

Intelligent Note To Coin Exchanger With Fake Note Detection

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Abstract— The number of peoples that are facing the major problem such as availability of coins increases continuously. Because of the coins are largely required in daily life of human being. The places that needs the coin are like bus station, railway station, shopping mall etc. To solve this problem completely, we have design the simple and user friendly system. In this system note is converted into its equivalent value of coins. Firstly note currency is detected using UV LED mechanism, called as fake note detection unit. Then image of note taken by camera is passed through the MATLAB processing for denomination of note value (i.e 10 or 20). After successive completion of note denomination coin equivalent to note will be dispensed by coin dispensing unit. (i.e 1 or 5 rs coin)

(Index terms)— Fake note detection, Matlab Processing, coin dispensing unit)

I. Introduction

Now days, we have to suffer a lot for the change in various public places in daily life. The need of change has been increased. Rather coins are used more instead of note in various places like bus station, railway station, malls, parks, even in rural areas where nowadays also coin telephone system is used. The coin vending machine used at the Madurai railway station has eased the pressure of coin shortage on passengers as well as railway staff. The machine put up by Karur Vysya Bank, near the unreserved ticketing counter has been useful in ensuring a continuous supply of coins. The vending machine spews coins in the denominations of Rs. 5, and Re 1 when currency notes are inserted. Passengers who are short of coins are advised by the counter staff to get coins from the vending machines.

Fake Indian currency note (FICN) is a term used by officials and media to refer fake currency notes circulated in the Indian economy.[12] The fake notes of latest Gandhi series are so perfect that it is hard to identify them from the real notes. The Reserve Bank has the sole authority to issue bank notes in India. Reserve Bank, like other central banks the world over, changes the design of banknotes from time to time. The Reserve Bank has introduced banknotes in the Mahatma Gandhi Series since 1996 and has so far issued notes in the denominations of Rs.10, Rs.20, in this series.[12] These notes contain distinct easily recognizable security features to facilitate the detection of genuine notes.[12]



Fig1: 10 rs note

In counterfeit notes, the watermark is made by using opaque ink, painting with white solution, stamping with a dye engraved with the picture of Mahatma Gandhi. Then oil, grease or wax is applied to give the picture a translucent feel.[11] In genuine notes, the security thread is incorporated into the paper at the time of manufacture. But in fake notes, the security thread is imitated by drawing a line with a pencil, by printing a line with grey ink, or by using aluminium thread while pasting two thin sheets of paper.[11] Forgers find it difficult to reproduce the same shape of individual numbers again and again with accuracy. The

alignment of figures is also difficult to maintain. Spreading of ink, smaller or bigger number, inadequate gaps, and different alignments in numbers should be regarded with suspicion. In counterfeit notes, the printed lines will be broken and there may also be ink smudges.

The best way to identify a note is the silver bromide thread that runs vertically through a currency note. Fake currency notes tend to have silver-coloured band painted in place of the silver thread.[5] A real note has a prominent thread with raised 'RBI' markings made on it in English and Hindi. Also, in a real note, the colour of the thread shifts from green to blue when viewed from different angles.[12]

In this project we intend to provide a solution that will be convenient to obtain change in terms on coins in exchange of note. Also the system will be able to identify whether the note is genuine or fake. 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).[1] Once the note is recognized coins will be dispensed by coin dispensing unit. [1]

II. PROPOSED SYSTEM

A. BLOCK DIAGRAM

The system 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.

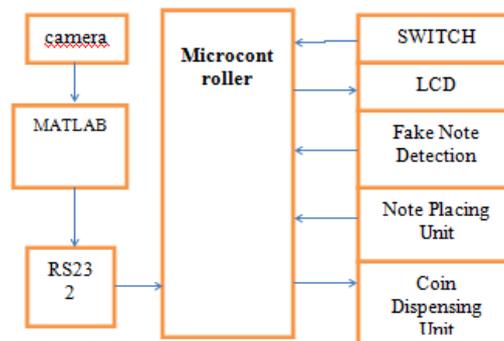


Fig 2. Block diagram of system

B. Note placing unit and coin dispensing unit

This unit consists of Drawer to place a note Coin stack to store coin inside a machine Motor driver board. Two motors for coin dispensing of Rs1 and Rs5. Controller checks coin counter which indicates coin sufficiency. If coins are sufficient then motor rotates as per choice entered which dispenses the coins. [5] After dispensing of coins motor actuates to drop the note inside the machine.

C. Fake note detection unit

The Indian currency note 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.[10] 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.[5]

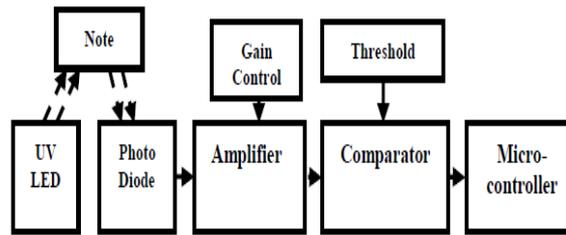


Fig 3: Fake note detection unit block diagram

D. Photodiode

A photodiode is a semiconductor device that converts light into current. The current is generated when photons are absorbed in the photodiode. A small amount of current is also produced when no light is present. Photodiodes may contain optical filters, built-in lenses, and may have large or small surface areas.[10] Photodiodes usually have a slower response time as their surface area increases. The common, traditional solar cell used to generate electric solar power is a large area photodiode. Photodiodes are similar to regular semiconductor diodes except that they may be either exposed (to detect vacuum UV or X-rays) or packaged with a window or optical fiber connection to allow light to reach the sensitive part of the device. Many diodes designed for use specifically as a photodiode use a PIN junction rather than a p-n junction, to increase the speed of response. A photodiode is designed to operate in reverse bias

E. UV-LED

A light-emitting-diode (LED) is a semiconductor diode that emits light when an electric current is applied in the forward direction of the device, as in the simple LED circuit. The effect is a form of electroluminescence where incoherent and narrow-spectrum light is emitted from the p-n junction in a solid state material. An LED is usually a small area (less than 1mm -2mm) light source, often with optics added directly on top of the chip to shape its radiation pattern and assist in reflection. The color of the emitted light depends on the composition and condition of the semiconducting material used, and can be Infrared, visible or Ultraviolet.

Current bright blue LEDs are based on the wide band gap between semiconductors GaN (gallium nitride) and InGaN (indium gallium nitride). They can be added to existing red and green LEDs to produce the impression of white light. Modules combining the three colors are used in big video screens and in adjustable-color fixtures. Ultraviolet LEDs in a range of wavelengths are becoming available on the market. Near-UV emitters at wavelengths around 375–395 nm are already cheap and often encountered, for example, as black light lamp replacements for inspection of anti-counterfeiting UV watermarks in some documents and paper currencies. Shorter-wavelength diodes, while substantially more expensive, are commercially available for wavelengths down to 240 nm.^[91] As the photosensitivity of microorganisms approximately matches the absorption spectrum of DNA, with a peak at about 260 nm, UV LED emitting at 250–270 nm are to be expected in prospective disinfection and sterilization devices. Recent research has shown that commercially available UVA LEDs (365 nm) are already effective disinfection and sterilization devices

III. Image processing for detecting note denomination

Once the fake note detection unit detects the note to be genuine, the camera will capture the note image and convert the image into HSI image and the digit is extracted after binarization by comparing with the threshold.

A. RGB Image

This is another format for colour images. It represents an image with three matrices of sizes matching the image format. Each matrix corresponds to one of the colours red, green or blue and gives an instruction of how much of each of these colours a certain pixel should use. The importance of RGB as a color model is that

it relates very closely to the way we perceive color with the r g b receptors in our retinas. RGB is the basic color model used in television or any other medium that projects the color. It is the basic color model on computers and is used for Web graphics, but it cannot be used for print production.

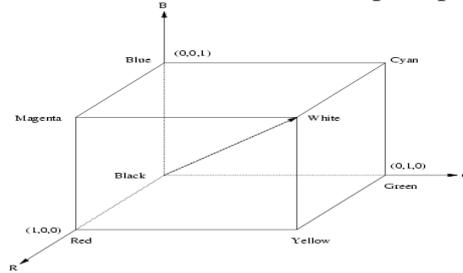


Fig 4. RGB Model

B.The CMY Model

Cyan, magenta, and yellow correspond roughly to the primary colors in art production: red, blue, and yellow. In the illustration below, you can see the CMY counterpart to the RGB model. Just as the primary colors of CMY are the secondary colors of RGB, the primary colors of RGB are the secondary colors of CMY.[5] But as the illustrations show, the colors created by the subtractive model of CMY don't look exactly like the colors created in the additive model of RGB. Particularly, CMY cannot reproduce the brightness of RGB colors. In addition, the CMY gamut is much smaller than the RGB gamut. The CMY model used in printing lays down overlapping layers of varying percentages of transparent cyan, magenta, and yellow inks[5]. Light is transmitted through the inks and reflects off the surface below them (called the substrate). The percentages of CMY ink (which are applied as screens of halftone dots), subtract inverse percentages of RGB from the reflected light so that we see a particular color

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

.....(1)

C.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 below[10]

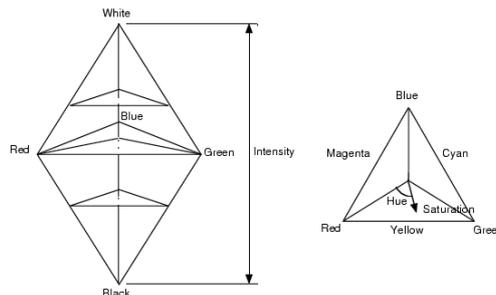


Fig 5. HSI Model

The HSI model, showing 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. Colours on the surface of the solid are fully saturated, i.e. pure colours, and the greyscale spectrum is on the axis of the solid. For these colours, hue is undefined. Conversion between the RGB model and the HSI model is quite complicated. [10]The intensity is given by

$$I=(R+G+B)/3 \quad \dots\dots\dots(2)$$

where the quantities R, G and B are the amounts of the red, green and blue components, normalized to the range [0,1]. The intensity is therefore just the average of the red, green and blue components. The saturation is given by:

$$S=1- (\min (R,G,B) /I) \quad S=1- (\min (R,G,B) /I) \\ =1-((3 /(R+G+B))*\min(R,G,B) \quad \dots\dots\dots(3)$$

where the min(R,G,B) term is really just indicating the amount of white present. If any of R, G or B are zero, there is no white and we have a pure colour. The expression for the hue, and details of the derivation may be found in reference.[10]

The YIQ (luminance-inphase-quadrature) model is a recoding of RGB for colour television, and is a very important model for colour image processing[10]. The conversion from RGB to YIQ is given by:

$$\begin{pmatrix} Y \\ I \\ Q \end{pmatrix} = \begin{pmatrix} 0.299 & 0.587 & 0.114 \\ 0.596 & -0.275 & -0.321 \\ 0.212 & -0.523 & 0.311 \end{pmatrix} \cdot \begin{pmatrix} R \\ G \\ B \end{pmatrix} \quad \dots\dots\dots(4)$$

The luminance (Y) component contains all the information required for black and white television, and captures our perception of the relative brightness of particular colours. That we perceive green as much lighter than red, and red lighter than blue, is indicated by their respective weights of 0.587, 0.299 and 0.114 in the first row of the conversion matrix above. These weights should be used when converting a colour image to greyscale if you want the perception of brightness to remain the same. This is not the case for the intensity component in an HSI image

E. Image Histogram

An **image histogram** is a graphical representation of the number of pixels in an image as a function of their intensity[2]. Histograms are made up of *bins*, each bin representing a certain intensity value range. The histogram is computed by examining all pixels in the image and assigning each to a bin depending on the pixel intensity[2]. The final value of a bin is the number of pixels assigned to it. The number of bins in which the whole intensity range is divided is usually in the order of the square root of the number of pixels. Image histograms are an important tool for inspecting images. They allow you to spot Background and grey value range at a glance. Also clipping and Quantization Noise in image values can be spotted immediately[3]. In the one-dimensional histogram shown here below (as in the other linked examples), the number of pixels in each bin is represented both by the height of a bar, and by a color scale coloring each bar higher bars have colors closer to red. By extending this histogram concept to multiple dimensions we can also make representations of Two Channel Histograms, or more.[2]

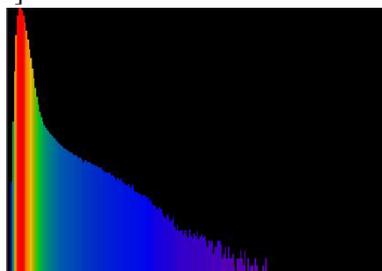


Fig 6. Histogram

F. 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. The points at which image brightness changes sharply are typically organized into a set of curved line segments termed *edges*. The same problem of finding discontinuities in 1D signals is known as step detection and the problem of finding signal discontinuities over time is known as change detection. Edge detection is a fundamental tool in image processing, machine vision and computer vision, particularly in the areas of feature detection and feature extraction.

Following are some of the commonly used edge detection methods

- Prewit Operator
- Roberts Operator
- Sobel Operator

Sobel Operator

It is one the most commonly used edge operators computes the edge at (i,j) Smoothing at the same time places emphasis on pixels closest to (i,j).It places emphasis on pixels closest to (i,j) [10]

$$G_x=(1/4) \begin{pmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{pmatrix}, \quad G_y=(1/4) \begin{pmatrix} 1 & 2 & 1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{pmatrix} \dots\dots\dots(5)$$

IV. Result & Simulations :

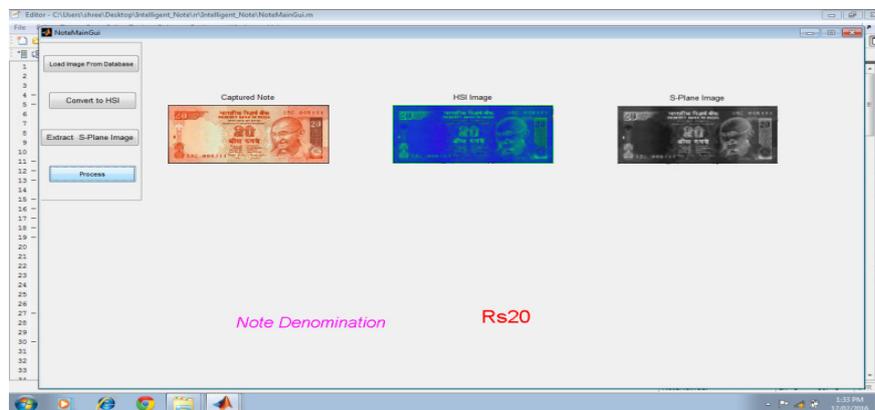


Fig. 7 note denomination

V. Algorithms

A. Algorithm for note denomination detection

1. Set threshold “th”.
2. Set COM port for serial communication.
3. Wait for “*” to be received on serial port from microcontroller.
4. When arrives, get snapshot of note by using camera.
5. Convert RGB image from camera to HSI image.
6. Separate S plane image from HSI image.
7. Cropping the image:
8. Set threshold “m” for Binarization of image.

9. Binarize the image.
10. 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.

B. Processing of 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 checks the fake note.
6. If 1 is received from fake note detection circuit then note will be 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

VI. CONCLUSION

The above system will be very beneficial in public areas like bus station, railway station where there is a requirement of coins. This system accept note and give equal rupees in the form of coins. The system is useful in checking whether the note is fake or real. In future this system is very crucial for bus station.

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