'(x,y) = \begin{Bmatrix} \sum_{i=1}^{x} \sum_{j=1}^{y} t'(x,y) & if\ Area(t'(i,j) > threshold \\ 0 & if\ Area(t'(i,j) < threshold \end{Bmatrix} \tag{2}$$

$$t(x,y) = t(x,y) - t' \tag{3}$$

Figure-9 : Sample Pre-processing results on $t(x, y)$ using equation (2) and (3)

Segmentation :

- Segmentation of the region of interest will be done by removing the unnecessary connected regions by applying bounding box *bb* measuring the region properties of logo, oblique lines and regions contains Hindi characters since some of the bank cheques considered for recognition in the database also possess Hindi names. For eliminating these regions, the bounding box of the connected components will be considered, the regions like hindi characters and logo will contain height *h* and width *w* difference always maximum than any other region values of all connected components.

$$t\ (x,y) = \sum_{i=1}^{x}\sum_{j=1}^{y} bb(i,j,h,w) = 0\ , \forall\ h - w > max\left(\sum_{i=1}^{x}\sum_{j=1}^{y} t(x,y)\right) \qquad (4)$$

- Once the region of interest is made noise free, the next stage will be to fetch only bank name surrounded by black pixels by performing discourser operation, after inverting the binary image this operation will scan for the occurrence of '0' which means to find the coordinates of character regions with respect to all four coordinates viz uppermost, bottommost, leftmost and rightmost.

$$t\ (x,y) = \begin{Bmatrix} \sum_{i=1}^{x}\ t\ (i,y) \quad if\ t\ (i,y) = 0, uppermost = i \\ \sum_{j=1}^{Y}\ t\ (x,j) \quad if\ t\ (x,j) = 0, leftmost = j \\ \sum_{j=y}^{1}\ t\ (x,j) \quad if\ t\ (x,j) = 0, rightmost = j \\ \sum_{i=x}^{1}\ t\ (i,y) \quad if\ t\ (i,y) = 0, bottommost = i \end{Bmatrix} \qquad (5)$$

The cropped image will be given by

$$t(x,y) = \sum_{i=uppermost}^{lowermost}\ \sum_{J=leftmost}^{rightmost} t(i,j) \qquad (6)$$

Figure-10 : Result of discourser fonction on $t(x, y)$ using equation (5) and (6)

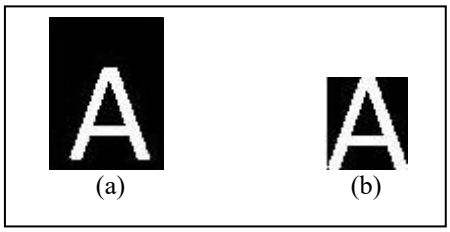
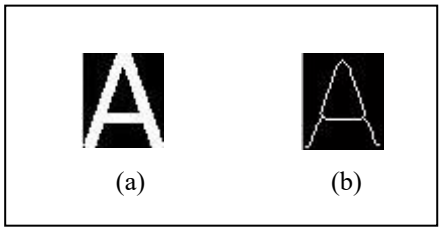


Figure-11 : Sample discourser results (a) Before cropping ; (b) After cropping

Feature extraction :

Feature extraction plays a significant role in classification and recognition of characters considered from bank name, using region properties. Morphological operations are performed to fill holes and shrinks to a minimally connected stroke, and an object with holes shrinks to a connected ring halfway between each hole and the outer boundary. This option preserves the Euler number.



(a) (b)

Figure-12 : Skeletonization results (a) Before Skeletonization ;(b) After skeletonization

Thinned character image into 7x5 size is converted into one-dimension character array, to classify 52 characters, these character arrays will be passed to neural network classifier. The letters extracted from the segmented name region of the image is converted into 35x1 binary value one-dimension array will be as below :

$A = = [0\ 0\ 1\ 0\ 0\ 0\ 1\ 0\ 1\ 0\ 0\ 1\ 0\ 1\ 0\ 1\ 0\ 0\ 0\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 0\ 0\ 0\ 1\ 1\ 0\ 0\ 0\ 1]$

(a)

$B = = [1\ 1\ 1\ 1\ 0\ 1\ 0\ 0\ 0\ 1\ 1\ 0\ 0\ 0\ 1\ 1\ 1\ 1\ 1\ 0\ 1\ 0\ 0\ 0\ 1\ 1\ 0\ 0\ 0\ 1\ 1\ 1\ 1\ 1\ 0]$

(b)

So on …

Figure-13 : (a) Feature array and Binary pattern for character A ;(b) Feature array and Binary pattern and Binary pattern for character B

The above character arrays are unique and different for all 52 characters so that the classifier can match the appropriate pattern with particular respective characters from the query image. Knowledge base will be created using a standard binary template for all 52 characters of the dimension 7x5 as below,

$$\text{Letter}A = \begin{bmatrix} 0\ 0\ 1\ 0\ 0 \\ 0\ 1\ 0\ 1\ 0 \\ 0\ 1\ 0\ 1\ 0 \\ 1\ 0\ 0\ 0\ 1 \\ 1\ 1\ 1\ 1\ 1 \\ 1\ 0\ 0\ 0\ 1 \\ 1\ 0\ 0\ 0\ 1 \end{bmatrix} \qquad \text{letter } B = \begin{bmatrix} 1\ 1\ 1\ 1\ 0 \\ 1\ 0\ 0\ 0\ 1 \\ 1\ 0\ 0\ 0\ 1 \\ 1\ 1\ 1\ 1\ 0 \\ 1\ 0\ 0\ 0\ 1 \\ 1\ 0\ 0\ 0\ 1 \\ 1\ 1\ 1\ 1\ 0 \end{bmatrix} \quad \text{so on ...}$$

(a) (b) ..

Figure-14 : (a) template for letter A ; (b) template for letter B

Neural network classifier :

The character recognition includes, the classification of 52 characters based on the distinct feature arrays to improve the classification rate effectively. In order to improve the efficiency of the performance, consider all Neurons (35) into the Neural Network, the 52 invariant feature arrays of characters of each of the image will be given as input to the Neural Network. Characters of each cheque image is represented by 35 standard feature array set. This feature set is fed to the Neural network as training set for the purpose of classification at later stage.

Sample experimental results of processing of the training of bank cheque name character image using Neural Network is shown in the figure-2 to 5.

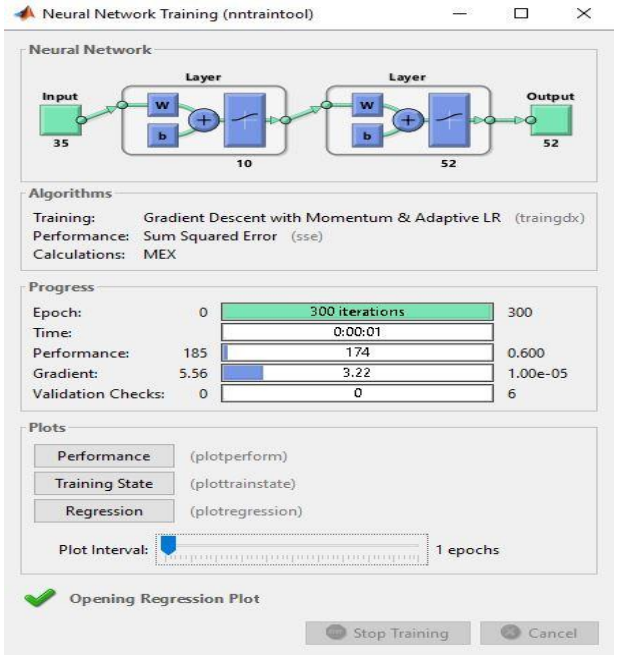


Figure-15 : Creation and Training of a Neural Network

Figure-11 gives the diagrammatic representation of "sample neural network architecture" The output of the neural network classifier predicts the particular character type of a bank name in the classification level using equation (7),

For a given input x, the output of the FFNN with respect to the network weights consider a multilayer FFNN with n input units (where n is the dimensions of the domain), one hidden layer with H sigmoid nodes, and a linear output unit is

$$y = \sum_{i=1}^{H} v_i \, \sigma(z_i) \tag{7}$$

Where v_i: The weight connecting the hidden unit *i* to the output unit
$\sigma(z_i)$: The matrix that represents the testing character image.
y : The predicted character

$$z_i = \sum_{j=1}^{n} w_{ij} \, x_j + b_i \tag{8}$$

Where w_{ij} : The weight connecting the input unit *j* to the hidden unit *i*
b_i : The bias of hidden unit *i*

The characters of a bank cheque are classified by using Neural Network. The training of the neural network with knowledgebase v_i and test character image will be done using the equation (7). The value of y which carries maximum value with index to represent the class for which the given query character image belongs using equation (9)

$$y = max \int_{i=1}^{c_n} (y, i) \tag{9}$$

Where c_n: The number of different supervised classes (in our case c_n=52)

III. Proposed Algorithm:

Proposed algorithm for bank name recognition using OCR and feed forward ANN from the given Query Cheque image is as given below :

Input : Query cheque image

Output : Determine bank name viz sbi, canara, axis, vijaya, sbm or union bank

Step 1 : To Train, input all 52 binary templates of 7 x 5 to the Neural Network and create a Knowledgebase with 52 distinct feature arrays as shown in figure 14.

Step 2 : Segment the potential bank name region by selecting top left region, bounding box and extract Individual characters using equation (4) and (5).

Step 3 : Apply morphological thinning operation to generate distinct feature arrays of binary patterns as Shown in figure 12.

Step 4 : Set the Target for the classification of 52 categories of characters for bank name.

Step 5 : Create & Train the Neural Network with above knowledgebase using equation (7).

Step 6 : Determine the index for maximum value using the equation (9) and this value will constitute the Type of character and to generate the bank name class for which the query cheque image Belongs.

IV. Experimental Results:

The proposed method is found to be very accurate in terms of speed and efficiency. The different bank cheques names have been segmented and recognized successfully. While conducting experimental results, 1570 cheques are detected out of 1700 bank cheques, the comparison of different the success rate of detection with respect to all six bank cheques is as shown in the following table,

Table1 : Success rate comparaison

Name of the bank	Success Rate
Axis Bank	93.3%
Canara bank	90.5%
Sbi bank	91%
Sbm bank	92%
Union bank of India	93.33%
Vijaya bank	92%

Above table is calculated as the average success rate of six bank cheques. The average time taken to detect each character is 1 second. However, proposed method fails to detect the damaged, distorted, crossed, watershed and occluded cheque images. Comparative analysis is given in the below given in figure (12). Sample misdetection results are shown in the figure (13) & (14).

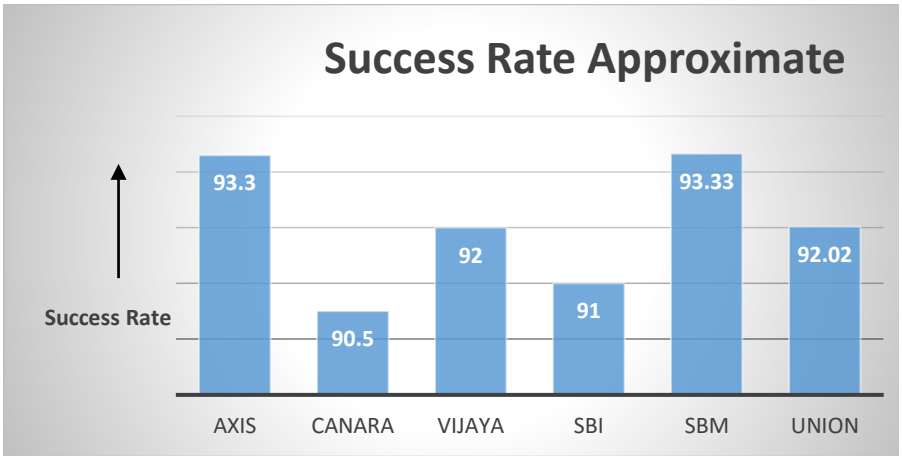


Figure-16 : Plot showing recognition rate of different banks.

The Experimental results conducted will be depicted with respected to the Performance, training phase and value of regression analysis and error analysis will be shown in the following figures (17), (18), (19) and (20)

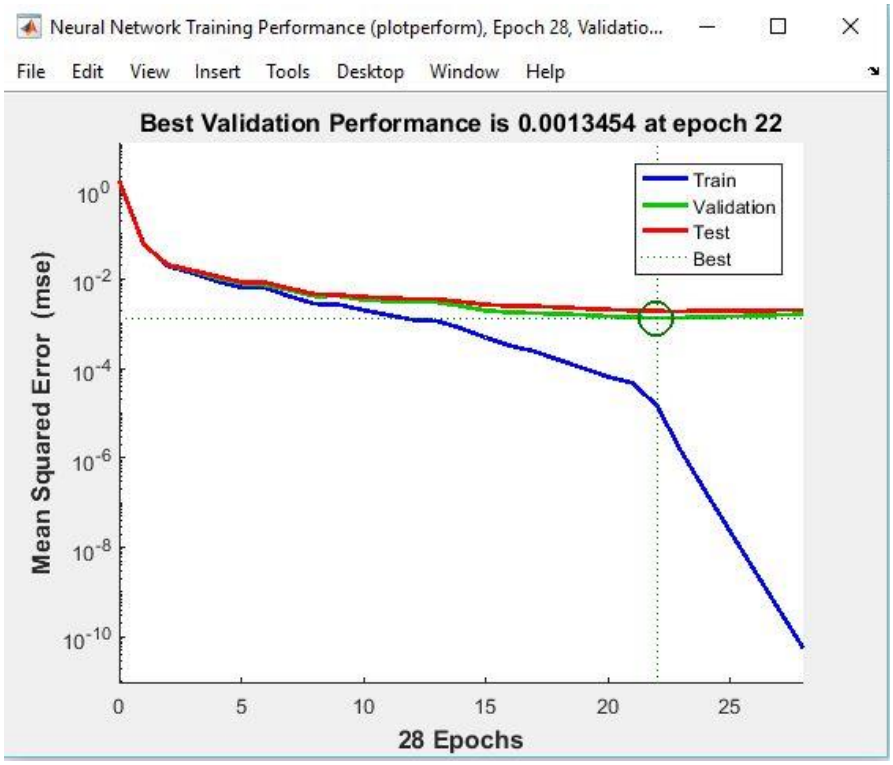


Figure-17 : Plot showing Best validation performance

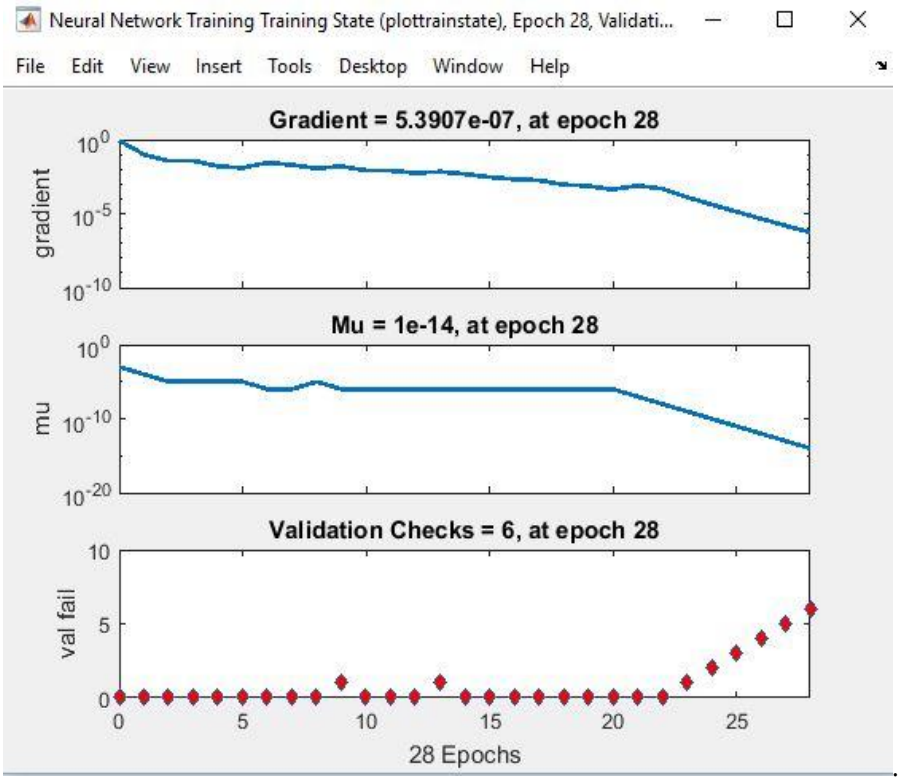


Figure-18 : Plot showing results of grdient, Mu, Validation at trainig phase

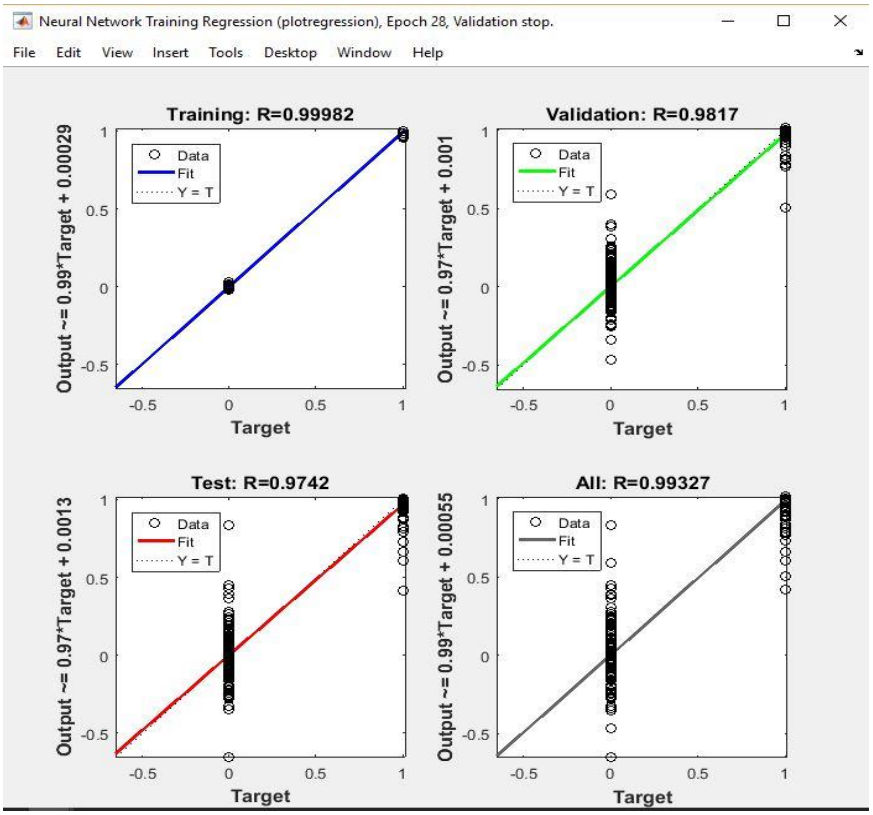


Figure-19 : Plot showing Regression analysis result at Stages Training, Validation, Test and All stages

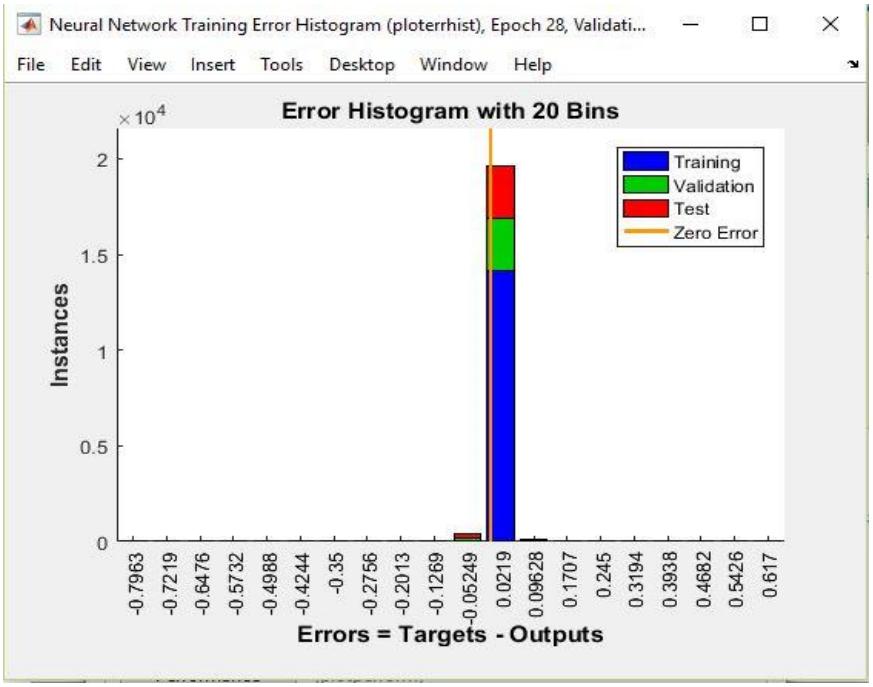


Figure-20 : Plot showing Histogram of Error analysis

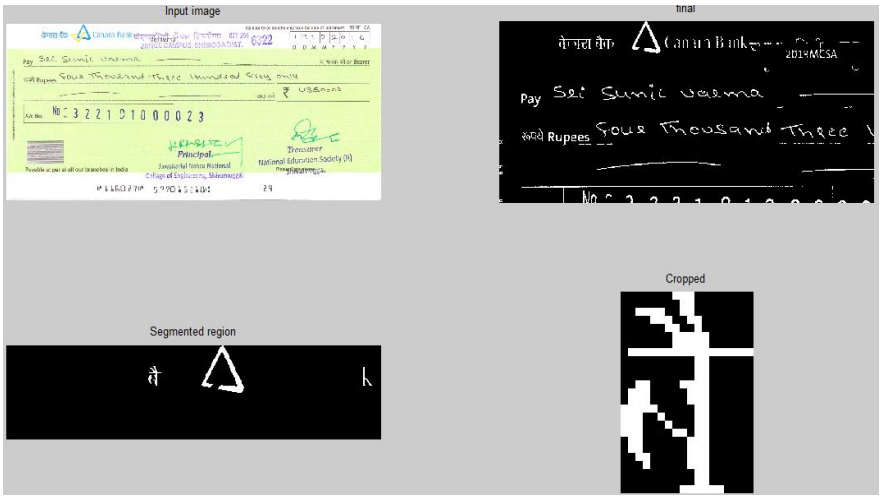


Figure-21. Sample misdetection results

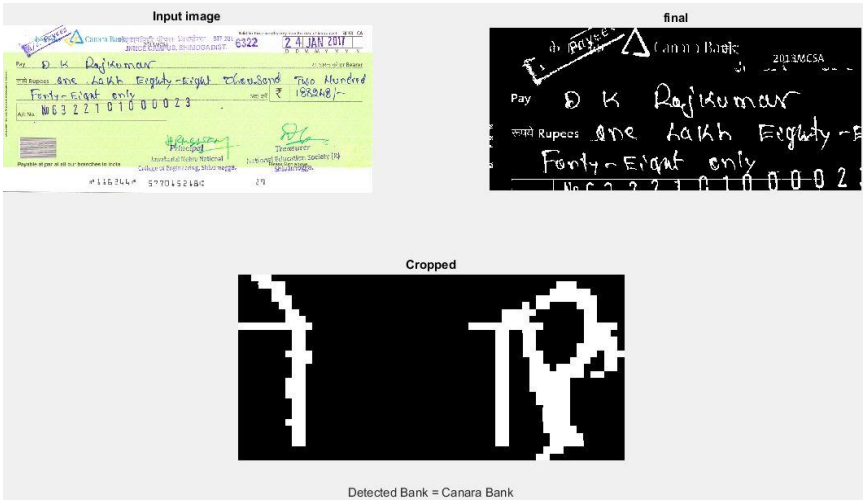


Figure-22. Sample misdetection results

V. Conclusion:

In this paper, a novel algorithm for the recognition of the Bank based on optical character recognition with unique character array patterns and neural network is presented. The proposed method is efficient in terms of speed and accuracy. Different bank cheque images with different bank names are segmented and recognized successfully with success rate of 92.02%. A misdetection occurs if the input image contains distorted, damaged, crossed, low illumination, low resolution and oblique view of cheques having one segment missing or crossed line or cancelled cheques with oblique line. These issues are considered in our future work.

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