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IV SEMESTER BE

Microcontrollers and Embedded Systems- Experiential Learning

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Cloud connected smart scale with business analytics for shops

Submitted By,

Vibhav Sharma	**1RV18CS060**
Siddarth Chauhan	**1RV18CS166**
Sriram N C	**1RV18CS173**
Sujay Hebbar	**1RV18CS175**
Utkarsh Singh	**1RV18CS181**

Verified By,

Dr Badarinath

Asst. Professor,

Dept of Computer Science Engineering, RVCE

Abstract

Many shops across the country continue to use outdated techniques for carrying out their business and also engage in cheating as well as adulteration. Due to this, many poor people suffer as they lose business to Amazon, Walmart and other businesses with more trustworthiness and modern practices. There is a need to modernize shops using cheap and innovative methods to keep businesses afloat, by autonomously offering business analytics or advice, delivery systems, etc. There is also a need to eliminate unfair trade practices like non-standard weights to cheat customers or PDS shops swindling ration grains. Additionally, in the period of pandemic(COVID-19), we must also adopt contactless shopping and avoid physical payment or exchange.

Existing System

We have a traditional shopping trend where the owner purchases the stock from the wholesaler and sell it to the consumer and for business analytics part he either maintains the physical memo or just uses some management library which does not store the data permanently or predict future aspects of business.We also have some online platforms for purchase of fruits and vegetables but some customer and owner behavior does not follow this.

Proposed System

We propose a fully-automatic cloud connected smart scale with business analytics for shops which provides both offline and online shopping . It allows you to have contactless shopping with a paperless invoice. It also keeps track of the customer visits and generates a discount offer according to the profit they made. The system provides a friendly web page and app to use. It also shows necessary analytics and future scopes with addition to remainder in the owner’s plan. Hence the system provides both offline

and online modes of easy shopping for customers and well trained data analytics for the owner.

Technologies used

1.Keil software

2.Matlab

3.Thingspeak cloud

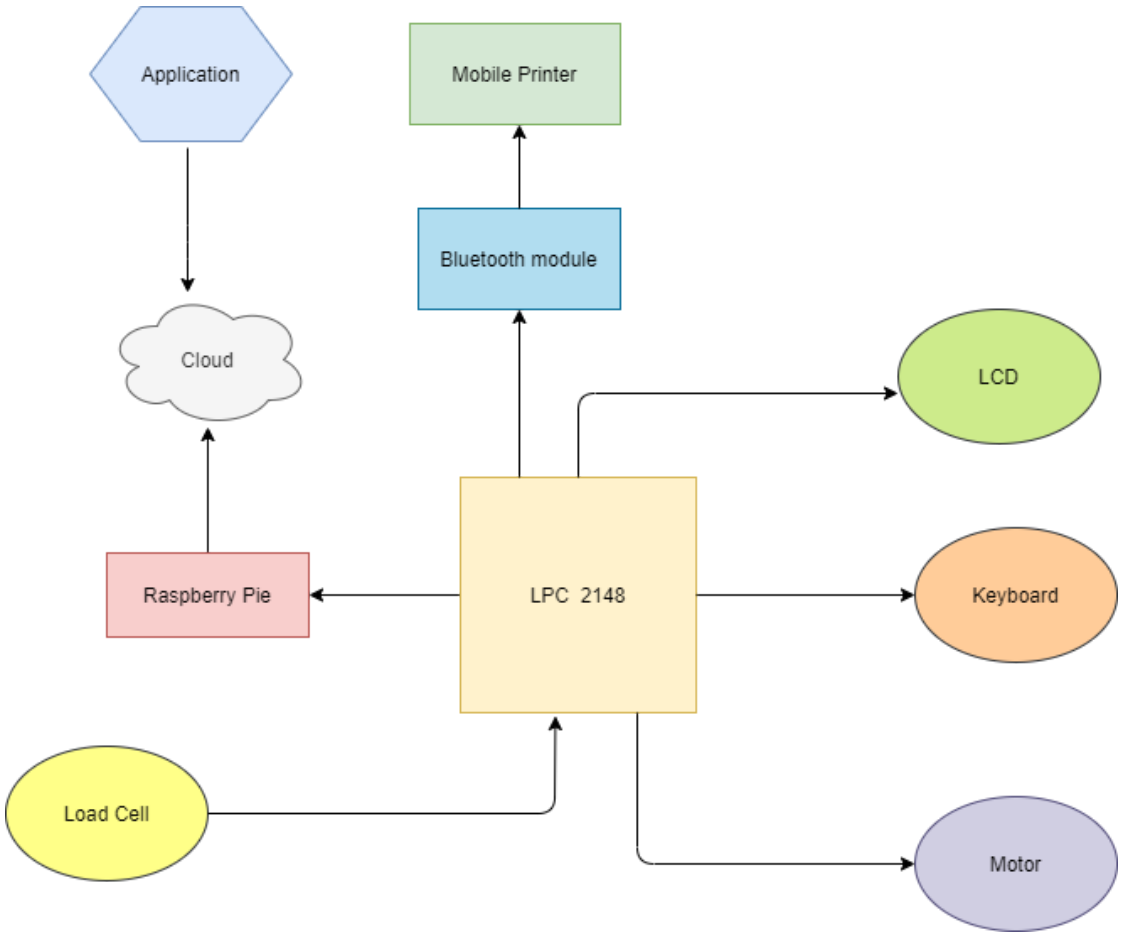
4.Python library

5.Web development

6.App development

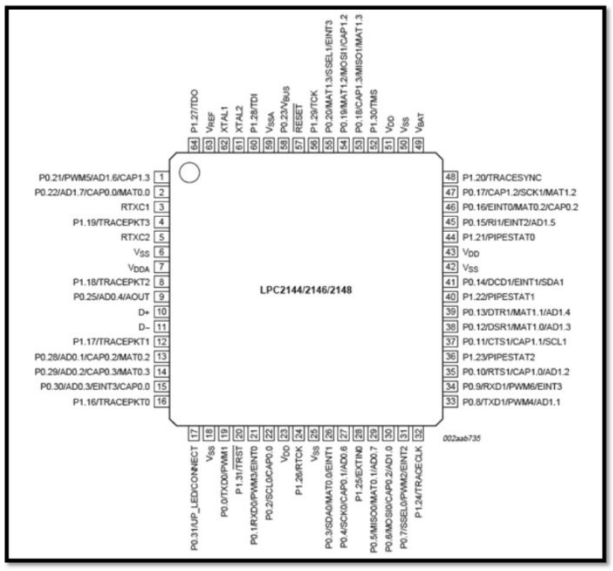
7.RPI stimulator

Introduction and Block Diagram



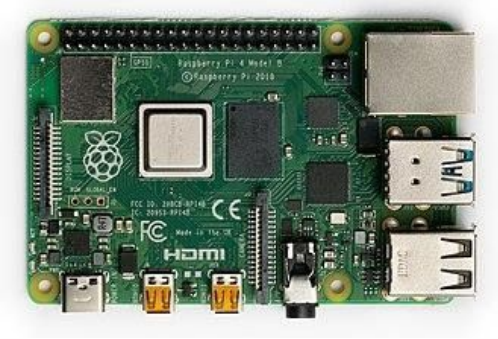
The components of the block diagram are:

1. LPC 2148 microcontroller.



LPC 2148 is a Popular ARM microcontroller from NXP Semiconductors, used by many popular industry level embedded products. It is based on ARM7 TDMI-S ARM 7 core. It has features like Thumb instructions set (T), JTAG debugger (D), fast multiplier (M) and the embedded ICE (I) [ICE- in circuit emulator, useful while debugging hardware & software, S-synthesizable]. It is known for tiny size and low power consumption. It consists of various types of interfaces for interfacing components such as ADC (Analog to Digital Conversion) for load sensor, UART serial ports (one for rpi and the other for Bluetooth module).

2. Raspberry Pi - It is a small, single-board computer with a proper Operating System to interface LPC 2148 with the internet for cloud analytics.



3. Load Cell

During a measurement, weight acts on the load cell's metal spring element and causes elastic deformation. This strain (positive or negative) is converted into an electrical signal by a strain gauge (SG) that is installed on the spring element. The simplest type of load cell is a bending beam with a strain gauge. Often, the (mandatory) basic components, i.e. spring element and strain gauge, are complemented with additional elements (housing, sealing elements, etc.) protecting the strain gauge elements.

We are using the T66 bending beam.

Key features:

- Fully welded and hermetically sealed stainless steel construction, with protection class IP68/IP69K
- Complies with OIML R60 regulations up to 3000 divisions (C3) or 6000 divisions (C6) for scales according to EN 45501
- Nominal capacities: 5kg, 10kg, 20kg, 30kg, 50kg, 75kg, 100kg, 150kg, 200kg, 250kg, 300kg, 500kg
- Nominal capacities (C6 version): 50kg, 75kg, 100kg, 150kg, 200kg, 250kg
- 6 wire (with sense wires) configuration as standard

- Wide operational temperature range: -30 °C to +70 °C
- Options: Parylene coating for the load cell when used in extremely harsh environments, as well as a version for high temperature use

It is connected to ADC 0.4.

4. Matrix Keyboard

   Keypad is used as an input device to read the key pressed by the user and to process it.

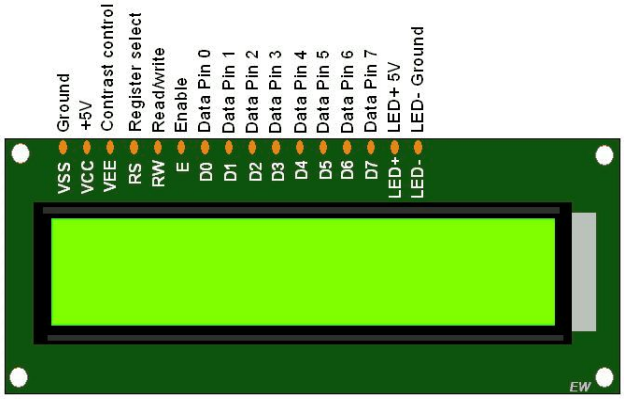
   4x4 keypad consists of 4 rows and 4 columns. Switches are placed between the rows and columns. A key press establishes a connection between corresponding row and column between which the switch is placed.

   In order to read the key press, we need to configure the rows as outputs and columns as inputs.

   Columns are read after applying signals to the rows in order to determine whether or not a key is pressed and if pressed, which key is pressed.

5. LCD- LCD consists of DDRAM, CGROM, shift registers, bit/pixel drivers, refreshing logics and LCD controller. The data to be displayed on LCD, is to be written on to the DDRAM-display data Ram using the ASCII format. CGROM-Character generator rom, contains dot/pixel patterns for every character to be displayed (pre-programmed). Shift registers are used to convert CGROM parallel data to serial data(serializing), drivers are required to drive (ON/OFF) the bits, refreshing logics are required to hold the display data, as the dots are

displayed row by row basis continuously, like in CRT.



6. Stepper Motor

   Stepper motor is a brushless DC motor that divides the full rotation angle of 360° into a number of equal steps.

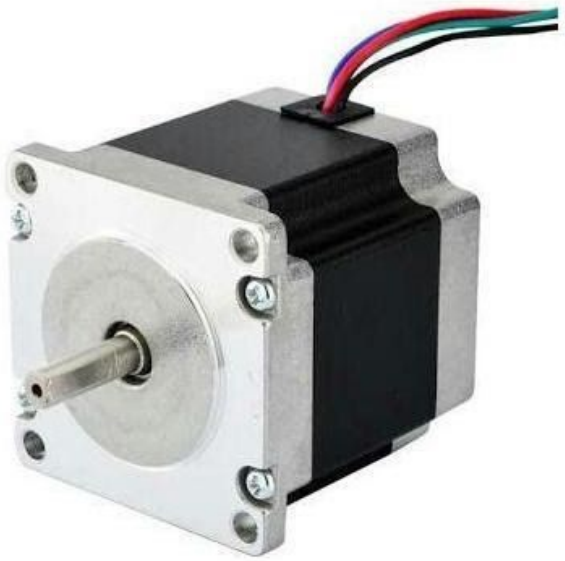
   The motor is rotated by applying a certain sequence of control signals. The speed of rotation can be changed by changing the rate at which the control signals are applied.

   Various stepper motors with different step angles and torque ratings are available in the market.

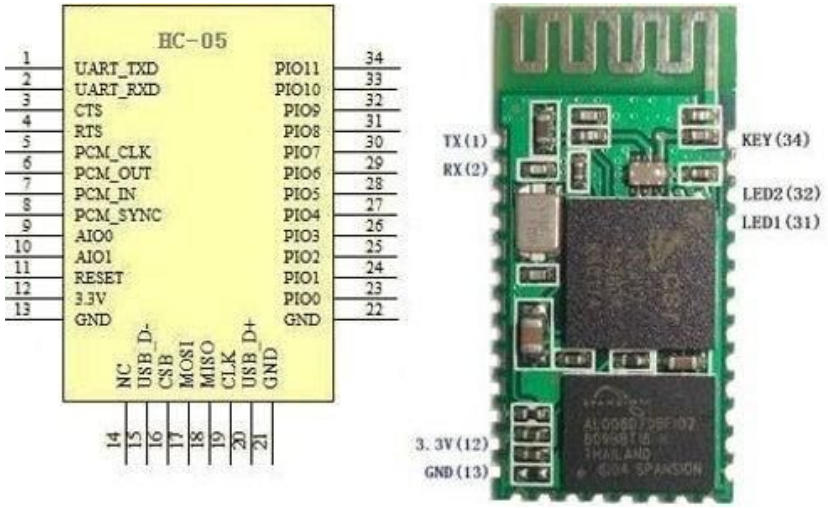
   Microcontroller can be used to apply different control signals to the motor to make it rotate according to the need of the application.

   Here, we are using a six wire unipolar stepper motor. Only four wires are required to control this stepper motor. The two centre tap wires of the stepper motor are connected to 5V supply.

   ULN2803 driver is used to drive the stepper motor.



7. Bluetooth Module



The HC – 05 Bluetooth module is an UART based device. Hence, the connection between the LPC2148 and Bluetooth module requires only two wires. In LPC2148, there are two UART modules: UART 0 and UART 1.

We are connecting the Bluetooth Module to the UART 1 i.e. PORT0 Pins P0.8 and P0.9. The TX pin of the Bluetooth Module is connected to RXD1 (P0.9) of LPC2148. Similarly, the RX pin of the Bluetooth Module is connected to TXD1 (P0.8) of LPC2148.

Note: The TX and RX pins of Bluetooth Module can tolerate only 3.3V. Since the output of the LPC2148 MCU is only 3.3V, the connections can be made directly.

The Bluetooth Module has on – board 3.3V regulator. So, 5V supply can be given to the module.

Hardware features

- Typical -80dBm sensitivity
- Up to +4dBm RF transmit power
- Low Power 1.8V Operation ,1.8 to 3.6V I/O
- PIO control
- UART interface with programmable baud rate
- With integrated antenna
- With edge connector

Software features

- Default Baud rate: 38400, Data bits:8, Stop bit:1,Parity: No parity, Data control: has.
- Supported baud rate: 9600,19200,38400,57600,115200,230400,460800.
- Given a rising pulse in PIO0, the device will be disconnected.
- Status instruction port PIO1: low-disconnected, high-connected;
- PIO10 and PIO11 can be connected to red and blue led separately. When master and slave
- are paired, red and blue led blinks 1time/2s in interval, while disconnected only blue led blinks 2times/s.
- Auto-connect to the last device on power as default.

Permit pairing device to connect as default.

- Auto-pairing PIN CODE:”0000” as default
- Auto-reconnect in 30 min when disconnected as a result of beyond the range of connection

The full datasheet is found below:
https://components101.com/sites/default/files/component_datasheet/HC-05%20Datasheet.pdf

8. Bluetooth Printer

   Atpos HOP h58 printer can be paired to Bluetooth module and can print a receipt accordingly.
   https://www.atpos.in/product/atpos-hop-h58-58mm-thermal-receipt-printer/?gclid=CjwKCAjwlZf3BRABEiwA8Q0qqz3I_qf_UKus-79yubu5yJyPEEGIzoMYbYTnWiXUc8aj8-m0_M9fHBoCnx0QAvD_BwE

Unique Features

1. Automatic grain distribution by stepper motor as per desired weight.
2. Calibration mode for police or inspectors to examine to ensure fair trade practices.
3. Bluetooth printer to print the bill in offline mode, in case of internet failure.
4. Online mode that first sends data to Raspberry Pi via serial port and then to cloud.
5. A Gui is provided so as to manually enter the data to the cloud if the UART communication fails.
6. A Linear regression model is provided so as to compute the weight of items that the shopkeeper might sell the next day so that he can prepare for the next day.
7. The weight of each item in his store is stored in the cloud and the corresponding bar graph is generated for the data that can be viewed through the app.
8. A separate channel is reserved for noting the remaining goods left in the shop.

9. It provides an individual user friendly front end for both owner and customers.

Algorithm

1. When the shopkeeper turns on the device, he is given 2 choices: online or offline mode.

2. If in online mode, the quantity and name of item selected will be sent via UART1 to rpi which sends the data to the cloud for bill computation

3. If in offline mode, it uses offline rates, which may differ from online rates, to print a physical bill.

4. The next choice is between fruit, vegetable, grain and calibration.

5. For fruit and vegetable, the name of the fruit or vegetable is selected after which the shopkeeper enters the weight of the product desired by the customer. Shopkeeper then places random quantities of the product on the weighing machine until weight on the machine equals entered customer weight.

6. For grain, the stepper motor rotates an angle such that the desired weight of grains falls on the weighing machine. This angle to weight mapping is pre-determined and can be changed in the calibrate mode.

7. The calibrate option is for inspectors or police officers to examine the correctness of the weighing machine's measurements as well as that of the stepper motor's rotation. It may also be used if grains of different properties are loaded into the container which needs a different angle of rotation.

8. After step 5,6 or 7 (depending on choice entered in step 4), in online mode the amount and name of product is serially sent to rpi in real time (ultimately creating an online invoice). In offline mode that line for one selected product is printed on the bill. The device asks the shopkeeper if the selections are done, if so, the total will also be

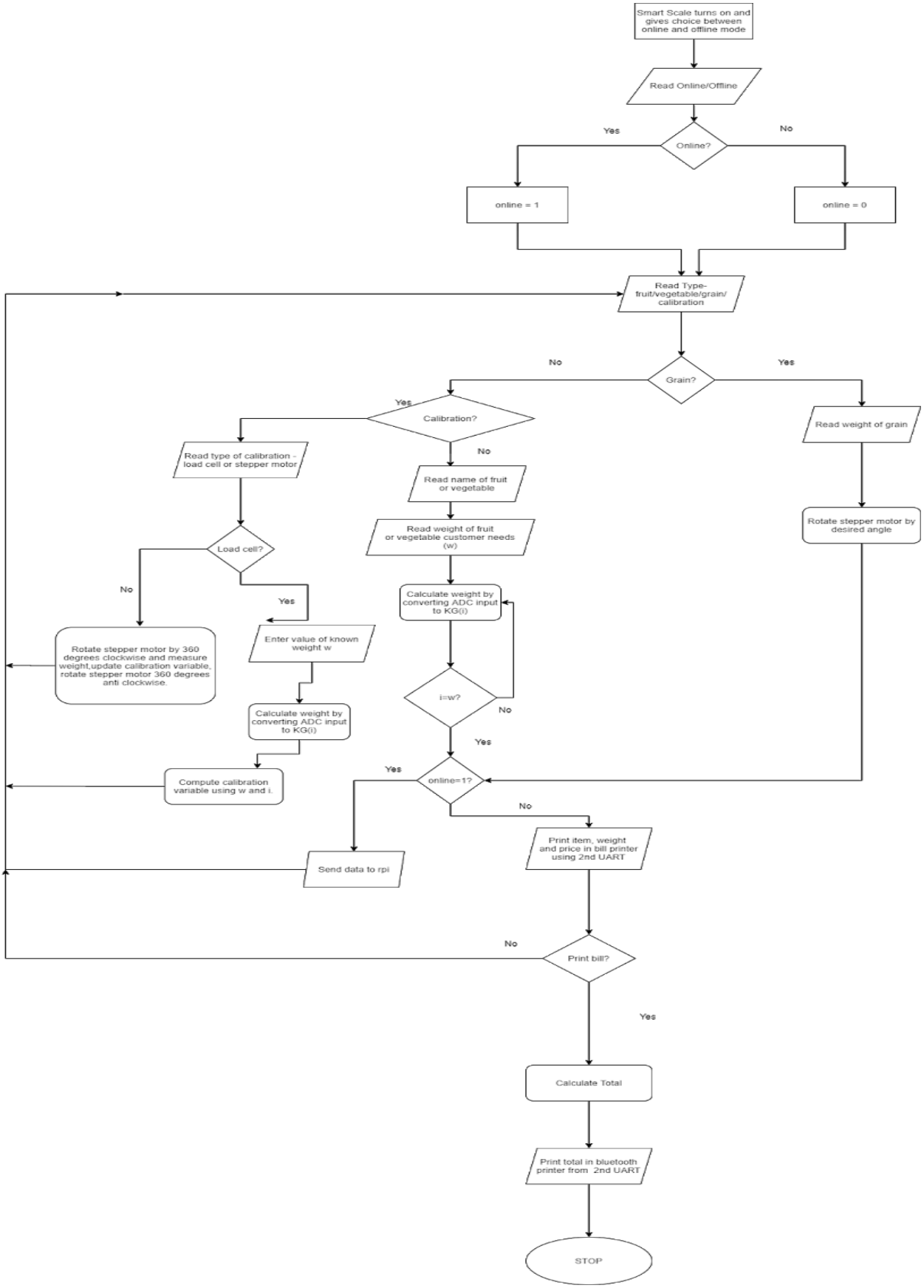
printed and then the shopkeeper can tear the receipt from the bill printer and hand it to the customer.

9. The program goes back to step 4 to service future customers or re-calibrate without having to reset the device.

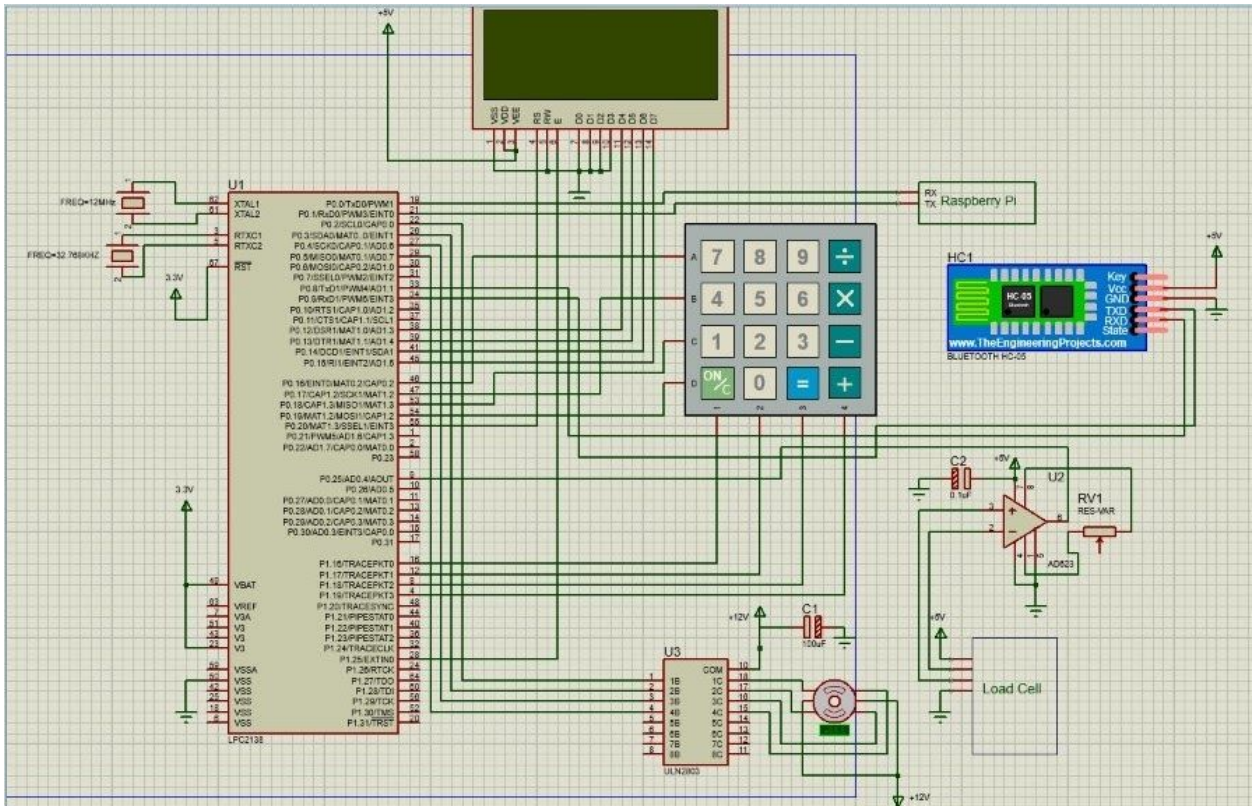
10. If step 2 fails ,the shopkeeper is provided with a software GUI to manually enter the corresponding inputs to the cloud.

Algorithm for cloud computing

1. The individual weights of the items in his storage(leftover+new) are updated to the cloud.
2. The entered weights in the cloud are subtracted with the weights that each individual consumer buys and a bar graph is displayed for the same.
3. At the end of each day the Matlab code for the Linear Regression model(has an inbuilt timer for execution) gets executed and predicted weight for the next day is displayed.
4. Step 1,2,3 are repeated every day in the same order.


Smart Scale turns on and gives choice between online and offline mode
Read Online/Offline
Online?
Yes
No
online = 1
online = 0
Read Type- fruit/vegetable/grain/ calibration
Grain?
No
Yes
Calibration?
Yes
No
Read type of calibration - load cell or stepper motor
Read name of fruit or vegetable
Read weight of grain
Load cell?
Read weight of fruit or vegetable customer needs (w)
Rotate stepper motor by desired angle
No
Yes
Calculate weight by converting ADC input to KG(i)
Enter value of known weight w
Rotate stepper motor by 360 degrees clockwise and measure weight,update calibration variable, rotate stepper motor 360 degrees anti clockwise.
i=w?
No
Calculate weight by converting ADC input to KG(i)
Yes
Yes
online=1?
Compute calibration variable using w and i.
No
Print item, weight and price in bill printer using 2nd UART
Send data to rpi
No
Print bill?
Yes
Calculate Total
Print total in bluetooth printer from 2nd UART
STOP

Circuit Diagram



Code

The full Keil Microvision project can be found in the following drive link:

https://drive.google.com/open?id=1XZ0EYuDH1yaWPMNfxFpyslzjl37tjt_1

The code for uploading data to cloud is below:

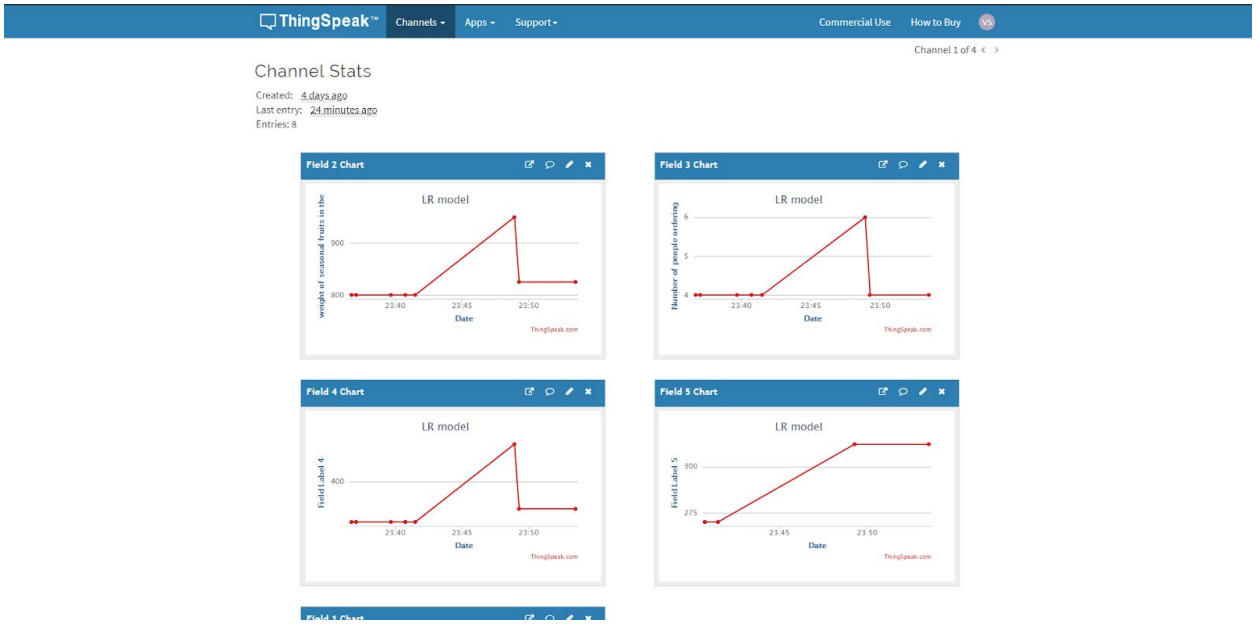
https://drive.google.com/drive/u/1/folders/1mnkU9nwzFj-GMV5QlZ0gZQhK4SgLV1MD

The code for thingspeak cloud can be found below:

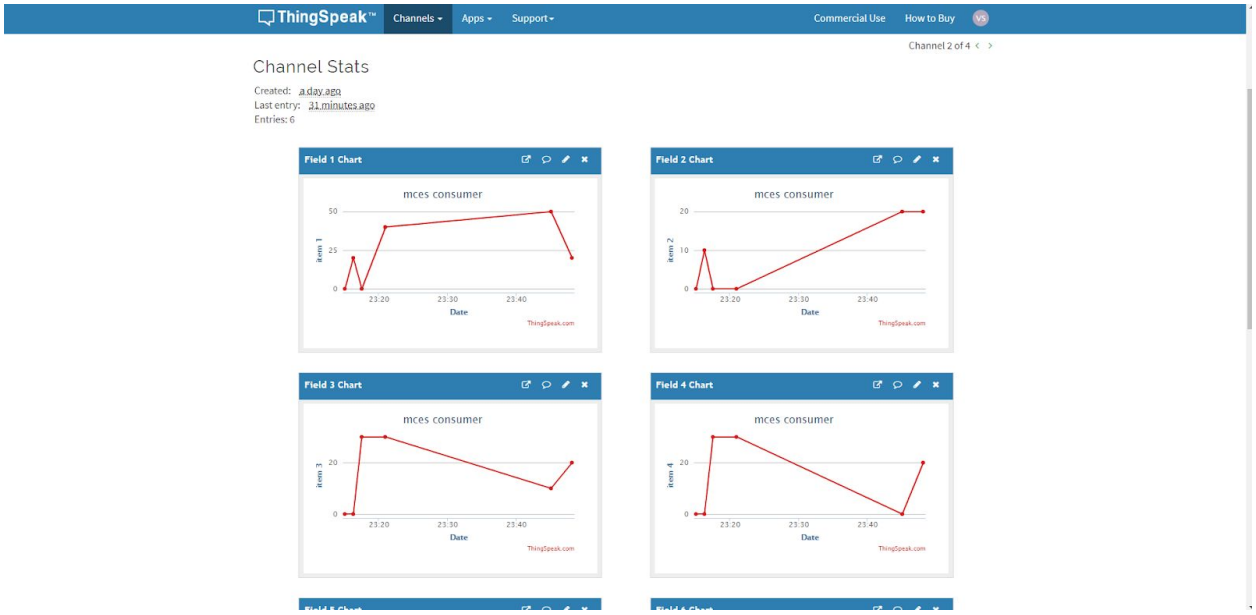
https://thingspeak.com/channels/public?username=vibhavsharma

Results and Discussion

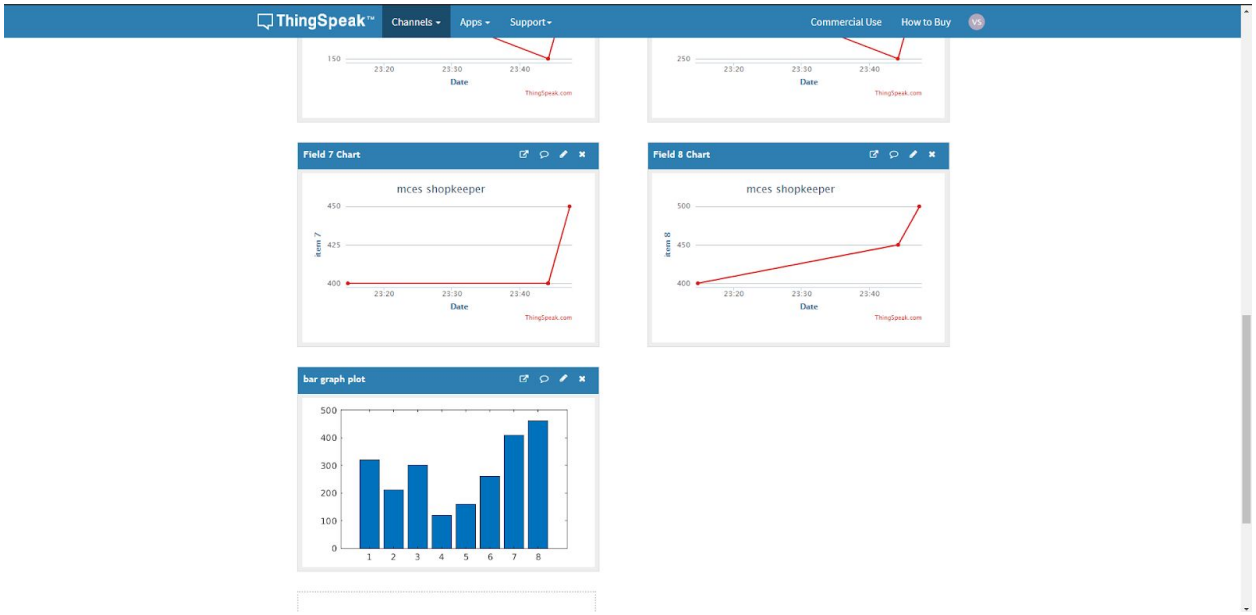
LR model-channel1

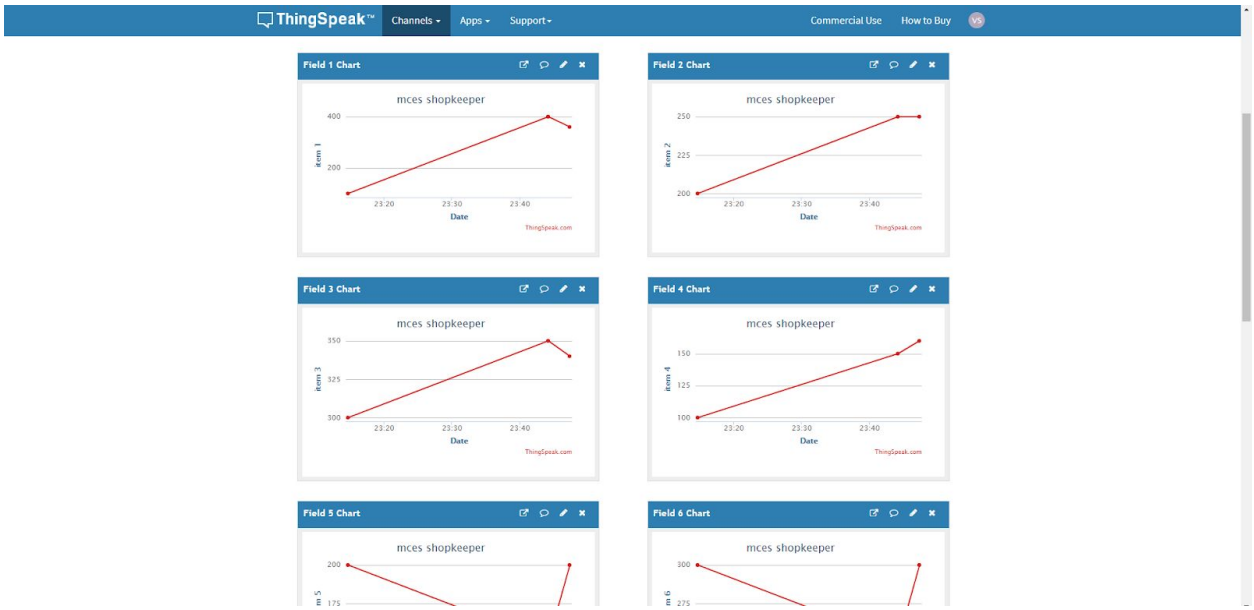


Consumer-channel2

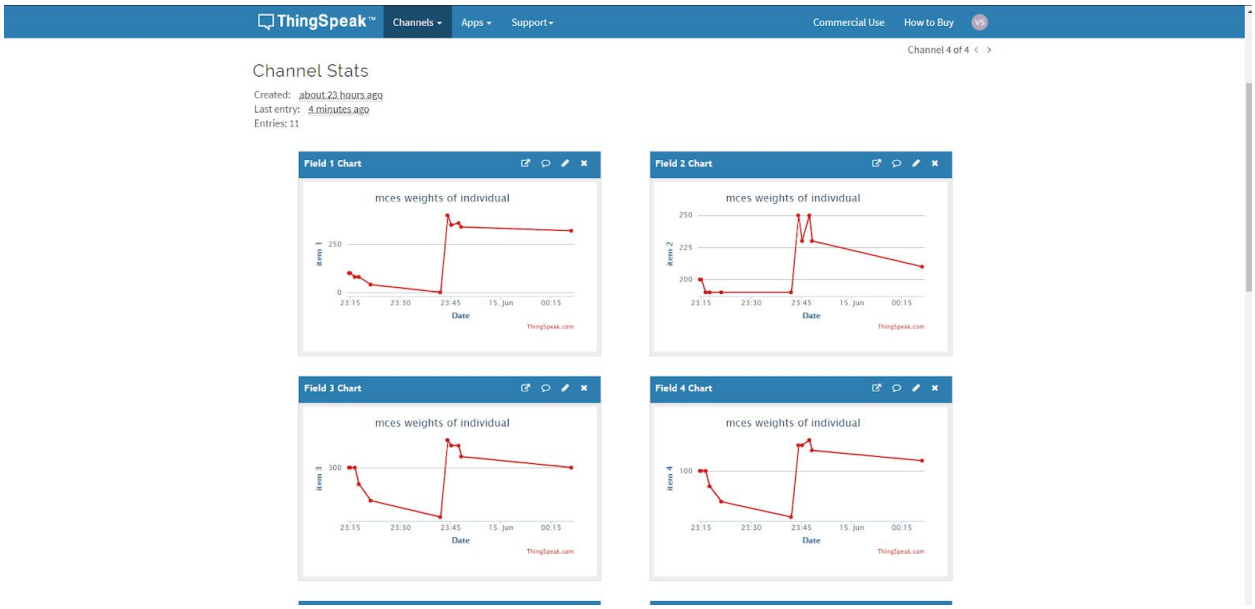


Shopkeeper(static-updates once a day)-channel3

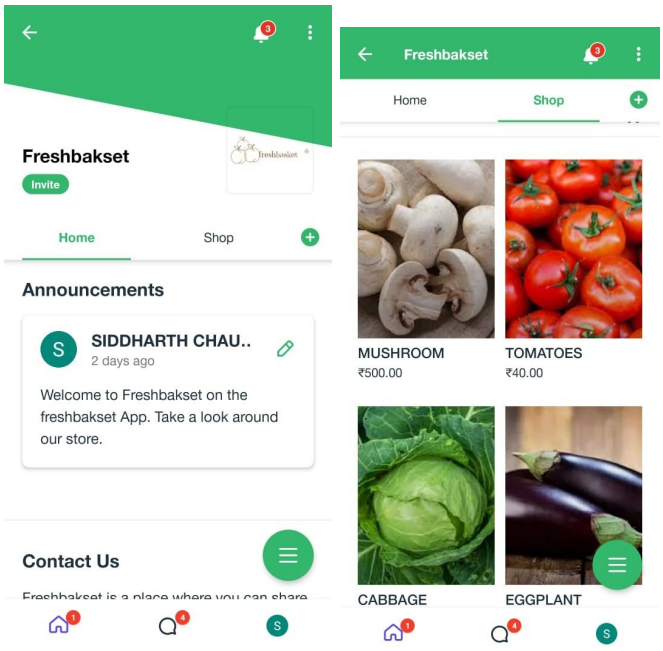




Shopkeeper(variable-updated when consumer purchases)



Application mode



Conclusion

Thus, a smart system for shops has been successfully created which helps to make business decisions, ensure transparency and fairness, ease of operations for shopkeepers, consumer satisfaction, etc. and also assists in home delivery which is of great use during this pandemic, potentially saving lives. This would help in making a Healthy, Digital and Modern India.

Future Scope

- We can add more types of grains.
- We can update offline prices after every online transaction.
- Remote locking of grain container.
- Intelligent systems to monitor shelf life of fruits and vegetables and suggest which fruits must be sold off in a given time to maximise profits.

- Other functions like in built fire detector, shutters closing device, intercom system, etc.

References

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2. Dhanoj Mohan, Rathikarani, Gopakumar, “Automation of Ration Shop Using PLC” International Journal of Modern Engineering Research, 2013, Vol. 3, Issue. 5, pp. 2971-2977.
3. S.Valarmathy, R.Ramani, “Automatic Ration Material Distributions Based on GSM and RFID Technology” International Journal Intelligent Systems and Applications, 2013, Vol. 11, pp. 47-54.
4. Rajesh C. Pingle and P. B. Boroley, “Automatic Rationing for Public Distribution System (PDS) using RFID and GSM Module to Prevent Irregularities” HCTL Open International Journal of Technology Innovations and Research, 2013, Vol. 2, pp. 102-111.