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Smart Shopping Cart and Billing Assistance System

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Abstract - *With the current COVID-19 pandemic scenario we all have realized that social distancing is the key measure to be taken in order to control the contagion. In this situation it is very crucial to avoid close contact among people. The area where people are most vulnerable to contract this disease are market places from where daily essentials are bought. Thus, the staff working at these shops are very much prone to contract such diseases as they spend a major part of their day handling and managing customers. This increases the risk of infection not only for the staff but also for the customers. Hence a proper method has to be implemented in order to avoid any contact between the staff members and the customers, and implementation of technology can provide a solution for this issue. To tackle this problem, we have come up with an idea where a model of a smart trolley will be made which will be equipped with a camera to scan the products for billing which will be reflected on the mobile application that we build. As for the security feature we are making use of IR sensors and Weight sensors to keep a check on malpractices performed by the customer. This device will ensure no contact between people and also apart from being a safety device, the need for standing in queues for billing is eradicated. Here the mobile application is also being built to ease the shopping experience of customers.*

Key Words: COVID-19, smart trolley, IR sensor, Weight sensor, mobile application

1. INTRODUCTION

Recently, shopping at malls has become a daily activity, and there are a lot many people at shopping malls on holidays and on special discount days amidst the pandemic situation. People can buy so many different products and keep that in the trolley and after completion of purchasing products, people are going to pay the amount at the cash counter. At the billing counter, the cashier has to give the bill for products using a barcode scanner which consumes time. To avoid the long queue in the billing section and to ensure social distancing we are implementing a smart electronic trolley. The main goal of this project is to develop a system wherein the mentioned problems can be solved. All the items or products will have a barcode. Using the mobile application, the barcode of these products will be scanned. It is a consumer-oriented system which will make shopping easier, faster and enjoyable. The customer will be able to scan the products themselves and LCD exhibits on the trolley will be updating the number items and total bill. The main goal of smart electronic shopping market trolley is to reduce the time taken in billing section in shopping malls and grocery stores by designing a smart electronic trolley which uses a mobile application barcode reader to allow users to self-checkout and increase the productivity time and reduce the paper usage while billing and reduce the manpower in the billing section. An idea of building a technology that can help in calculating the bill of all the items we wish to purchase and vanishing the system of queues for paying the bills will help in the ongoing crisis and maintaining social distancing all around. This small idea basically draws attention to "smart market place" where everything can be done with minimal human intervention. This in turn will save time and social distancing is also followed here.

2. LITERATURE REVIEW

2.1 Barcode Scanning Using Image Processing

The barcode placed in front of the scanner or the camera is detected and read and all the product or details to which the barcode is linked is retrieved and displayed. There are mainly two ways of scanning barcodes. There is a dedicated barcode scanner which scans or reads a barcode symbol and then provides an electrical output to a computer, via a decoder and a cable. The decoder recognizes the type of barcode symbols and then translates the bar and space content and transmits data to a computer in a human readable format[1]. The second method is to integrate image processing with a camera attached or built in to a computer or mobile using an application.

2.1.1 OpenCV

OpenCV (Open-Source Computer Vision Library) is an open-source library which mainly helps in Image processing. The main application in image processing is to detect and identify objects. OpenCV incorporates image to image transformation and the input and output both are images[2].

2.1.2 Phpmyadmin

In order to store all the product information and retrieve it whenever the barcode of the product is scanned, a DBMS is required. phpMyAdmin is an open-source software tool written in PHP, which handles the administration of MySQL over the Web. phpMyAdmin supports a wide range of operations on MySQL. Frequently used operations like managing databases, tables, columns, relations, indexes, users, permissions, etc. can be performed via the user interface, while still having the ability to directly execute any SQL statement.

2.1.3 XAMPP

XAMPP stack of software is an open-source localhost server providing a number of functionalities through the package of software it contains. The software, which is part of XAMPP, is started/stopped using the XAMPP Control Panel. It is used for testing the projects and modifications offline before launching it on the global web. One such very important functionality provided by XAMPP is the creation of the MySQL database. This is done by using phpMyAdmin.

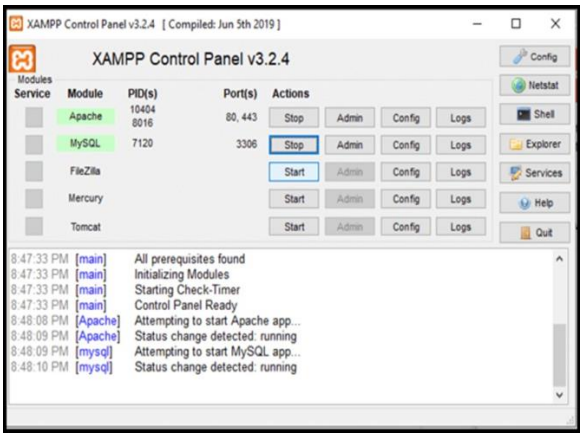

Fig. 1. XAMPP Control Panel

2.1.4 MySQL

MySQL is a freely available open-source Relational Database Management System (RDBMS) that uses Structured Query Language (SQL). MySQL is the most popular language for adding, accessing and managing content in a database. It is most noted for its quick processing, proven reliability, ease and flexibility of use.

2.2 Application Development

Developing an application for the user interface of the customer is essential which provides an effortless experience and would make the customer self-reliant. The application will include the barcode scanner which will be used to scan the products and retrieve the price of the commodities the customer wishes to purchase.

Android Studio

To support application development within the Android operating system, Android Studio uses a Gradle-based build system, emulator, code templates, and Github integration. Every project in Android Studio has one or more modalities with source code and resource files. These modalities include Android app modules, Library modules, and Google App Engine modules[3].

2.3 LCD for basic information

An LCD placed in the shopping cart will update the customer by displaying the products scanned and the total price of all the commodities scanned by the customer.

Adafruit_Python_Char_LCD Library

Adafruit is a library for python which helps with the interface of Raspberry microcontroller with an LCD. It contains many functions which can be used to display any desired message with a specific format of choice[4].

2.4 Security Gate

For security and to curb malpractices by the customer. A safety door has to be incorporated which would open when a customer makes a gesture for the gate to open and during the payment. This feature is very essential because staff numbers in an automated retail store are expected to be less and hence monitoring of customers becomes extremely difficult. The opening and closing of the security gate has to be programmed and interfaced properly to avoid any hiccups during the entire process.

2.4.1 Servo Motor

A servomotor is a rotary actuator or linear actuator consisting of a suitable motor coupled to a sensor for position feedback. The servo motor will drive the door to open and close. In order to do so the duty cycle for the motor has to be set.

PWM

Servos are controlled by sending an electrical pulse of variable width, or pulse width modulation (PWM), through the control wire. There is a minimum pulse, a maximum pulse, and a repetition rate. The PWM sent to the motor determines the position of the shaft, and based on the duration of the pulse sent via the control wire; the rotor will turn to the desired 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[5].

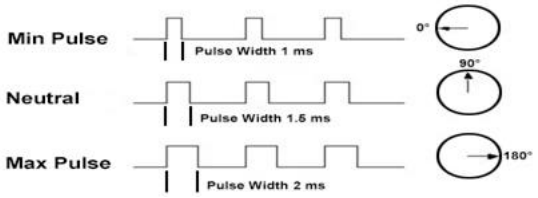

Fig. 2. Pulse Width Modulation

2.4.2 Hand Detection

A hand detection system will help the gate to open and close whenever the customer wishes. In order to achieve this an IR sensor poses the best way of implementation. Whenever the hand is detected, the gate will open and when the hand is taken away, the gate automatically closes.

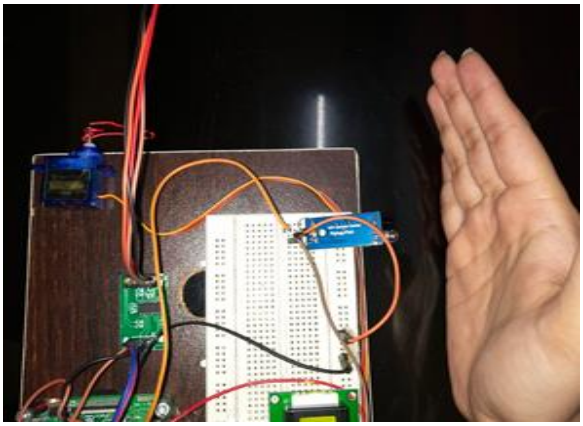

Fig. 3. Hand Detection using IR Sensor Module

2.5 Weight Sensing

The weight sensor equipment consists of the Load cell and the HX711 Amplifier.

2.5.1 Load Cell

As the force applied to the load cell increases, the electrical signal changes proportionally. A load cell is made by using an elastic member to which a number of strain gauges are attached. When the load is applied to the body of a resistive load cell, the elastic member deflects and creates a strain at those locations due to the stress applied[6].

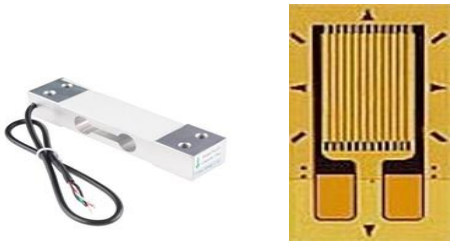

Fig. 4. Load Cell & Strain Gauge

2.5.2 HX711 Amplifier

The load cell produces very feeble electrical signals in the range of millivolts. For the microcontroller to make use of the signals produced by the load cell, a HX711 amplifier is used. The HX711 amplifier amplifies this electric signal for the microcontroller to read the output signals of the load cell. This amplifier is designed specifically for weight scale measurements.

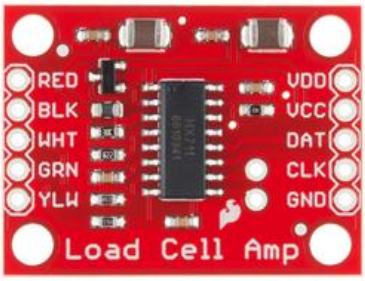

Fig. 5. HX711 Amplifier

3. IMPLEMENTATION

The system we implemented consists of the Raspberry pi 3 microcontroller, the HX711 amplifier, the load cell, servo motor, 16x2 LCD, IR sensor module, and a mobile application for barcode scanning. The microcontroller contains the code for all the devices and makes the entire system function. The functioning of the entire system is as follows: - The product is first scanned by the customer via the mobile application. Once scanned the product details i.e., price and quantity will flash on the lcd screen which is retrieved from the database containing information of all products. The product is then placed inside the cart. The weight of the products placed inside is compared with the weight specified in the database and an alarm or warning is given if there is a difference in the readings of the two values. This ensures that the customer does not indulge in foul actions. Finally, when the products are tallied and the payment is made by the app. The user has to place his/her hand in front of the IR sensor for the cart door to open by the servo motor to collect his/her commodities. The components used are as follows-

3.1 Component Interfacing

3.1.1 Weight sensor module (Load cell and HX711 amplifier)

For interfacing, the load cell is connected to the HX711 amplifier as shown in Fig. 6. The HX711 is then connected to the microcontroller. There are four wires to be connected VCC, GND and 2 GPIO connections.

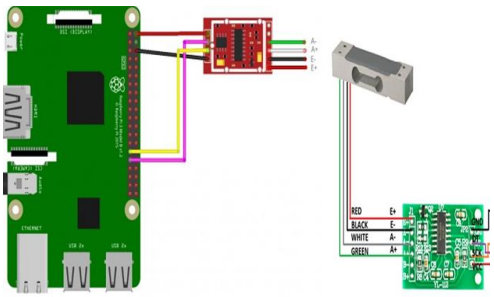

Fig. 6. Interfacing of weight sensor module

A python code is constructed for the sensors to produce meaningful values. The code also has an automatic calibration function. The entire functioning of the code is bound inside a while loop which ensures that the readings are recorded continuously[6].

3.1.2 16x2 LCD

The interfacing of LCD consists of VCC, GND and 7 GPIO connections. The LCD is programmed to display basic information such as number of products scanned, total price and total weight of the product. Python code for the same was implemented. For the interfacing of LCD "Adafruit_CharLCD library was imported". This library consists of many functions for the functioning of the LCD. For testing of the connections and the code a few basic functions were tested.

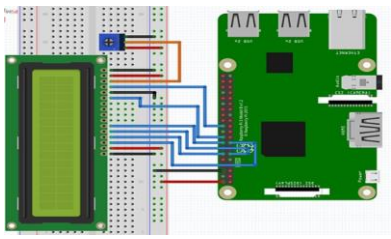

Fig. 7. LCD interfacing with microcontroller

3.1.3 IR Sensor Module and Servo Motor

The functioning of the IR sensor module and the servo motor go hand in hand. When the IR sensor detects an obstruction, the servo motor rotates which results in the door to open. For the servo motor to rotate a fixed angle, the concept of PWM is used. Servo motor is controlled using a PWM signal of 50hz, and the position is determined by varying the duty cycle of the signal. The input to the module is the number of milliseconds that the signal should be high (pulse width).

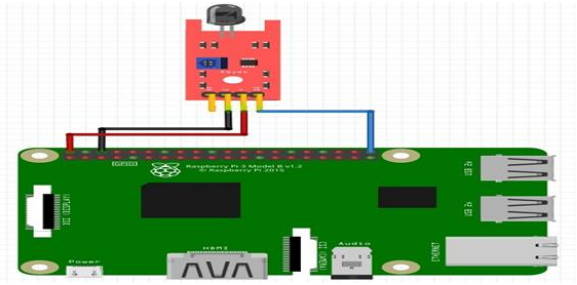

Fig. 8. IR Module interfacing

The IR sensor returns a simple true or false value. If the sensor returns False, then there is an obstruction and if returns True, there is no obstruction. Python code was implemented for the interfacing of the same and the portion of IR sensor code is put inside a while loop so that obstruction can be detected continuously. The implementation of PWM to set the duty cycle and to implement the opening and closing function of the cart door.

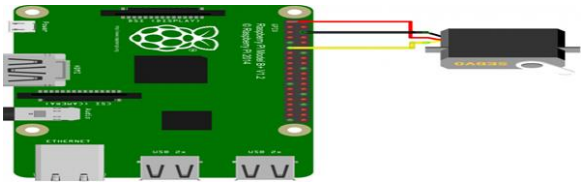

Fig. 9. Servo motor interfacing

3.1.4 Proteus

Proteus is a Virtual System Modelling and circuit simulation application. The suite combines mixed mode SPICE circuit simulation, animated components and microprocessor models to facilitate co-simulation of complete microcontroller based designs. Proteus also has the ability to simulate the interaction between software running on a microcontroller and any analog or digital electronics connected to it.

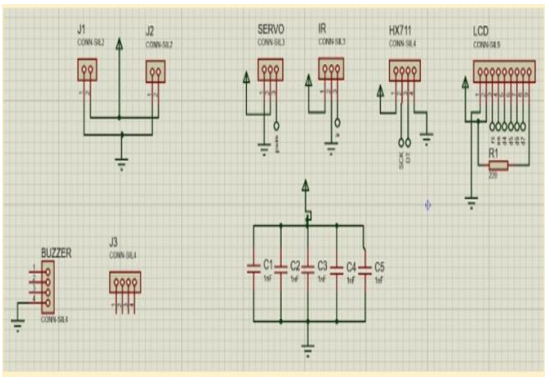

Fig. 10. Proteus Layout of components

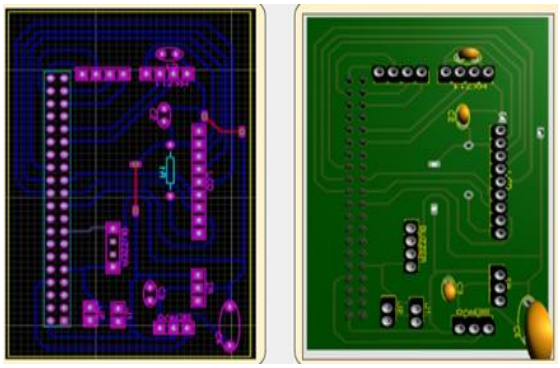

Fig. 11. PCB Layout

4. RESULT AND DISCUSSION

4.1 Smart Shopping Cart Mobile Application

This is the mobile application

1. The login page- Enter the username, password, IP Address and press login.
2. Details such as items, weight and bill total.
3. Screen showing the scanned materials.
4. Payment Information.

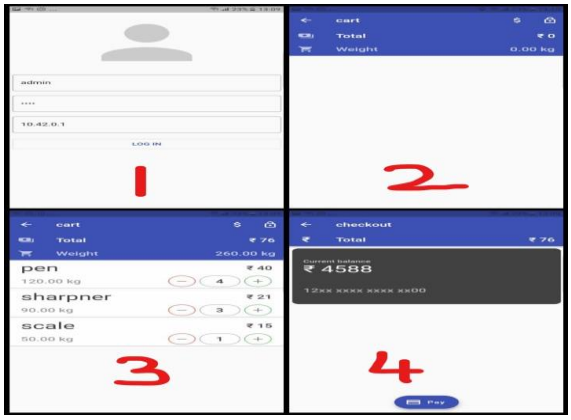

Fig. 12. Smart Shopping Cart Mobile Application

4.2 Trolley QR Code

By scanning the QR code of trolley, we get connected with that trolley. Now every detail of the trolley will be seen in our mobile application.

Fig. 13. Trolley QR Code

4.3 Internal Circuit of Trolley

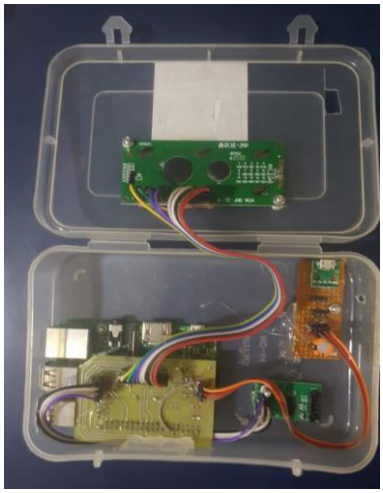

Fig. 14. Internal Circuit of Trolley

4.4 Final Trolley Prototype

Fig. 15. Final Trolley Prototype

Fig. 15 shows the final prototype after assembling and interfacing software and hardware together. First the barcode of the product is scanned using the scanner, then the internal circuit consisting of Raspberry Pi 3B works in coherence with the load cell, weight sensor, LCD and servo motor. The output of this is, the lcd displays the door open or closed conditions whereas the servo motor eventually opens and closes the door accordingly.

4.5 Safety System

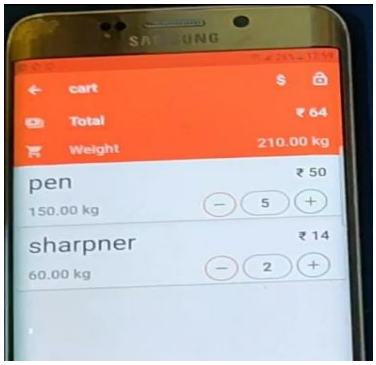

Fig. 16. Product mismatch warning

If someone scans only one product, but inserts two products instead, the application changes its colour from blue to red indicating a warning and payment tab gets blocked. There is a weight sensor which senses the weight of the product in the trolley and compares it with the scanned product's weight in the database, if both of them match then the payment tab opens otherwise the system refuses to proceed to the payment section.

5. CONCLUSIONS

The Smart Shopping Trolley helps the customers in shopping, billing and payment in less time and in an easy way. By simply scanning the barcode the customer can pay the bill. Supermarket owners get benefit with respect to time saving, less manpower and space which reduces the investment. The smart shopping trolley can be used in all retail shopping malls, supermarkets, hypermarkets.

After the interfacing and software testing has been done individually as well as in synchronization the security features were tested and were found successful. The security flap mechanism was very efficient and we were able to achieve the desired calibration for the weight sensor.

There are a few aspects that can be included to make it more robust and economical which include increasing the range of product detection using latest technologies, this manual trolley could be upgraded to the trolley following the person, also location-based services can be installed in the trolley for the guidance of the customer.

ACKNOWLEDGEMENT

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REFERENCES

[1] Yunhua Gu and Weixiang Zhang, "QR code recognition based on image processing," International Conference on Information Science and Technology, Nanjing, 2011, pp. 733-736, doi: 10.1109/ICIST.2011.5765349.

[2] Pulli, Kari; Baksheev, Anatoly; Kornyakov, Kirill; Eruhimov, Victor, "Realtime Computer Vision with OpenCV",1st April 2012.

[3] Yener, Murat & Dundar, Onur. (2017). Android Application Development With Android Studio. 10.1002/9781119419310.ch3.

[4] Vidyasagar, Dattaraj & Satpute, Hemant. (2019). Code for Simplified Connections of 16x2 LCD Display with Arduino UNO. 10.13140/RG.2.2.16772.07042.

[5] Pinckney, Nathaniel. (2006). Pulse-width modulation for microcontroller servo control. Potentials, IEEE. 25. 27-29. 10.1109/MP.2006.1635026.

[6] Chua Mason, Huang Shen & Kee, T & Lee, Brenda & Albert, F. (2016). Development and Implementation of Load Cell in Weight Measurement Application for Shear Force.