

Walchand College of Engineering, Sangli
Department of Electronics Engineering (Academic Year :2019-20)
Electronic Product Design- I Lab (3EN 360)
Mini Project Report

Submitted By :

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Name of Project : Smart Trolley

Abstract :

In metro cities we can see a huge rush at shopping malls on holidays and weekends. This becomes even more when there are huge offers and discounts. Now a days people purchase a variety of items and put them in the trolley. After total purchasing one should approach counter for billing purpose. By using barcode reader the cashier prepares the bill which is a time consuming process. Also precision of barcode reader is less. This results in long queues at the billing counters. This project presents an idea to develop a system in shopping malls to overcome the above problem. To achieve this all products in the mall should use aruco code instead barcode and all trolleys should be equipped with a PICAM and R-PI. When one puts any product in the trolley its Aruco code will be detected using PICAM , the item name and cost will be taken from dynamic database, thereby the cost gets added to the total bill. Final information passes to the central billing unit after completion of shopping via connecting R-PI to CPU. Hence the billing can be done in the trolley itself thereby saving a lot of time to the customers and as Aruco code is used instead barcode its detection is fast. One more plus point of this system is owner of mall gets all the information regarding product.

Introduction or concept :

Individuals have constantly created innovation to bolster their requirements as from the start of humankind. The fundamental reason for development in innovation is ought for more independency and this leads to improving tasks and making regular one simpler and speedier. One significant task that individuals invest maximum measure of energy is in shopping. Shopping center is a spot where individuals get their every day necessities running from sustenance items, garments, electrical machines and so forth. Some of the time clients have issues with respect to the unspecific data about the item marked down and misuse of superfluous time at the counters. In this innovative world, each grocery store and supermarkets utilize shopping trolleys with a specific end goal to help clients to choose and store the items which they expect to buy. Customers usually purchase the products required and place them in their carts and thereafter wait at the counters for payments of bills. The payment of bills at the counters is really troublesome and time consuming process which thereby increasing a heavy crowd at the counters.

As indicated by a study directed by US Department agency , on a normal, people spend through 1.4 hours consistently on shopping. A considerable number of clients will tend to leave a line if the line is too long. The present Shopping environment can be essentially be characterized into two classifications

(1) Shopping in-individual

(2) Shopping in absentia.

Shopping in absentia is upheld from various perspectives including web shopping, online shopping, and so forth which will not require the buyer to be manually held at the Counters. Purchasing in-individual includes an individual call at location of purchasing and choosing items in view of different variables including need, comfort, brand, and so on. The proposed keen Shopping basket framework plans to help shopping in-individual that will minimize the time spent in shopping. Persistent change is required in the customary time spent at the counters to enhance the nature of shopping background to the clients. To beat these issues expressed above and to enhance the current framework, we have composed a Shopping trolley. This can be done possible by basically connecting Aruco code to the items and PICAM with R-PI in the

shopping trolley. This framework will save time of clients and labor required in shopping center with respect to cost of the item .

Figure illustrates the Shopping Environment in the modern World and and waste of unnecessary time at the billing counters.



Figure : Current Shopping Environment

Requirement analysis

SMART TROLLEY DESIGN ANALYSIS :

The Smart Trolley design consists of the following components. Each component was allocated to different team member to research and submit the required design criteria.

1. Smart Trolley design and user interface
2. Connection to the store database
3. Wireless access
4. Network
5. Scanning product
6. Power
7. Payment methods and generation of receipt

Smart Trolley design and user interface :

The Smart Trolley inevitably will require very good and flexible design that will attract the client to use the product. The first question during the group discussion before the design was “Who are the users, where it will be used and the space the trolley to be placed”. The answer is the Supermarkets and the users will be anyone using the product in the store; however the space for the trolley will be decided by the store owner. Basically, the trolley play and remain an integral part of the customers’ shopping experience and businesses who uses them should ensure that the design meet the requirement of the customers.

- The Smart Trolley should be easy to move around.
- It should be fitted with a PICAM which acts as a scanner.
- Each Smart Trolley should be fitted with security tracking device to stop people taking it out of the retailer’s premises.
- The Smart Trolley should be able to link or connect with the store database for product search and item browsing.

- The trolley should be designed with four wheels and easy to handle or steering.
- After shopping the device has the capability to send a receipt via printer to the counter boy.
- Requires power supply for all attached devices.

Connecting to the Store Database :

Database connection is the process by which client software communicate with a database server. The software uses the database connection to send requests and get replies from the database server. The database holds information that can be queried by the client software . For the purpose of this design, the client software is the application installed on the R-PI which is connected to the store local database or the company centralized database.

It contains product information, availability and pricing. Connection to the database is user friendly with a simple and interacting interface.

The present design allows the tills and self-service checkout to have direct access to the store database because they are all directly connected to the network with the database server. The R-PI on the Smart Trolley will also operate in similar way through wireless access. All the Smart Trolleys will be directly and securely connected to the store Wi-Fi. It has access to the store centralized database.

The design requirement includes:

- Access to the shop Wi-Fi. The devices must be in a secure connection to protect the company from any intruder or hackers.
- Update the existing database.
- Connection to the database. This is a set of programming instructions that enables the application on the tablet to access the database server.
- Permissions to access centralized database .

Wireless Access :

Wireless access provides connection for the trolley to connect to the store Wi-Fi and access resources. Each controller has Wi-Fi capability. For security reasons the Service Set Identifier (SSID) or wireless network name for the Wi-Fi should not be broadcasted in order to prevent hackers

to have access to the store database. Also the Wi-Fi only accepts connection to devices whose MAC address has been permitted through the firewall. This is added manually.

Networking :

The technique for networking in Smart Trolley should have fast speed, reliability, cost effective, minimum energy usage and communication with other trolleys and also to the base station of the shopping center in order to ensure efficient customer service and also able to deal with any discrepancy or dishonest activity at the customer side .

Scanning Product :

The smart trolley will have PICAM so that the sale items are scanned much faster and more efficiently .

Power :

Power is the essential portion of Smart Trolley as it equipped with a R-Pi requires about 3.3 to 5 volts and load cell which requires 9 volts.

Product Features

Technology Capabilities	User needs	Segment	Product	Feature
Smart Trolley connected to store database for product specifications	Description of products	Customer and retailer	Smart Trolley	Faster way of shopping to attract customers
Self-scanning of products by customers	Skipping long queues for payment			Easy shopping procedure by smart interface
Replace Barcode with Aruco code	Making product scan faster			Efficient product scan

Keyword : Database, MYSQL database, Aruco code , PICAM, Raspberry Pi3

MYSQL Database :

MYSQL is a relational database where all the data is stored in the form of rows and column.

MySQL Features:

- **Relational Database Management System (RDBMS):** MySQL is a relational database management system.
- **Easy to use:** MySQL is easy to use. You have to get only the basic knowledge of SQL. You can build and interact with MySQL with only a few simple SQL statements.
- **It is secure:** MySQL consist of a solid data security layer that protects sensitive data from intruders. Passwords are encrypted in MySQL.
- **Client/ Server Architecture:** MySQL follows a client /server architecture. There is a database server (MySQL) and arbitrarily many clients (application programs), which communicate with the server; that is, they query data, save changes, etc.
- **Free to download:** MySQL is free to use and you can download it from MySQL official website.
- **It is scalable:** MySQL can handle almost any amount of data, up to as much as 50 million rows or more. The default file size limit is about 4 GB. However, you can increase this number to a theoretical limit of 8 TB of data.
- **Compatibale on many operating systems:** MySQL is compatible to run on many operating systems, like Novell NetWare, Windows* Linux*, many varieties of UNIX* (such as Sun* Solaris*, AIX, and DEC* UNIX), OS/2, FreeBSD*, and others. MySQL also provides a facility that the clients can run on the same computer as the server or on another computer (communication via a local network or the Internet).
- **Allows roll-back:** MySQL allows transactions to be rolled back, commit and crash recovery.
- **High Performance:** MySQL is faster, more reliable and cheaper because of its unique storage engine architecture.
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- **High Flexibility:** MySQL supports a large number of embedded applications which makes MySQL very flexible.
- **High Productivity:** MySQL uses Triggers, Stored procedures and views which allows the developer to give a higher productivity.

Aruco code :

ArUco marker is a 4x4 or 5x5 or 6x6 or 7x7 grid that is black and white in color. ArUco markers are based on Hamming code.

To understand aruco let take aruco of 5x5 grid. In the grid, the first, third and fifth columns represent parity bits. The second and fourth columns represent the data bits. Hence, there are ten total data bits. So the maximum number of markers that can be encoded are :

$$2^{10} = 1024$$

Let us consider the number 650. Its binary representation is 1010001010. There are two data bits in each row.

The first and third parity bits are calculated using even parity while the second parity bit uses odd parity. We get the encoded values as follows-

Parity bit 2	Data bit 1	Parity bit 3	Data Bit 2	Parity bit 1
0	1	0	0	1
0	1	0	0	1
1	0	0	0	0
0	1	0	0	1
0	1	0	0	1

If the cell value is 0, color it black; if value is 1, color it white. This will give us the ArUco marker-

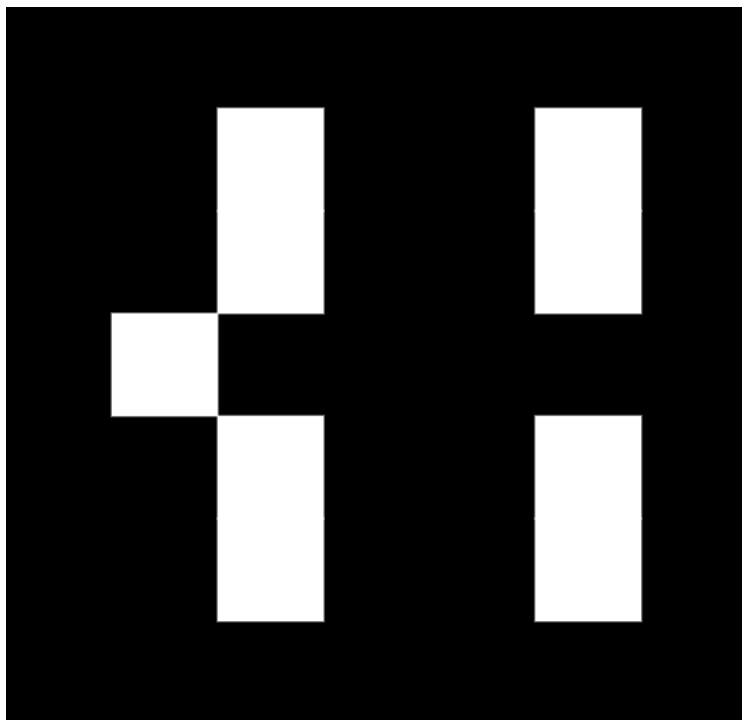


Figure : Aruco ID 650

Decoding :

After understanding the above section, decoding is an extremely simple process. The following steps are to be followed while decoding a perfect, computer-generated image of an ArUco marker.

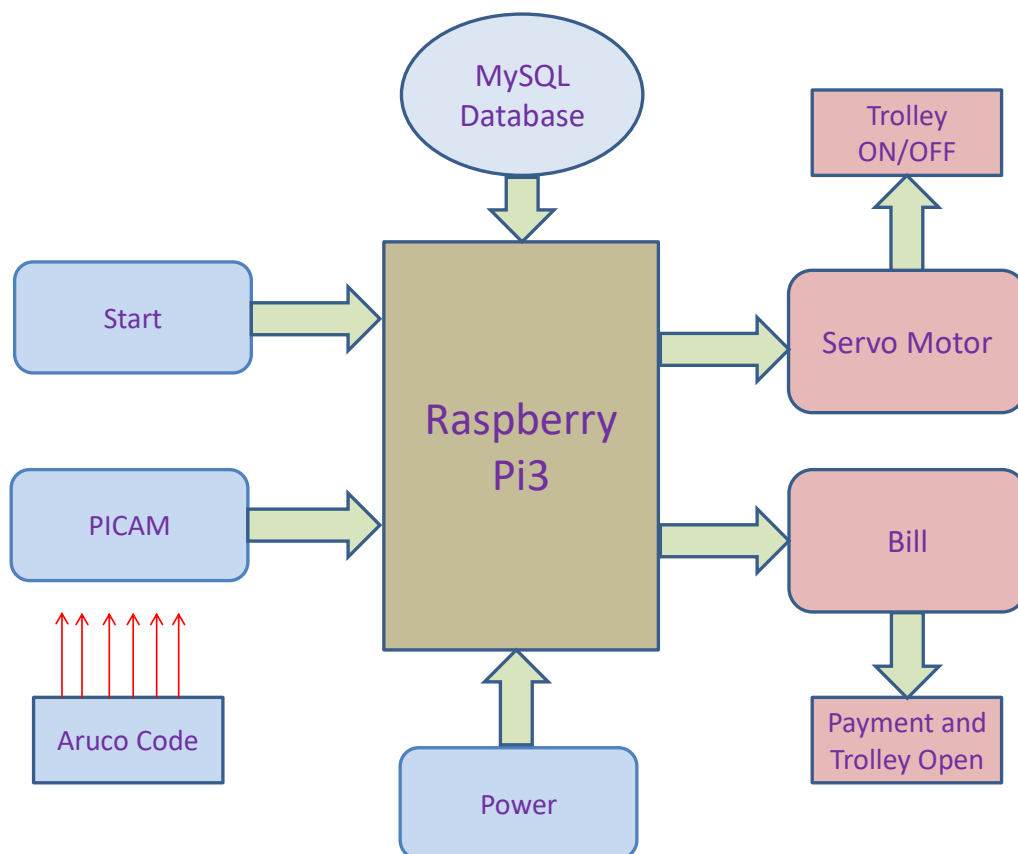
Step 1 : Extract the ArUco from the image.

Step 2 : Remove the extra padding.

Step 3 : Divide the resulting image into a 5x5 grid and check the color in each cell of the second and fourth columns(in that order) in a top to bottom manner.

Step 4 : If the color is white, write 1; else, write it 0.

Step 5 : The resulting number will be in binary. Convert it into decimal

System architecture (System Level Design)

Hardware Selection:

Raspberry Pi3 :

Figure shows Raspberry Pi3 which is used as microcontroller in our proposed system

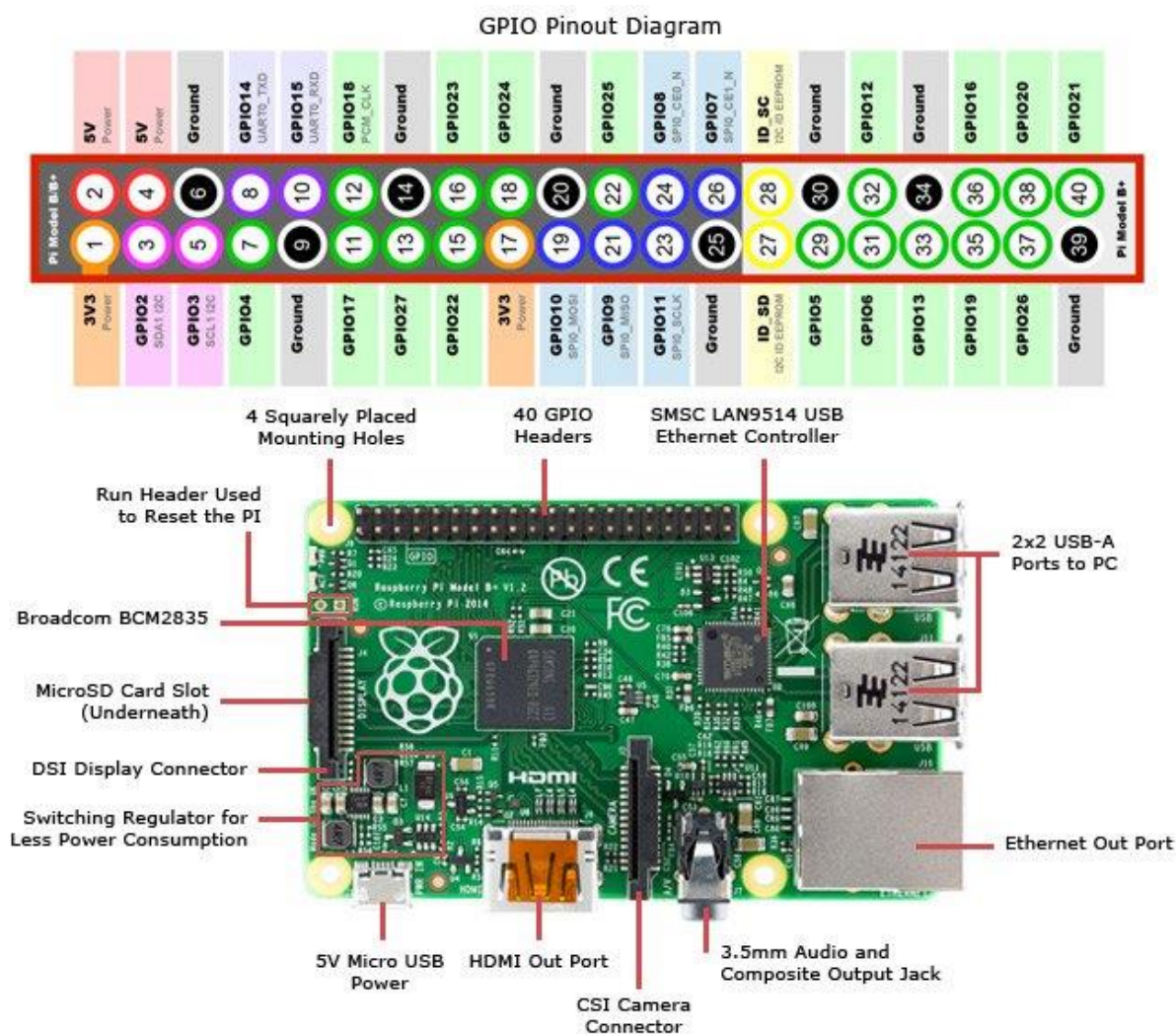


Figure : Raspberry Pi 3

It is the third generation RaspberryPi. This strongly built credit card sized single board computer can be used for various implementations and dominates Raspberry Pi Model B+ and Raspberry Pi2 Model B. This is ten times faster than the first generation Raspberry Pi. Besides it possess the wireless LAN and Bluetooth Connectivity making it excellent solution for many connected designs. This is operated with 5.1V micro USB supply. Generally it uses amidst 700-1000mA depending on what peripherals are connected. The maximum power Raspberry Pi can use is 2.5Amp. The power requirements of the Raspberry Pi increase depending on different interfaces attached to it. The

GPIO pin uses 16mA safely, The HDMI port uses 50mA, the camera module uses 250mA, the keyboard and mice can take as small as 100mA or above 1000mA.

Technical Specifications :

- Broadcom BCM2387 chipset
- 1.2 GHz Quad Core ARM Cortex- A53 25
- 1 GB RAM
- 64 Bit CPU
- 4 x USB ports
- 4 pole Stereo output and Composite video port
- Full size HDMI
- 10/100 Base T Ethernet Socket
- CSI camera port
- DSI display port
- Micro SD port for loading your operating system and storing data
- Micro USB power source

Characteristics :

- 10x faster
- Completely HAT Compatible
- 40 pin extended GPIO to enhance your real time projects
- Streams High Definition Output at 1080

PICAM :

Figure shows PICAM which is used as scanner in our proposed system

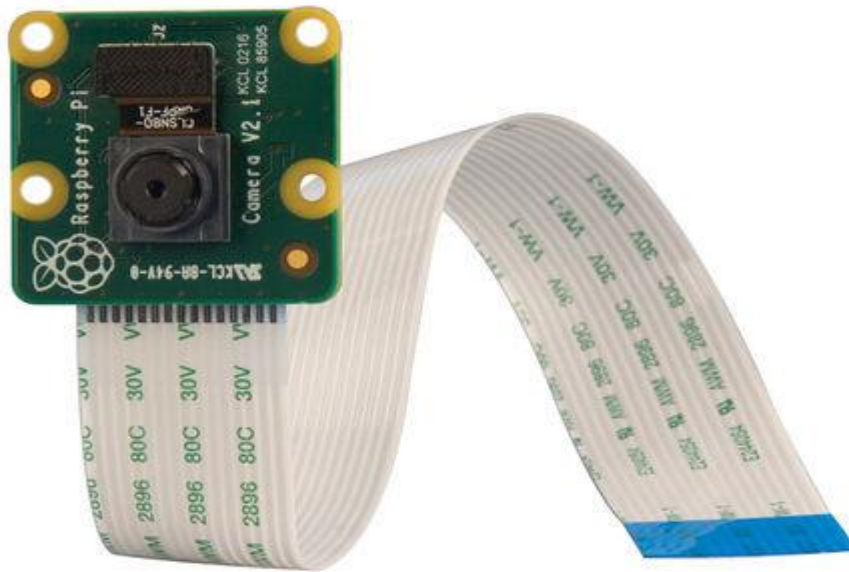


Figure : PICAM

The Raspberry Pi Camera Board plugs directly into the CSI connector on the Raspberry Pi. It's able to deliver a crystal clear 5MP resolution image, or 1080p HD video recording at 30fps! Latest Version 1.3! Custom designed and manufactured by the Raspberry Pi Foundation in the UK, the Raspberry Pi Camera Board features a 5MP (2592x1944 pixels) Omnivision 5647 sensor in a fixed focus module. The module attaches to Raspberry Pi, by way of a 15 Pin Ribbon Cable, to the dedicated 15-pin MIPI Camera Serial Interface (CSI), which was designed especially for interfacing to cameras. The CSI bus is capable of extremely high data rates, and it exclusively carries pixel data to the BCM2835 processor. The board itself is tiny, at around 25mm x 20mm x 9mm, and weighs just over 3g, making it perfect for mobile or other applications where size and weight are important. The sensor itself has a native resolution of 5 megapixel, and has a fixed focus lens onboard. In terms of still images, the camera is capable of 2592 x 1944 pixel static images, and also supports 1080p @ 30fps, 720p @ 60fps and 640x480p 60/90 video recording. The camera is supported in the latest version of Raspbian, the Raspberry Pi's preferred operating system.

The Raspberry Pi Camera Board Features:

- Fully Compatible with Both the Model A and Model B Raspberry Pi
- 5MP Omnivision 5647 Camera Module
- Still Picture Resolution: 2592 x 1944
- Video: Supports 1080p @ 30fps, 720p @ 60fps and 640x480p 60/90 Recording

- 15-pin MIPI Camera Serial Interface - Plugs Directly into the Raspberry Pi Board
- Size: 20 x 25 x 9mm
- Weight 3g
- Fully Compatible with many Raspberry Pi cases

BUZZER:

Figure shows buzzer which is used as a indicator of scanning in our proposed system



Figure : BUZZER

A buzzer is a small yet efficient component to add sound features to our project/system. It is very small and compact 2-pin structure hence can be easily used on breadboard, Perf Board and even on PCBs which makes this a widely used component in most electronic applications. There are two types are buzzers that are commonly available. The one shown here is a simple buzzer which when powered will make a Continuous Beeeeeeppp.... sound, the other type is called a readymade buzzer which will look bulkier than this and will produce a Beep. Beep. Beep. Sound due to the internal oscillating circuit present inside it. But, the one shown here is most widely used because it can be customised with help of other circuits to fit easily in our application. This buzzer can be used by simply powering it using a DC power supply ranging from 4V to 9V. A simple

9V battery can also be used, but it is recommended to use a regulated +5V or +6V DC supply. The buzzer is normally associated with a switching circuit to turn ON or turn OFF the buzzer at required time and require interval.

Buzzer Pin Configuration

Pin Number	Pin Name	Description
1	Positive	Identified by (+) symbol or longer terminal lead. Can be powered by 6V DC
2	Negative	Identified by short terminal lead. Typically connected to the ground of the circuit

Buzzer Features and Specifications :

- Rated Voltage: 6V DC
- Operating Voltage: 4-8V DC
- Rated current: <30mA
- Sound Type: Continuous Beep
- Resonant Frequency: ~2300 Hz
- Small and neat sealed package
- Breadboard and Perf board friendly

Servo Motor:

Figure shows servo motor which is used to open the opening of the trolley in our proposed system:



Figure : Servo Motor

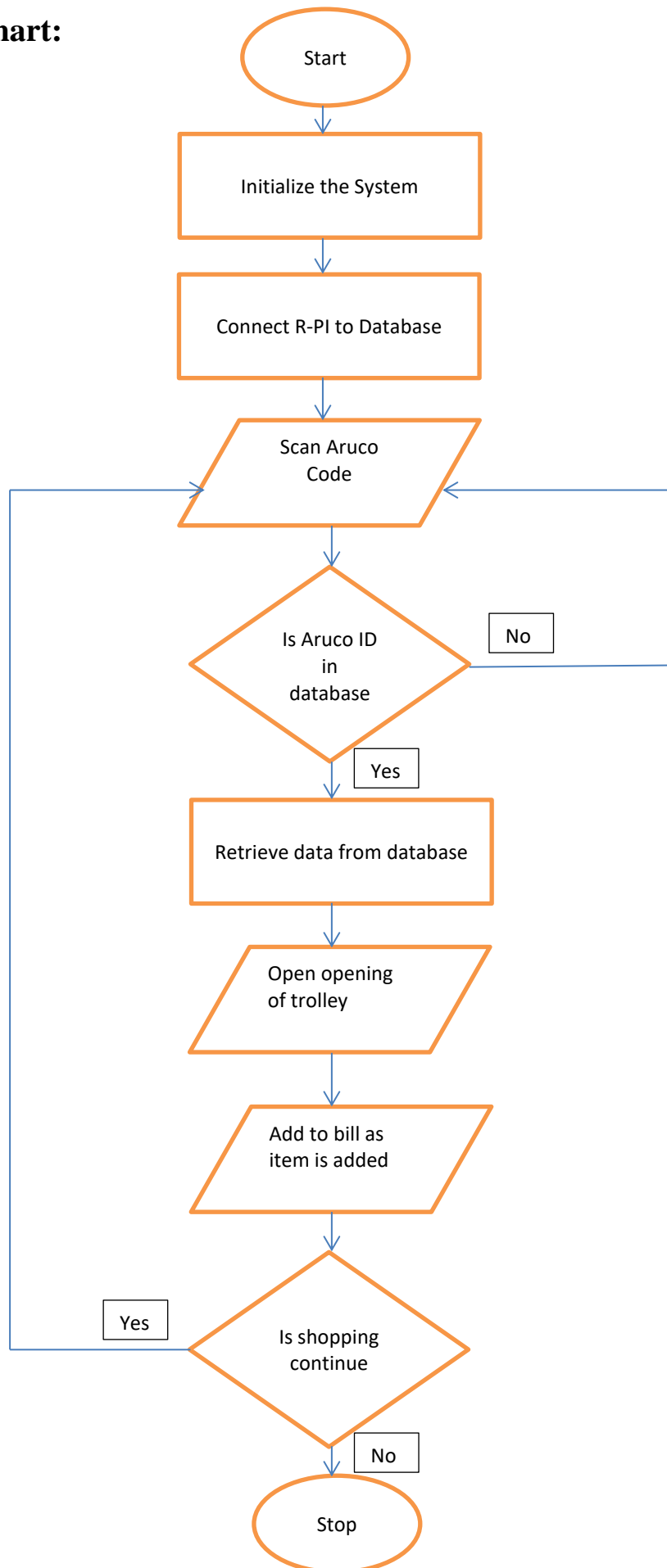
The TowerPro SG90 9g Mini Servo is 180° rotation servo. It is a Digital Servo Motor which receives and processes PWM signal faster and better. It equips sophisticated internal circuitry that provides good torque, holding power, and faster updates in response to external forces. They are packed within a tight sturdy plastic case which makes them water and dust resistant which is a very useful feature in RC planes, Boats, and RC Monster Trucks etc. It equips 3-wire JR servo plug which is compatible with Futaba connectors too.

Features :

- High resolution
- Accurate positioning
- Fast control response
- Constant torque throughout the servo travel range
- Excellent holding power

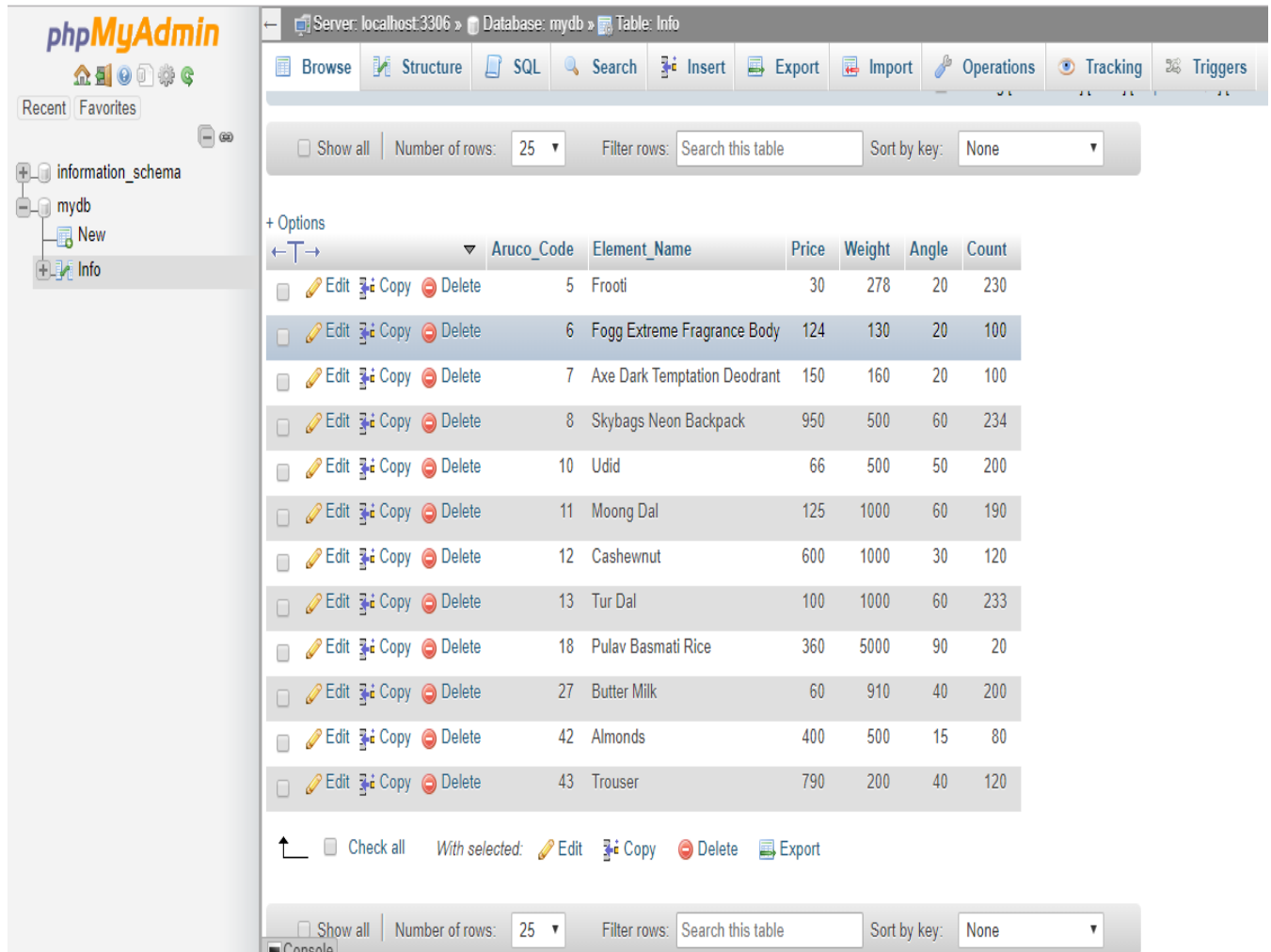
Wire Configuration :

Wire Number	Wire Colour	Description
1	Brown	Ground wire connected to the ground of system
2	Red	Powers the motor typically +5V is used
3	Orange	PWM signal is given in through this wire to drive the motor

FlowChart:

Enclosure Design :

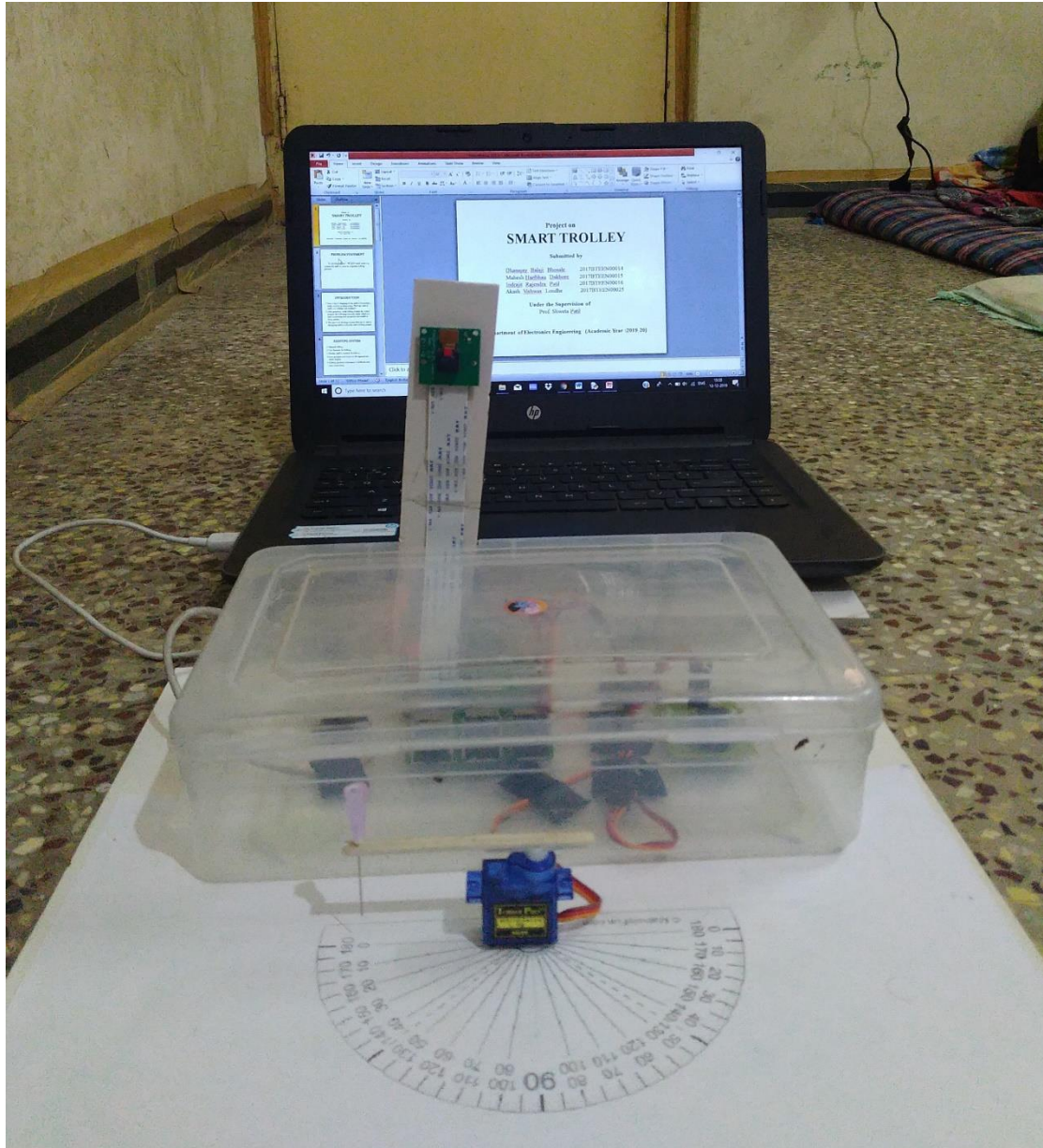
1. MySQL Database



The screenshot displays the phpMyAdmin interface for a MySQL database named 'mydb'. The left sidebar shows the database structure with 'information_schema' and 'mydb' listed. The 'mydb' database is selected, and the 'Info' table is highlighted. The main area shows the 'Info' table with the following columns: Aruco_Code, Element_Name, Price, Weight, Angle, and Count. The table contains 13 rows of data, each with a checkbox for selection and icons for Edit, Copy, and Delete. Below the table, there are options to 'Check all', 'With selected', 'Edit', 'Copy', 'Delete', and 'Export'. The interface also includes a top navigation bar with tabs for Browse, Structure, SQL, Search, Insert, Export, Import, Operations, Tracking, and Triggers. The bottom of the interface shows a console area.

	Aruco_Code	Element_Name	Price	Weight	Angle	Count
<input type="checkbox"/>	5	Frooti	30	278	20	230
<input type="checkbox"/>	6	Fogg Extreme Fragrance Body	124	130	20	100
<input type="checkbox"/>	7	Axe Dark Temptation Deodrant	150	160	20	100
<input type="checkbox"/>	8	Skybags Neon Backpack	950	500	60	234
<input type="checkbox"/>	10	Udid	66	500	50	200
<input type="checkbox"/>	11	Moong Dal	125	1000	60	190
<input type="checkbox"/>	12	Cashewnut	600	1000	30	120
<input type="checkbox"/>	13	Tur Dal	100	1000	60	233
<input type="checkbox"/>	18	Pulav Basmati Rice	360	5000	90	20
<input type="checkbox"/>	27	Butter Milk	60	910	40	200
<input type="checkbox"/>	42	Almonds	400	500	15	80
<input type="checkbox"/>	43	Trouser	790	200	40	120

2. Hardware enclosure



Conclusion :

The advancement in science and technology is a persistent process. Latest gadgets and latest technology are being designed and developed . This application is used in shopping malls for assisting customers by saving a lot of time in buying commodities. In this project Aruco-PICAM is used as safety access for the item which thereby enhances the surveillance performance. This implementation initiates for an automated central billing system in shopping malls and supermarkets. With this, shoppers no longer have to wait near counters for payment of bills because of their purchased item information getting ready before reach to central billing unit. By this billing process speed increases and becomes much more simpler. In addition to this capability, the mechanism also assures recognition of cases of theft induced by fraudulent consumers which makes the system more reliable and fascinating to both customers as well as sellers. This will enhance the shopping experience to a new level. Different variables like item cost, item name etc are continuously taken by the R-PI attached to the trolley from the database. Thus we can say that automatic billing of products by using Aruco-PICAM technique will be a more feasible choice in the upcoming days and thereby operation becomes more concise and systematic. The objective is effectively attained in the prototype model developed. The developed product is of low cost, amiable to use and does not require any specific practice. It reduce time and money of the customers.

References :

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- <https://dev.mysql.com/doc/refman/5.7/en/problems-connecting.html>
- youtube-video:
<https://www.youtube.com/watch?v=DVGMDYpk5Ds>
- Aruco detection
https://docs.opencv.org/trunk/d5/dae/tutorial_aruco_detection.html
- Servo motor running using specific angle
<https://tutorials-raspberrypi.com/raspberry-pi-servo-motor-control/>
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https://picamera.readthedocs.io/en/release-1.10/api_array.html
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https://www.youtube.com/watch?v=_gvvK6h-wxg
- To install new version of open cv as aruco present in new version of opencv
<https://www.youtube.com/watch?v=QV1a1G4IL3U>