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Automated Ration Vending Machine

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Abstract: *Our aim is to design an automated ration vending machine to help people overcome the demerits of TPDS. The Traditional Public Distribution System (TPDS) was established in 1997 to assist the underprivileged while maintaining the government's desired level of control over the budgetary food subsidies. The TPDS programme aims to eradicate poverty by providing the bare minimum of food grains at significantly discounted rates. These ration stores' supplies will be purchased directly from the farmers and then resold at reduced prices. The Traditional Public Distribution System (TPDS) has drawbacks which involve lot of corruption such as black marketing of these food grains and many families claim the quota of other families. Even when the material is not bought at the end of the month, the shopkeeper would send them to others without permission of the Government. There is no transparency between the Government and the customer.*

Keywords: Ration Vending, RFID, Sensors

I. INTRODUCTION

During September 2013, Parliament passed the National Food Security Act (NFSA), 2013. The NFSA seeks to make the right to food a legal entitlement by providing subsidised food grains to nearly two-thirds of the population. The Act relies on the existing Targeted Public Distribution System (TPDS) mechanism to deliver these entitlements. This note describes the functioning of the existing TPDS mechanism and the role played by the centre and states. It also explores challenges in the effective implementation of TPDS and alternatives to reform the existing machinery.

The existing TPDS operates through a multi-level process in which the centre and states share responsibilities. The centre is responsible for procuring or buying food grains, such as wheat and rice, from farmers at a minimum support price. It also allocates the grains to each state on the basis of a formula. Within the total number of poor in each state, state governments are responsible for identifying eligible households. The centre transports the grains to the central depots in each state. After that, each state government is responsible for delivering the allocated food grains from these depots to each ration shop. The ration shop is the end point at which beneficiaries buy their food grains entitlement.

Subsequently, in 1997, the government launched the Targeted Public Distribution System (TPDS), with a focus on the poor. TPDS aims to provide subsidised food and fuel to the poor through a network of ration shops. Food grains such as rice and wheat that are provided under TPDS are procured from farmers, allocated to states and delivered to the ration shop where the beneficiary buys his entitlement. The centre and states share the responsibilities of identifying the poor, procuring grains and delivering food grains to beneficiaries. In September 2013, Parliament enacted the National Food Security Act, 2013. The Act relies largely on the existing TPDS to deliver food grains as legal entitlements to poor households. This marks a shift by making the right to food a justiciable right. In order to understand the implications of this Act, the note maps the food supply chain from the farmer to the beneficiary, identifies challenges to implementation of TPDS, and discusses alternatives to reform TPDS.

The system is an automated ration vending machine which reduces the human interaction and increases the reliability on machine for ration vending. Here the user can transact with the machine any time he needs his allotted ration on any day of the month. Considering the drawbacks of existing system, he or she may have a clear transaction happening without any involvement of a person to prove the ration. This system may require only one person to refill the system tank with ration as and when the system empties its inventory. This reduces manual efforts to take on the ration number records

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cross check with it and later proceed further. Security can be enhanced as the system allows the user to interact directly with the RFID card and a finger print scanner.

1.1 Drawbacks of the Existing System

The existing system has the following drawbacks,

- The Traditional Public Distribution System (TPDS) has drawbacks which involve lot of corruption such as black marketing of these food grains and many families claim the quota of other families.
- Even when the material is not bought at the end of the month, the shopkeeper would send them to others without permission of the Government.
- There is no transparency between the Government and the customer.

1.2 Proposed Technology

The proposed system is an automated ration vending machine which reduces the human interaction and increases the reliability on machine for ration vending. Here the user can transact with the machine any time he needs his allotted ration on any day of the month. Considering the drawbacks of existing system, he or she may have a clear transaction happening without any involvement of a person to prove the ration. This system may require only one person to refill the system tank with ration as and when the system empties its inventory. This reduces manual efforts to take on the ration number records cross check with it and later proceed further. Security can be enhanced as the system allows the user to interact directly with the RFID card and a finger print scanner.

II. LITERATURE SURVEY

The need for the automated ration vending machine has given rise to many research works in the area. Some of the works are presented here.

In the paper [1], a " RFID - based automatic ration vending machine to avoid corruption and malpractices at ration shops" is developed to implementation of automatic distribution system in a ration shop. Civil Supplies Corporations the major public sector which manages and distributes the essential commodities to all the citizens. In that system various products like Rice, sugar and Water are distributed using conventional ration shop system. This project focuses on design and implementation of the fair price shop automated vending machine design using RFID technology, and removes major drawbacks of conventional ration system namely, the in-appropriate quantity of products and making of fake entries, material hijacking, card piracy, black market and human errors. This project is low cost, low power consumption and more accurate suited for real time implementation.

Also, in paper [2], it describes the concept to automate the PDS, A Government of India initiative process in which a fixed amount of ration is provided monthly to the people by the PDS stores. The increased corruption in the market sector can be prevented if the system becomes automated, increase adulteration can be prevented as well, the hoarding done by the officials and laborers of Govt. There will be two units. Main control unit from where all the registration process is done. Second unit is placed at the ration shop, which will completely control the activities at shop like customer identification, grain distribution and database updating.

In the study [3], it describes in this system overall functioning of module and proposed system that incorporates PLC based automated ration shop. Using AADHAR number and contact details government can send a message to the individuals, containing information regarding quantity of products allotted to a public in a respective ration shop. The smart card and finger print scanner is used for identification. PIC microcontroller is programmed in such a way that the above-mentioned processes are done automatically without any manual interface. Power supply is solar based power supply.

The paper [4] In this project manual work in the ration shop is replaced by the automated embedded system. The government money and people time is saved by this project. Poor people are greatly benefited by this system. The database can be maintained for long years easily without any illegal activities. The user details are created and part of the system is simulated using KEIL and ECLIPSE. By comparing the hardware and software results, the user details can be displayed automatically. If the user is below poverty line or above poverty line, it can be displayed by using the GLCD. GLCD (Graphical Liquid Crystal Display) is used to represents the variations in the colour format. If the user is below poverty

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line, it indicates the green colour in GLCD and the consumer's name, product details are displayed in LCD. If the user is above poverty line, it indicates the red colour in GLCD and the consumer's name, product details are displayed in LCD. By using KEIL software, all these details are simulated and displayed in the UART. So, by creating database and simulating it using KEIL and ECLIPSE it is easy to maintain database and display details using ECLIPSE. Also, it is easy to maintain database using KEIL.

III. SYSTEM REQUIREMENTS

3.1 Functional Requirements

These are the requirements for the proper functionality of the system to be taken place.

- The system has to dispatch the rice grains with requested quantity.
- The load sensor to indicate the manager when storage tank is low on grains.
- Fingerprint sensor backed up with TTL module.
- RFID reader and fingerprint module to interact with each other for verification.
- Raspberry pi for the entire decision-making logic operation.
- Smart GSM system to send OTP and messages.
- End transaction button interaction.

3.2 Non-Functional Requirements

These are the conditions under which the system works to get the desired functionality such as the need of power supply for the operation of the system. The availability of grains in the tank for dispensing the grains to the user.

3.3 Software Requirements

The software tools used are,

- Thonny Python
- MySQL Workbench
- The software language used is Python
- DBMS used is MySQL

Thonny is a new IDE (integrated development environment) bundled with the latest version of the Raspbian with PIXEL operating system. Using Thonny, it's now much easier to learn to code. Thonny comes with Python 3.6 built in, so you don't need to install anything. Just open up the program, which you'll find under Menu > Programming. It offers a lot of advanced features not currently available in the Python 3 (IDLE) program, which is still included with Raspbian.

When you start Thonny, you'll see a new script editor and a shell. As with Python 2/3 IDLE, you enter a program in the script editor and run it in the shell. You can then use the shell to interact directly with the program; accessing variables, objects, and other program features. Thonny has a range of additional features that are perfect for learning programming. One of the best features is a powerful, but easy-to-use, debug mode. Instead of running your program, it steps through the code line by line. You can see the variables and objects being created, and values being passed into functions or assessed by comparators. You often find debuggers in powerful IDEs, but they tend to require you to manually set breakpoints (places where the program freezes so you can examine the code). The approach in Thonny is much more straightforward. It also has a range of panels that enable you to inspect various items, such as variables, objects, and the heap (the memory space where items are stored).

Easy to get started. Thonny comes with Python 3.7 built in, so just one simple installer is needed and you're ready to learn programming. (You can also use a separate Python installation, if necessary.) The initial user interface is stripped of all features that may distract beginners.

Step through expression evaluation. If you use small steps, then you can even see how Python evaluates your expressions. You can think of this light-blue box as a piece of paper where Python replaces subexpressions with their values, piece-by-piece.

MySQL Workbench is a unified visual tool for database architects, developers, and DBAs. MySQL Workbench provides data modeling, SQL development, and comprehensive administration tools for server configuration, user administration, backup, and much more. MySQL Workbench is available on Windows, Linux and Mac OS X.

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3.4 Hardware Requirements

The hardware module consists of the following,

- Raspberry pi 4 Model B
- Raspberry pi 7inch Display
- Optical Fingerprint Reader Sensor Module
- RFID Reader and Cards
- GSM Module
- Weight Sensor
- 5v Single Channel Relay
- TTL Module
- Servo Motor

3.4.1 Raspberry Pi 4 Module B

Raspberry Pi 4 Model B is the latest product in the popular Raspberry Pi range of computers. It offers ground-breaking increases in processor speed, multimedia performance, memory, and connectivity compared to the prior-generation Raspberry Pi 3 Model B+, while retaining backwards compatibility and similar power consumption. For the end user, Raspberry Pi 4 Model B provides desktop performance comparable to entry-level x86 PC systems. This product's key features include a high-performance 64-bit quad-core processor, dual-display support at resolutions up to 4K via a pair of micro-HDMI ports, hardware video decode at up to 4Kp60, up to 8GB of RAM, dual-band 2.4/5.0 GHz wireless LAN, Bluetooth 5.0, Gigabit Ethernet, USB 3.0, and PoE capability (via a separate PoE HAT add-on). The dual-band wireless LAN and Bluetooth have modular compliance certification, allowing the board to be designed into end products with significantly reduced compliance testing, improving both cost and time to market

3.4.2 Raspberry Pi 7inch Display

The 7" Touch screen Monitor for Raspberry Pi gives users the ability to create all-in-one, integrated projects such as tablets, infotainment systems and embedded projects. The 800 x 480 display connects via an adapter board which handles power and signal conversion. Only two connections to the Pi are required; power from the Pi's GPIO port and a ribbon cable that connects to the DSI port present on all Raspberry Pi's. Touch screen drivers with support for 10-finger touch and an on-screen keyboard will be integrated into the latest Raspbian OS for full functionality without a physical keyboard or mouse.

3.4.3 Optical Fingerprint Reader Sensor Module

Fingerprint scanners aren't just reserved for the very top-tier of smartphones anymore. Even many budget phones sport the tech these days. The technology has also moved on a lot from its early iterations, becoming faster and more accurate at capturing your fingerprint. With that entire in mind, let's take a look at how the latest fingerprint scanners work and what the differences are.

R307 fingerprint module is a finger print sensor with TTL UART interface. The user can store the fingerprint data in the module and can configure it in 1:1 or 1: N mode for identifying the person. The FP module can directly interface with 3.3 or 5v Microcontroller. A level converter (like MAX232) is required for interfacing with PC serial port. R307 Fingerprint Module consists of high-speed DSP processor, high-performance fingerprint alignment algorithm, high-capacity FLASH chips and other hardware and software composition, stable performance, simple structure, with fingerprint entry, image processing, fingerprint matching, search and template storage and other functions.

3.4.4 RFID Reader and Cards

Radio Frequency Identification (RFID) is the wireless non-contact use of radio frequency waves to transfer data. Tagging items with RFID tags allows users to automatically and uniquely identify and track inventory and assets. RFID takes auto-ID technology to the next level by allowing tags to be read without line of sight and, depending on the type of RFID, having a read range between a few centimeters to over 20+ meters.

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RFID has come a long way from its first application of identifying airplanes as friend or foe in World War II. Not only does the technology continue to improve year over year, but the cost of implementing and using an RFID system continues to decrease, making RFID more cost-effective and efficient.

The MFRC522 is a highly integrated reader/writer IC for contactless communication at 13.56 MHz. The MFRC522 reader supports ISO/IEC 14443 A/MIFARE and NTAG.

The MFRC522's internal transmitter is able to drive a reader/writer antenna designed to communicate with ISO/IEC 14443 A/MIFARE cards and transponders without additional active circuitry. The receiver module provides a robust and efficient implementation for demodulating and decoding signals from ISO/IEC 14443 A/MIFARE compatible cards and transponders. The digital module manages the complete ISO/IEC 14443 A framing and error detection (parity and CRC) functionality.

3.4.5 GSM Module

The SIM800A Quad-Band GSM/GPRS Module with RS232 Interface is a complete Quad-band GSM/GPRS solution in an LGA(Land grid array) type which can be embedded in the customer applications. SIM800A support Quad-band 850/900/1800/1900 MHz, it can transmit Voice, SMS, and data information with low power consumption.

With tiny size of 100 x 53 x 15 mm, it can fit into slim and compact demands of custom design. Featuring and Embedded AT, it allows total cost savings and fast time-to-market for customer applications.

The SIM800A modem has a SIM800A GSM chip and RS232 interface while enables easy connection with the computer or laptop using the USB to the Serial connector or to the microcontroller using the RS232 to TTL converter. Once you connect the SIM800A modem using the USB to RS232 connector, you need to find the correct COM port from the Device Manager of the USB to Serial Adapter.

3.4.6 Weight Sensor

A load cell is a transducer which converts force into a measurable electrical output. Although there are many varieties of load cells, strain gage-based load cells are the most commonly used type. Except for certain laboratories where precision mechanical balances are still used, strain gage load cells dominate the weighing industry. Pneumatic load cells are sometimes used where intrinsic safety and hygiene are desired, and hydraulic load cells are considered in remote locations, as they do not require a power supply. Strain gage load cells offer accuracies from within 0.03% to 0.25% full scale and are suitable for almost all industrial applications.

3.4.7 Relay

A relay is an electrically operated switch. Many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid-state relays. Relays are used where it is necessary to control a circuit by a separate low-power signal, or where several circuits must be controlled by one signal. For a relay to operate a suitable pull in and holding current should be passed through its coil. Relay coils are designed to operate from a particular voltage often 5V or 12V. The job of relay driver circuit is to provide the essential current energize the relay coil, when a LOGIC 1 is written on the PORT PIN thus turning on the relay. The relay is turning off by writing LOGIC 0 on the port pin. In our system, eight relays are used for device control [9]. In order to develop our proposed system 2 Channels Relay has been used. This is a 5V, 10A 2-Channel Relay interface board. It can be used to control various appliances, and other equipment with large current. For 2 Channels Relay each channel in the module has three connections named NC, COM, and NO. Depending on the input signal trigger mode, the jumper cap can be placed at high level effective mode which „closes" the normally open (NO) switch at high level input and at low level effective mode which operates the same but at low level input.

3.4.8 TTL Module

PL2303 - PL2303HX USB to TTL Serial UART Converter Module is a handy, low cost module. Adopt imported controller RS232 TTL, which can stabilize the flash with high-speed 500mA self-recovery fuse for protection.

Two data transmission indicators can monitor data transfer status in real time. Reserve 3.3V and 5V pin interface, easy for DDWRT of different voltage system that needs power. The entire board is coated by a high-quality transparent heat-

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shrinkable sleeve, making the PCB in insulation state from outside, so that the board won't be burnt down by a material shortcut.

- Adopt imported controller PL2303HX, which can stabilize the flash with high speed • 500mA self-recovery fuse for protection
- Two data transmission indicators can monitor data transfer status in real time
- Reserve 3.3V and 5V pin interface, easy for the DDWRT of different voltage system that needs power
- The entire board is coated by the high-quality transparent heat-shrinkable sleeve, making the PCB in insulation state from outside, so that the board won't be burnt down by material shortcut.
- Electrostatic package ensures the board will not be damaged before use
- Excellent driver support--drivers are available for Windows 98 to Windows 7 (32 bit and 64 bit), Mac OS 8 to OS X (32 bit and 64 bit) and Linux. Even Android is supported.

3.4.9 Servo Motor

A servomotor is a linear actuator or rotary actuator that allows for precise control of linear or angular position, acceleration, and velocity. It consists of a motor coupled to a sensor for position feedback. It also requires a relatively sophisticated controller, often a dedicated module designed specifically for use with servomotors. The servo motor is usually a simple DC motor controlled for specific angular rotation with the help of additional servomechanism (a typical closed-loop feedback control system). Nowadays, servo systems are used widely in industrial applications.

IV. SYSTEM DESIGN

4.1 Architectural Design

The block diagram architecture of the system is as shown in the Fig. 4.1. It consists of an RFID reader, Fingerprint scanner, Raspberry pi module, load cell, servo motor, load cell and a GSM module. There is also a database interaction shown in the diagram.

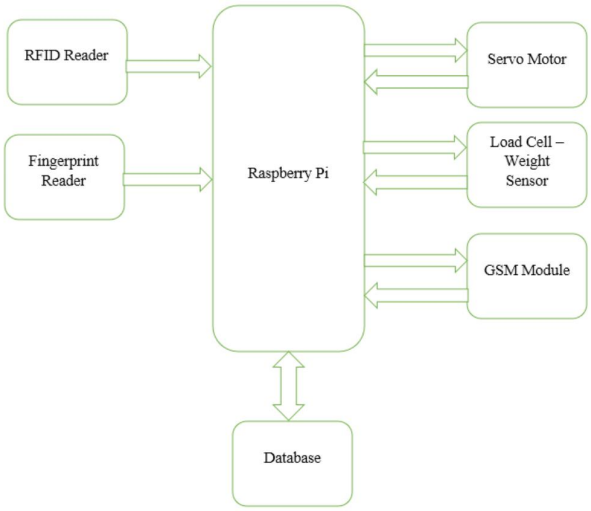

Fig. 4.1. Block Diagram of the system

In Fig 4.1, the RFID reader, an input device accepts the RFID card reads it and inputs a unique RFID number to the Raspberry pi module. Another input device is a fingerprint module which accepts biometric fingerprint, reads it and sends it to the raspberry pi as an input. Both the fingerprint and the RFID number are then verified using a database query. The database consists of all RFID numbers and the fingerprints associated with them stored, so the data is authenticated by the Raspberry pi module interacting with the database. Later a GSM module is pinged to send an OTP to the user and its authentication is done by the Raspberry pi module. After the complete authentication the Load cell is pinged to check the tank capacity and the servo motor is pinged to perform its operation, opening and closing of output lid.

The entire system working is explained in 2 modules and represented in the flow charts as shown in Fig. 4.2 and Fig. 4.3. The initial process is represented in Fig 4.2 and the main activity is represented in Fig 4.3.

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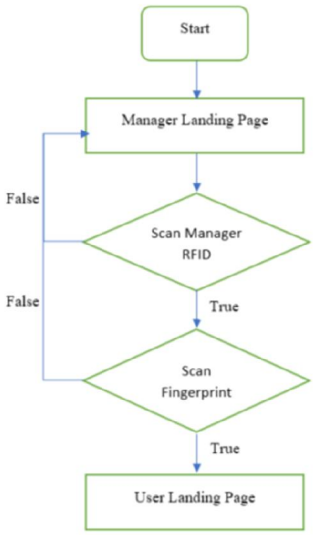
The flow chart of the initial process is as shown in Fig 4.2. When the system starts, the store manager is asked to login to the system setting up to be a base user upon which all other users will login. The manager is asked to login first using 2 step verification process they are RFID card scanning and then if its true the system asks for Fingerprint authentication. If anu one step fails it reflects back to the main homepage. Later after verification the user landing page is shown.

In the Fig. 4.3, the flow chart of main user activities is shown. The process flow is similar to initial activity, but here, once the user logins after verification he will be prompted to select the grains quantity and confirm for dispatch. After dispatch the user can logout and the system loops back to the user landing pace for new session but these activities continue to be in the base session that is manager's account.



4.2 Flow Chart of the initial process

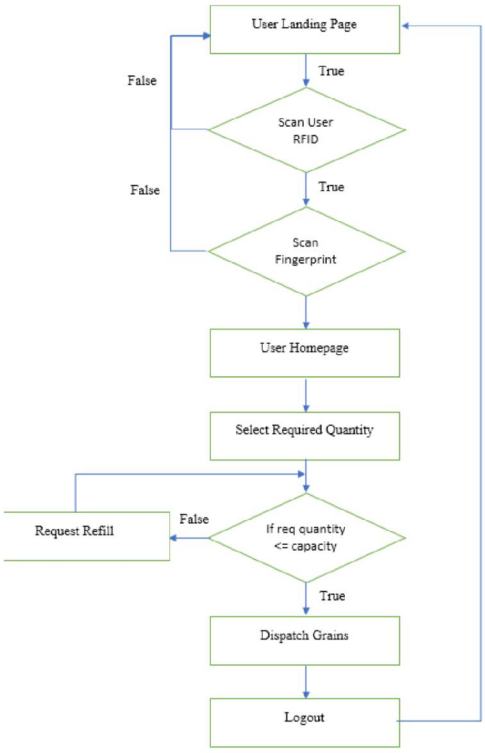


Fig. 4.3: Flow Chart of the system

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V. IMPLEMENTATION

5.1 Algorithm

In this work, a user defined algorithm has been implemented, and the flow has been represented below.

Step 1: Initialize the System

In this step, the system is powered up and the modules come up online to accept new data and ready to start the processes. Also checks its connectivity with the database.

Step 2: Scan Manager RFID card and Fingerprint

Once the system is initialized the system requests the store manager to login first. RFID reader reads the card and the fingerprint modules reads the manager's fingerprint.

Step 3: If Scanned Manager data == Stored Manager data goto Step 4, else goto Step 2

The RFID data and the fingerprint data are verified by the system by matching it with the stored data. If match is found the system proceeds to step 4, else it prompts invalid user and reverts back to step 2.

Step 4: Show Manager Homepage

A new session is created where the store manager can see his users and their transactions.

Step 5: User Login

In the managers session, each user attempts to login a sub-session is created as a user session.

Step 6: If Scanned User data == Stored User data goto Step 7, else goto Step 5

Similar to manager the user also scans his RFID and fingerprint upon successful authentication system goes to next step else reverts back to step 5.

Step 7: Send OTP

An OTP is sent to the users registered mobile number to validate the user.

Step 8: User Homepage

Upon successful OTP validation the user's homepage with all the basic details and his allotment of food grains are displayed.

Step 9: Select the required quantity of food grains

The user needs to select the required quantity of food grains and click on confirm to dispatch the same.

Step 10: If requested Quantity <= Allotted Quantity goto step 11, else goto step 9

If the user's requested quantity is less than or equal to the allotted quantity to him, then goto step 11 else revert back to step 9 so that he can choose the quantity again.

Step 11: If requested quantity <= Available quantity goto Step 12, else refill storage and goto Step 12

Now system checks weather the requested quantity is available in the storage. If available then goto next step else prompts to refill the storage and goto next step.

Step 12: Dispatch the requested quantity of food grain and update the same in database

The requested quantity of grains is dispatched and the transaction is updated in the database accordingly.

Step 13: Logout User session and goto Step 5

After the user's task is complete, he can logout of the session and loopback to Step 5.

Step 14: Logout Manager session and goto Step 1

After all the task is complete, manager can logout of the session and loopback to Step 1 and exit.

VI. CONCLUSION AND FUTURE ENHANCEMENT

In the present era, there are numerous social problems which are expected to be looked at, ration distribution to card holders in an optimized and easier manner is one of them. The proposed system can help the users quit waiting in long ques and can easily collect their ration at any time and any quantity desired. This system also controls corruption and back marketing of food grains by automating the entire process, not involving any third-party person to interfere in the transaction. The system is user friendly and easily understandable process follow. This system has a greater scope in the future involving automated product delivery or even online transaction.

The system is expected to have a lot of improvements, including remote access, booking of commodities. Also automated or semi-automated home delivery system may be implemented with research and study. To a great extend it is possible to have AI influence to enhance the security and avoid involvement of any external body in transaction. The Proposed idea can also be implemented in Supermarkets, Malls etc other than ration shops.

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