

See discussions, stats, and author profiles for this publication at: <https://www.researchgate.net/publication/336254215>

AN ARTIFICIAL INTELLIGENCE APPROACH TO FAKE CURRENCY DETECTION SYSTEM

Article · October 2019

DOI: 10.33832/ijcip.2019.12.3.01

CITATIONS

2

READS

855

4 authors, including:



Bosubabu Sambana

Raghu Engineering College

119 PUBLICATIONS 29 CITATIONS

[SEE PROFILE](#)



Mohan Mahanty

Vignan's Institute of Information Technology

11 PUBLICATIONS 9 CITATIONS

[SEE PROFILE](#)



Srinivasa Rao Molli

Dadi Institute of Engineering & Technology(DIET)

10 PUBLICATIONS 6 CITATIONS

[SEE PROFILE](#)

Some of the authors of this publication are also working on these related projects:



Copyrights [View project](#)

AN ARTIFICIAL INTELLIGENCE APPROACH TO FAKE CURRENCY DETECTION SYSTEM

Bosubabu Sambana^{1*}, Mohan Mahanty², Molli Srinivasa Rao¹
and P.J.V.G. Prakasa Rao¹

¹*Department of Computer Science and Engineering,
Viswanadha Institute of Technology and Management, Visakhapatnam,
Andhra Pradesh, India*

²*Department of Computer Science and Engineering,
Vignan's Institute of Information Technology, Visakhapatnam*

^{*1}*bosukalam@gmail.com, ² mahanty.mohan@gmail.com,
³sri_nivas_molli@rediffmail.com, ⁴ prakash.pyla@gmail.com,
nakkathiru@gmail.com*

Abstract— Everywhere throughout the globe a completely 200+ nations are utilized monetary standards for their ads and money related necessities .The present science and innovative arrangement of cash paper note perceive different order intends to finding and sifting, extricates the delicate obvious with utilize multiple case mode comparative already exist eminent imprints recognizes region of interest on existing paper money note for required effective characterization strategies, required currency paper fake note recognition and transformation every module will comparative original source through AI analyzer module supervision examination. We propose another technique for an image segmentation access by embedding sequencing ordering on input-output mapping with feature extraction technique with image separating and preparing procedure to recognizing and match the distinguished information required to analyzed filter operations, required identified picture and the first reference picture, will compilation with text, dimensions, color, bookmarks, font sizes during the execution process, each money note taken a Region of Interest (ROI) on existing currency note condition.

A separated cash picture ROI can be utilized to different example development and acknowledgment procedures and ANN hubs recognizing systems on every module, at once numerous cash notes are distinguished by coordinated with pre processing identified note image then a web or online AI tools will seek based following framework to recognize coordinating procedure is allowed for getting to for their specific timeframe. At first we secure required the cash note by multiple level image scanning on the settled DPI shading, Font size, and dimensions with a required quantity arrangement, the dpi pixels various stages are set to get ordinary picture utilizing picture preparing strategy. Barely any cutting edge picture channels are connected to proposed picture remarkable estimation of required cash take note of, this relegated esteem or images are contrasted and the doled out information sign images to coordinate unique note esteem, at that point a web or online based AI tools getting to technique controls by microcontroller to examine all prerequisite fields and fundamental activities based on Artificial Intelligence approach.

Received: May 10, 2019

Reviewed: August 12, 2019

Accepted: September 2, 2019

* Corresponding Author



Keywords— Flat Filters, Currency, Region of Interest, Pattern Recognition, Artificial Intelligence, Neural Networks, Currency Recognition, Digital Image Processing Techniques. Image Processing, Gray scale Images, Artificial Intelligence.

1. INTRODUCTION

It is claimed that artificial intelligence is playing an increasing role in the research of management science and operational research areas. Intelligence is commonly considered as the ability to collect knowledge and reason about knowledge to solve complex problems. In the near Future intelligent machines will replace human capabilities in many areas. Artificial intelligence is the study and developments of intelligent machines and software that can reason, learn, gather knowledge, communicate, manipulate and perceive the objects. John McCarthy coined the term in 1956 as branch of computer science concerned with making computers behave like humans.

This paper gives an overview of AI and the current state and possible future directions for the AI Applications. In this paper nanotechnology plays vital role in AI. The group of emerging technologies in which the structure of atom is controlled under nanometer scale to produce novel materials and devices that have useful and unique properties. All nation monetary forms the world over appear to be totally unique from each other, in light of note size of the paper is different varieties from different monetary forms, in this same path as the shading, measure and different examples. Representatives of who are working at better places like cash changes focuses need to existing between numerous sorts of money notes and it is a repetitive errand. They need to ascertain with recall same image, esteem and shade of every cash note.

This might be comes about into wrong acknowledgment with recognizing notes, so this technique needs an effective way and colossal confirmation of exist supporting framework to help in their current change conceivable works. The fundamental objective of existing strategy is to extremely helpful to specialized and typical individuals who need to perceive distinctive nation cash notes and transformation work with client accommodation and proficient strategies.

With innovative work of present day managing an account administrations, programmed consistent techniques and money related segment and every day wage our operational requirements for paper cash note acknowledgment wind up dreary assignment in numerous applications, for example, candy machines on web based business segment, this is extremely focused undertaking to countable different section cash notes in a bundle. In this paper we are proposing a picture handling and sifting procedure utilized for required distinguishing proof of misrepresentation or phony notes in paper money acknowledgment and transformation cases [1], the separated ROI can be utilized with different advancements like Pattern Recognition and NN coordinating methods [2, 6].

The picture separating and handling method is regularly talked about with MATLAB to identify the particular highlights of paper cash notes. This system includes picture adjustments remembering the true objective to enhance, its image pictorial data for intelligible elucidation and examination, distinctive strategies for money paper acknowledgment that may including content, designing, shading, images or concealed codes based [4]. In this critical thinking utilizing advanced picture separating strategies are distinguishing to discover specific ROI, further Artificial neural Networks, along with different pattern recognition techniques are utilized used for current coordinating the cash notes.

This proposed framework will chips away at least two money notes, one unique picture and paper cash test picture on which confirmation is to be performed [2]. Along these lines a no. of strategies is utilized to bank cash note arrangement has

been proposed in view of our necessities. This proposed strategy can recognize format coordinating is regularly utilized as a basic grouping and characterization techniques to order banknotes. Be that as it may, new format or distinguishing coordinating principles are requirements for new proposed charge installment writes.

In the interim in the wake of breaking down number of nation money notes and considering with the accessibility, we have picks diverse cash notes to chip away at for this paper. The picked required monetary standards are fundamentally on Indian Rupees (INR) after we went before other nation monetary forms are Australian Dollar (AUD), Euro (EUR), Saudi Arabia Riyal (SAR) and US Dollar (USD-\$).

2. BACKGROUND

LITERATURE SURVEY

We review the most up-to-date technique to detect variance and trust relay in Artificial Intelligence environment. Also, we mainly focused on reviewing various methods and algorithms to detect financial fraud from various traditional methods to the most recent one. V. Sharma et al. proposed a original solution in the structure of fission mechanism.

Also, a enveloping trust supervision structure be accessible for Pervasive Online Social Networks (POSNs), which is accomplished of generate sky-scraping trust significance among the users with a lesser price of monitor [2]. As a explanation to identify anomaly in Artificial Intelligence environment, a representation be projected on the starting point of cognitive token, which present an Intelligent Sensing Model for Anomalies (ISMA) recognition through with intent bring to mind defective facts to catch the attention of the irregular users [1,3]. Van Wyk Hartman recommended automatic network topology detection and fraud detection. If fraud is detect in the sharing association, the classification schedule the follow-up and filed inquiry to examine and fix the fraud [2, 5].

And, proposed new structural methods used for online fraud detection include be projected. The proposed front-end device generates a first automatically dynamic physical device identification based on dynamic device characteristics and the back end device generates a second dynamic device identification based on the dynamic device characteristics of the front end device for an authentication [6].

Decision trees and Support Vector Machine (SVM) are a kind of supervised learning method detecting normal transaction and fraud by classifier, which can predict whether the transaction is normal or fraud. Decision tree and SVM are to compare the transaction information with historical profile patterns to predict the probability of being fraudulent for a new transaction [3, 4, 7].

There are also other methods for credit card fraud detection such as fuzzy Darwinian detection which comprises Genetic Programming (GP). Syeda *et al.*, in 2002 proposed fuzzy neural networks which run on parallel machines to speed up the rule invention for credit card fraud detection which was customer-specific. In this technique, the Granular Neural Network (GNN) method that uses fuzzy neural network which is based on information discovery was taken to instruct the network fast and can be processed for fraud detection in parallel [5].

3. RELATED WORK

In this exploration paper at first filtered on different group certified receipts at 180 dpi with 136x136 pixels, we can separate monetary order section esteem or images beginning each one paper cash. A required stage is position in support of every single unique picture, by changing over numerous parts and connected

distinctive picture channels, for example, Sobel edge channel, Average channel, Laplacian channel, and Denomination esteem is extricated.

The proposed design acknowledgment methods and fake neural system assessing process is compelled to apply for input check coordinating to distinguish cash note given image or numeric esteem, after this procedure picture coordinating required outcomes are utilized to enter for their getting to a web through various systems [3].

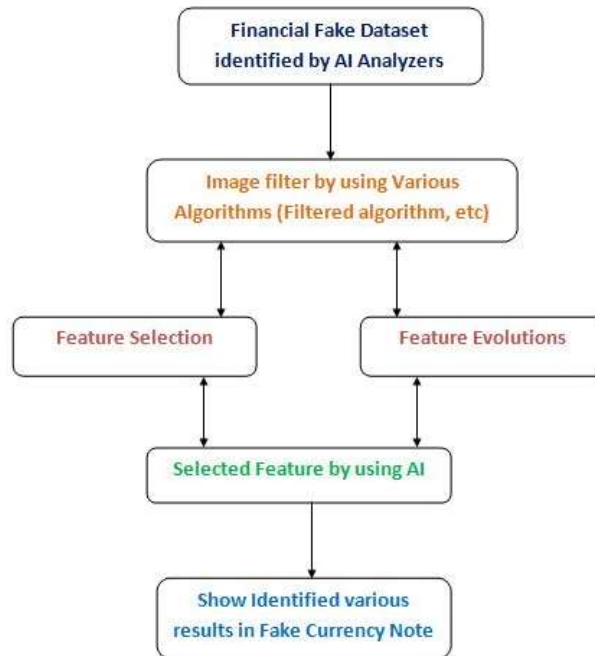


Fig. 1 Image feature selection process flowchart

The above diagram represents detection mechanism of internal process, such as initially financial fake dataset identified by AI analyzers based on feature extraction and this extraction done comparative original source to identified object, then further image filters has working by using image filtering algorithms to action all necessary things. Then feature selection also extract the images by various parameters and feature evaluations has done by mutual exchange of filtering mechanism and selected features, finally unidentified object may find out during the AI analyzers immediately.

These below description supports and clear idea about every module,

3.1. SINGLE LAYER FEED FORWARD SYSTEM: The ordinary very conservatives Neural Network could be a Single or one of a kind Layer Perception (SLP) arrange, it comprises each single layer conveys just a single yield wages or hubs, the sources of info square measures encouraged on to the yields through a succession of weights. The greater part of the stock weights and furthermore existing sources of info are computed to dissect in each hub, amid this single-layer bolster forward Neural Networks [3, 4], the required systems inputs are straightforwardly associated with existing yield layer discernments. An information hub is measure associated with a solitary hub or numerous hubs.

3.2. MULTILAYER NETWORK SYSTEM: A multilayer sustain forward Neural Networks is a bury correspondence to association between perception's, inside which estimated learning and counts stream breaking down amid a restricted heading, from the coveted info record to the yields. A multilayer NN plays out a

layer of information units, at least one layers of concealed estimation units, and one yield layer of units.

3.3. PATTERN RECOGNITION: This system includes a colossal measure of dissected information recovery process issues of adaptable and prominent noteworthiness regions, from voice acknowledgment and arrangement of composed characters, to adaptation to internal failure or discovery in apparatus and diagnosing cases and so on.

A tremendous measure of tasks are done in requested to sorted into perceive diverse monetary forms consequently; remarkable focuses are estimated into extraction cases utilized a related with neighbor information extraction technique from vital recognizing case delicate parts of an Indian Rupees cash Banknote speaking to a similar shading. Remembering the true objective to, and what do we exactly needed as per requirements are arranging through perceive required banknotes, they used to recognize adaptation to internal failure of at least two observable key properties of banknotes [4]:

- A part from Directions (front, pivoted front view, back view, and turned back) and required recognized face esteem, ANN based character through acknowledgment and confirmation, approval technique, the Learning identification vector identifies strategy to perceive striking and Italian Liras, Robustness and effective component-based strategy for bank currency note money recognition by different SURF specifications.
- A straightforward proposed measurable test strategy is utilized to check and approval step, where for this situation univariate Gaussian dissemination strategy is utilized, at that point in another current method for paper money note acknowledgment, essentially three attributes of banknote paper monetary forms including size, shading, images and surface are utilized as a part of the acknowledgment [5]. Additionally examining the already utilized strategies for paper cash acknowledgment, we can see that the majority of these proposed calculations are utilized to Artificial Neural Networks for effectively money acknowledgment.

3.4. NEURAL NETWORK CLASSIFICATION: These specialized word regularly utilized as Neural Network" has been spurred from different its beginning by the character and images acknowledgment that contrast and the human mind and processes are standing out a completely very extraordinary cases from the Pattern traditional advanced to simple machine investigation. We know our mind is a superlative learning Complex investigation, nonlinear and Parallel PC perceives, its distinguishes numerous data picture handling framework dissect in light of utilization case module.

3.5. IMAGE RECOGNITION: In these cases diverse picture handling and sifting strategies are accustomed to recognizing current money note acknowledgment that those technique include distinctive examples, for example, surface, images, design information or shading based. In this way we utilize distinctive advanced picture handling strategies to discover ROI, later an Artificial Neural Networks (ANN) and various Pattern Recognition Techniques are utilized for coordinating multiple current and required examples. Microcontroller works various channel based interfaces utilizing the web get to strategy for the time opened which is a modified control [2]. At the each case the time opened to be over the referenced controller requests forward access to through a web activity. These means are as per the following:

- Scanning the first picture at 200 Dpi with 256x256 pixels by picture channel and level scanner.
- ROI is extricated based client necessities.
- Image changing over into dim scale and required picture arrange at starting stage.
- After applying different picture channels and getting referenced distinguishing proof check or esteem.
- Finally getting reference image or example or esteem, it is coordinated by utilizing ANN and Pattern Recognition advancement Toolkit in MATLAB tasks, if the required picture is coordinated then web get to assessing strategy gives in inside length and region constrain [6].

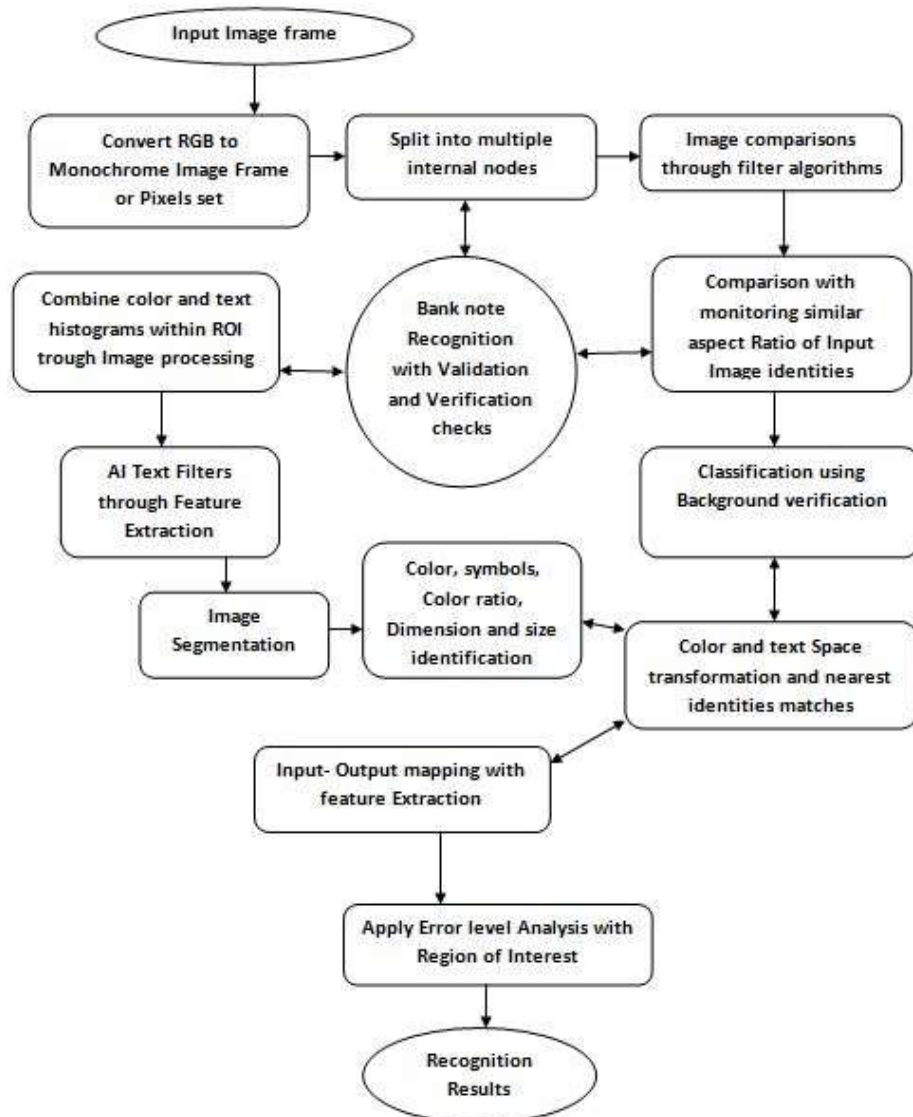


Fig. 2 Blok diagram of internal detecting mechanism of currency image

The above block diagram represents background internal working mechanism; each block works in exact operational procedures, from input image frame to

recognition results comes output. These below recognition patterns give background understanding concepts.

3.6. PATTERN RECOGNITION METHODS: This technique consolidates of different cases, quickly advancement of various improvement applications in different assignments. Distinctive models are settled on different example acknowledgment strategies can be assessed into various classes in view of various cases selected to information and characterization investigation [5]. Different models are accustomed to distinguishing assignments are demonstrated into

- Statistical Model
- Structural Model
- Neural Network Based Model
- Fuzzy Based Model
- Hybrid Model

3.6.1. STATISTICAL MODEL: In this model from identified multiple blueprint matching or coordinating on each example is assesses as far as highlights, these highlights are picked in various ways that different sorts of examples possess non-covering highlight on space. It perceives and distinguishes in adaptable nature both of the data we look to process [7, 8]; it works advanced way when required structures are prompt element spaces which investigate grouping in a perceiving way. Best highlights are picked in view of breaking down preparing assess designs. Required test designs are connected to discover reasonable framework to distinguish perceive coordinating examples.

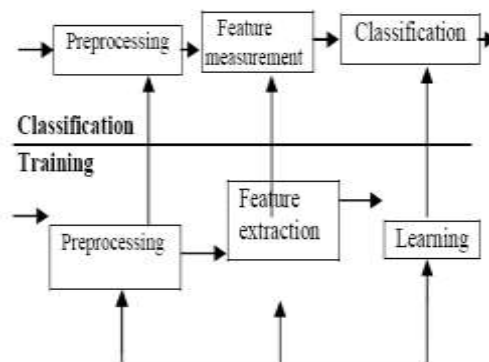


Fig. 3 Statistical model

3.6.2. STRUCTURAL MODEL: This model perceive design advancement techniques are ended up being powerful route for information which contains selected picture information and time arrangement. This is sorted out by availability and used to basic diverse example acknowledgment techniques and arrangement undertakings.

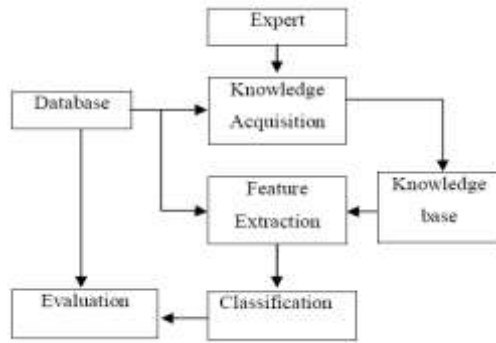


Fig. 4 Structural model

3.3.3. FUZZY BASED MODEL: Formalities Syntactic example assesses methods are utilizing, when the example matches identified with the ordinary formal structure situated images or dialects. Semantic fluffy methods are utilized to sort different segments of datasets are to be delivered in numerous associated areas, and distinguished comparable measures in light of hub remove is catch to concerned degrees between the fluffy rationales on discovers obscure and reference shape.

3.3.4. HYBRID MODEL: These model Primitive ways to deal with outline a Pattern acknowledgment framework, which primary objective is utilized to appropriate hub have less disadvantages, this is excessively muddled undertaking to checking an important order to dissect more noteworthy need information driven is accessible at utilize case module. To upgrade required framework assesses execution can quantify an arrangement of homogeneous classifiers and taken example combiner to settle on an official choice.



Fig. 5 Banknote of ROI

The multilayer feed forward artificial neural network systems find each DPI pixel of given current bank cash note and give the correct match ROI.

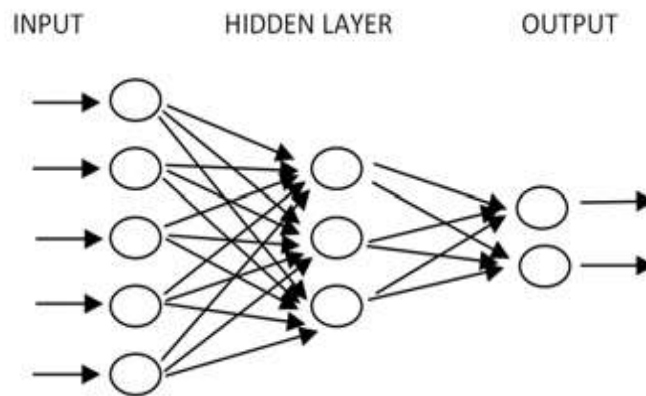


Fig. 6 Matching process

The Design of Interface: The target of proposed technique center hubs are the controller interface ENC28J60 every goal made by different center organizations, it is fundamentally intended for fill in as an Ethernet arrange design identified interface for any microcontroller outfitted with given SPI. ENC28J60 identifies every single required determination of IEEE 802.3 having different parts are fused MAC and PHY modules.



Fig. 7 RBI issued Indian Currency notes

The proposed microcontrollers are improved composed projects in a way that, it works and controls the whole activities through web getting to. The required timeslot for their getting to programs are finding every money monetary order. For every nation cash monetary certificate picture is as of now put away in the current memory space, these openings through the needed info the time is assigned and recognize ordinary picture and ref pictures. For instance the 500, 1000 and 2000 rupees notes are modified for getting to below 15 mille seconds.

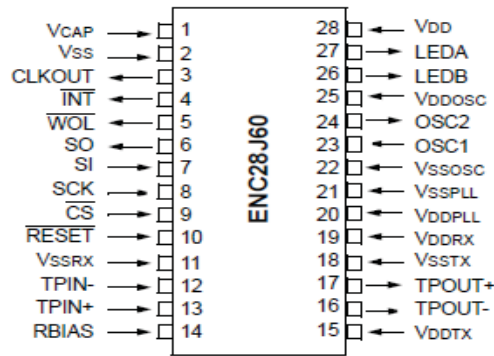


Fig. 8 Pin configuration of ENC28J60

4. PROPOSED WORK

At first our nation cash paper is embeddings into picture distinguishing proof info territory, at that point it is right off the bat, and once identified the money's picture were coordinated with the nearby existing reference picture, then a flag is sent to the microcontroller and perceive counterfeit note [6,8]. The microcontroller is utilized to control the schedule vacancy administration and getting to web based activity through AI analyzers. The time is modified and it apportioned in light of the information and get yield. Once the time is going to terminate, the microcontroller requests that the client whether proceed or not amid the current condition.



Fig. 9 Difference between original and fake Indian currency notes



Fig. 10 Identification of various parameters

The required programming stage interface between that we are proposing new strategies utilized for different monetary standards changed over into existing assets. Commonly our utilizing money notes are foggy or harmed in every day wage uses, a large portion of cases have numerous intricate plans to upgrade raises security issues. In this cases errand performs occupation of present cash acknowledgment perform extremely muddled and aggressive undertaking. Along these lines this undertaking performs key part to pick the precisely particular advantages and appropriate calculation for this reason and current investigation [9]. Introductory fundamental prerequisites for a calculation to be considered as tentatively actualizes are ordinary way, low unpredictability with utilization cases, fast, investigation and proficiency.

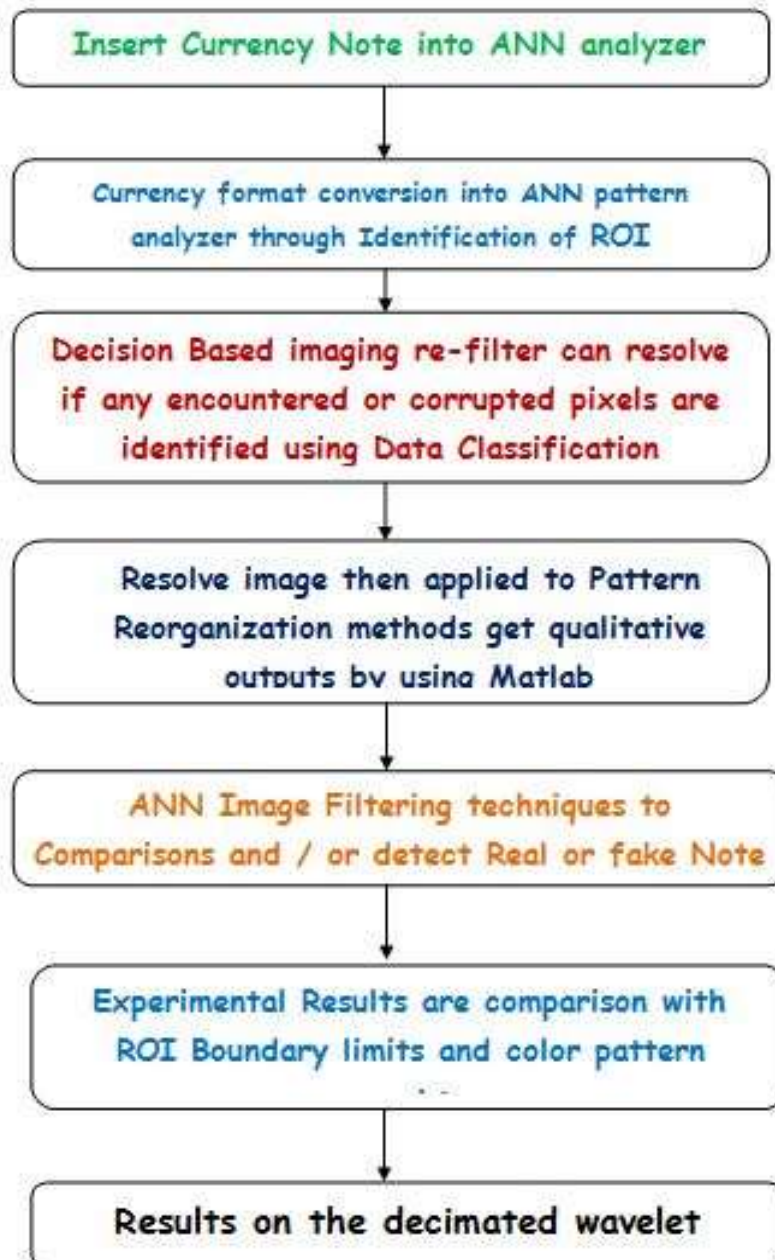


Fig. 11 Overview of internal operations

This paper speaks to plan a simple assignment yet required proficient calculation that would be helpful for gigantic number of monetary forms, since all nation monetary forms contains different security highlights and determinations, making it a basic errand to outline reasonable finest calculation that could be utilized for acknowledgment of all accessible required Currencies. Software engineers can compose numerous projects for all is likewise a repetitive assignment. The primary objective of potential outcomes to center around this paper is to classify and perceive the required monetary forms and not put stock in gathering or validation.

ALGORITHMAM

- Taken the cash photo of the doled out paper note utilizing different conceivable cases.
- Applied to picture sifting and handling based calculations are distinguished required cash picture in need request to remove important data.
- Finding inside limits and concentrate the ROI utilizing editing examination.
- Analyze and concentrate the required highlights.
- Compare past picture and current picture to remove this cash note in images, signs, numeric esteems with one of a kind particular element distinguishing proof esteems that are computed.
- Insert inputs paper money notes and yield accompanies appropriate outcomes.

Description

We proposed this calculation is to executing a calculation which can be connected to various nation Currencies and has much better proficiency and fast amid the timeframe.

Stage 1: *Inserting an Image:* Currency note picture can be gotten utilizing number of various info supplies, PDA's, for example, cameras or Scanners. Further Precautions are we have to examine and attempt to control existing condition with the goal that external distinctive components does not effect of highlight input results or qualities.

Stage 2: *Before Analyzed operations:* Beginning handling activities be necessary on the way to change the idea of the picture, whatever make drawing away of highlights Easier. here that specific casing, earlier handling activities include, obscuring, grayscale transformation, thresholding, clamor Removal utilizing channels, shading obscuring RGB to HSV change. This tasks support in distinguishing limits, editing the ROI along with conniving shading highlights [8].

Stage 3: *Boundary limits detection and editing:* on behalf of limit recognition, we necessitate a paired picture, which has just 2 hues, high contrast. Everything we perform inside internal procedure is essential, divide the foundation along with the closer view, also part the ROI [9].

Stage 4: *Specific quality Extraction:* This following stage is on the way to remove the necessary data beginning the trimmed ROI picture. Therefore, beginning a double picture we discover the elements of the cash and discover the viewpoint proportion, angle proportion stays the same in every light condition, so it turns into an essential component for perceiving picture. At that point, we think about the angle proportion of the objective picture with the perfect viewpoint proportions of the considerable number of groups of that specific cash. Different highlights we extricate be H, S, and V of specific squares of the cash, we separate this money during a quantity of squares. We extricate the HSV estimations of the considerable number of Pixels in addition to capture normal of their H,

S and V highlights with for a second time contrasts their and qualities starting the record or Database [10].

We utilize and examine dependent on Euclidian separation condition for discovering the normal estimations for contrasts among the objective along with ideal HSV highlights

$$dp, q = \text{Sqrt}((h2 - h1)^2 + (S2 - S1)^2 + (V2 - V1)^2)$$

wherever, (h1, S1, V1) = Objective picture highlight position, and (h2, S2, V2) = perfect list of capabilities.

Stage 5: Displaying results: To see required outcomes, we have assembled a GUI, where we are additionally giving an extraction explicit element to ascertain current money changes for which we are attempting to acquire current transformation rates from the Internet assets.

RESULTS:

We validated each step to measure the efficiency of the proposed model. Before the feature selection process, the accuracy of each algorithm with raw dataset was measured, after the previous step; the accuracy of each algorithm using the feature extracted through the proposed feature selection method was measured. We used both supervised learning algorithm and unsupervised learning algorithm. In addition to actual datasets, open data were also applied additionally for more accurate verification of our proposed methods. We performed the validation based on the identical actual financial transaction data for machine learning method and artificial neural network.

- **Validation.** In machine learning method, which is based on statistics, F-measure is a well-known measurement of model performance between predicted class and actual class using recall and precision. In our research, the F-measure is used to measure the ratio between the actual value and the value that the algorithm detects and predicts and the confusion matrix used to measure the various measure value is as in shown below

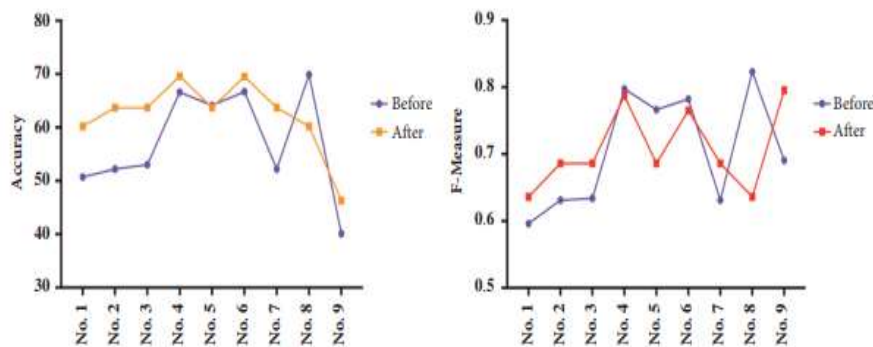


Fig. 12 Comparison of various accuracy before and after Feature selection process

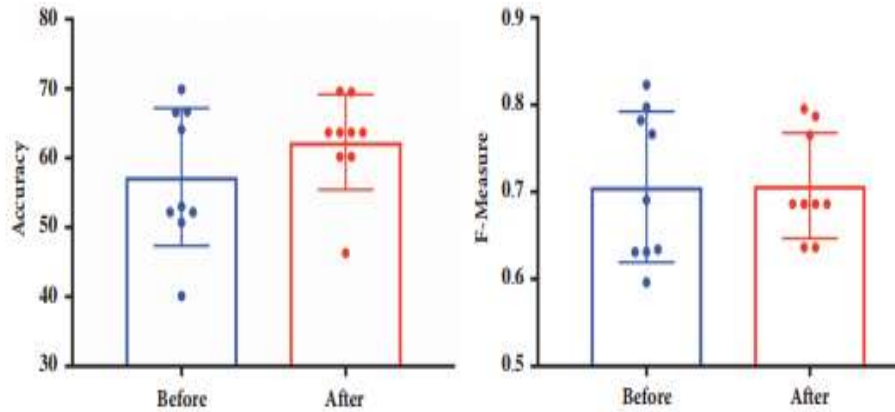


Fig. 13 Distribution of accuracy and measure value before and after the feature selection process

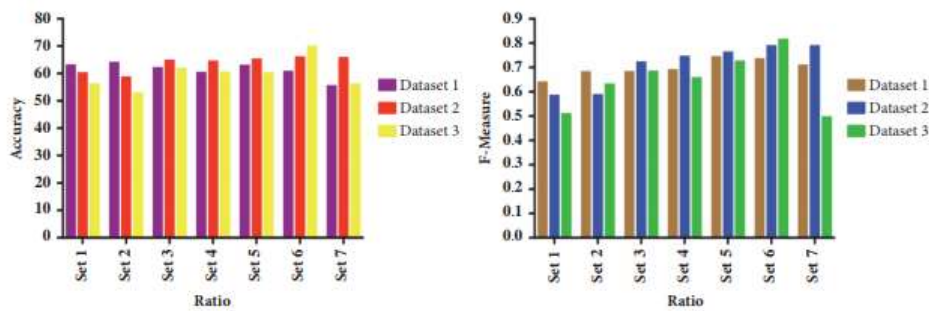


Fig. 14 Average various sampling ratios detection accuracy using f –measure in

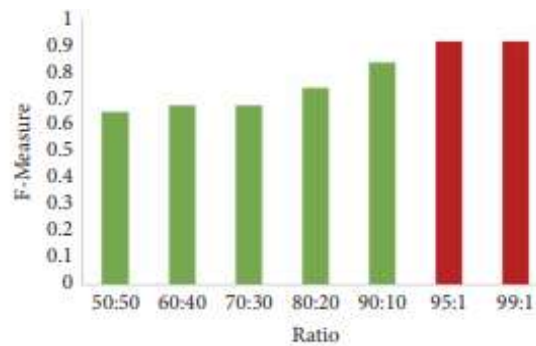


Fig. 15 Results for detecting financial fake using Artificial neural network in various levels

5. CONCLUSION

We proposed fake currency detection method by using AI analyzers give exact results into accuracy measurements with background image processing and segmentation. The Microcontroller interface performs now offers outstanding arrangement, making most minimal cost (20Euros), strength in activity. The required framework can be utilized for observing and remote control administration framework is available through any web openness. We connected to associate microcontrollers or chip and other in this way 4692 enhancing information recovery preparing speed to converted into RGB to image frame filters required requesting Classification using Background verification framework by Color, symbols, Color ratio, Dimension and size identification for encourage exact real output measures comes on as a unit utilize.

So we can close proposed to identified mismatch objects during the validation and verification calculation, we can find undoubtedly unidentified object or pixels are confirmed by AI text filters through feature extraction `recognize for monetary standards, thusly better separations are distinguishes in image, different identities, measure and some other concealed goals with identified with particular highlights. Additionally Artificial Neural Network advancements through approach this prime issue, at that point gives best productive outcomes through Classification using Background verification. We have additionally effectively recovered required detection multiple identifications from the apply error level analysis with ROI, utilizing input-output mapping with feature extraction with accurate verification and validation, within a specific end goal to make this paper generally gives valuable outputs to including different line recognition or investigation strategies in the proposed measures.

REFERENCES

- [1] Surjeet Singh, KulbirSingh "Segmentation Techniques for Iris Recognition System," International Journal of Scientific & Engineering Research Volume 2, Issue 4, April-2011
- [2] Currency Recognition Using Image Processing ,International Journal of Innovative Research in Computer and Communication Engineering, Vol. 3, Issue 5, May 2015, ISSN(Online): 2320-9801,
- [3] Zheng, He; Classification technique in pattern recognition; faculty of IT, University of technology, January 31 – February 04, 2009.
- [4] SeemaAsht, Rajeshwar Dass, "Pattern recognition Techniques: A Review, International Journal of Computer Science and Telecommunications- Volume 3, Issue 8, August 2012.
- [5] Harish Agarwal, Padam Kumar, " Indian Currency Note Denomination Recognition in Color Image, Int. Journal on Advanced Computer Eng. and Communication Tech. Vol.1.
- [6] Amel Saeed Tuam" Iris Image Segmentation and Recognition" Int. J Comp Sci. Emerging Tech Vol-3 No 2 April, 2012.
- [7] A.Ms.Trupti Pathrabe and B.Dr. N.G.Bawane, "Paper Currency Recognition System Using Characteristics Extraction and Negativity
- [8] Correlated NN Ensemble, 2010, Int. Journal of Latest Trends in Computing.Statistical pattern recognition: A Review; Robert, Jain, Mao, IEEE transaction on machine learning and pattern analysis, VOL.22. NO.1. Jan 2000.
- [9] D.A.KS.Gunaratna,N.D.Kodikara,H.L.Premaratne, " ANN Based currency Recognition System using Compressed Gray Scale and Application for Sri Lankan currency Notes-SLCRec", World Academy of Science, Engineering and Tehnology,2008.
- [10] CAO Bu-Qing1, 2,3LIU Jian-X1 un, "Currency Recognition Modeling Research Based on BP Neural Network",2010.

