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Intelligent Note to Coin Exchanger with Fake Note Detection

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Abstract— Requirement of coins in a day to day transaction at places like bus station, railway station, mall and park is the main motive of designing an efficient and simple machine which will fulfill need of coins for transactions so that people will not face problem of coins. This project will provide coins for note, for this purpose we have developed mechanical coin dispensing model which takes the note inside and checks whether note is fake or real, if note is real camera takes picture of it. After that it will find out its value using image processing technique and then according to the value equivalent number of coins are dispensed. In this way we are trying to design an efficient machine which will be having low production cost as compared to other existing machines. In this project we have developed a MATLAB algorithm for image binarization to detect the value of note. And we have implemented a fake note detection unit using UV LED and photodiode.

Index Terms—*Fake Note Detection, coin dispensing model, Image binarization*

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I. Introduction

The aim of this project is to provide coins equivalent to note. The circuit uses microcontroller with mechanical structure which have motors to perform requested tasks. Here the machine accepts note and checks whether a note is fake or real. If a note is real, camera takes picture of note and with help of computer having MATLAB program checks which note it is (Rs 10 or Rs 20). Once the note is recognized coins will be dispensed by coin dispensing unit.

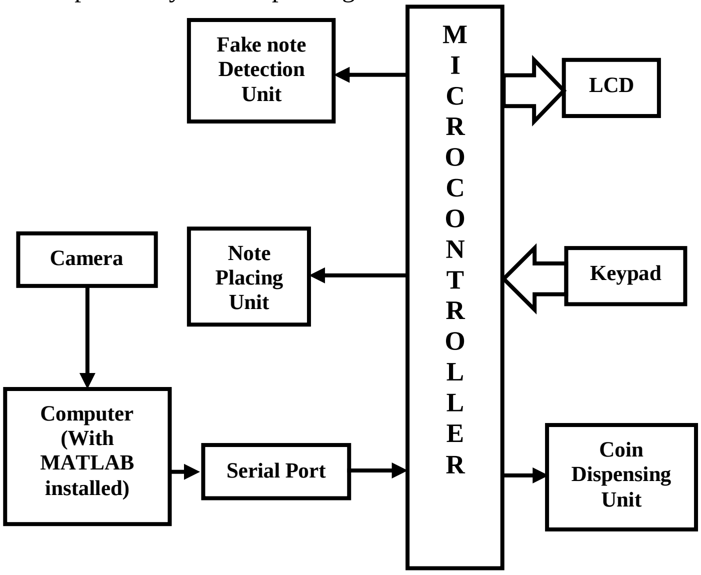

Fig 1. Block diagram of intelligent note to coin exchanger

II. Fake Note Detection Unit

The speciality of Indian currency note is that it absorbs the UV light and a fake note reflects the UV light. Fake note detection unit consist of UV LED, photodiode, amplifier and comparator. The UV LED source transmits the UV rays, if the note is real it will absorb some amount of UV rays and if the note is fake then the all rays will be reflected back towards the photodiode. This output of the UV Photodiode is given to amplifier. This output is amplified and then given to comparator. Threshold voltage is applied to comparator. According to threshold voltage output of the comparator is then given to the microcontroller for further processing.

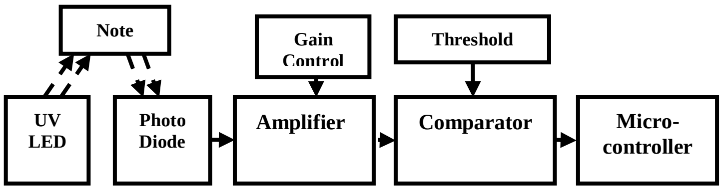

Fig 2. Block diagram of fake note detection unit

III. Image Processing for Detecting Note Denomination

There are various methods available for detecting note denomination as follows.

A. *Histogram*

An image histogram is a type of histogram that acts as a graphical representation of the tonal distribution in a digital image.[1] 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.[1] 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 color histogram represents the number of pixels that have color in each of a fixed list of color ranges that span the color space of image, the set of all possible colors. The color histogram can be built for any kind of color space, although the term is more often used for three-dimensional spaces like RGB or HSV.

Like other kinds of histograms, the color histogram is a statistic that can be viewed as an approximation of an underlying continuous distribution of colors values. The main drawback of histograms for classification is that the representation is dependent of the color of the object being studied, ignoring its shape and texture. Color histograms can potentially be identical for two images with different object content which happens to share color information. Conversely, without spatial or shape information, similar objects of different color may be indistinguishable based solely on color histogram comparisons. Another problem is that color histograms have high sensitivity to noisy interference such as lighting intensity changes and quantization errors. High dimensionality (bins) color histograms are also another issue. Some color histogram feature spaces often occupy more than one hundred dimensions.[2]

B. Edge Detection

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.[3] Edge detection is a fundamental tool in image processing, machine vision and computer vision, particularly in the areas of feature detection and feature extraction.

The one of the most used masks or operators for edge detection are as follows

1. Prewitt Operator
2. Sobel Operator
3. Robert Operator

1. Prewitt Operator

The Prewitt operator is used in image processing, particularly within edge detection algorithms. Technically, it is a discrete differentiation operator, computing an approximation of the gradient of the image intensity function. At each point in the image, the result of the Prewitt operator is either the corresponding gradient vector or the norm of this vector.

2. Sobel Operator

Sobel operator is used in image processing, particularly within edge detection algorithms. Technically, it is a discrete differentiation operator, computing an approximation of the gradient of the image intensity function. At each point in the image, the result of the Sobel operator is either the corresponding gradient vector or the norm of this vector.

3. Robert Operator

The Roberts cross operator is used in image processing and computer vision for edge detection. It was one of the first edge detectors and was initially proposed by Lawrence Roberts in 1963. As a differential operator, the idea behind the Roberts cross operator is to approximate the gradient of an image through discrete differentiation which is achieved by computing the sum of the squares of the differences between diagonally adjacent pixels.

These edge detection operators can have better edge effect under the circumstances of obvious edge and low noise. But the actual collected image has lots of noises. So many noises may be considered as edge to be detected. Although there are various edge detection methods in the domain of image edge detection, certain disadvantages always exist. For example, restraining noise and keeping detail can't achieve optimal effect simultaneously.

C. Color Models

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 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).

1. The RGB Model

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

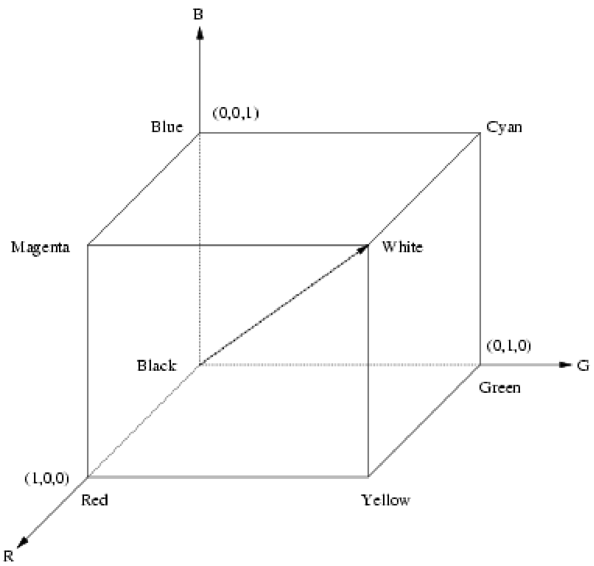

Fig 3. Geometry of the RGB colour model using a Cartesian coordinate system

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

2. The CMY Model

The CMY (cyan-magenta-yellow) model is a subtractive model appropriate to absorption of colours, for example due to pigments in paints. Whereas the RGB model asks what is added to black to get a particular colour, the CMY model asks what is subtracted from white. In this case, the primaries are cyan, magenta and yellow, with red, green and blue as secondary colors. When a surface coated with cyan pigment is illuminated by white light, no red light is reflected and similarly for magenta and green, and yellow and blue. The relationship between the RGB and CMY models is given by:

$$\begin{bmatrix} C \\ M \\ Y \end{bmatrix} = \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix} - \begin{bmatrix} R \\ G \\ B \end{bmatrix}$$

Fig 4. Relationship between the RGB and CMY model

3. The HSI Model

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

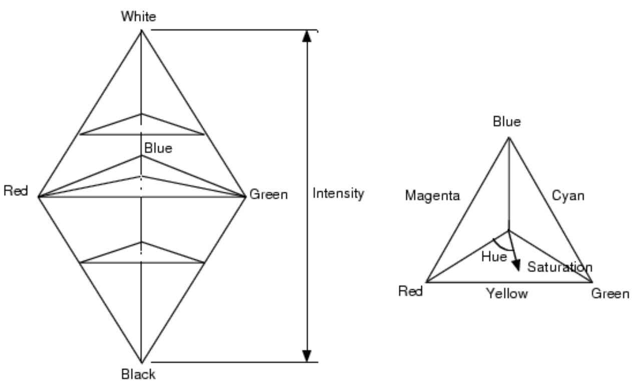


Fig 5. The HSI solid

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.

D. MATLAB Algorithm for note denomination detection

1. Initialize.
2. Set threshold 'th'.
3. Set COM port for serial communication.
4. Wait for '*' 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. Binarize 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.

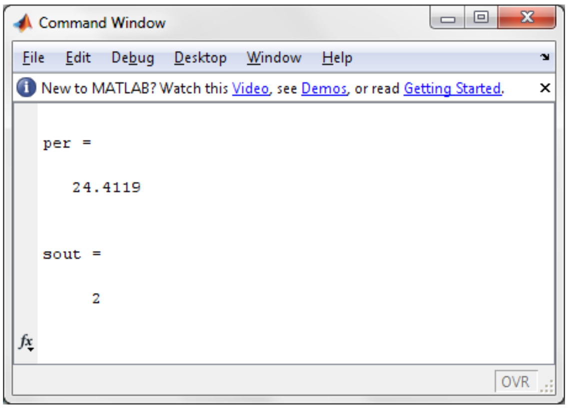
E. MATLAB processing

1. As '*' 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.

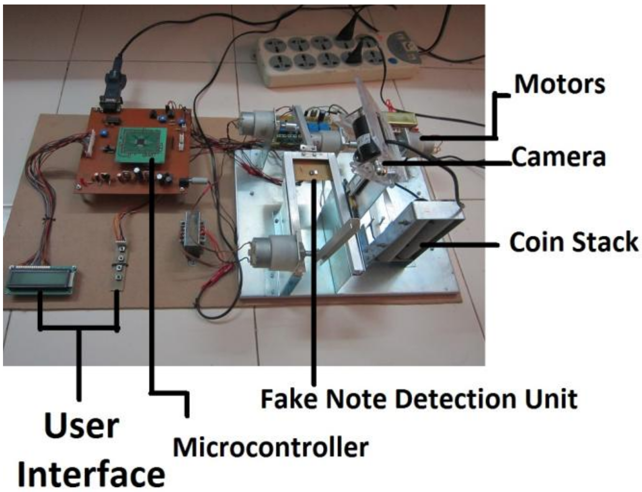
4. Then according to MATLAB coding, Output is generated and sent over serial port. And same is shown on command window.



IV. Hardware Development

Hardware of this project consists of

1. User interface for user to machine communication.
2. Microcontroller development board to control overall working of project. Microcontroller controls all motor operation and it communicates with MATLAB running on computer.
3. Drawer to place a note.
4. Fake note detection unit
5. Camera to take picture of note
6. Coin stack to store coin inside a machine.
7. Motor driver board.
8. Four motors, one for drawer in out, one for taking note inside a machine, two for coin dispensing of Rs1and Rs5.



V. Algorithm for Microcontroller

1. Initialize
2. Set coin counter as per stack of Rs 1 and Rs 5.
3. Wait for 'eject' key to be pressed.
4. When eject key is pressed motor actuates and tray comes out.
5. Now fake note detection circuit check the fake note.
6. If 1 is received from fake note detection circuit then note will given out.
7. If 0 is received controller will send '*' to serial port.
8. Then MATLAB code is executed to check denomination.
9. If 1 is received by controller from PC, controller waits for choice of coins entered by user.
10. Same if 2 is received.
11. Controller checks coin counter which indicates coin sufficiency.
12. If coins are sufficient then motor rotates as per choice entered which dispenses the coins.
13. After dispensing of coins motor actuates to drop the note inside the machine.

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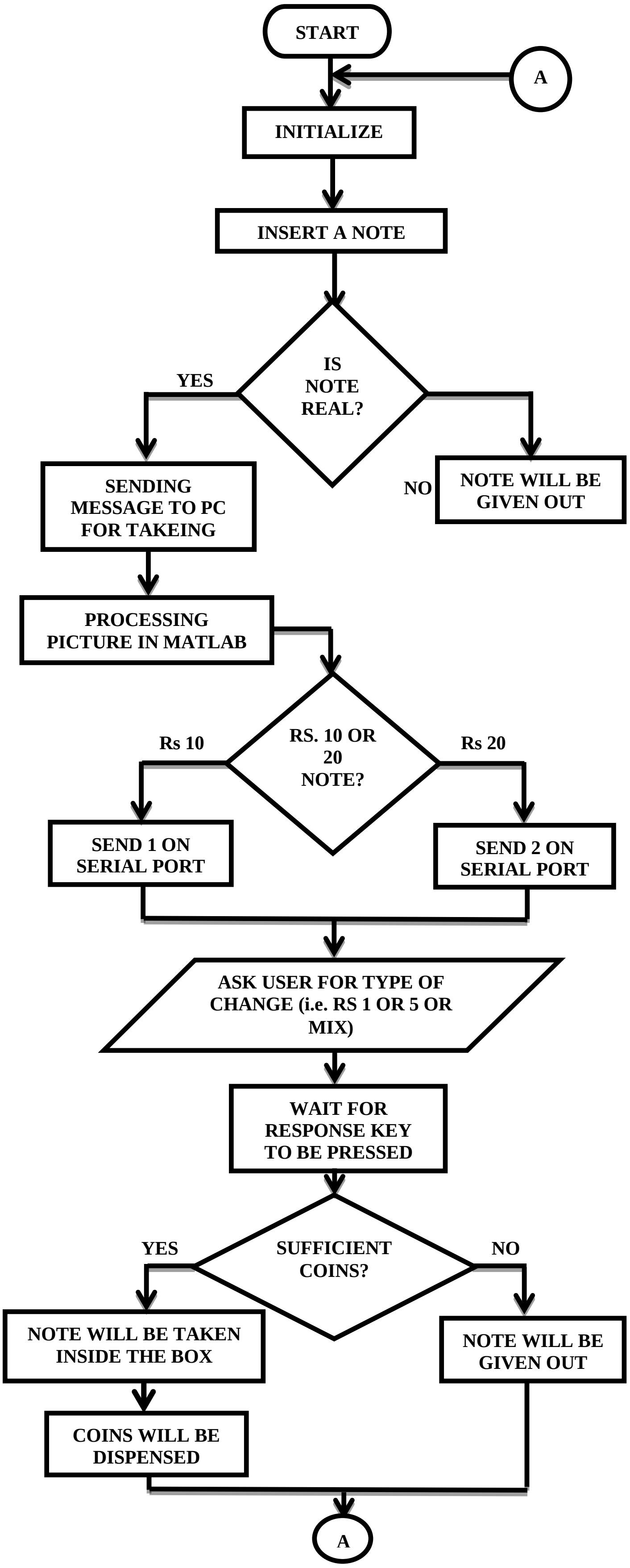
VI. FLOWCHART



VII. 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.

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