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Indian Currency Recognizer and Counter System

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Abstract*— The invention of ATM machine marked a revolutionary change in the Banking sector. It made the money withdrawal an easier and flexible task. This changed the acronym of ATM from Automated Teller Machine to Any Time Money. This popularity was gained only with a single feature WITHDRAW. It is difficult to deposit the money to a Bank account through the traditional method of going to the bank, writing the slip, standing in the queue and depositing the money. So, what if DEPOSIT is also made possible in an ATM? As per the Reserve Bank of India (RBI) data, cash in the system (currency with people) stands at Rs. 11,64,450crore as on September 6, 2013. Approximately 10 per cent of the economy is cash with people. So, if a part of that cash comes back into the system, that itself puts more resources with the banks and the country would benefit. Today, bank branches close at 4 or 5 p.m. whereas most of India's retail trade happens in the evening. So, banks need to have the ability to set up cash deposit machines. We propose a system that can not only accept bank notes, but also detect the presence of counterfeit notes, separate notes based on genuineness and denomination, and give the total amount deposited; and hence provide a highly useful extension to existing ATMs and a secure way of cash deposits.

Keywords*— Image processing, Embedded System, Mechatronic, Counterfeit detection, Indian currency, currency recognition, correlation, microcontroller.

I. INTRODUCTION

The currency system is prevalent in India since a very long time. The Government of India introduced its first paper money issuing 10 rupee notes in 1861. These were followed by 20 rupee notes in 1864, 5 rupees in 1872, 10,000 rupees in 1899, 100 rupees in 1900, 50 rupees in 1905, 500 rupees in 1907 and 1000 rupees in 1909. In 1917, 1 and 2½ rupees notes were introduced. The Reserve Bank of India (RBI) began note production in 1938, issuing 2, 5, 10, 100 and 1000 rupee notes, while the Government continued to issue 1 rupee notes. Currently, the Indian currency system has the denominations of Rs. 5, Rs. 10, Rs. 20, Rs. 50, Rs. 100, Rs. 500, and Rs. 1000. All the above mentioned denominations are unique in one feature or the other. These features may be color, size or some identification marks etc. The system based on the computer communicates with web cam, catches video frames which include a visible image of currency amount and processes them. Various methodologies are used on the surface of the image. The selected area of the image is processed and analyzed with it's parameters.

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Once the image of the currency amount was detected, its digit is recognized. Each note is then stored in a cabinet reserved for that denomination. At the end the total amount will be displayed on the user interface. This program will be developed using MATLAB.

II. SYSTEM OVERVIEW

The bundle of notes, to be counted will be placed in the note feeding unit. The user then pushes the START button in the GUI. The note feeding unit feeds the note, one by one, to the conveyor belt. Sensors are placed at various points on the conveyor belt, which detects the presence of the note. The conveyor is stopped when the note reaches the fake note detection unit. The unit checks whether the note is fake or not. Then the conveyor is restarted. After passing the fake note detection unit, the note move again on the conveyor until it will pass another sensor. This sensor is to detect the presence of the note and stops the conveyor once the note is under the camera. Once the note is under the camera, data will be sent serially to MATLAB to start capturing the image of the note and do the image processing in MATLAB. Once processed, the data will be sent to controller serially from MATLAB ad controller will make decision about the category of the note. Once decision is made, the decision or signal will be sent to the twister to move the correct cabinet under the conveyor so that the note will fall into respective cabinet. The twister consists of on a rotating platform driven by a stepper motor. The stepper motor is controlled by the microcontroller. Cabinets for various denominations are mounted on the twister. Once the process is completed, the recognition amount of the currency and the itemized bill are displayed on the Graphical User Interface (GUI).

III. BLOCK DIAGRAM

The entire system is dual core and is based on communication between the PC (MATLAB) and the microcontroller. Control functions are performed by PIC16F877A and image processing by MATLAB.

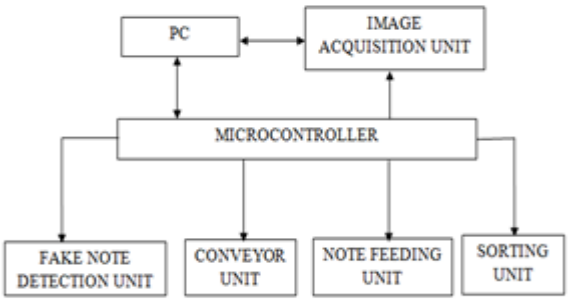

Fig. 1. lock Diagram

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A. Microcontroller

Microcontroller is used to control the process. The work of controller is to interpret data from fake note detection unit to check if currency is fake, control and synchronize the note feeding mechanism, instruct the PC to capture image using camera and interpret the data from PC MATLAB.

B. PC

MATLAB, which is used for image processing and to implement User Interface runs on the PC. Communication with the microcontroller is done using serial communication.

C. Note Feeding Unit

It will accept note from the user. It consists of rollers which take the respective note from the user.

D. Fake Note Detection Unit

We use signal conditioning to identify whether the note is fake or real. For this, every note is passed through UV light to detect the originality of the note. The specialty of a currency note is that it absorbs the UV light and a fake note reflects the UV light. The conditioning and testing is done using a UV LED transmitter and UV receiver or detector.

E. Image Acquisition Unit

Camera is used for image acquisition. It will take picture of every incoming note and will forward it to processing unit. After suitable image processing actuating signal will be produced.

F. Conveyor Unit

This unit is used to convey the note from note feeding unit to the sorting unit, after passing through the fake note detection and image acquisition units.

G. Sorting Unit

On the basis of suitable processing, actuating is produced and sent to the sorting unit. It makes use of a select-&-drop system. Actuators will drop the notes in their respective cabinets. The select and drop mechanism is implemented using a sorting table with a twister mechanism.

IV. METHODOLOGY

A. Fake note Detection

Every note is passed through UV light to detect the originality of the note. The specialty of a currency note is that it absorbs the UV light and a fake note reflects the UV light. The conditioning and testing is done using a UV LED transmitter and UV receiver or detector. The UV LED source transmits the UV rays. If the note is real it will absorb the UV rays. If the note is fake, then the rays will be reflected towards the receiver or the detector TSL 235R. TSL 235R gives output frequency proportional to the input light intensity which can be measured using PIC's TIMER2 module. Since its spectral range is from UV to visible, due compensation for ambient light condition has to be made.

B. Image Acquisition

This step is one of the most important and crucial phase for obtaining a good result. The 'getsnapshot' MATLAB function is the one used to capture and obtain matrix representation of images for our work. An *iball* camera of 0.3 megapixels sensor resolution was used for capturing the images. The captured images are converted to grayscale. Raw images obtained from camera are larger in size. Hence, we need to have some resizing methods so as to lower the size of images and as well to make all images of equal size. The raw images were resized using bilinear interpolation.

C. Data Extraction

This is a key step in currency recognition system, which influences the accuracy of the system significantly. Currency note localization is done by applying scan line algorithm on the image after converting to black and white. The number of pixels present in each line is counted while the image is scanned from left to right line by line. The first line that contains a pixel is highlighted (marked). Likewise is applied from right to left, top to bottom and bottom to top. As a final point, we have a distinct area produced by the intersection of both the scans. It is in the form of a rectangle which surrounds the currency note present in the image. This forms the localized part of the image. We extract denomination value part from each note by cropping the rectangular ROI from the centre.

D. Currency Recognition

Before recognition algorithm, the denomination is normalized. Normalization is to refine the characters into a block containing no extra white spaces (pixels) in all the four sides of the characters. Then the denomination is fit to equal size. Fitting approach is necessary for template matching. For matching the characters with the database, input images must be equal-sized with the database characters. Here the characters are fit to 40 x 100. The extracted denomination from the note and the ones on database are now equal-sized. The next step is template matching. Template matching is an effective algorithm for recognition. The character image is compared with the ones in the database and the best similarity is measured using correlation function.

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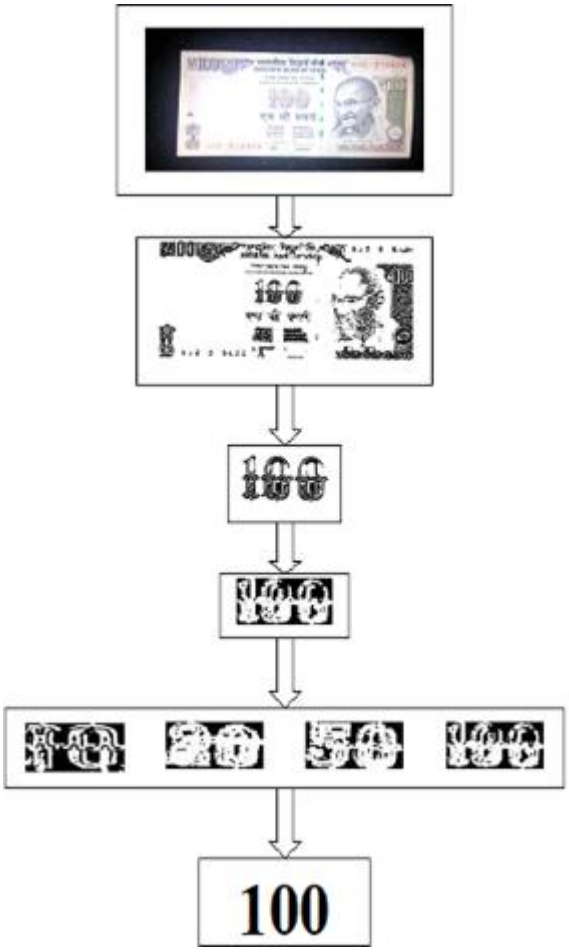

Fig. 2. Currency Recognition

E. PC Microcontroller Communication

For the synchronization of process control and image processing, a bidirectional communication has to take place between the embedded system and image processing system. The microcontroller has to instruct the PC to capture the image when the note is beneath the camera. Similarly, the PC has to convey the denomination to the microcontroller, once it is identified. The communication between PIC microcontroller and MATLAB takes place through serial communication between UART module of PIC and serial port of PC. A MAX232 chip is used perform the conversion between TTL and RS232 voltage levels.

F. Currency Counting

Currency counting is carried out in software along with the recognition, using MATLAB. Each time a denomination is recognized, a counter corresponding to that denomination is incremented in the code. At the end, the count of each denomination is multiplied by its value to obtain the corresponding amount. The total amount is calculated by adding the amounts corresponding to each denomination.

G. Currency Sorting

Sorting of notes is done with the help of a sorting table. Each denomination is allotted a bin number in the code. Once denomination is recognized the corresponding bin has to be brought under the conveyor belt. The microcontroller uses the bin numbers of the previous and present denomination to determine the direction and number of steps required to rotate the table in the most efficient manner so that number of steps and hence the time required for rotation is minimized. At the end, the table is brought back to the initial position.

H. MATLAB GUI

The GUI is developed using Graphical User Interface Development Environment (GUIDE) in MATLAB. The GUI contains a START button, which when clicked, after placing the bundle of notes initiates the automatic counting process. Each time the start button is clicked a log file is also generated, which contains the information regarding processing of each note, such as correlation with each template, the processing time and the result. Once the process is completed, the recognition amount of the currency and the itemized bill are displayed on the Graphical User Interface (GUI).

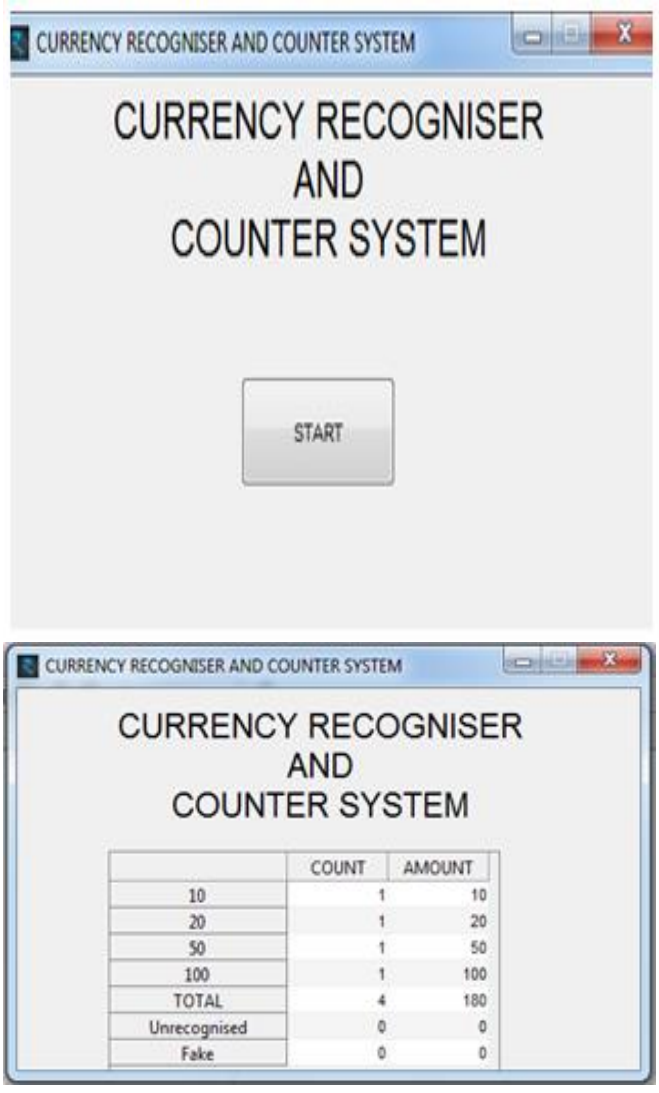

Fig. 3. MATLAB GUI

I. Software Design

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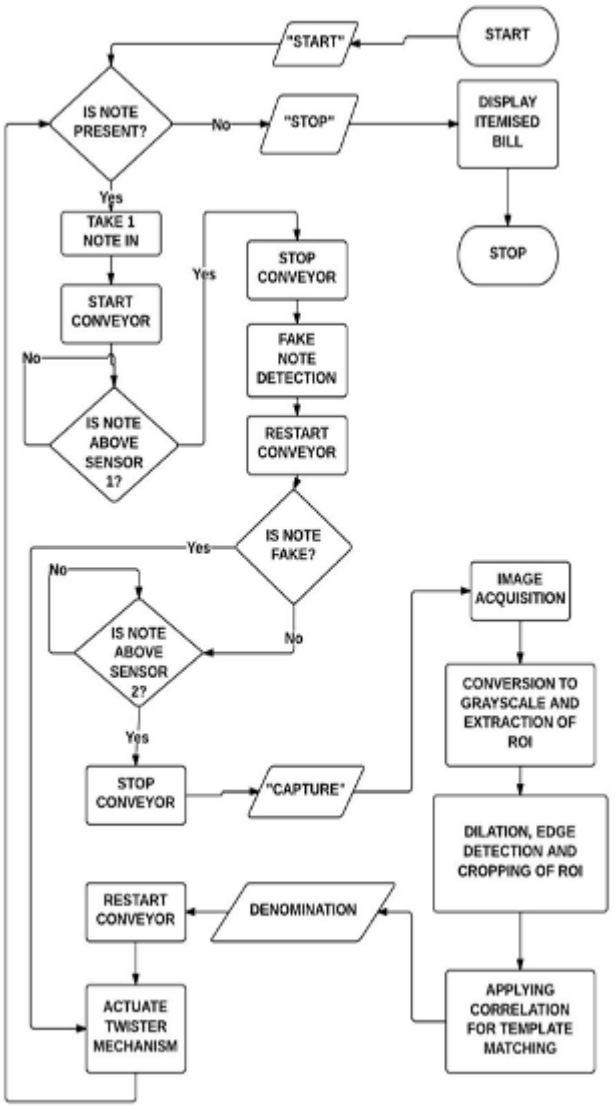

Fig. 4. Flowchart

V. APPLICATIONS

a) Local Government Offices: Payment of rents, taxes, court fines, water, gas, electricity, telephone bills.
b) Transport: Airline cabin crew, bus or train drivers and conductors who need to deposit fares or payments received.
c) Retail Outlets: Convenient cash deposit system for daily takings and offers customers a paying in point for store cards.
d) Utility company Offices: Payment of water, gas, electricity, telephone bills.
e) The system can also find use in a variety of other applications like Bill validators in vending machines, Foreign exchange teller machines / counters and Note to coin converters.

VI. CONCLUSION

The system successfully accepts bank notes including old notes, crumpled and worn out notes. The denominations of these notes are successfully identified and sorting of notes done as per requirement. Currently Fake notes are also detected by the system and put in its respective cabinet. Itemized bill of total cash deposited obtained on the user interface. Hence, the above system is a highly useful extension to existing ATMs and is shown to have high levels of speed and reliability after integration and testing. The proposed system would make banking more economical, flexible and optimal and time saving which indeed is an asset to India to make it a Developed Country. With incorporation of cash deposit machine we will be able to solve the problems like fake note detection. Main purpose of cash deposit machine is to provide facility for depositing money 24x7 in particular bank account. Reduction in queuing time in banks increases customer satisfaction. It also improves speed of deposit and level of convenience with security. The recognition method of Indian paper currency is quite simple, efficient and easy to be realized because denomination numerals are used for identification which can be extracted easily from paper currency.

Fig. 5.Mechanical Implementation

VII. FUTURE SCOPE

The proposed system can be used to implement image intelligent ATMs. An Intelligent Deposit ATM scans deposited cash and check items as they are inserted into the ATM; no envelope, deposit slip or pen necessary. The Intelligent Deposit ATM counts the items and totals the deposit for, providing an image of each check and an itemized list of notes deposited by denomination. Automated cash deposit machines can offer significant benefits to both banks and their depositors. The machines can enable depositors to deposit cash at more convenient times and places than during banking hours at branches. At the same time, by automating services that were previously completed manually, CDMs can reduce the costs of servicing some depositor demands. These potential benefits are multiplied when banks share their CDMs, allowing depositors of other banks to access their accounts through a bank's CDM. Advantages of such a system would be improved speed of deposit and ease of use, and presents a revenue generating opportunity, as staff can be re-deployed to profitable activities, and this would be a stand-alone fully automated and intelligent system.

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