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Automated Ration Distribution System

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Abstract— The system proposed in this paper is an "Automated Ration Distribution System". Which is an advanced solution to prevent black market and false entries. By using this system The government also able to track the record of commodities distributed. The purpose behind the project is to prevent the black market and to track the record of the distribution of commodities. The Technology behind this is the Internet of Things (IoT), Which is an efficient and advanced solution to connect all the distribution centers to the master center. Which is possible by using node MCU ESP32. Distribution automated by using Node MCU and the track of commodities distributed are uploaded on the server via Lora module SX1278 over the long-range where the main center is located. There is no human interaction between user and system, So there will not be any chance of black market or false entries of the user. The project involves hardware and software parts. Hardware part contains ESP32, SX1278, Fingerprint module. The software part involves programming to operate the ESP32, which is written in embedded C language and then uploaded into ESP32 by using Arduino IDE software. The prototype of the Automated Ration Distribution System has met all the objectives as derived and planned.

Keywords— Internet of Things (IoT), Arduino IDE, ESP 32, LoRa Module, SX1278, Ration Distribution System, Fingerprint sensor.

I. INTRODUCTION

Distribution of the commodities started in June 1997, in order to support the people of the nation, who can't afford or who has less income beyond the threshold. The threshold income is set by the government. Eligible families get the ration card if they fall under the guidelines set by the government. The government provides commodities to all the eligible families at the subsidized rates, who holds the ration card. Major commodities distributed include staple food grains, such as wheat, rice, sugar, and essential fuels like kerosene, through a network of fair price shops also known as ration shops established in several states across the country. In the current system, Ration card holder families just have to go to the ration distribution shop and need to pay some amount of money by showing the ration card to the officer. Then they got the commodities at subsidized rates. subsidized rates are very low as compared to the actual value of the commodity. According to the type of ration card, commodities distributed wisely. But, if all this system comes in practice, it has found out of happening of the black market in this system [3]. Primarily, to prevent this we designed this automated system.

Let's start with the process, how it works?. After showing the ration card at the distribution center, the officer gives the commodity to the customers with a subsidized price, which is set by the government. Before a while, officers started doing the black market, which means they are started doing corruption. They put some false entries without telling the customers and sell that commodity at the regular rate. So service not reach the ration card holders properly [3]. To prevent this kind of corruption and to provide this service to the eligible families, previously some systems designed, in order to prevent black market or corruption[5]. But there was a very big limit in those systems, that was communication range. They designed a system only for one region, they did not connect all those regions where they want to install the system[1]. to make it possible and to prevent all those problems, we designed the "Automated Ration Distribution System". In this paper, we are going to discuss "How this proposed system going to prevent corruption in the system?". If "Automated Ration Distribution System" will install in the country, then happening of the black market and corruption will definitely reduce to a great extent because there won't be any human interaction during the process except the ration cardholder.

The proposed system is an advance solution over the flaws of the previous system. In the proposed system, all the process of distribution happens automatically and the count of commodity distributed is also uploading on the server along with the user. In the proposed system, there will be a user interface. Users need to enter aadhar card no on the keyboard install on the system and verify themself by biometric. We are using a Fingerprint sensor for biometric

verification. Then users need to select commodity and after that, users need to collect commodities at the outlet of the system.

We took advantage of the LoRa module to transfer data over a long range[7]. Basically, We transfer the data of all the node MCU to the main central node MCU via Lora RF module SX1278. So the status of commodities distributed can be tracked any time at the central node MCU side.

II. BLOCK DIAGRAM

Let's understand the proposed system by using a block diagram. for simplicity, we divide it into two sections, as shown below.

A. Transmitter Section

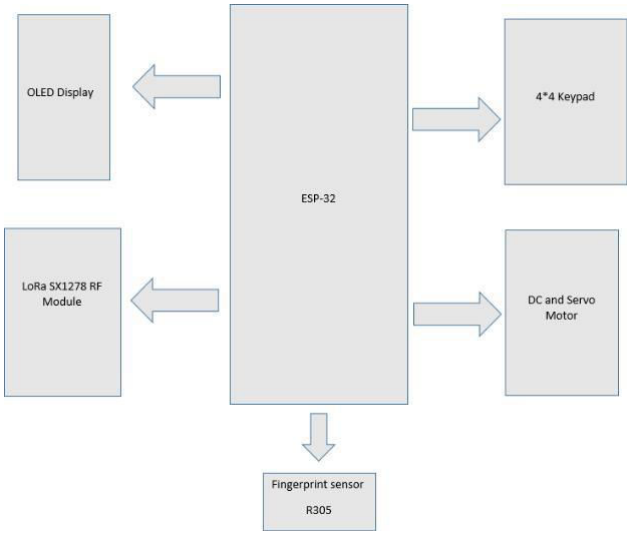

Fig. 1: Block Diagram of Transmitter Section

Transmitter section means the side at from almost whole process is happening, i.e user interface side. Transmitter section includes microprocessor NodeMCU ESP32, LoRa SX1278 RF Module, Fingerprint Sensor R305, 4*4 Keypad, OLED 0.96" Display, DC motor, and Servo Motor.

ESP 32 is main processor, who is controlling all the operations of other components, such as Display, keypad, LoRa module and motors. This section is installed at the ration shop only. Ration cardholder need to enter aadhar card no on the system by using 4*4 keypad and after that user needs to put his finger on the fingerprint sensor R305 for person verification. It just check whether the user is a member of the family or not? OR check whether the user linked with the ration card or not?. Fingerprint sensor checks whether user fingerprint is matching with the member of the family or not?.

After validation of the user, OLED display shows the name of the user. Fingerprint data of each member of each family, who holds the ration card is already saved on the system. We put each family's information and fingerprint data along with the member information while programming the NodeMCU. After verification users have to select the type and quantity of commodities. And need to collect the commodity at the outlet of the system. The dispensing of the commodity is achieved by DC and Servo motor. DC motor used for dispensing of liquid, we calibrate it, before installing and servo motor used for grain dispensing.

That information is sent to the receiver section via LoRa SX1278 RF Module. The information contains what and who is collecting the ration commodity? with what quantity?. The front view of the system is shown in Fig.2.

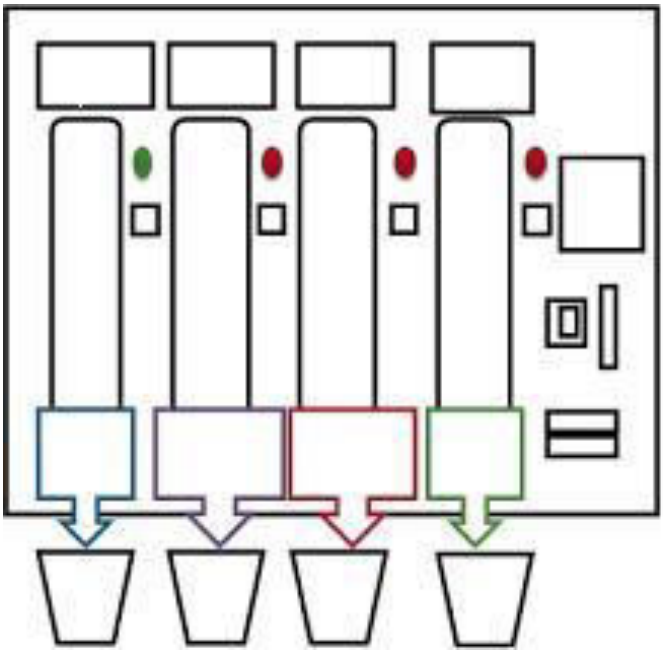

Fig. 2 : Front view of user interface

B. Receiver Section

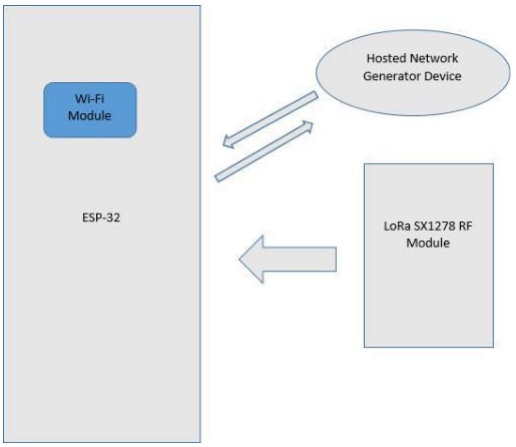

Fig. 3: Block Diagram of Receiver section

Above Fig. 3 shows the block diag. of receiver section, which contains NodeMCU ESP-32 and LoRa SX1278 RF Module. Information sent by the transmitter section via the LoRa module received by another LoRa module of the receiver section. As shown in the block diagram, the LoRa module receives information for the NodeMCU ESP-32. For creating a network server, a secured hosted network should be there, such as a Wi-Fi network or smartphone's hosted network. NodeMCU has an inbuild Wi-Fi module. By programming, we connect MCU's Wi-Fi module to a secured Hosted network. After receiving the information, NodeMCU pushes that live receiving information on the server. We program the NodeMCU in such a way that, after logging in on the server, it shows an HTML page containing all the information as discussed.

III. HARDWARE USED

Project hardware part is divided into two parts, First one is Transmitter section or User interface section and the second one is server-side section or main center side section.

A. Transmitter section or User interface section:

The user interfaces section, the main component is ESP32. which is a microcontroller and in the proposed system, ESP32 interfaced with the components, such as fingerprint sensor R305, 4*4 keypad, LoRa RF module SX1278, dc, and servo motors. To get the data from the user 4*4 keypad is used. For verification of the user, fingerprint sensor R305 is used. DC motors and servo motors are used to dispense kerosene and the grain. SX1278 LoRa RF module is used to transfer the ESP32 data wirelessly over a very long-range to the receiver section.

B. Receiver section or Main center side section:

At the main center side section, LoRa SX1278 RF Module is interfaced with NodeMCU ESP32 which creates a server. Data receive via SX1278 module and upload it to the server made by the microcontroller. The server is only created by connecting inbuilt wifi of microcontrollers to the hosted network. In practice, all the distribution centers are far away from each other, so to make a server all centers need to connect each other and it is not possible to connect all the centers via Wi-Fi, because of wifi range constraints. wifi range of esp32 is around 6 meters. So it is not possible to use wifi to connect the centers together, as they located far from each other. LoRa SX1278 has the communication range around 10-15 km, so a convenient way is to use the LoRa SX1278 RF module in order to connect all the centers.

Let's focus on the server side, after receiving the data via SX1278, node MCU upload it to the server created by itself. Data uploaded on the server is display on the HTML page. We code the nodemcu to create an HTML page, which is continually updated by the data received from the appropriate distribution center. Initially, we code the nodemcu to connect a hosted secure network and to get the network IP address. To check the status of distribution, an officer need to connect the device to the same secure hosted network. Devices could be anything like smartphones or computers. After connecting, the officer needs to enter the network IP address in the device and then the HTML page will display. The hosted network should be secure and then only trusted users can log in. Let's see "How to login on the server?". Initially, users need to connect on that secured network with a computer or smartphone, on which nodemcu is connected. when once nodemcu connected on the network, we can have the network IP address by programming.which is shown in Fig.4. After getting that IP address, the user needs to enter that IP address on the browser to open the html page.

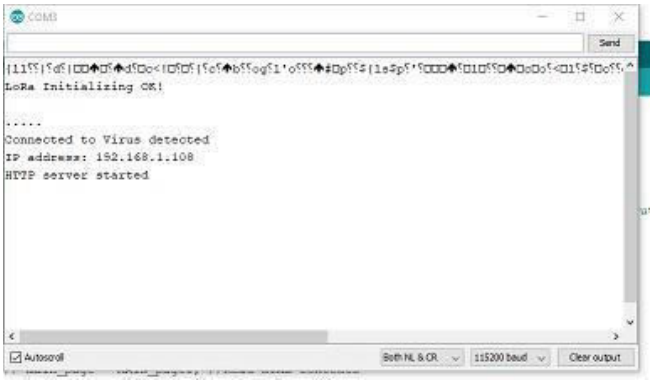

Fig. 4: Internet Protocol Address of NodeMCU

IV. SOFTWARE USED

We have used ''Arduino Integrated Development Environment" tool to write and upload the code to the NodeMCU. The code is in embedded C language. We have used 1.8.10 version of Arduino IDE. The Arduino Integrated Development Environment is a cross-platform application that is written in functions from C and C++. It is used to write and upload programs to Arduino compatible boards, but also, with the help of third-party cores, other vendor development boards too. We used embedded c language in programming. In this project, we made a system by interfacing all the necessary components. To drive those components, we include some header files in the code, shown in table 1.

No.	Header File	Use
1.	#include <SPI.h>	SPI communication protocol

2.	#include <Keypad.h>	4*4 Keypad
3.	#include <Wire.h>	This library allows you to communicate with I2C / TWI devices
4.	#include<Adafruit_GFX.h>	The Adafruit_GFX library for Arduino provides a common syntax and set of graphics functions for all of our LCD and OLED displays
5.	#INCLUDE <ADAFRUIT_SSD1306.H>	ADAFRUIT SSD1306 OLED LIBRARY
6.	#include <LoRa.h>	LoRa SX1278 RF Module
7.	#include <Servo.h>	Servo motor

Table 1: Header files with uses in Embedded C language

Below are some features of the language.

- C language is a software designed with different keywords, data types, variables, constants, etc.
- Embedded C is a generic term given to a programming language written in C, which is associated with a particular hardware architecture.
- Embedded C is an extension to the C language with some additional header files. These header files may change from controller to controller.

V. COMPONENTS INTERFACED:

A. ESP 32

1. ESP32 Development board is based on the ESP WROOM 32 Wifi + Bluetooth Low Energy Module. It's a low-power and can be easily used with a breadboard. It is on-chip low-power microcontroller with build-in integrated Wi-Fi and dual-mode Bluetooth. We programmed the microcontroller by using the Arduino IDE environment. We used embedded C programming to program the microcontroller. By programming, we can customize the use of pins for UART, I2C, SPI, PWM, etc. This is possible due to the ESP32 chip's multiplexing feature.

Fig.5 : NodeMCU Development Board (ESP 32)

Specifications:

- The ESP32 is dual core (2 processors).
- It has built-in Wi-Fi and Bluetooth.
- It runs with 32 bit programs.
- The clock frequency can go up to 240MHz and it has a 512 kB RAM.
- This particular board has 30 pins.
- It also has wide variety of peripherals available, like: capacitive touch, ADCs, DACs, UART, SPI, I2C and much more.
- It comes with built-in hall effect sensor and built-in temperature sensor.

B. LoRa SX1278 RF Module

Lora SX1278 RF module works with SPI (Serial Peripheral Interface) communication protocol so it can be used with any microcontroller that supports SPI. as both modules ESP32 and SX1278 supports SPI protocol, we used them both together.

The main purpose of using LoRa SX1278 is its communication range, which is around ten's of Kilometer. as ration shops and the main center are located far from each other. LoRa SX1278 RF modules will be placed at each center along with microcontrollers in order to transmit the data of the microcontroller to the main center over the long distance. Transmitted data then deliver to the receivers ESP32 through SX1278 RF Module. Basically, all centers are connected to the main center. LoRa SX1278 RF module provides 15 to 20 km of communication range, however communication range also depends on the performance of the antenna, transmitter power, and obstruction by the surrounding environment. Those factors can influence communication[7].

LoRa uses license-free sub gigahertz radio frequency bands like 433 MHz, 868 MHz (Europe), 915 MHz (Australia and North America) and 923 MHz (Asia). LoRa enables long-range transmissions (more than 10 km in rural areas) with low power consumption[7]. The technology covers the physical layer, while other technologies and protocols such as LoRaWAN (Long Range Wide Area Network) covers the upper layers. This module uses SX1278 IC and works on a 433MHz frequency. Frequency hopping which gives that balance of quality signal transmission, which will cover a range of 420-450MHz. This long-range wireless capability is packed into a small (17 x 16mm) package and delivered through a spring antenna, which is mounted on the module.Interfacing Of SX1278 with microcontroller is shown in Fig. 7

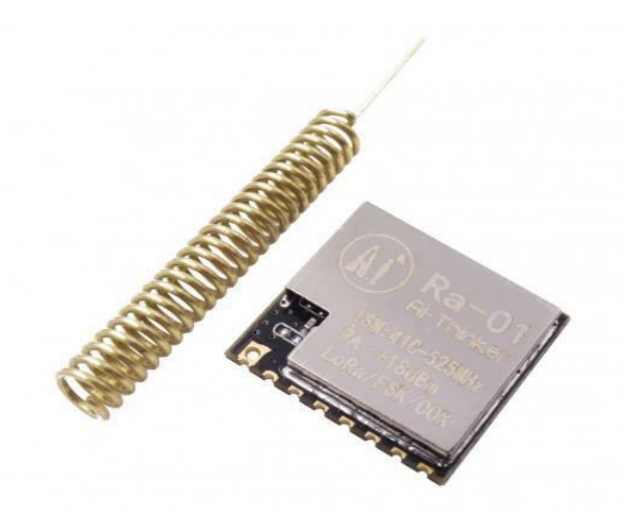

Fig 6 : LoRa SX1278 RF Module

Features :

- LoRa Modem Operating Voltage: 3.3V
- Operating Frequency: 433MHz
- Half-Duplex SPI communication
- Modulation Technique FSK,GFSK,MSK,GMSK,
- LoRa Packet size: 256 bytes
- Sensitivity: -148d

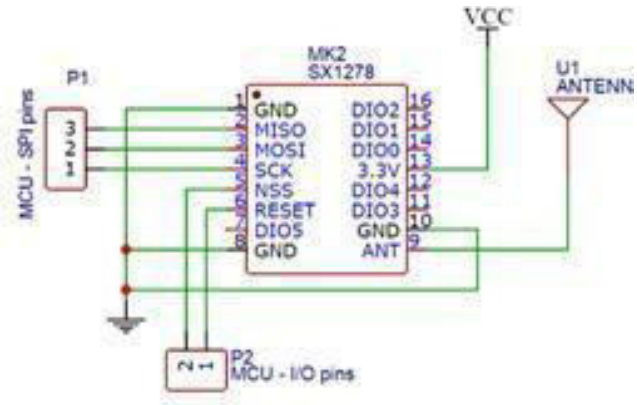

Fig 7 : Interfacing of LoRa SX1278 RF Module with Microcontroller

C. Fingerprint sensor R305:

The R305 is an optical fingerprint the sensor which consist of a powerful AS601 DSP (digital signal processor) chip. The DSP chip does all the image rendering, calculation, feature finding, and searching for the sensor. The DSP chip also works as the form of storage device which can store up 250 fingerprints on its flash memory. The chip also has a TTL serial out in order to connect with a microcontroller or any other system. The sensor registers a fingerprint by collecting the image copy of the fingerprint and store it for future use, and when repeated the sensor once again collects a new picture of a fingerprint and compares it with the store fingerprint in order the identify the individual. Operating power is 3.6V-6.0V DC.operating temperature is -10 to +40 degrees Celcius. We used this sensor for the biometric verification of the user[2].

R305 is an optical fingerprint sensor module and uses TTL UART interface i.e Transistor-Transistor Logic (TTL) universal asynchronous receiver-transmitter (UART). the way an optical scanner works is by shining a bright light over your fingerprint and taking a digital photo of a finger. The light-sensitive microchip makes the digital image by looking at the ridges and valleys of the fingerprint and then turning them into 1's and 0's, and creates the user's own personal code. R305 can stores that personal code along with a person's identity.

Features of R305 fingerprint sensor:

- Interface : UART (TTL logical level)/ USB 1.1
- Working current : 100mA
- Peak Current : 150mA
- Matching Mode: 1:1 and 1:N
- Baud rate (9600*N)bps, N=1-12 (default N=6 57600bps)
- Character file size: 256 bytes
- Image acquiring time : <0.5s
- Template size : 512 bytes
- Storage capacity: 256
- Security level : 5 (1, 2, 3, 4, 5(highest))
- FAR : <0.001%
- FRR: <0.1%
- Average searching time: < 0.8s (1:880)
- Window dimension : 18mm*22mm

Fig 8: R305 Fingerprint sensor Module

Fig 9 : 0.96" OLED Display Module - SPI/I2C - 128x64 - 7 Pin (Blue)

D. OLED Display

The display we used In our project is 0.96" OLED Display Module - SPI/I2C - 128x64 - 7 Pin (Blue). The display can be used with I2C (Inter-Integrated Circuit) or SPI (serial peripheral Interface) communication protocol. In our project, the esp32 microcontroller communicates with OLED display by using the I2C communication protocol.

OLED stands for Organic Light Emitting Diode. In LED technology light is produced by organic molecules. These organic LEDs are used to create the world's best display panels. OLED displays are made by placing a series of organic thin films between two conductors. When an electric current is applied across it, a bright light is emitted. OLEDs enable emissive displays, which means each pixel is controlled individually and emits its own light. OLED displays feature great image quality, bright colors, fast motion, and most importantly a very high contrast. Most notably, "real" blacks which can't be achieved in LCDs due to the backlighting. The simple OLED design also means that it is relatively easy to produce flexible and transparent displays. Fig 9 shows the 0.96" OLED display. We are using OLED display in order to display the user information[6].

E. Servo and DC motor

We used servo motor to turn outlet of the grain container ON and OFF. The amount of grain comes out from the outlet directly proportional to the ON time of the outlet. the outlet needs to be open for an amount of time to get the grain of a particular amount. If 1kg of grain comes out from the outlet of the container in 100ms, then to get 5kg of grain, the outlet of the container should be open for 500ms. To open or close the outlet of the container, we used a servo motor. To open the outlet, the microprocessor rotates servo motor by 90 degrees, and to close the outlet, it will rotate the servo motor by 90 degrees again. We broaden the rotating flap of the servo motor and used it as a door for outlet of grain container. According to this concept, we calibrate the system.

Fig. 10: Servo Motor

Servo motor is controlled by PWM (Pulse with Modulation) which is provided by the control wires. There is a minimum pulse, a maximum pulse, and a repetition rate.

Servo motor can turn 90 degrees from either direction from its neutral position. The servo motor expects to see a pulse every 20 milliseconds (ms) and the length of the pulse will determine how far the motor turns. For example, a 1.5ms pulse will make the motor turn to the 90° position, such as if the pulse is shorter than 1.5ms shaft moves to 0° and if it is longer than 1.5ms than it will turn the servo to 180°.

Servo motor works on the **PWM (Pulse width modulation)** principle, which means its angle of rotation is controlled by the duration of applied pulse to its Control PIN. Basically servo motor is made up of **DC motor which is controlled by a variable resistor (potentiometer) and some gears**. The high-speed force of the DC motor is converted into torque by Gears. We know that WORK= FORCE X DISTANCE, in DC motor Force, is less and distance (speed) is high and in Servo, force is High and distance is less. The potentiometer is connected to the output shaft of the Servo, to calculate the angle and stop the DC motor on the required angle.

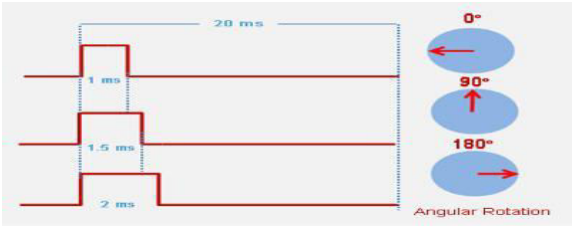

Fig. 11 : Angular Rotation of Servo motor

Servo motor can be rotated from 0 to 180 degrees, but it can go up to 210 degrees. This degree of rotation can be controlled by applying the **Electrical Pulse** of proper width, to its Control pin. As shown in Fig. 11, Servo checks the pulse every 20 milliseconds. The pulse of 1 ms (1 millisecond) width can rotate the servo to 0 degrees, 1.5ms can rotate to 90 degrees (neutral position) and 2 ms pulse can rotate it to 180 degrees. Servo motor works on the 5v DC supply.

We used DC motor to dispense the liquid-like kerosene. The calibration of this section is also done by using the same method used for servo motor.

F. 4*4 Keypad

Keypad uses 4*4 matrics and uses as an input device. which consists of 16 keys in parallel. 16 keys are made by the combination of 4 rows and 4 columns. This keypad is interfaced with the esp32 parallelly by using 8 pins. Out of those 8 pins, pin 1-4 are of 4 rows and remain 5-8 are of 4 columns. These 8 PINs are driven out from 16 buttons present in the MODULE. Those 16 alphanumeric digits on the MODULE surface is the 16 buttons arranged in MATRIX formation.

Fig. 12 : 4*4 Keypad

The internal structure of the 4*4 keypad matrix is shown below in Fig. 13. As we can see rows and columns are arranged in 4*4 matrix form. If we press the button located at intersection of 1st row and 1st column then key 1 got selected. Assume Pmn, 'm' is the number of rows and 'n' is the number of columns. When key got to press and m=1 and n=4, then key 'A' got selected. Likewise for all the 16 keys.

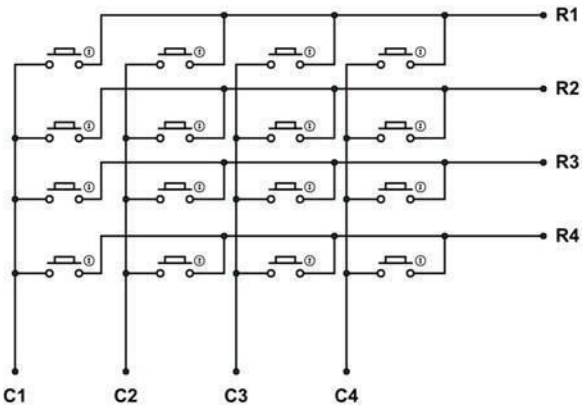

Fig. 13 : Internal Structure of 4*4 Keypad

VI. RESULTS AND DISCUSSION:

We interfaced fingerprint sensor R305, 4*4 Keypad, LoRa SX1278 RF module, Servo motor, and DC motor with ESP-32. After performing all tasks for one user microcontroller send data to the main server-side microcontroller via LoRa and after receiving the data microcontroller upload it to the server created by itself. The server's HTML page is shown in Fig.14, which contains the quantity of commodity is available per user. for example, we told the 1st user to use the system and he took the 2kg of wheat. the result after getting the commodity, real-time data is sent to the receiver side and uploaded on the server. After the user took 2kg of wheat, HTML page updates according to that. The updated page is shown in figure 15. We used Arduino programming to perform those tasks. By using efficient programming, we were able to perform the whole ration distribution system automatically.

Fig. 14 : HTML page

Fig. 15: Real Time updated page

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