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Automated Public Distribution System using Biometrics and Internet of Things

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Abstract: ***The Automated Public Distribution System is a novel approach which utilizes biometrics, Internet of things (IoT) and automation using Raspberry Pi3 for a secure, fast, and accurate distribution system. The customer's fingerprint is first authenticated on a fingerprint scanner, and then a One Time Password (OTP) sent by E-mail is verified. On successful authentication, type and quantity of material is requested and chosen by speech/text. The system dispenses materials from storage with help of motors and load cells for solids while using actuators for fluids. Transaction summary is received by the customer and the governing authority via E-mail.***

Keywords—Automated Public Distribution System; Raspberry Pi 3; Fingerprint scanner; OTP; E-mail; Motors; Actuators

I. INTRODUCTION

The Public Distribution System (PDS) of India was established in 1947 under Ministry of Consumer Affairs, Food, and Public Distribution to distribute subsidized food and non- food items to general public. It is done through ration shops where a distributor manually provides items prescribed for a person by virtue of his ration card. Major commodities include rice, wheat, sugar, and kerosene. Food Corporation of India procures and maintains the PDS along with the State Government. The manual system has worked for a long time, but there many drawbacks. It is slow, inaccurate, and involves waiting in long queues. Moreover, it is also subject to material theft through forgery of ration cards and illegal sale of goods to the black market by distributors. These problems are overcome by the use of proposed Automated Public Distribution System.

II. BLOCK AND CIRCUIT DIAGRAMS

Fig. 1 and Fig. 2 represent the system's block and circuit diagrams respectively. The components utilized include a Raspberry Pi 3, Zhiantec ZFM-20 fingerprint identification module, mouse, keyboard, headset, relay systems, motor, actuator, and a display unit such as an LCD monitor. Raspberry Pi3 works as a central processing unit that controls and processes data for the system to work. Zhiantec ZFM-20 fingerprint identification module is used to enroll and verify customer's fingerprint using the template system. The mouse and keyboard are used to control system functions. The speech output requesting type and quantity of material to be chosen is played out through a headset and speech input for type and quantity of material is taken in through the built in microphone.One relay system each is used to control the actuator and motor. Actuator is used to control the quantity of fluid material that is dispensed. Motor is used to control the quantity of solid material that is dispensed.

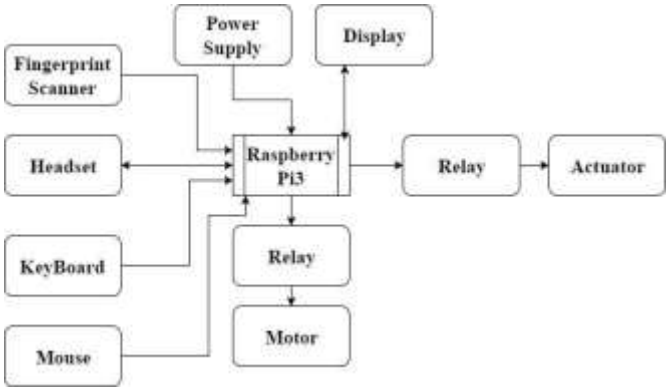

Fig. 1: Block Diagram Of The Proposed System

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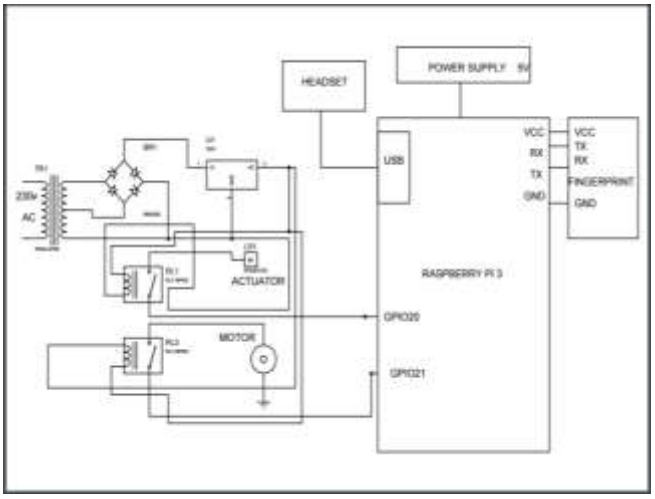

Fig. 2: Circuit Diagram Of The Proposed System

Raspberry Pi3 is powered by a 5V supply and Debian-based, Raspbian is used as the Operating System. A step down transformer, bridge rectifier, and 12V voltage regulator are used to provide 12V supply needed for proper functioning of the actuator and motor through relay systems. The headset, mouse and keyboard are connected to USB ports provided on Raspberry Pi3 board while a display unit is connected through the HDMI port. Supply for the fingerprint module is provided using supply from Pi 3 board. Transmission pin of fingerprint module is connected to the reception pin of Pi 3 board while reception pin of fingerprint module is connected to transmission pin of Pi 3 board. Commands for the relay systems are obtained through general purpose input output (GPIO) pins 20 and 21 of the Raspberry Pi3 board. Pin 21 is used to control the motor's relay system while pin 20 is used to control the actuator's relay system. Raspberry Pi 3 board is wirelessly connected with a hotspot device to connect it to the internet.

A. Fingerprint Sensor

Zhiantec ZFM-20 fingerprint identification module is used for the system. Customer fingerprint enrollment process is done by entering the following command in the terminal emulator window:

sudo –E python example_enroll.py

Fingerprint template is created by scanning the fingerprint of the user two times in quick succession. This template is used to verify the user when he tries to access the distribution system by 1: N matching. Main parameters of the fingerprint sensor are given in Table I. Interfacing connector pins for serial communication with the user device and their functions are briefly given in Table II.

Table I: Main Parameters Of Zfm-20 Fingerprint Id Module

Parameter	**Value**
Power	DC 3.6V-6.0V
Working Current	Typical: 100 mA Peak:150 mA
Interface	UART
Image Acquisition Time	<1s
Matching Mode	1:1 and 1:N
Template Size	512 bytes
Average Searching Time	<1s

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TABLE II: INTERFACING PINS FOR SERIAL COMMUNICATION

Name	Type	Function
Input voltage Vin	input	Power input(red cable)
Transmission TD	output	Data output(green cable)
Reception RD	input	Data input(white cable)
Ground	--	Signal ground(black cable)

B. Raspberry Pi3

Raspberry Pi 3 is the third generation of Raspberry Pi which effectively replaced the Raspberry Pi 2.
Like Pi2, it has 1GB of RAM, 4 USB ports, 40 GPIO pins, full HDMI port, Ethernet port, combined 3.5mm audio jack and composite video, camera interface (CSI), display interface (DSI), Micro SD card slot and a Videocore IV 3D graphics core. New features introduced along with Pi 3 was its ability to connect with Bluetooth 4.1, a 1.2Ghz 64-bit quad-core ARMv8 CPU, and 802.11n wireless Lan support which enable it to be connected wirelessly to the internet. Moreover, the Pi 3 utilizes low power Bluetooth for energy efficiency. Raspbian, a Debian based OS is popularly used for the Pi 3.A pictorial representation of the Raspberry Pi3 board is given in Fig. 3. Pin diagram layout of the GPIO pins is given in Fig. 4.

Fig. 3: Parts Of A Raspberry Pi 3 Board

FIG 4: Layout Of The Gpio Pins In Raspberry Pi 3

III. ALGORITHM

1. Customer details are registered into the database.
2. Customer's fingerprint is verified at the time of ration distribution.
3. One-time password (OTP) is sent via E-mail after fingerprint verification.
4. OTP is entered using the keyboard and subject to verification.
5. On successful authentication, user is asked to choose the type of material.
6. Once a material is chosen, user is asked to choose the quantity.
7. The chosen quantity of selected material is dispensed from storage.
8. Transaction summary is sent via E-mail to both the customer and the governing authority. The system is reset for a new user.

If fingerprint verification fails, system is reset and the customer has to scan again for verification.

If fingerprint verification is successful, but OTP verification fails, system is reset and the customer has to start again from fingerprint verification.

If the customer selects an invalid material or quantity, a warning message is displayed indicating the error.

IV. WORKING

A. Preparation

Customer database is prepared using name, address, contact information, and the type and quantity of materials allotted for people who are to use this system. The fingerprint template is taken and added with their respective data. The appropriate materials are filled into the storage tanks and the system is setup for operation.

B. Authentication

When a customer decides to avail his sanctioned materials, fingerprint verification is first done using the fingerprint identification module. If the fingerprint doesn't match with the database, system is reset. If fingerprint verification is successful, an OTP is sent to the customer's E- mail ID registered in the database. The customer has to then enter this OTP using a keyboard attached to the system. If the OTP doesn't match, system is reset. If OTP matches, the user is granted access.

C. Selection

On successful authentication, the system plays an audio file or displays a text sequence requesting the user to select a material. The material is chosen either through voice or text input. The system then plays an audio file or displays a text sequence requesting the user to select the required quantity of chosen material. This may be chosen by voice or text input as well. If the user selects materials or quantities not valid according to the database, the system issues a warning message stating the error.

D. Distribution

If proper material and quantity is chosen, the corresponding relay system is activated to run the motor or actuator. The relay mechanism is deactivated only if the chosen and dispensed quantities are a match. If it isn't a match, the relay mechanism continues to operate. On process completion, transaction summary is sent by E-mail to both the customer and the governing authority. System then resets to the initial stage waiting for a new transaction.

Fig. 5 depicts a flow chart illustrating the system's operation For our example, let us consider three possible situations:

Situation A:

Customer requests the system to dispense kerosene and selects the quantity.

Situation B:

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Customer requests the system to dispense rice and selects the quantity.

Situation C:

The customer requests the system to dispense both rice and kerosene and selects their respective quantities.The system responds in three distinct ways depending on the situation which arises.For situation A, the relay system corresponding to kerosene is activated after selecting a specific quantity. This opens the actuator which remains open until dispensed kerosene is equal to the selected quantity after which the actuator is closed by halting this relay system and a transaction summary is sent by E-mail. For situation B, the relay system corresponding to rice is activated after selecting a specific quantity. This runs the motor until rice dispensed is equal to amount of rice requested. At this point, the motor is stopped by halting the relay system and a transaction summary is sent by E-mail.For situation C, the relay system for kerosene is activated after selecting a specific quantity, to open the actuator and allows kerosene to be collected. When dispensed quantity is equal to requested quantity, the actuator is closed by halting the relay system corresponding to kerosene. The relay system corresponding to rice is activated after choosing a specific quantity of rice. This runs the motor and allows rice to be collected until required and selected quantities match. Once the quantities match, the relay system is stopped and transaction summary is sent by E-mail. Once distribution is complete, the system is reset and awaits the next user. Material stocks will have to be regularly refilled by the governing authority to ensure continuous, hassle-free working. Fig. 6 represents the final setup of components used in the system.

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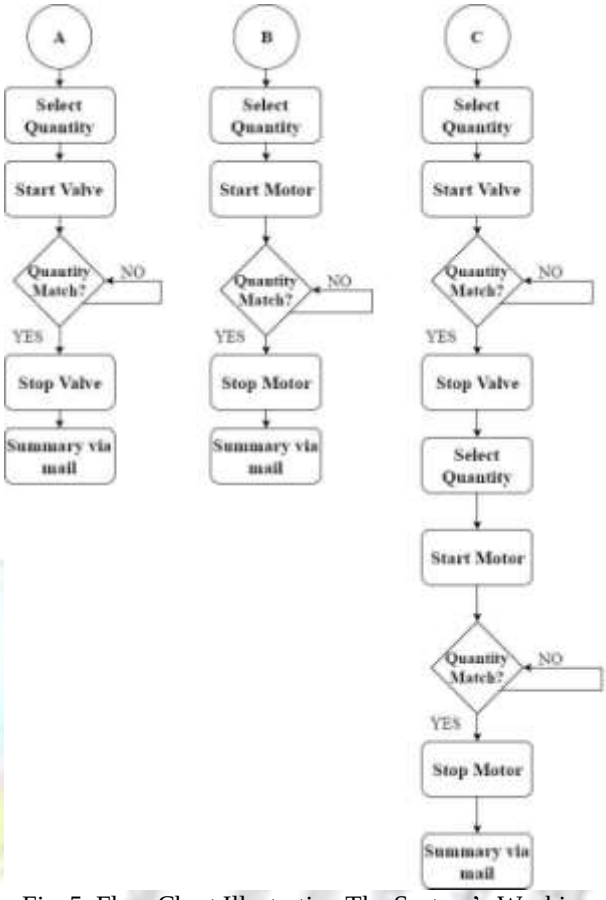

Fig. 5: Flow Chart Illustrating The System's Working

Fig 6: Final Setup Of Components Used In The System

V. CONCLUSION

This proposed Automated Public Distribution system is a perfect improvement over the tried and tested conventional method of ration distribution. The multi-layered authentication process protects against various identity-related malpractices while effective automation solves accuracy related issues. The entire process occurs in a smooth and streamlined manner offering a pleasant customer experience. Moreover, due to use of sophisticated modern components, the system is future secure.

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