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ROBUST & EFFECTIVE COIN EXCHANGER SYSTEM WITH FAKE NOTE DETECTOR

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ABSTRACT

Now a day the requirement of coins in our day to day transaction at public places such as, shopping malls, railway stations, multiplexes, bus station, and parking places, even in rural areas where nowadays coin telephone system is used, and many more is increasing rapidly. The main motive of designing this efficient and simple machine which will fulfill need of coins for transactions. In olden days the value of coins was much more than what it is today. Thus the system is designed so far that the people will not face problem of coins in public places. This project will provide coins for note of respective value, for this purpose we have developed mechanical coin dispensing model which will accepts the note inside system and checks whether note is fake or real, if it is found that note is real camera takes picture of that note. After that this will find out its value using image processing technique and then according to that value equivalent number of coins are dispensed from dispenser unit. Thus in this manner we are trying to design a robust and efficient machine which will be having a very low production cost as compared to other existing machines. In this system we have developed a MATLAB algorithm for image denomination to detect the value of a particular note, and we have implemented a fake note detection unit using Ultraviolet LED and photodiode terminology.

KEYWORDS: Edge detection, Image processing, MATLAB algorithm, Currency note, Fake note, and Coin dispensing.

INTRODUCTION

The main scenario of robust and effective coin exchanger system is a machine to accept large denominations of currency and returns an equal amount of money in smaller bills or coins. Generally these machines are used to provide coins in exchange for paper currency. The Indian currency system is prevalent since a long time. The Government of India introduced its first paper money issuing 10 rupees notes in 1961. The Reserve bank of India began note production in 1938, issuing 2,5,10,100 and 500 rupees notes. Currently the Indian currency system has the denomination of Rs. 1, 2, 5, 10, 20, 50, 100, 500 and 1000. Every denomination notes has its value on it. In this paper we scanned the different denomination notes[8]. We extract denomination value part from each note. Overall concept of system block diagram for the robust system is shown below,

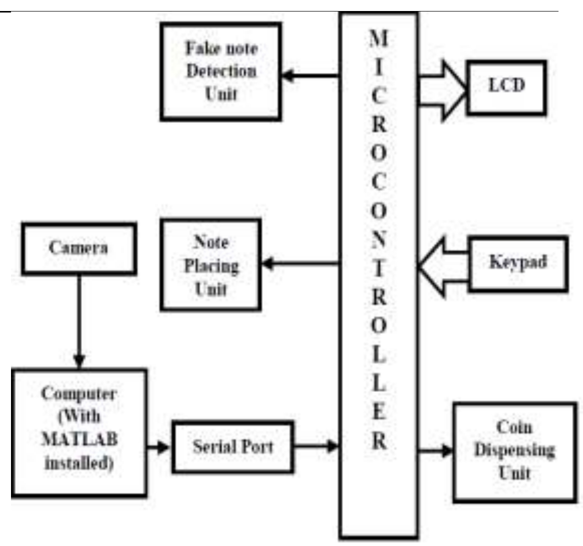

Fig.1: Block diagram of coin exchanger machine.

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Figure.1 shows the blueprint of robust and effective coin exchanger system with fake note detector. As there are lots of techniques to detect the Indian currency note, these are texture based, pattern based, checking by the watermarking, checking the micro lettering, color based recognition technique. The most preferable technique along all these is color based recognition. It is constructed by counting the number of pixels of each colon. For detecting kind of note the MATLAB algorithm runs and the result is given to the controller which will manipulate the coin container through relays and motors, the user simply press the keypad for which type of change user wants whether one rupee coins or two rupee or mixed and hence in the output we get coins as user requirement. Developing such system was a challenge for us as one has to consider various difficulties coming in the way. In order to develop such system one has to keep an eye on various factors such as detecting whether the note is fake/real, distinguishing various currency notes from each other etc. Usually we have equipment's that are used for identifying fake note. Such machines are seen in banks, high profile offices etc. The system circuit uses the microcontroller with mechanical structure which has motors to perform requested tasks[20].

NOTE PLACING UNIT

This unit will accept input in form of note from the user, it consists mechanical design of relays to take the respective note inside the machine from the user. It takes 12v to drive the DC motor of 10RPM, two IR sensors. There will be 3 relays and 2 DC motors at the user side to take the note inside the machine. This information is sent to the microcontroller for further processing. Once the note is accepted, Controller will send indication to the MATLAB to take a snapshot of the note.

FAKE & ORIGINAL NOTE DETECTION

The specialty of Indian currency note is it can absorb the UV light when UV rays incident on it and a fake note reflects the total UV light. So keeping this prospects in mind, Fake note detection unit consist of UV LED, photo diode, amplifier and comparator. When the UV LED source transmits the UV rays and it incidents on the note then, if the note is original, it will absorb large amount of UV rays and if the note is fake then the all rays will be reflected back towards the photo diode. Thus this output of the UV Photo diode is given to amplifier. This output is amplified and then given to comparator. The Threshold voltage is applied to comparator. According to threshold voltage output of the comparator is then given to the microcontroller for further processing and provides the instructions[7].

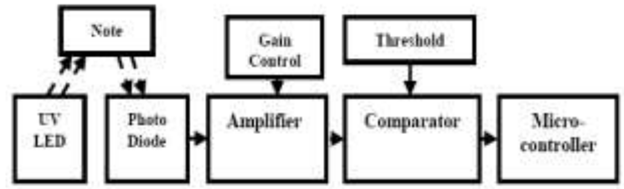

Fig.2: Block diagram of fake detection unit.

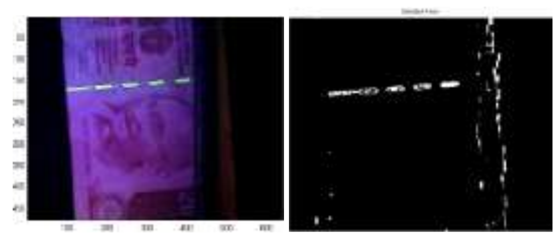

Fig.3: Original & Fake note detection.

Some of important security features on Indian bank note detect it fake/real are illustrated below:

A. Watermark:

The Mahatma Gandhi Series of banknotes contain the Mahatma Gandhi watermark with a light and shade effect and multi-directional lines in the watermark window.

B. Latent Image

On the obverse side of Rs.1000, Rs.500, Rs.100, Rs.50 and Rs.20 notes, a vertical band on the right side of the Mahatma Gandhi's portrait contains a latent image showing the respective denominational value in numeral. The latent image is visible only when the note is held horizontally at eye level.

C. Fluorescence

Number panels of the notes are printed inflorescent ink. The notes also have optical fibers. Both can be seen when the notes are exposed to ultra-violet lamp.

D. Micro-lettering

This feature appears between the vertical band and Mahatma Gandhi portrait. It contains the word 'RBI' in Rs.5 and Rs.10. The notes of Rs.20 and above also contain the denominational value of the notes in micro letters. This feature can be seen well under a magnifying glass.

E. Optically Variable Ink

This is a new security feature incorporated in the Rs.1000 and Rs.500 notes with revised color scheme introduced in November 2000. The numeral 1000 and 500 on the obverse of Rs.1000 and Rs.500 notes respectively is printed in optically variable ink viz., a color-shifting ink. The color of the numeral 1000/500 appears green when the note is held flat but would change to blue when the note is held at an angle.

F. See through Register

The small floral design printed both on the front (hollow) and back (filled up) of the note in the middle of the vertical band next to the Watermark has an accurate back to back registration. The design will appear as one floral design when seen against the light.

G. Serial Numbers

Every banknote has its own serial number, so it is more important to check whether the number is wrong, repeated or misspelled[5],[4].

PREPROCESSING FOR IDENTIFICATION OF NOTE USING IMAGE PROCESSING

A. Image Acquisition

Image acquisition is the creation of digital image, typically from a physical scene. The co-ordinates of the pixels of the digital image in 2D form is given by 1st and 2nd index of an array and the 3rd index stores the RGB intensities for each coordinate. Each element of array then stores an unsigned 8-bit integer. Once the images are obtained, they were further processed using programs to extract whatever information is desired.

B. Image Pre-Processing

The aim of image pre-processing is to suppress undesired distortions or enhance some image features that are important for further processing or analysis. It includes the results and discussion may be combined into a common section or obtainable separately. They may also be broken into subsets with short, revealing captions.

C. Image Adjusting

When an image is obtained from a digital camera, the size of the image is too big. In order to reduce the calculation, the size of the image should be reduced. Image adjusting is done with the help of image interpolation.

D. Image Smoothening

While performing image transfers, some noise may appear on the image. Removing the noise is an important step when image processing is being performed. However noise may affect segmentation and pattern matching. Mask values can be used to determine the degree of smoothening and to reduce noise. Higher is the size of mask, more is the smoothening[4],[6].

IMAGE PROCESSING FOR DETECTING NOTE DENOMINATIONS

Lots of research and work has been already done on detection of note denomination. Some of these denomination techniques are illustrated as below,

A. Histogram Method

An image histogram is a type of histogram that acts as a graphical representation of the tonal distribution in a digital image it plots the number of pixels for each tonal value. By looking at the histogram for a specific image a viewer will be able to judge the entire tonal distribution at a glance. The horizontal axis of the graph represents the tonal variations, while the vertical axis represents the number of pixels in that particular tone. The left side of the horizontal axis represents the black and dark areas, the middle represents medium grey and the right hand side represents light and pure white areas. The vertical axis represents the size of the area that is captured in each one of these zones. For digital images, a colour histogram represents the number of pixels that have colour in each of a fixed list of colour ranges that span the colour space of image, the set of all possible colours. The colour histogram can be built for any kind of colour space, although the term is more often used for three-dimensional spaces like RGB or HSV. Like other kinds of histograms, the colour histogram is a statistic that can be viewed as an approximation of an underlying continuous distribution of colours values. The main drawback of histograms for classification is that the representation is dependent of the colour of the object being studied, ignoring its shape and texture. Colour histograms can potentially be identical for two images with different object content which happens to share colour information. Conversely, without spatial or shape information, similar objects of different colour may be indistinguishable based solely on colour histogram comparisons. Another problem is that colour histograms have high sensitivity to noisy interference such as lighting intensity changes and quantization errors. High dimensionality (bins) colour histograms are also another issue. Some colour histogram feature spaces often occupy more than one hundred dimensions.

B. Edge detection Method

Edge detection is the name for a set of mathematical Methods which aim at identifying points in a digital image at which the image brightness changes sharply or, more formally, has discontinuities. Edge detection is a fundamental tool in image processing, machine vision and computer vision, particularly in the areas of feature detection and feature extraction.

C. Colors Models Method

Color models provide a standard way to specify a particular color, by defining a 3D coordinate system, and a subspace that contains all constructible colors

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within a particular model. Any color that can be specified using a model will correspond to a single point within the subspace it defines. Each color model is oriented towards either specific hardware (RGB, CMY, YIQ), or image processing applications (HSI)[8].

1. The RGB Model

In the RGB model, an image consists of three independent image planes, one in each of the primary colors: red, green and blue. Specifying a particular color is by specifying the amount of each of the primary components present.

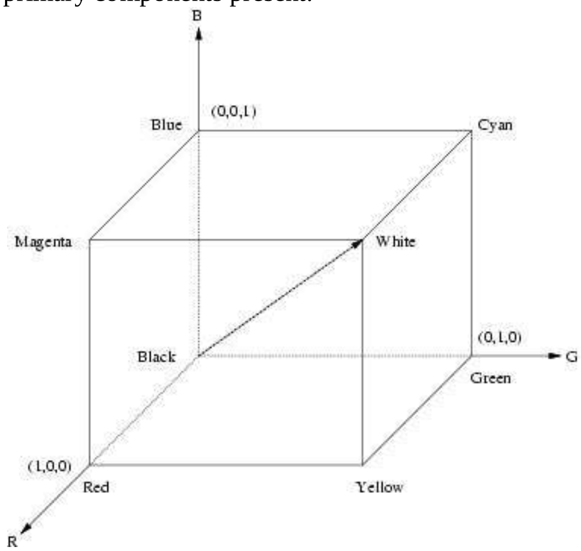

Fig.4: Geometry of the RGB color model using a Cartesian coordinate system.

Figure shows the geometry of the RGB color model for specifying colors using a Cartesian coordinate system. The greyscale spectrum, i.e. those colors made from equal amounts of each primary, lies on the line joining the black and white vertices.

2. The HSI Model

Color may be specified by the three quantities hue, saturation and intensity. This is the HSI model, and the entire space of colors that may be specified in this way is shown in figure below,

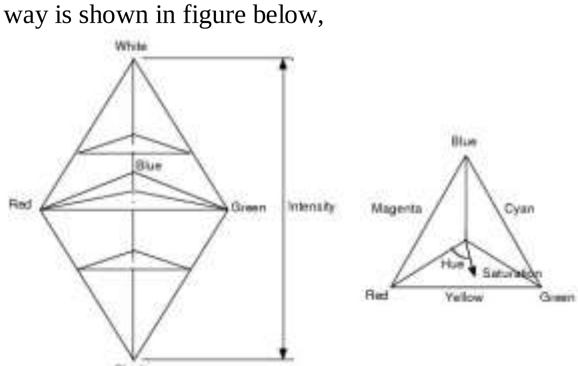

Fig.5: The HSI solid

Figure shows the HSI solid on the left and the HSI triangle on the right, formed by taking a horizontal slice through the HSI solid at a particular intensity. Hue is measured from red, and saturation is given by distance from the axis. Colors on the surface of the solid are fully saturated, i.e. pure colors, and the grayscale spectrum is on the axis of the solid. For these colors, hue is undefined. Conversion between the RGB model and the HSI model is quite complicated. HSI color model is most suitable color model to distinguish between black and white colors[8],[13],[14].

CONTROLLING UNIT

In this system, the controller used is ATmega32A controller; it has High Endurance Non-volatile Memory segments. The ATmega32A is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. By executing powerful instructions in a single clock cycle, the ATmega32A achieves throughputs approaching 1 MIPS per MHz allowing the system designed to optimize power consumption versus processing speed. The main function or task of this controller is to control the action of each and every block. It checks whether the note is inserted or note, it also controls the coin dispenser unit. According to the indication from MATLAB it will display the respective notification. Controller performs some mathematical operation in order to check the amount inserted by user in terms of coin is exactly matched with the amount of note or not. All the DC motors used for different purposes are controlled by this unit only.

COIN DISPENSER UNIT

After inserting the note, the note goes through various tests and and processes like pre-processing of image acquired by system, remove noise then after detection of note whether it is original or fake note, detection of 10 or 20 rupee note and then controller will ask the user about the choice of coins and the message for the same will be displayed on display screen. Based on user’s choice of coins indications are given to the driver IC to drive the respective motors and the motor will rotate in such way that it gives desired no of coins. Coins of 1, 2, and 5 are stored on the cups which are mounted on a conveyor belt. We have used a switch at the edge in order to give indication to the controller that the exact number of coins is given.

MATLAB PROCESSING

Algorithm for processing:

1. Initialize.

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2. Set threshold “th”.
3. Set COM port for serial communication.
4. Wait for instructions to be received on serial port from microcontroller.
5. When arrives, get snapshot of note by using camera.
6. Convert RGB image from camera to HSI image.
7. Separate “S” plane image from HSI image.
8. Cropping the image: Top and Bottom by 40 pixels Left and Right by 50 pixels.
9. Set threshold “m” for Binarization of image.
10. Binaries the image.
    If above “m”, store 1 in image matrix.
    If below “m”, store 0 in image matrix.
11. Calculate percentage of 1 present in the image matrix.
12. If percentage of 1 is more than threshold “th”, send “2” on serial port as denomination for Rs 20.
13. Else send “1” on serial port as denomination for Rs10.
14. Go to step 3 until counter becomes full.

Processing part:

1. As instruction signal is received on serial port MATLAB started its processing and takes picture of note by camera connected to computer.
2. The original image taken in RGB format is converted into HSI image format.
3. S-Plane image is extracted from HSI image format for calculation and threshold purpose.
4. Then according to MATLAB coding, Output is generated and sent over serial port. And same is shown on command window[20].

ALGORITHM FOR CONTROLLER

The procedure for the high level design working in functional prospect is illustrated by means of the algorithm for the microcontroller as below,

1. Start
2. Initialize LCD
3. Display Project name “NOTE TO COIN EXCHANGER”
4. Is note placed on the plate? No, go to step 2.
5. Yes, note is taken inside the machine using dc motor.
6. Send the indication to MATLAB on PC via RS232.
7. MATLAB will take the snap of note using colour segmentation and give us the reading in RGB format.
8. If MATLAB sends 1 then go to next step else go to step 21.
9. Display “ORIGINAL NOTE” and send the indication to MATLAB on PC via RS232. MATLAB will take the snap of note using colour segmentation and give us the reading in RGB format.
10. Again wait for the indication of MATLAB via RS232 cable.
11. If it receives 1 then go to next step else go to step number 14.
12. Display “Rs. 10 NOTE”, and go to step 15.
13. Display “Rs. 20 NOTE”, and go to step 15.
14. Wait for Keyboard I/P from user for denomination in 1, 2 or 5 Rs coin.
15. Equate the amount entered by user with amount or value of the note.
16. If amount matches then go to step 19 else go to next step.
17. Display “Amount Not Matched” Rotate motor in reverse direction to eject the note, and go to step 22.
18. Turn ON DC motor, Deposit the Note in the container.
19. Turn on the Coin dispensing mechanism to give the respective number of coins according to coin denominations, go to step 22.
20. Display “Fake Note”, and Rotate motor in reverse direction to eject the note.
21. Display “THANK YOU” and go to step 1[8].

APPLICATIONS

1. At Railway Stations where people need change for the tickets.
2. Similarly at Bus stations.
3. In Mall’s and Parks where peoples are to be with change at checkout counters.
4. To make call from the coin box.

EXPERIMENTAL RESULTS & ANALYSIS

Each category i.e. Rs. 10 & Rs. 20 of bill images covers all of the conditions such as of partial occlusion, cluttered, background, rotation, scaling change, and illumination change, as well as wrinkling. The banknote dataset is collected from a wide variety of circumstances. Fig. 6 demonstrates three sample images from each condition. In the recognition experiments that are evaluated in our testing dataset some of images with different sample aspects are as shown in below diagrams combinely.

Training and testing dataset of banknote images taken under different conditions and negative image shown below,

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Fig.6: Training and testing dataset of banknote images taken under different conditions and negative image.

The proposed algorithm achieves 100% true recognition accuracy and respective coins dispensed for Rs. 10 & Rs. 20 notes and 0% false recognition rate. Although our algorithm is evaluated in a more challenging dataset, our algorithm achieves much better recognition results and outperforms the existing banknote recognition algorithms. For instance, the average recognition rate of the algorithm based on other methods is 76%. Some neural-network-based banknote recognition systems achieved recognition rate no larger than 95%. Because of specific design, the testing images in these references were captured in highly constrained environments, such as a transaction machine or a specific sensor system which are not portable. Therefore, the variations of testing images evaluated in these systems are quite limited[4].

Compared with these references, our system is designed as for common users in daily life which contains general currency notes which includes wrinkles, muddy etc. In other words, the variety conditions that are presented in our dataset fully cover the ones in others. While our system is evaluated on much more challenging images, our recognition result is still better than other work evaluated on images collected in much simpler conditions. Their images only presented rotation and translation changes, and sometimes might be worn out or with defected corners. However, further experiments show that extremely large scaling change will affect the recognition results.

This is because the coin dispensing unit is resistant to scaling change in a certain range. When the resolution of a query image is very low, the system cannot detect considerable points in currency. However, in real application, it is reasonable to assume that a person takes the note in the range without extreme scaling change. The average speed of the algorithm on a testing image at the resolution of 1024 × 768 pixels is about 2.5 s on a computer with 3-GHz CPU.

The flowchart for operation of overall system is as shown below which will itself illustrate the functionig of the coin exchanger system as shown below[4],[8],[20].

FLOWCHART

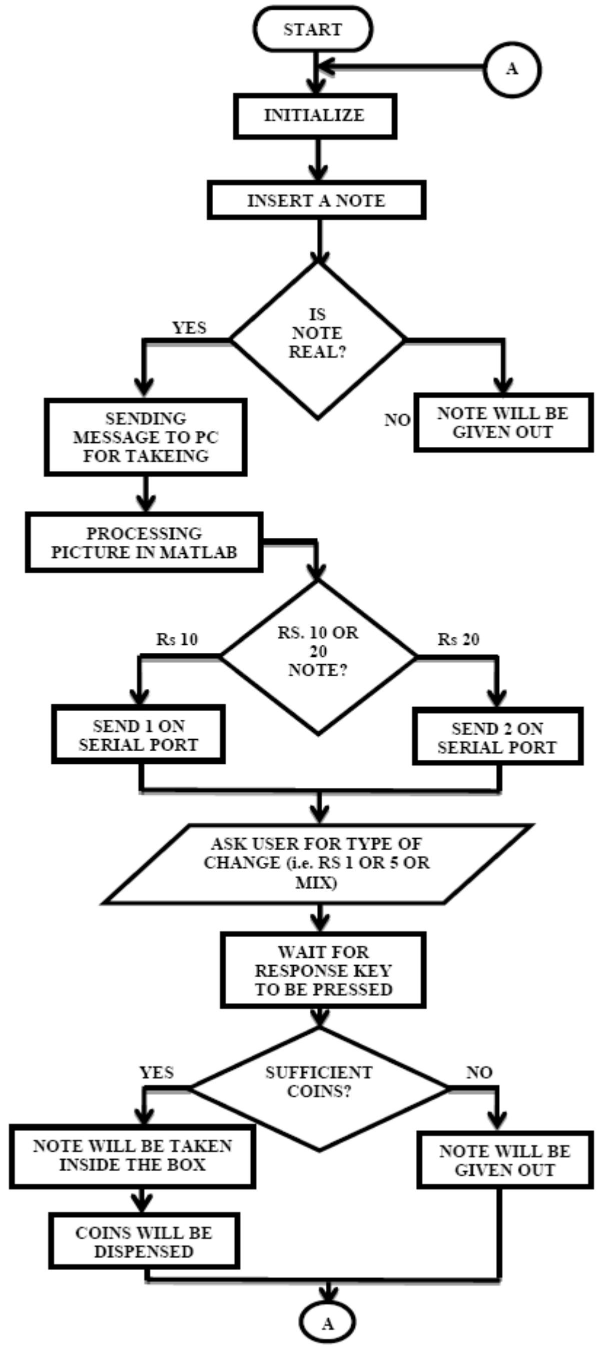

Fig.7: Operational flowchart

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FUTURE WORK

We can extend our project to use it on a large scale i.e. in the banks or other such places. We can even extend our idea for getting a change of Rs. 50 or Rs. 100 in the form of 10 and 20 rupee note. One can use our project for detecting realness of the note. The proposed algorithm has been evaluated by system and datasets to a variety of conditions including occlusion, rotation, scaling, cluttered background, illumination change, view point variation, and worn or wrinkled currency, and further by fake/real notes. Our approach achieves 100% true recognition rate, dispensing coins and 0% negative recognition rate. As per the Aim and Objective of our project we have successfully developed a model than will provide change to the user. The efficiency of our project is around 99% to respesctively respond to the valid input in the system.

CONCLUSION

This Project provides an interactive system that generates currency recognition system using color model and binarization technique with the help of MATLAB. The system adopts the interactive techniques of image binarization using specific threshold depending upon surrounding environment and allows the user to identify the Currency denomination. As per the Aim and Objective of our project we have successfully developed a model than will provide change to the user. The efficiency of our project is around 99%. Original and fake note are detected very perfectly and is accurate in detection of 10 and 20 rupee note.

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