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An Intelligent Coin Dispensing Machine with Fake Note Detection

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***Abstract*—In the Indian Economy, even instead of cash and digital transaction facilities which vary from paise to Crore, due to digital illiteracy and convenience of coin with long durability, many grassroots businesses extensively use coin currency for local ancillary transactions like bus-railway tickets, Coin based water system where people face shortage of coins and loose change. Whereas, the existing non-mobile coin vending machines are bulky, expensive and non-commercial for common people. There is a critical need for detecting counterfeit notes due to continuous technological advancement leading to duplicate currency frauds. The paper extracts the methodology of our developed hardware-software compiled model covering the domains of embedded system, image processing and robotics implementation with hybrid mode for currency authenticity, value identification and dispensing coins equivalent to the note. Our proposed system consists of a fake note detection unit which checks if the note is real or not. If real, the RaspberryPi camera module clicks its picture; the value of the note is determined using image processing and Brute Force Matching algorithm. As per the arithmetic denomination calculated by RaspberryPi, coins will be dispensed from hopper slots with the help of DC motors, L293D drivers. The model offers a broad spectrum for future improvisations in assistive technology and for the ease of business. This inexpensive portable machine can be used in economically backward states like Bihar, Odisha and other places where local people mostly rely on coin currencies. Overall, our coin dispensing machine focuses on social welfare and accelerates coin currency with ease.**

***Keywords*— Indian grassroots economy, Currency authenticity, counterfeit (fake) banknotes, embedded systems, methodology, hybrid mode, Image Processing, inexpensive and portable.**

I. INTRODUCTION

Problem statement: The banknotes and coins are extensively used individually in Indian economic activities. The demonetization history reminds us of the critical need of detecting counterfeit banknotes. Also, the rural grassroots economy often faces insufficiency of changes for the local transactions like with vegetable vendors, signal side ancillary products vendors and so on. Hence keeping the above problems as a purpose of fulfilment, an adoptive implementation of an interactive machine is developed with the initial objective to identify the counterfeit Indian currency notes. The second objective is to provide coins equivalent to the currency notes proposed.

In the 21st Century, Even Instead of adequate Digital transaction modes like BHIM UPI, the working class of society, transact in Rupee and Paise, have not accepted the overall approximation of the amount. For example, when the cost of an object is 5 rupees and 75 paise, it will be accepted if it is rounded up to 6 rupees but not 5 rupees. Common people fight for each paise of their own hard work.

Hence, our proposed system aims to provide coins in the most cost-effective and optimized way concerning the existing model where our modification is specialized in automatic mode for detecting counterfeit notes and dispensing coins, manual interface for selection of coin choices along with the very user-friendly and understandable procedure.

II. RELATED WORK

In the 19th century, the first vending machine was successfully commercialized as a chewing gum/ candy machine by Thomas Adams in New York and further adopted by Pepsi for he sales. By using the same vending strategy, coin vending machines were developed worldwide.

In Bihar and Jharkhand, on 12-08-2010, the SBI has installed 45-coin vending machines (CVMs) to cater for the public needs, also further in the corners of countries to tackle the shortages of change. In Pune, RBI recently complimented coin vending machines at railway ticket counters.

III. REAL LIFE VIEW OF SYSTEM

This is a 3D model of the real-life view of our system using CAD software simulation. As per the optimized size and weight of the system, we can see the machine offers easy maintenance and portability. Also with future improvisation, new features can be added.

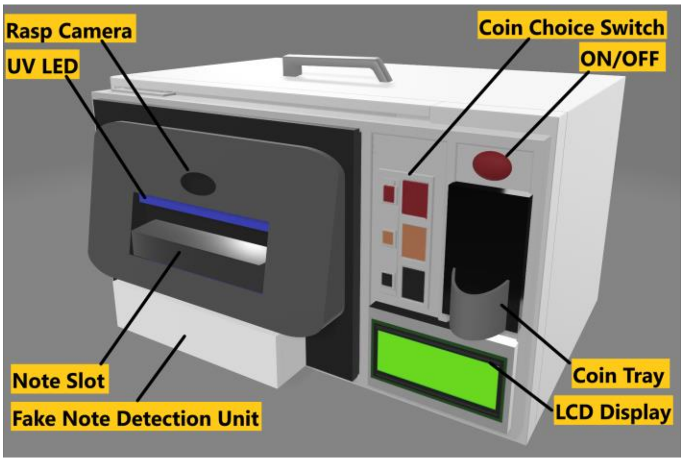

Fig 1. front view of the model

IV. SPECIFICATION

- Dimension: 400 x 300 x 300 mm
- Weight: max 1.5 kg
- Input voltage: 9v

- Power consumption: 18 watt
- Ergonomic Push Buttons are provided for the users to select Coin denomination when the machine is configured in Manual Mode.
- 16*2 LCDs the result statements for Note authenticity, acceptance of notes, coin selection option, Change tendering process Indication.
- Supports denominations of INR 5, 10, 20, 50 Notes and dispenses any of the coins of INR 1, 2, 5 and 10 with universal coin hoppers.
- The components used for the machine are easily available and cheap.
- The dispensing machine is quite portable and flexible for mobility along with easy maintenance.

Table 1. Hardware Specifications

No.	Component Required	Quantity	Nomenclature
1	RaspberryPi3	1	MOD B+
2	UV LED & Sensor	1	VEML 6075
4	Relay	1	5V, SPDT
5	RaspberryPi3 Camera Module	1	5 MP
6	DC Motor	6	60RPM
7	DC Motor Drive	2	L293M
8	16*2 LCD Display	1	OLED
9	Push Switches	4	-

V. METHODOLOGY

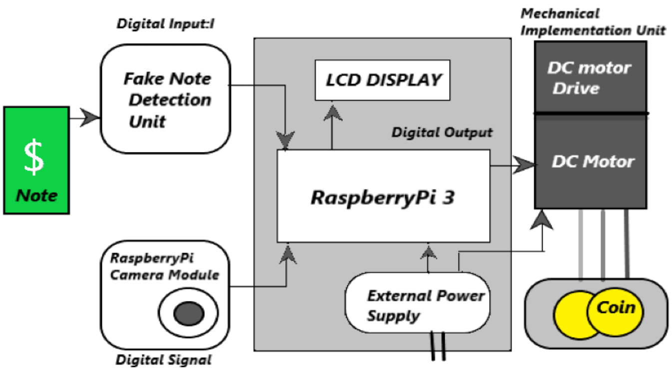

Fig 2. Block Diagram

A. CURRENCY NOTE AUTHENTICITY

As per the security feature of the Indian currency note, it absorbs the UV light, and the fake note will reflect the UV light. This is the determining strategy for the fake note detection unit. It consists of an ultraviolet light-emitting diode and UV sensor. UV LED is a source of UV rays once the UV rays fall on a real note, observed rays will be detected by the UV sensor. The note is inserted in the slot designed in between the UV LED & UV sensor facing each other on the opposite end of the unit.

The output of the UV sensor is in the form of voltage. This voltage decides whether a note is fake or real. Here we are using a VEML6075 ultraviolet (UV) sensor with RaspberryPi**.** It operates between 1.7 V to 3.6 V. Adafruit's VEML6075 library will read all the values of UVA and UVB rays. This sensor is a digital one, so we don't need any other external circuit like ADC. VEML6075 uses the I2C (Inter-Integrated Circuit Communication) data serial protocol.

Fig 3. (a) Note under UV light, (b)VEML6075

Once the detected note is real, the RaspberryPi camera module with 5MP resolution will capture it. The clicked image will be feedback to the image processing unit to detect the value of the currency note. The RaspberryPi has its camera module port which is known as the camera serial interface (CSI) port. Raspistill and Raspivid are two command lines used to control the camera module.

Fig 4. Raspberry Pi 3 Camera module

B. CURRENCY NOTE IDENTIFICATION

Image Acquisition is done by RaspberryPi camera module where the image is preprocessed for resizing and removing noise followed by image localization to identify one or more objects in an image. Feature extraction, detection and description are further steps. In which ORB, A fusion of FAST key points detector and BRIEF descriptor, is used to extract the features of an image. FAST stands for Accelerated Segment Test Algorithm used for detecting features and finding key points {kp1, kp2}in the form of a binary vector. BRIEF stands for Binary Robust Independent Elementary Feature {des1, des2}, is a feature descriptor applied to all {nd (x, y)} location pairs to get dimensional bit string. In the given figure, 16-pixel intensity key points are considered using FAST. By using BRIEF out of 16, only 4 pixels are taken for convenience (1,5,9,13), hence collectively ORB is utilized. Then, a STAR detector is used to delimit the search area.

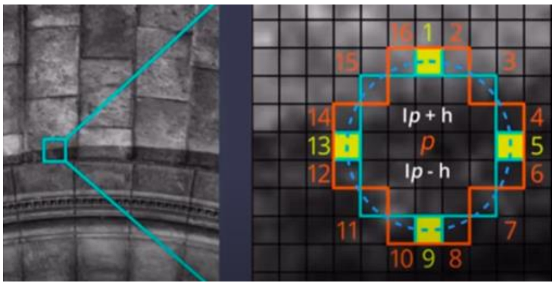

Fig 5. Intensity pixel matrix

By using Brute Force Matcher, correct matching between the test image descriptors and reference currency note descriptors is established the descriptor of one feature (1st [i]) is matched with all other features in (2nd [i]) using a minimum hamming distance calculation {good 100 matches}. Here, the real-time input test image is matched with all the reference trained images and the minimum Hamming distances are displayed where the match having more than 75% is the value of Currency Note.

C. COIN SELECTION

The input is taken from the user with the help of pushbuttons. Where push buttons are labelled as 1 Rs., 2 Rs., 5 Rs. and 10Rs. Each hopper connected to the DC motor is labelled as per the respective switches attached. This is to understand which motor should be driven for the combination of coins. For all the input combinations, we need to build an if and Else If ladder. According to the input combinations, the DC motor rotations will be decided by the RaspberryPi to determine the number of coins. Here to drop one coin, the motor will rotate 90^0. As shown in the picture below, a combination of 1 Rs., 2 Rs., 5 Rs. for 10 Rs.

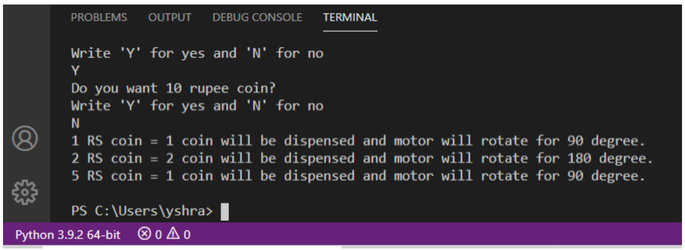

Fig 6. Simulation result for coin dispensing

D. COIN DISPENSING MECHANISM

We have used six motors to control the entire machine beginning from the note collecting to the coin dispensing. The first two motors are used to receive and deposit notes inside the machine, the other four motors are used to dispense the coins. In the coin dispensing unit, hoppers 1,2,3, and 4 will contain 1 Rs., 2 Rs., 5 Rs., and 10 Rs. coins respectively. To drive this motor, we are using an L293D IC. As we know a small 5V DC motor needs a large drive current of around 300-400mA. L293D motor drives to access the command signals from the RaspberryPi and source sufficient current to the motors. One single L293D can drive two DC motors. To control 4 DC motors, we are using two L293D motor drivers. If the coins as per the need of the user are not present in the coin container, then a message will be displayed on the LCD "INSUFFICIENT COINS"

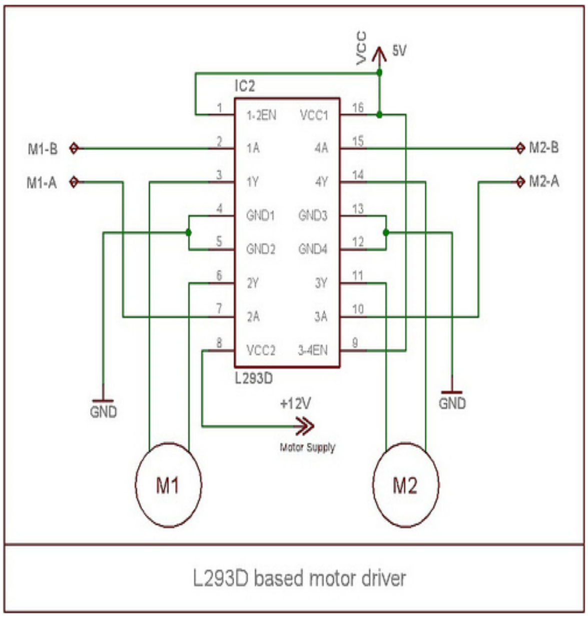

Fig 7. DC Motor Driver L293D

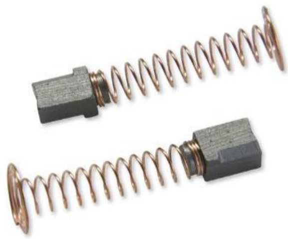

Fig 8. Carbon brush

VI. WORKING

The interfacing of the components with pin numbers is given in the figure below -

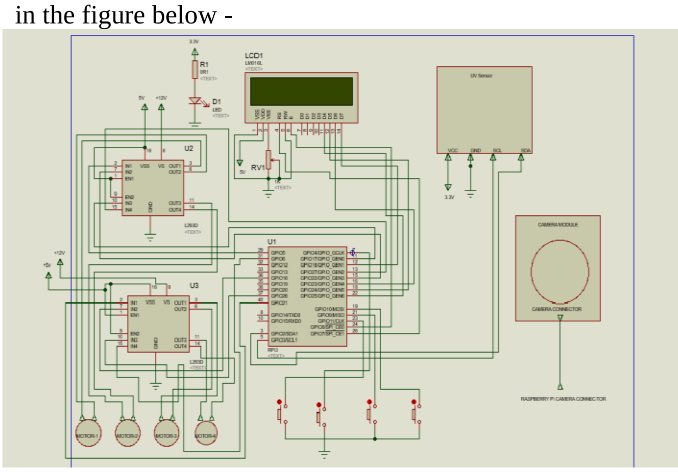

Fig 9. Circuit Diagram

TASK 1: Detecting Counterfeit Currency Note

- Insertion of note in the slot
- Relay turns ON the fake note detection unit
- Flash UV light on the note
- The real note will be differentiated from the fake note depending upon the absorption of UV light by using UV sensor

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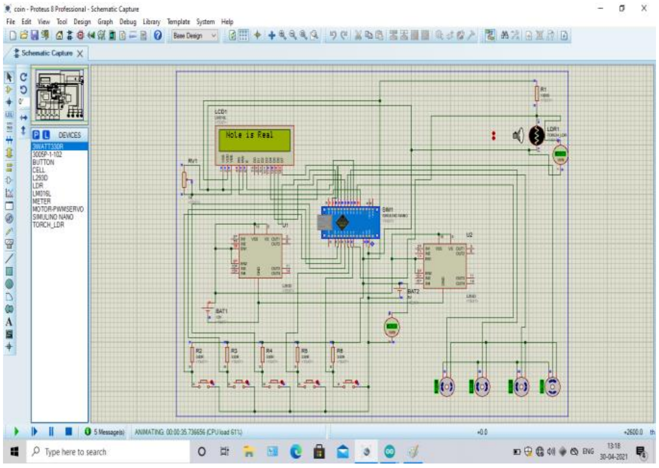


Fig 10. Proteus simulation of the system

TASK 2: Determining the note value

- Image acquisition using the RaspberryPi3 camera module
- Essential preprocessing (binarization, edge detection, etc.) are operated
- The feature extractions are done using ORB and proceed for the Brute force Matching Algorithm for the two, trained and real-time test images
- The real-time image is compared with all train reference note images i.e., 10, 20, 50, 100
- Template matching for good 100 matches using minimum Hamming distance logic is done
- The result will be given in the form of hamming distance measures where the closest match of more than 75% will be considered as the image value on OpenCV python

Fig 11. Brute Force Matcher for both notes

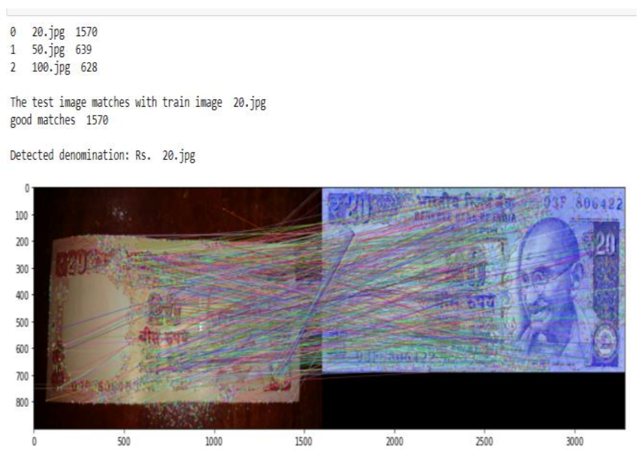


Fig 12. Simulation Result for Detecting value of the note

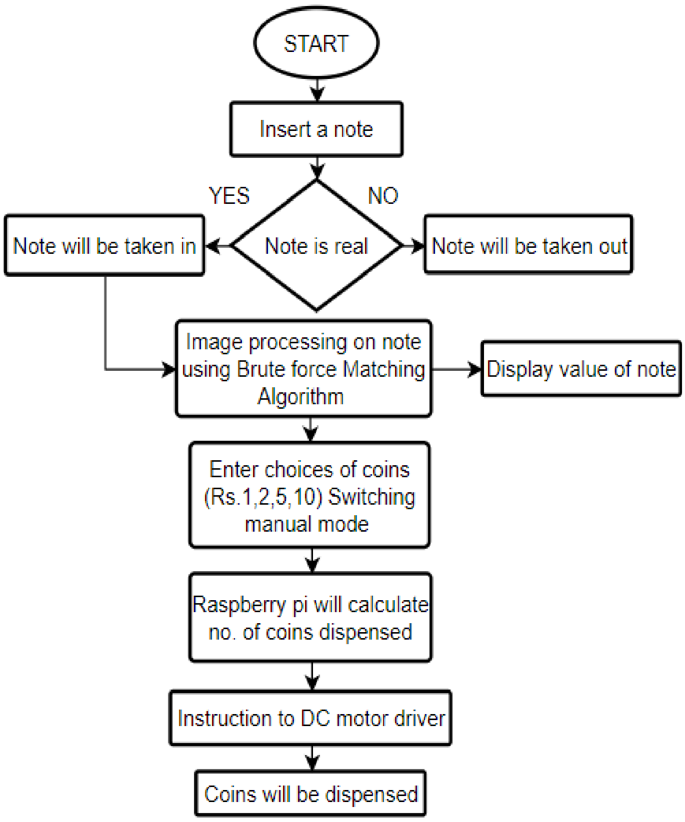
TASK 3: User input choice for the coins.

- Choice of coins will be taken by the user using 4 switches
- The Raspberry Pi will decide the coins to be dispensed and the number of rotations given to each DC motor

TASK4: Coin dispensing Unit

- 4 DC motors using 2 L293D drivers will be driven with different rotations or angles with the same speed as per the requirement denomination of coins decided
- Coins will be dispensed in a coin tray

FLOWCHART



VII. APPLICATION

1. For Bus and railway tickets
2. Coin based water system
3. Parking lot ticket
4. Signal side ancillary product sellers
5. Departmental stores
6. Sanitary pad vending machine
7. Medicine dispensing machine
8. Candy/chips/drink vending machine
9. Market vendors for vegetables, fruit, flowers etc.
10. STD PCO booth

VIII. RESULT

The model successfully detected counterfeit currency using the security feature of Indian notes of absorbing the UV light. The value identification of notes is determined by image processing. The reference and real-time image template are matched by Brute Force Matching Algorithm. The arithmetic denomination of coins is done using RaspberryPi3 and the choices are provided by using switches for the users. By adoptive robotic implementation, the coins equivalent to the provided note are dispensed. Hence, the obtained results are accurate and quick.

IX. CONCLUSION AND FUTURE SCOPE

The proposed coin dispensing machine is very adaptive to implement in real-time for transactions. The developed model offers a flexible, simple and rugged solution for basic coin acceleration and societal welfare. The machine can be customized to suit any type of terrain or climate with minimal changes to the hardware and software.

The area of improvements in our device is the security (lock buzzer alarm) and power failure handling.

For future work, we propose modification as if the note and coin capacity can be increased, for example, our proposed system gives coin denomination for rupee 10 and 20 notes only. The system can also be programmed f or Rs 50 and 100 notes. The addition of sensors inside the hopper can be installed to let users know the availability of coins in the slot. GSM Telemetry security System with SMS alerts can be introduced along with Touch screen-based systems. The achieved model with audio modules can be used by visually impaired people in ATMs for detecting counterfeit currency to avoid fraud. In this way, an intelligent coin dispenser machine with fake note detection will accelerate the coin currency and welfare the society at grassroot level.

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