Department of Computer Science & Engineering
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Architectural Design Specification
CSE 4316: Senior Design I
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Vending Service
Automated Vending & Reservation System

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Revision History

Revision	Date	Author(s)	Description
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1 Introduction

The smart vending machine should be able to a) allow ordering from remote locations via mobile app b) reservations /inventory checks from remote locations c) vending goods d) detect and report errors/tampering with the machine.

We expect it to be used either by people who frequent the building it is located in / around (using mobile app) or by random visitors with the touch screen. Commercially, we would expect this to be bought by vending service companies (for large corporations, universities, etc.) or small businesses for convenience. This product is designed for a wide spectrum of potential customers. It is intended for general use.

2 System Overview

The smart vending machine behaves similarly to a regular vending machine, but it has additional features allowing users to pay for and reserve snacks in advance. The user will do this through an app which will display the available inventory of the selected machine and handle dummy transactions. It will then give the user a four digit code which they will input into the machine to retrieve their reserved snacks.

The smart vending machine consists of three layers: the Database Layer, the Machine Layer, and the App Layer. Below is an architectural layer diagram of the entire system. Each layer will discussed later in the document.

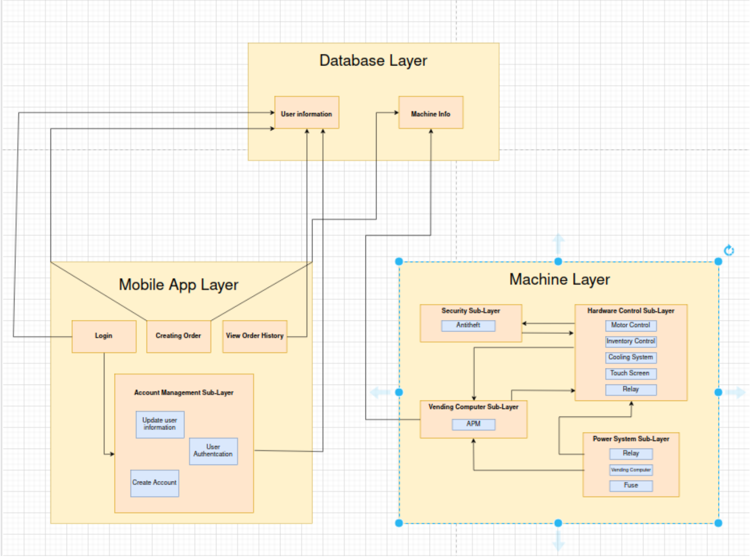

Figure 1: A simple architectural layer diagram

2.1 Database Layer

The Database Layer contains three sub layers: User Information and Machine Information. The Database will store all information from the system and will communicate with the Machine and App. For the app, it will store user information which includes: phone number which is the unique ID, order history, and current balance. For the machine, it will store the current inventory and machine specific information. It will also store card information for dummy payment methods.

2.2 Machine Layer

The Machine Layer contains four subsystems: Power System, Hardware Control, Security, and the Vending Computer.

2.3 App Layer

The App Later contains four subsystems: Login, Creating Order, View Order History, and Account Management. The App is used by the user to create orders, handle payment, view order history, and change account information. The app is cross platform and must have an internet connection.

3 Subsystem Definitions & Data Flow

This is a data flow diagram of the Smart Vending Machine that shows how each subsystem is connected.

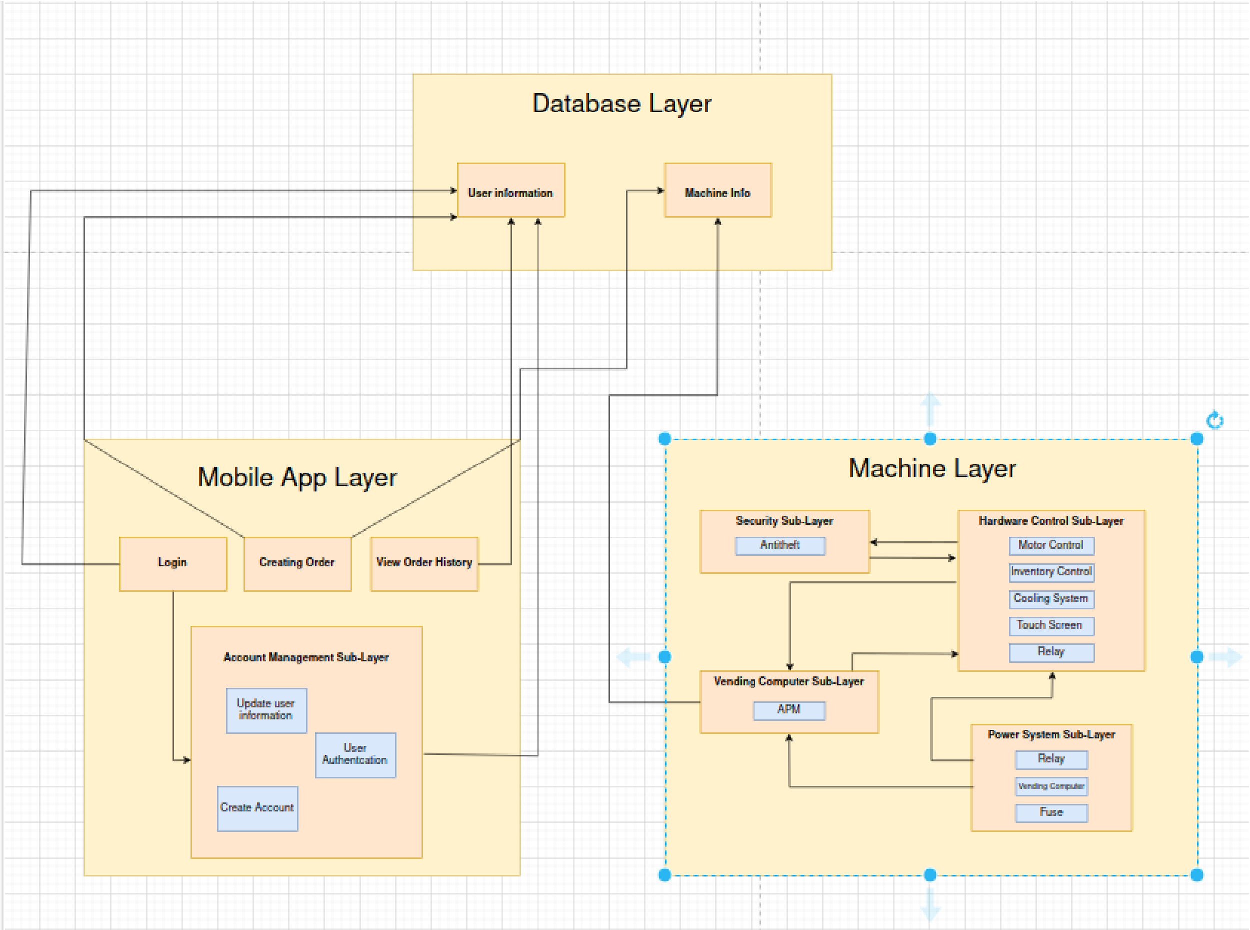

Figure 2: A data flow diagram

4 Database Layer Subsystems

Google Firebase will be uses to host our database and handle back end systems. App and Machine Layers will make queries here to retrieve information.

4.1 User Information Subsystem

A large portion of the database will be handling user information. This includes: phone number, order history, and current balance. The app will be the primary layer using this information.

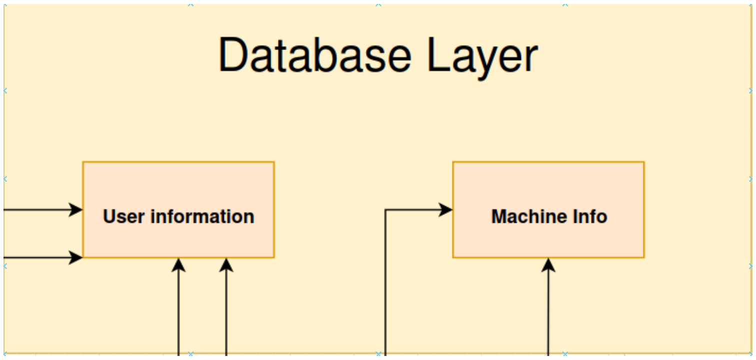

Figure 3: Database Layer subsystem description diagram

4.1.1 Assumptions

User's phone will be connected to the internet and it will be either an iPhone or Android.

4.1.2 Responsibilities

It will check if a user's account exists when an attempt to log in is made. It will also display past orders from a user, and it will update when a user changes account information.

4.1.3 Subsystem Interfaces

The input will be a query request from the App Layer. This request will be either to check if information exists, pull existing data, or update information. The output will be a Boolean for logging in or a list of order objects for order history.

Table 2: Subsystem interfaces

ID	Description	Inputs	Outputs
#1	Login	Query request w/ User phone number	Boolean
#2	Order History	Query request w/ User phone number	List of orders
#3	Account Update	Query request w/ User phone number	N/A

4.2 Machine Information Subsystem

A portion of the database will be used to store information specific to each machine. The main purpose is inventory management between the app and each machine.

4.2.1 Assumptions

Smart Vending Machine will be connected to the internet, and the AVRS application will be installed on the machine's raspberry pi.

4.2.2 Responsibilities

It will keep track of the inventory in each machine and update accordingly when a user places an order.

4.2.3 Subsystem Interfaces

Inputs will come from the Machine and App Layers and will be in the from of query requests. Each time an order is made, the app will update the available inventory, and after an order is received the machine will update actual inventory.

Table 3: Subsystem interfaces

ID	Description	Inputs	Outputs
#1	Order Placed	Query request to update available inventory	N/A
#2	Order Retrieved	Query request to update actual inventory	N?A

5 Machine Layer Subsystems

5.1 Power System

The Power System subsystem will be responsible for powering the Vending Computer and the touch screen in Hardware Control subsystem. It is also provide the power for relay to run the motors.

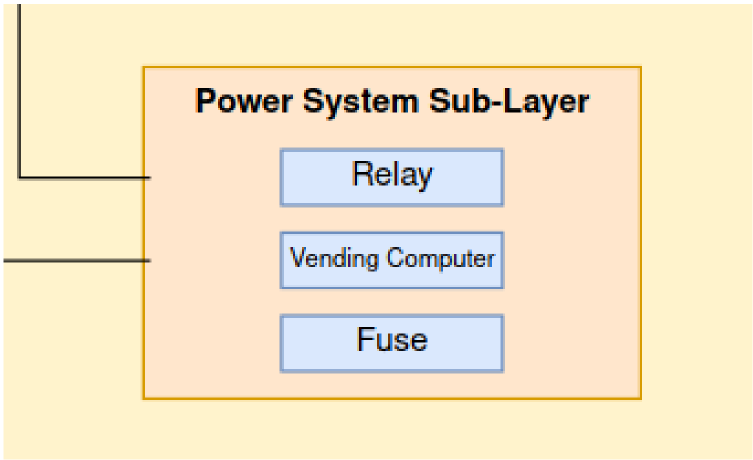

Figure 4: Power System subsystem description diagram

5.1.1 Assumptions

The power subsystem will provide the power for all electronic devices such as touch screen, raspberry Pi, and relay.

5.1.2 Responsibilities

It is responsible for turning the vending machine on or off and powering the devices in the machine. It is also responsible for protecting the appliance and the wiring if something goes wrong by using fuses.

5.1.3 Subsystem Interfaces

Table 4: Subsystem interfaces

ID	Description	Inputs	Outputs
#00	Power supply	AC neutral AC hot AC ground	DC 5V DC 12V DC ground
#01	Relays	Relay 1 Relay 2 Relay 3 Relay 4 Relay 5 Relay 6	Motor 1 Motor 2 Motor 3 Motor 4 Motor 5 Motor 6
#02	Fuse block	DC 12V DC ground	Relay 1 Relay 2 Relay 3 Relay 4 Relay 5 Relay 6

5.2 Hardware Control

This subsystem will control motor, inventory, cooling system, touch screen, and relay.

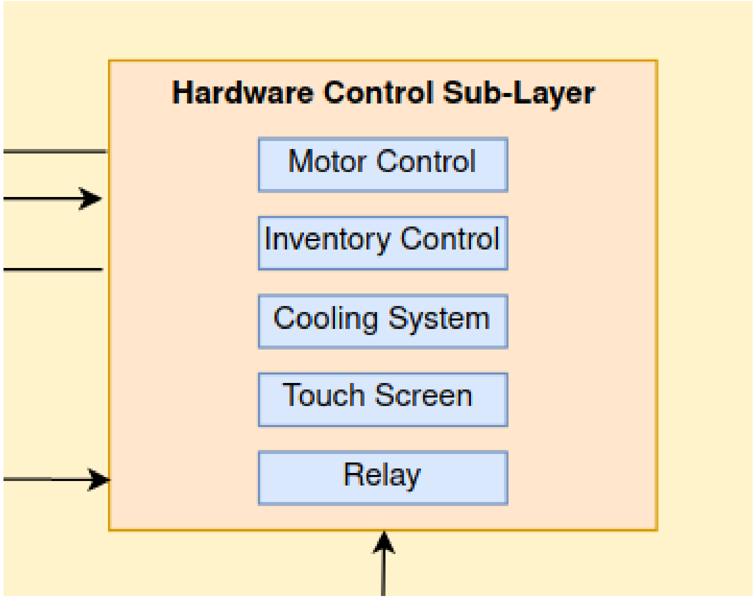

Figure 5: Hardware Control subsystem description diagram

5.2.1 Assumptions

The Hardware Control subsystem will get the output from the vending computer and relay to control the motor. It is also control the inventory and cooling system.

5.2.2 Responsibilities

The motor will be responsible for rotating the coil to push the snack out. The relay will receive the signal from the Vending Computer to run the motor. The touchscreen will get user input, send it to the Vending Computer, and display the updates. The cooling system will be responsible for cooling the system to keep the system from overheat. The inventory control will turn off the motors after it receive senses movement.

5.2.3 Subsystem Interfaces

Table 5: Subsystem interfaces

ID	Description	Inputs	Outputs
#00	Relays	Relay 1 Relay 2 Relay 3 Relay 4 Relay 5 Relay 6	Motor 1 Motor 2 Motor 3 Motor 4 Motor 5 Motor 6
#01	GPIO	n/a	IR sensor CPU fan
#02	Touchscreen	USB TID	HDMI

5.3 Security

This section is concerned with the security of the the APM.

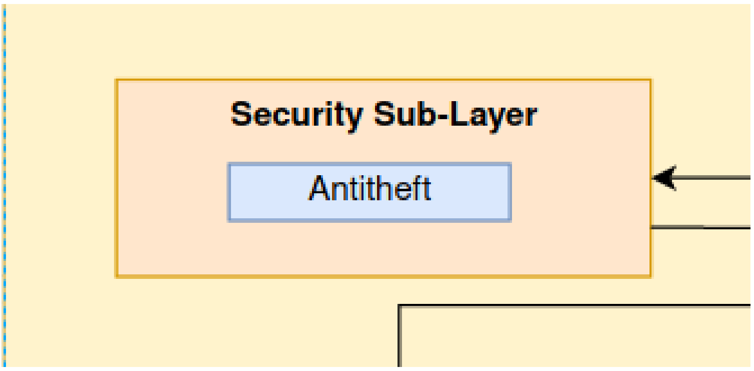

Figure 6: Security subsystem description diagram

5.3.1 Assumptions

The assumption must be made that the machine is not delivering any orders to the user and that it is powered on and connected to the Internet.

5.3.2 Responsibilities

The Security subsystem has only two responsibilities: anti-theft and anti-tip. Tipping is a major concern as we don't want the machine to relinquish items unless they are paid for / bought. As such, we will have an accelerometer which will alert the system if it detects the machine was tipped past a certain point. Also, the machine will be small enough to be picked up / moved by a person. As such, we will have an anti-theft system onboard which will allow us to track it.

5.3.3 Subsystem Interfaces

See Table 6 for more details. This subsystem is fairly self-contained and as such will only communicate the accelerometer readings to the APM. The GPS / other tracking hardware will have to be on a data connection (might not be WiFi to send coordinates over).

Table 6: Subsystem interfaces

ID	Description	Inputs	Outputs
#00	GPIO	n/a	accelerometer

5.4 Vending Computer

The Vending Computer subsystem consists only of the APM (a Raspberry Pi 4 Model B). It communicates with the Hardware Control, Power, and Security subsystems (via hardware control). It is basically the master control subsystem.

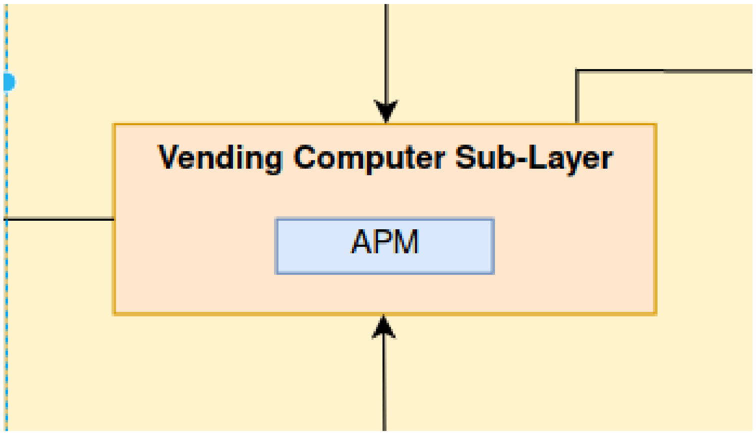

Figure 7: Vending Computer subsystem description diagram

5.4.1 Assumptions

The assumption can be made that the APM is turned on, sleep is disabled, and the screen is always on. We have no method for remote wake or turning on the machine other than power-cycling.

5.4.2 Responsibilities

The Vending Computer subsystem is responsible for controlling all other systems. It does so via the APM GPIO. Software running on the APM will have control over any other subsystem present. To expand on the responsibilities; security sets a flag / interrupt which the APM will need to handle, hardware control relies on the APM to toggle relays for motor control, and power distribution via relays.

5.4.3 Subsystem Interfaces

See Table 7 below for details. The GPIO is the only bus which the APM can communicate with other subsystems. There are 6 relay outputs, 1 CPU fan output, 1 accelerometer input, and 1 IR sensor input.

The APM gets power (5V DC) from the Power subsystem, but it cannot communicate back. Each relay is independently addressable, but should only be toggled one at a time for power usage requirements. The only check for this will be in software.

Table 7: Subsystem interfaces

ID	Description	Inputs	Outputs
#00	GPIO	accelerometer IR sensor	Relay 1 Relay 2 Relay 3 Relay 4 Relay 5 Relay 6 CPU fan

6 App Layer Subsystems

The App Layer is the main UI of the system. This where users can place orders at a particular machine.

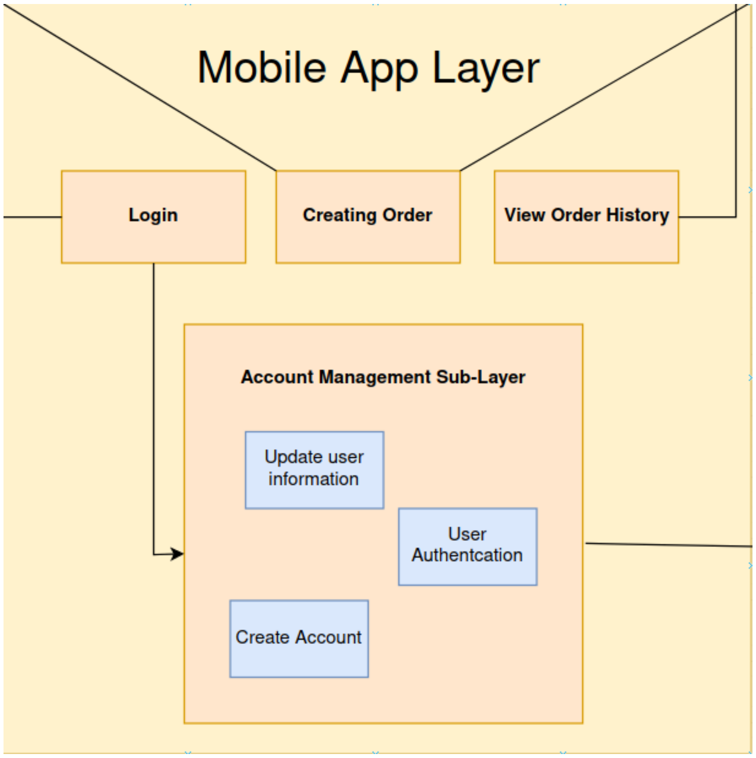

Figure 8: Mobile App Layer subsystem description diagram

6.1 Login

The Login Subsystem allows the user to login to the app. It will make a query request to check if the user's account exists.

6.1.1 Assumptions

The user must have already created an account with the system and has download the mobile app to their device.

6.1.2 Responsibilities

It must handle user input and check if the input matches an existing account.

6.1.3 Subsystem Interfaces

Table 8: Subsystem interfaces

ID	Description	Inputs	Outputs
#1	Login	User Input	Boolean

6.2 Creating Order

The Creating Order Subsystem allows the user to create and pay for orders. The user will be shown a selection of items to choose from depending on the inventory of the machine.

6.2.1 Assumptions

The assumption must be made that the user must have already created an account with the system and has download the mobile app to their device. The user must also be logged in.

6.2.2 Responsibilities

It must display an accurate representation of the available inventory to the user. It must also allow the user to place and pay for an order.

6.2.3 Subsystem Interfaces

Table 9: Subsystem interfaces

ID	Description	Inputs	Outputs
#1	Display Menu	User Input	Query Results
#2	Create Order	User Input	Update Database Unique Code

6.3 View Order History

The View Order History Subsystem displays past orders created by the user.

6.3.1 Assumptions

The assumption can be made that the user must already have an account and had previously placed an order with the system. The user must already also have download the application and be logged in.

6.3.2 Responsibilities

it must display only order created by the user.

6.3.3 Subsystem Interfaces

Table 10: Subsystem interfaces

ID	Description	Inputs	Outputs
#1	Display Orders	User Input	Query Results

6.4 Account Management

This section should be a general description of a particular subsystem for the given layer. For most subsystems, an extract of the architectural block diagram with data flows is useful. This should consist of the subsystem being described and those subsystems with which it communicates.

6.4.1 Assumptions

The assumption must be made that the user is connected to the Internet and already has downloaded the application. For most features, the user must be logged in, but for account creation, the user will be logged out.

6.4.2 Responsibilities

The account management layer has the main responsibility of managing the users account information. This layer must provide an interface to allow users to update their user information such as their name and/ or phone number. The layer must be able to initiate an authentication with the database layer in order to allow users to login and also provide an interface to allow the user to create an account.

6.4.3 Subsystem Interfaces

Table 11: Subsystem interfaces

ID	Description	Inputs	Outputs
#1	Display Account Info	user input	Query Result
#2	Create Account	N/A	Unique Database
#3	Change Information	N/A	Query Result

References