TRIBHUVAN UNIVERSITY

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DEPARTMENT OF ELECTRONICS AND COMPUTER ENGINEERING

KALANKI, KATHMANDU

A MAJOR PROJECT PROPOSAL REPORT

ON

SMART VENDING MACHINE

EX 707

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A Major Project Proposal submitted to the Department of Electronics and Computer Engineering in partial fulfillment of the requirements for Bachelors degree in Electronics, Communication and Information Engineering.

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Table of Contents

LIST OF TABLES

List of Figures

LIST OF ABBREVIATIONS

RFID Radio frequency identification

DC Direct current

LCD liquid crystal display

GSM Global system for mobile communication

FPGA Field programmable gate array

IoT Internet of Things

SBC Single board computers

PWM Pulse width modulation

GPIO General Purpose Input output

SPI Serial peripheral interface

LED Light emitting diode

IR Infrared

OS Operating System

GUI Graphical user interface

UI User interface

SDK Software Development Kit

Chapter 1
Introduction

1.1 Background

Vending machine is an automatic machine that dispenses different items such as snacks ,drinks, beverages as per the choice of the user. There are many instances of the development of the vending machines in the past.These are extremely convenient outlet for the industry known as automated retailing.

The first recorded vending machine was made in the Egypt in the first century by a man named Hero of Alexandario. He made a machine that takes the coin and dispenses the holy water for the devotees.And the first recorded technical vending machine was made by a english bookseller Simon Denham that dispenses the newspaper in the year 1867.

1.2 Motivation

The main intention for the development of the vending machine was to provide accessibility of goods and products to the customer without any human presence. This invention provided the stores to run and provide their goods without any presence of human, that is it automatically runs on its own to sell goods and products resulting in the efficiency of the business.

1.3 Project Objective

The main objective of any vending machine is to provide the desired goods to the customers without the presence of human after the insertion of coin or money.But vending machine we are about to propose is cashless vending machine.It refers that our proposed vending machine will only accept payment online.This vending machine can be operated via its own mobile application that is any user can download the app and select the desired goods from the app and also can make the payment through the app without the need of any physical money or cash.

1.4 Significance of the study

The significance of the vending machine is to develop a cashless vending machine allowing for the safe and convenient processing of mobile transactions.

Chapter 2
Literature Review

We have seen the vending machine for the conveniency of the human.Vending machine has been evolutionized till today's date.This invention provided the stores to run and provide their goods without any presence of human.That is it automatically runs on its own to sell goods and products resulting in the efficiency of the business.

M. AbuOdeh et al. have designed the vending machine that focuses on RFID tag payment system rather than coin/cash payment system.This vending machine consists of buttons for each vend so that the user who need the snacks can purchase one.Use of Arduino,DC motors,servo motors,sensors and GSM module can be seen.LCD screen displays the message for the user.There is provision for the vending machine providers in their mobile application that they can view the snacks that have ran out.There are two cases, either the card is empty or it is not enough to buy the snack, and a message will be sent on the screen that the value is not enough. Vending machine[1]

B. Jyothi and A. S. Isarah proposed the approach for the implementation of the FPGA based smart vending machine.The FPGA based machine is more flexible, programmable and can be reprogrammed. But in microcontroller based machine,if one wants to enhance the design, he has to change the whole architecture.Auto-billing system is the focusing feature of this project.The machine also supports a cancel feature means that the person can withdraw the request and the money will be returned back to the user.The machine usually works, when money (usually coins or paper money) is put in a slot. Then a button needs to be pushed, or a lever should be pulled.If there is enough money in the machine, the selected item will be dropped to a tray, where it can be taken out by the person making the purchase.The machine will demand for servicing when the products are not available inside the machine.If there is any change, machine will return it to the user. Older vending machines were mechanical, but most new ones are electronic. Many modern vending machines can accept debit or credit cards in addition to cash.Implementation of fpga based smart vending.[2]

S. Pandey and M. M. M. Gogate proposed the paper to design an IoT-based automatic vending machine that dispenses juice when the user wants one. This project uses concepts of IoT to create a smart vending machine .It offers a variety of refreshing and cool juices using

suitable refrigerant. A juice vending machine is a machine that distributes different sorts of fruit juice when a person inserts a coin into it, hence it is a coin-based vending machine. This project is implemented with an 8051 microcontroller that controls overall operation of this embedded system. This vending machine is an automatic juice extractor. Vending machines are convenient for minor purchases, take up less space, and do not require regular supervision.The operation should be easy and efficient. The machine should be less expensive and easier to construct. In the vending machine Juice is dispensed using a solenoid valve, while a juice level sensor measures the juice level in the reservoir tank. A temperature sensor monitors juice temperature and activates a cooling system if it exceeds a certain threshold. The data is wirelessly transmitted to the cloud via the internet using the ESP-8266.IOT cloud platforms, such as ThingSpeak and IOT Geek, securely store and visualize data. Digital storage allows owners to easily access and evaluate their records.Iot based smart automatic juice vending machine.[3]

P. Desai, M. S. M. Jadhav, M. P. S. Patil, M. N. S. Giri, et al., designed an automated vending machine to dispense the chocolate. This project's primary goal is to introduce technological applications into society. This vending machine, which sells several types of chocolates, is powered by Arduino. This paper aims to offer a solution for coin-operated vending machines that do not return the money that is taken out of the machine as change. Radio frequency identification will be utilized in conjunction with Arduino. After the card has been scanned and the product has been collected at the output unit, the user can choose the product once the RFID has been read. There are three steps. The first involves scanning an RFID card to make cashless payments. The second is an Arduino-implemented programming unit.The third section consists of information presentation and product delivery at output. In this essay, a solution to the coin-operated vending machine that isn't giving back the money is attempted.Automatic chocolate vending machine by using Arduino Uno.[4]

Chapter 3
Requirement Analysis

3.1 Hardware Requirement

3.1.1 Raspberry Pi

Raspberry Pi is a series of small single-board computers (SBCs) developed in the United Kingdom by the Raspberry Pi Foundation in association with Broadcom. Since 2013, Raspberry Pi devices have been developed and supported by a subsidiary of the Raspberry Pi Foundation, now named Raspberry Pi Ltd. The Raspberry Pi project originally leaned toward the promotion of teaching basic computer science in schools. The original model became more popular than anticipated, selling outside its target market for diverse uses such as robotics, home and industrial automation, and by computer and electronic hobbyists, because of its low cost, modularity, open design, and its adoption of the HDMI and USB standards.

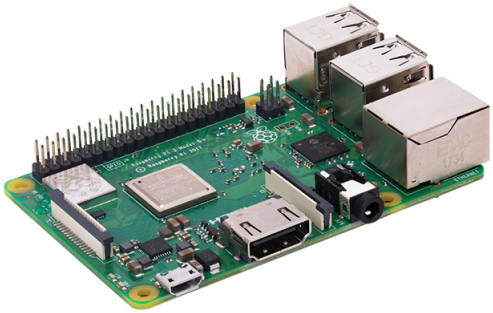

Figure 1: Raspberry Pi

3.1.2 Stepper Motor

Stepper motors are DC motors that move in discrete steps. They have multiple coils that are organized in groups called ”phases”. By energizing each phase in sequence, the motor will rotate, one step at a time. With a computer controlled stepping you can achieve very precise positioning and/or speed control. For this reason, stepper motors are the motor of choice for

many precision motion control applications. Stepper motors come in many different sizes and styles and electrical characteristics. This guide details what you need to know to pick the right motor for the job.

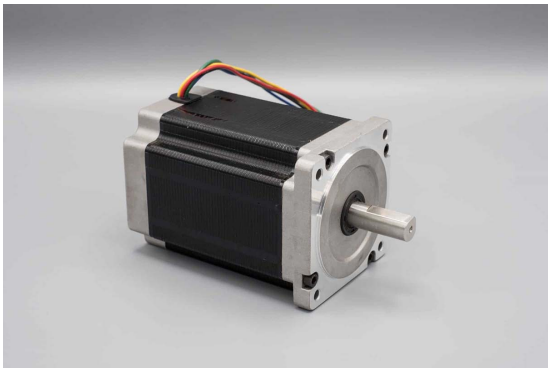

Figure 2: Stepper motor

3.1.3 Motor Driver

DC motors need a motor driver for control purposes. L298N is a motor driver which can control the speed and direction of up to two DC motors. This motor driver is one of the cheapest and the easiest way to control DC motors. One more advantage is that it can control a stepper motor as well. Pulse width modulation is used to control the speed of the motor. H-bridge connections are used to change the direction of the motor.The speed of the DC motor depends mainly on the input voltage it receives. So by varying the input voltage, we can vary the speed of a DC motor. This process is called Pulse Width Modulation (PWM).

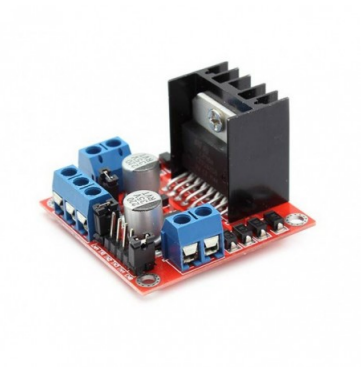

Figure 3: Motor driver

3.1.4 Touchscreen

A 2.8” TFT touchscreen LCD panel can be used for a variety of interactive applications, such as vending machine projects. This has a resolution of 320 x 240 pixels on average, is perfect for spaces with limited space since it offers vivid and crisp images in a small package. With its capacitive and resistive versions, the touchscreen feature enables natural user interactions including touching and swiping to pick things or navigate menus. SPI (Serial Peripheral Interface) bus is typically used to interface the display with a Raspberry Pi or comparable microcontroller, allowing for quick and effective communication. Typically, the Raspberry Pi’s GPIO pins are used to supply power directly, which makes wiring and setup easier.The display module can be used in medical devices, such as in patient monitoring systems, medical imaging systems, and medical laboratory equipment.

Figure 4: TFT touchscreen LCD panel

3.1.5 Servo motor

The SG90 servo motor is a popular and widely used micro servo motor known for its affordability, compact size, and versatility. It is commonly utilized in hobbyist and educational projects, including robotics, model aircraft, and automation systems. The SG90 operates on a standard voltage range of 4.8 to 6.0 volts and provides a torque of approximately 1.8 kg-cm at 6 volts, making it suitable for applications requiring precise control of movement within a limited range. The motor features three wires: power (typically red), ground (brown or black), and control signal (orange or white), which connects to a PWM (Pulse Width Modulation) signal to control the position of the servo horn. The servo can rotate approximately 180 degrees, allowing for precise positioning and movement. One of the key advantages of the SG90 servo motor is its ease of use with microcontrollers like Raspberry Pi.

Figure 5: Servo Motor

3.1.6 Infrared Sensor

An IR sensor is an electronic device that detects IR radiation falling on it. Proximity sensors (used in touchscreen phones and edge-avoiding robots), contrast sensors (used in line following robots), and obstruction counters/sensors (used for counting goods and in burglar alarms) are some applications involving IR sensors. IR LEDs are usually made of gallium arsenide or aluminum gallium arsenide. In complement with IR receivers, these are commonly used as sensors. The appearance of an IR LED is the same as a common LED. Since the human eye cannot see infrared radiation, it is not possible for a person to identify if an IR LED is working. A camera on a cell phone camera solves this problem. The IR rays from the IR LED in the circuit are shown in the camera. An IR sensor is an electronic device that detects IR radiation falling on it. Proximity sensors (used in touchscreen phones and edge-avoiding robots), contrast sensors (used in line following robots), and obstruction counters/sensors (used for counting goods and in burglar alarms) are some applications involving IR sensors.

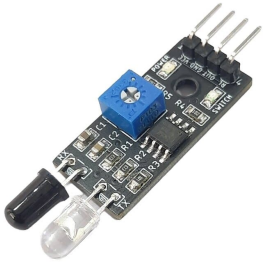

Figure 6: IR sensor

3.1.7 Iron Wire

After the person who has paid amount for the snacks the vending machine should dispense the required one. For that the stepper motor we have used attached to the wheel rotates the solenoid. That solenoid is main idea behind the science in this vending machine project. We make that solenoid with the help of any iron wire which can be easily bent. Iron wire can be utilized to make the solenoid's core, which regulates the dispensing mechanism, in a vending machine project. The iron wire core of the solenoid becomes magnetized when an electric current passes through the copper coil of the solenoid. The iron core moves as a result of the magnetic field, usually pushing or pulling a plunger. A snack item can be freed from a holding device by using this movement. The solenoid's usage of iron wire guarantees a strong enough magnetic field to dependable operation of the dispensing mechanism. Iron wire is a vital component in these electromechanical system because the vending machine's efficiency and responsiveness depend on the core's performance.

Figure 7: Iron Wire

3.2 Software Requirement

3.2.1 Operating system

Getting started with Raspberry pi is not so easy as we think. First of anything we should get started with the suitable operating system such as Raspberry Pi OS(Raspbian). Raspbian is best fitted for the hardware that we use in our Vending Machine project. We have to be sure that operating system, we are going to use must be up to date with various security approachment on it. And next thing is after we are done with setting up OS, we can now use Raspberry pi along with our monitor, mouse and keyboard.

3.2.2 Python Programming language

Python is a high-level, general-purpose programming language. Its design philosophy emphasizes code readability with the use of significant indentation.Python is dynamically typed and garbage-collected. It supports multiple programming paradigms, including structured (particularly procedural), object-oriented and functional programming. It is often described as a ”batteries included” language due to its comprehensive standard library. We have to install necessary libraries for interacting with peripherals, controlling GPIO pins, handling sensors, and communicating with external devices.

3.2.3 User Interface (UI)

As enlisted in hardware requirement, 2.8” TFT touchscreen LCD panel is the display we are going to use. So this have to be interfaced with the human as well. Developing a graphical user interface (GUI) to allow users to interact with the vending machine. We can find Tkinter, PyQt, or Kivy which are common type of Python libraries for creating GUI applications. Designing an intuitive interface for item selection, payment processing have to be done.For most recent Raspberry Pi OS versions, touchscreen drivers are included, otherwise we must include by using the python commands.

3.2.4 Flutter for App development

Flutter is a popular open-source UI software development kit (SDK) created by Google for building natively compiled applications for mobile, web, and desktop from a single codebase. Flutter can be utilized in our vending machine project for better application dashboard, secure

payment and better communication with the controller.Flutter allows us to develop beautiful customizable user interfaces (UIs) using its wide range of its widgets. We can design and implement the vending machine's UI for both mobile and desktop platforms with Flutter, ensuring a consistent experience across devices.

3.3 Functional Requirement

3.3.1 Product selection

The machine must display the available products with their prices and the touchscreen/app must allow the customer for the easy selection of the products.

3.3.2 Payment System

The machine must be compatible with the mobile app for the cashless payment via esewa or other methods.

3.3.3 Product Dispensing

After the successful of the payment, the machine must dispense the product chosen by the customer.Also, must notify about the product if it is not available.

3.4 Non-Functional Requirement

3.4.1 Usability

The designed interface must be simple and understandable by all age group.

3.4.2 Reliability

The dispensing mechanism must reliably deliver the products.

3.4.3 Performance

When the user makes a selection of the product, the user interface should react quickly and products must be delivered swiftly and effectively by the product dispensing mechanism.

3.4.4 Maintainability

Authorized personnel should be able to easily maintain and repair the machine and the components should be easily accessible and interchangeable.

Chapter 4
System Design and Architecture

4.1 Block diagram

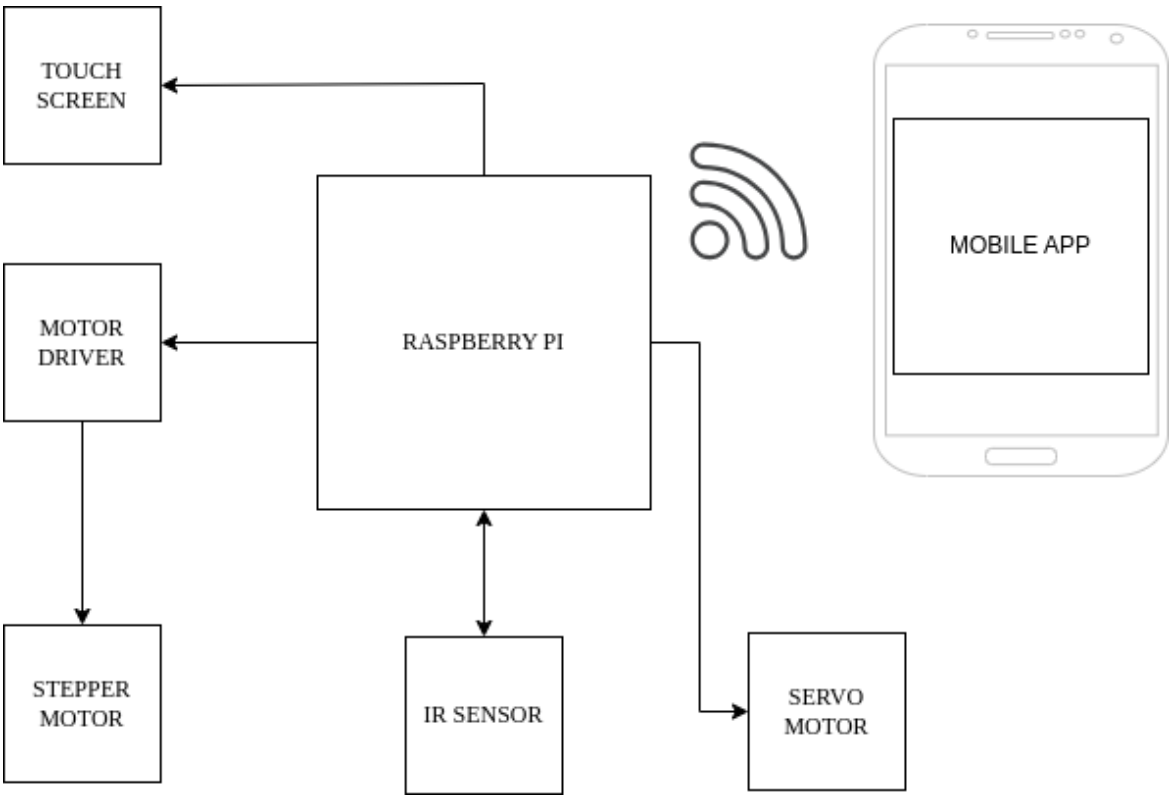

Figure 8: Block diagram for vending machine

The touch screen is used to display the product including its cost. Also, it displays the QR code for the price of the product. Stepper Motor is used to rotate the selves containing products.Motor driver is used to provide the consistent voltage supply to rotate the stepper motor. IR sensors are used in the shelves to detect the no of products present in the machine. Servo motor is used to open the door by the authorized person to refill the stock. Mobile application is used similar as touch screen where for the payment after selecting product ,it is redirected to e-sewa. Raspberry PI is used as the microcontroller.Overall the operations are handled by the Raspberry PI.

4.2 Flowchart

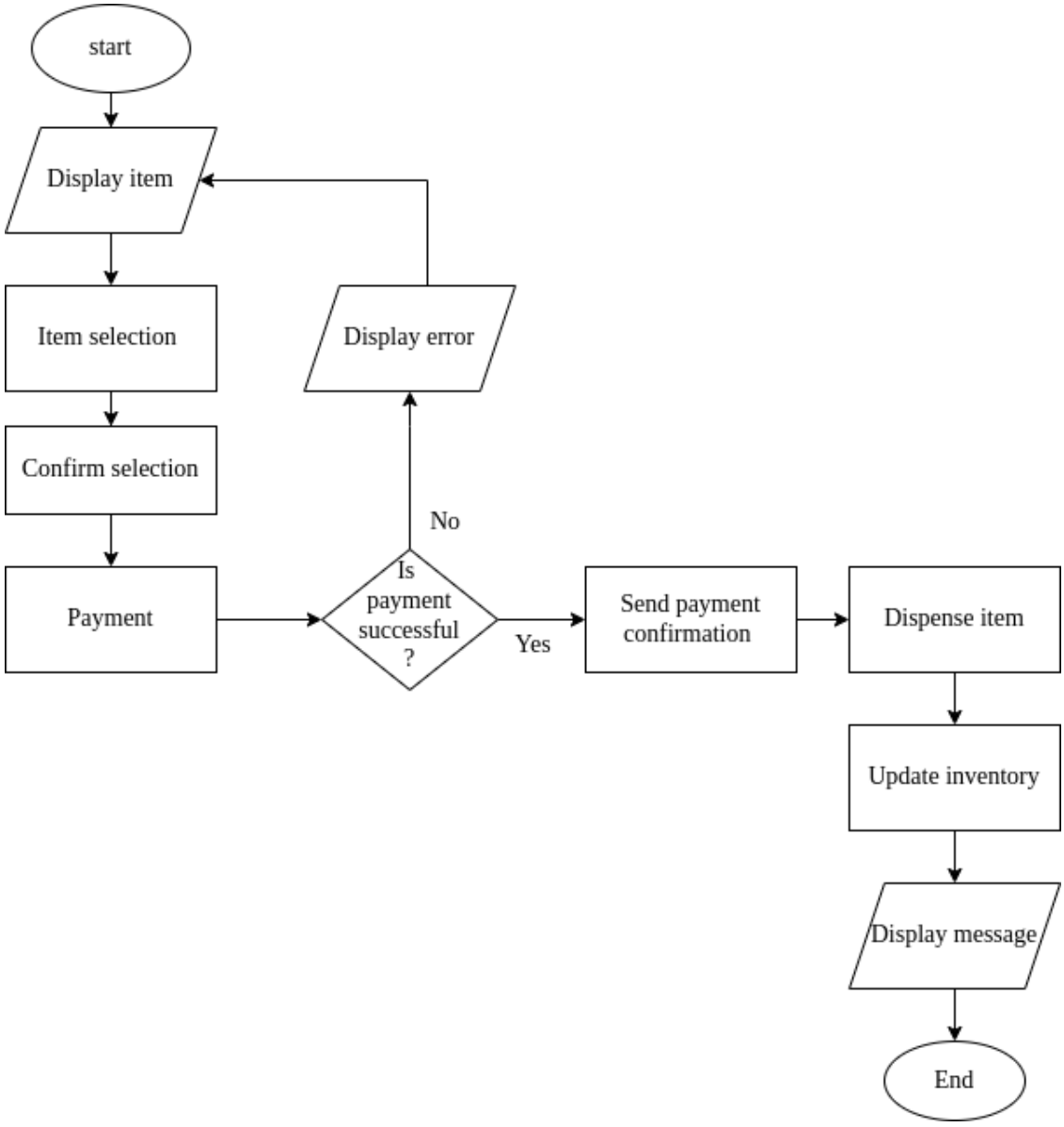

Figure 9: Flowchart for vending machine

The touch screen as well as the app interface displays the product which consists of the full details of the product including its cost. After selecting the product, the QR code for the product is generated if the customer uses the touch screen or simply gets redirected to the e-sewa gateway for the mobile application. Then, customer pays for the amount of the product and the Raspberry PI gets the signal of successful payment if done, triggers the stepper motor to rotate else displays error. And, thus the product is dispensed by the machine. After that, the inventory is updated and the message is displayed.

Chapter 5
Methodology

There are various procedures and approaches for the design for our vending machine. The first is to design the body that is mechanical parts which includes identifying, designing and installing the mechanical parts. The second section is to assemble the hardware parts and interfacing them with the controller. We will also be developing our mobile application as well. Similarly we will be interfacing our mobile application with our vending machine's controller.

5.1 Mechanical design

The initial design is the physical and structural design of our vending machine. The first job is to select the material either plastic,cardboard or metal from which we are going to make the mechanical parts. Mechanical design includes vending machine's shell, rotating selves (solenoid actuator), trays(racks) to store snacks and structure of dispensing mechanism. First of all, we will be designing outer shell and the selection levers by considering its size and weight. Also, we will be planning how the interface will look like for the display screen and the buttons.

5.2 Hardware Implementation

We will be selecting the best appropriate microcontroller that is raspberry pi, stepper motors for the dispensing, sensors to check whether snacks have ran out or not. Then, we will be developing a outline for the connections between the components. Servo motor will be implemented for opening door whenever store manager need to fill up the ran out snacks. Our project will also include the TFT touchscreen display for viewing, selecting, and for payment it generates the QR for the respective snacks.

5.3 Developing Software

Since our project is coinless/cashless vending machine so we will be doing payments through the mobile application. For that we will be developing the application using flutter sdk which uses dart programming language. In our application for inventory management we will be

using database concepts as well.

The good concept of python programming language is needed for programming raspberry pi. So we will also implement that as well. For payment our app will use the payment gateway like esewa from which any user can pay for any needed snacks. First of all flutter application should be integrated with the esewa SDK and esewa will respond to the app whenever the payment is done. Also the backend server or direct API communication is required for communication between mobile app and raspberry pi. As we know the payment transaction must be safe and secure, so we can use various encryption algorithm enlisted below:

- AES(Advanced encryption standard)
- RSA(Rivest-Shamir-Adleman)
- TLS/SSL(Transport layer security/Secure socket layer)

Chapter 6
Expected Output

The product selected and the way the consumer interacts with the vending machine determine the expected outcome.

- On his or her phone, the user must be able to view the prices of the things that are available.
- On selecting a product, the app should request that payment is confirmed using his/her linked means of paying money.
- After payment has been made by the user, the app should display a success message on the screen.
- The machine should dispense the chosen product through its mechanism upon receiving payment confirmation from the app.

Chapter 7

Time Schedule

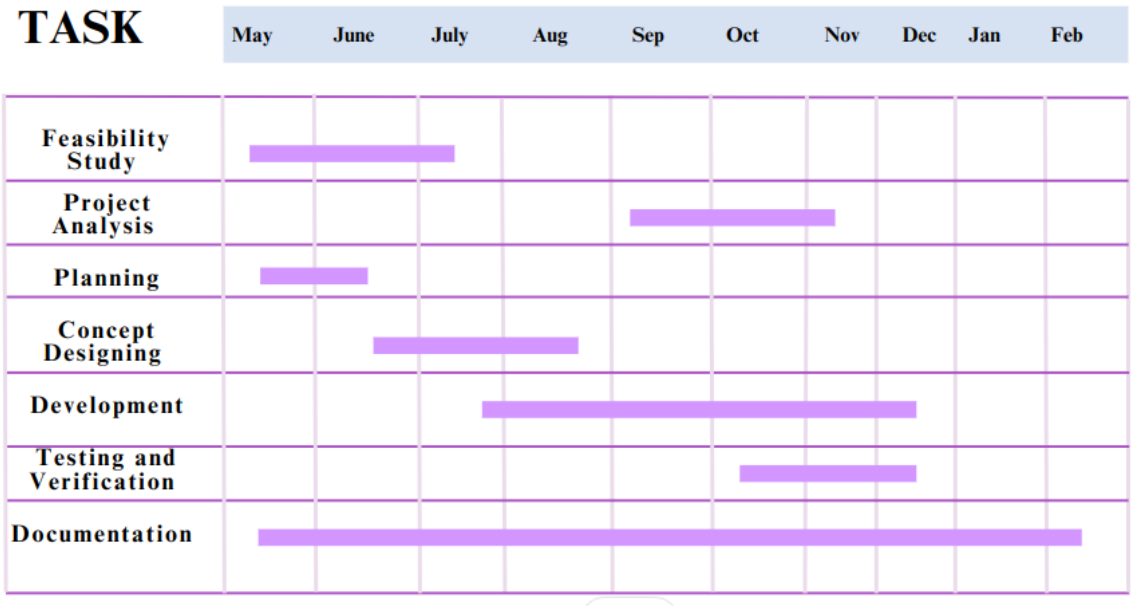

Figure 10: Time schedule Gantt chart

Chapter 8
Cost Estimate

Materials	Quantity	Price (Rs)
Raspberry PI 4 (4GB RAM)	1	20,000
Stepper Motor	4	1500
Servo Motor	1	350
Touchpad	1	2500
Motor Driver	2	300
Lipo Battery 1500Mah 11.1V	1	2000
Infrared sensor	4	100
Galvanized Iron wire(in kg)	1	50
Total	15	**32,200**

Table 1: Table for Cost Estimation

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