
# INDIVIDUAL ASSIGNMENT

## TECHNOLOGY PARK MALAYSIA

## CT047-3-2 -SPCC

## SYSTEM PROGRAMMING AND COMPUTER CONTROL

## APD2F2206CS

**HAND OUT DATE : 18/7/2022**

**HAND IN DATE : 15/9/2022**

**WEIGHTAGE : 40%**

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**INSTRUCTIONS TO CANDIDATES:**

1. **Submit your assignment at Moodle**
2. **Students are advised to underpin their answers with the use of references (cited using the APA Referencing)**
3. **Late submission will be awarded zero (0) unless Extenuating Circumstances (EC) are upheld**
4. **Cases of plagiarism will be penalized**
5. **The assignment should be bound in an appropriate style (comb bound or stapled).**
6. **Where the assignment should be submitted in both hardcopy and softcopy, the softcopy of the written assignment and source code (where appropriate) should be on a CD in an envelope / CD cover and attached to the hardcopy.**
7. **You must obtain 50% overall to pass this module.**

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**Name : Yam Chen Xi**

**TP Number : TP061635**

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# 1.0 Acknowledgement

The smart home control system is the result of years of academic research and development by many different groups of individuals. As a developer myself I want to convey my sincere appreciation to everyone who helped me finish this project with their support and advice. I encountered various challenges when working on this task. I want to thank my lecturer for my subject since she never stops motivating and advising me. My module instructor motivated me to do this work within the time allocated while also teaching us the fundamentals of LabVIEW programming. The lecturer's advice has helped me develop a high-quality system. Having some friends who helped me with the development process has also been a blessing for me. By sharing concepts in many fields, I am able to understand new methods and concepts to develop this system and successfully completed the assignment.

## 2.0 Abstract

The objective of this assignment is to develop a functioning Smart Home Control System by utilising LabVIEW, a graphical programming software. In LabVIEW, simulation and illustration of the smart home functions can be implemented to create a prototype that can be developed into real life. Smart home features included lights, doors, curtains and television are provided to bring convenience a household using technology. By adapting programming knowledge into the system development process, the Smart Home Control System is expected to allow authorised users to control appliances in home using a central control keypad remotely. With the use of TCP/IP connection, the central pad is designed to be able to connect to the sensors of specific appliances.

# 3.0 Introduction

In our daily life, safety and comfort are often top of our priorities when it comes to a place where we residence permanently and spend most of our time at. Hence, smart home technology is introduced to the public as this technology allow to provide a home that can act as safe haven and a comfort zone to people. A smart home is a practical home design where electronics and appliances can be remotely controlled via the internet from any location through one central point, it could be a smartphone, tablet or other networked device. The internet connects the devices in a smart home, enabling users to remotely control features such as lighting, door, curtain and security access through one home automation system. Besides, smart home configurations can be done via wireless or hardwired systems. This technology was invented to maximise daily convenience and save living expenses of homeowners (Chen, 2019). To achieve a functional smart home control system, LabVIEW is utilised in the development process.

# 4.0 Project Requirement

## 4.1 Project Requirements Fulfilled by LabVIEW

The goal of this project is to utilise LabVIEW programming language to develop a Smart Home Control System for the given floor plan. By utilising the controller in LabView, the user of this smart home control system may manage the home appliances remotely. A TCP/IP connection connects the second module, which is separate from the system's primary module to the overall system. The user interface, which serves as the controller for user interactions, is essentially the core module which known as Client.vi. Using a TCP/IP connection, the second module which is Server.vi will get the user commands from the first module and execute the selected function on the targeted houseware.

In this project, a smart home control system is created using LabVIEW software to manage household devices. The smart home control system is also specifically designed for the given floorplan. The goal of this project is to create a smart home management system that can be used to operate a variety of devices, including curtains, television, lights, and doors. To show the vital message regarding the house, it also offers some extra feature such as power usage indicator.

## 4.2 Required Hardware Sensors and Devices


*Figure 1: Example of home automation hardwares (Ansar, 2020)*

This smart home management system prototype is intended to help consumers manage their everyday home appliances in a practical way. Some components and sensors are needed to put this system into practise. Arduino Nano, Relay Circuit, Voltage Measurement Sensors, Light Switch, Smart Door Opener, and Curtain Motor are the components and appropriate types of sensors that can be implemented in the Smart Home Control System.

### 4.2.1 Arduino Nano

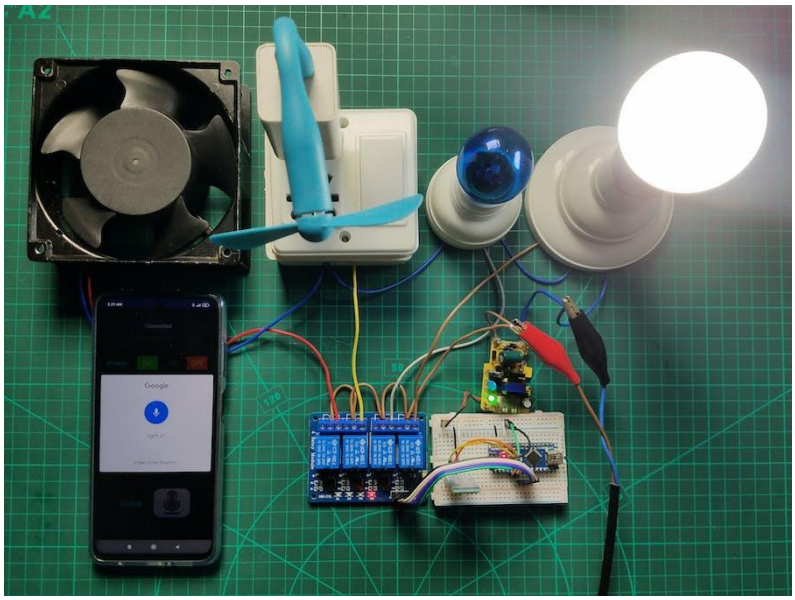

*Figure 2: Home Automation Sample using Arduino Nano (Ansar, 2020)*

Arduino Nano act as the core of the home automation platform. It used to connect all the other parts of the automation and uses TCP connect to authorise user to access smart home system with the use of network. Through Arduino Nano, it allows the user to control lighting, door lock, curtain and television by using a central control keypad.

### 4.2.2 Relay Circuit


*Figure 3: Relay Circuit ESP8266*

A relay circuit is required to build a home automation system. With relay circuit, it allows the appliance to switch on and off. The transistor inside the relay circuit act as a switch that able to transmit Boolean signal when triggered by certain number of voltages.

### 4.2.3 Voltage Measurement Sensors


*Figure 4: Voltage Sensor VCC<25V*

A voltage sensor was used in the system to monitor the daily usage of electricity among the circuit. By connecting it to Arduino Nano, the smart home control system will be able to monitor the power usage of the system and notify the user when the power consumption is heavily used.

### 4.2.4 Light Switch

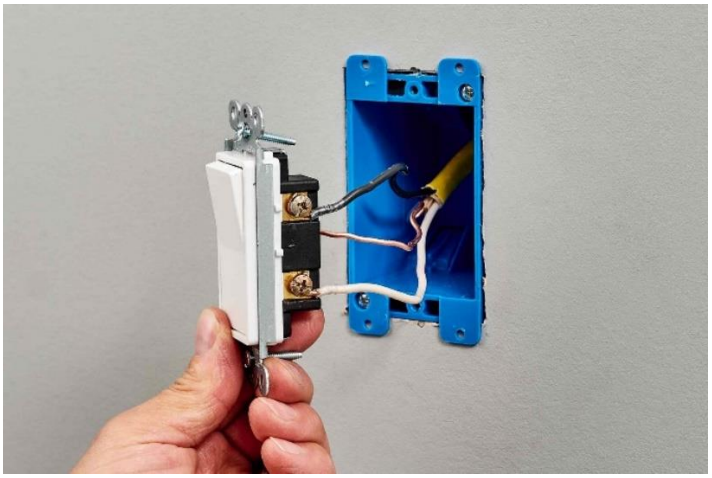

*Figure 5: Light Switch*

Light switches are required in the smart home system as it is used to connect the light bulbs in the house to the smart home system controller. A light switch can receive Boolean input such as on and off. LabVIEW are able to process the signal transmitted by a light switch to a designated the light bulb and carry out on and off function.

### 4.2.5 Smart Door Opener

*Figure 6: Smart Sliding Door Opener*

Smart sliding door opener are required in the smart home system as it is used to connect the doors in the house to the smart home system controller. A door opener can receive Boolean input from the home system controller to execute on and off function. The door opener will be able to open and close the door according to the signal given by the user on the system.

### 4.2.6 Curtain Motor

*Figure 7: Curtain Motor*

Smart curtain motors are used in the smart home system to control on and off the curtains in the house. A curtain motor can receive number input from the home system controller to decide to roll up how much of the curtain according to the given number by the user on the system.

# 5.0 System Design

## 5.1 Client-Side Flowchart

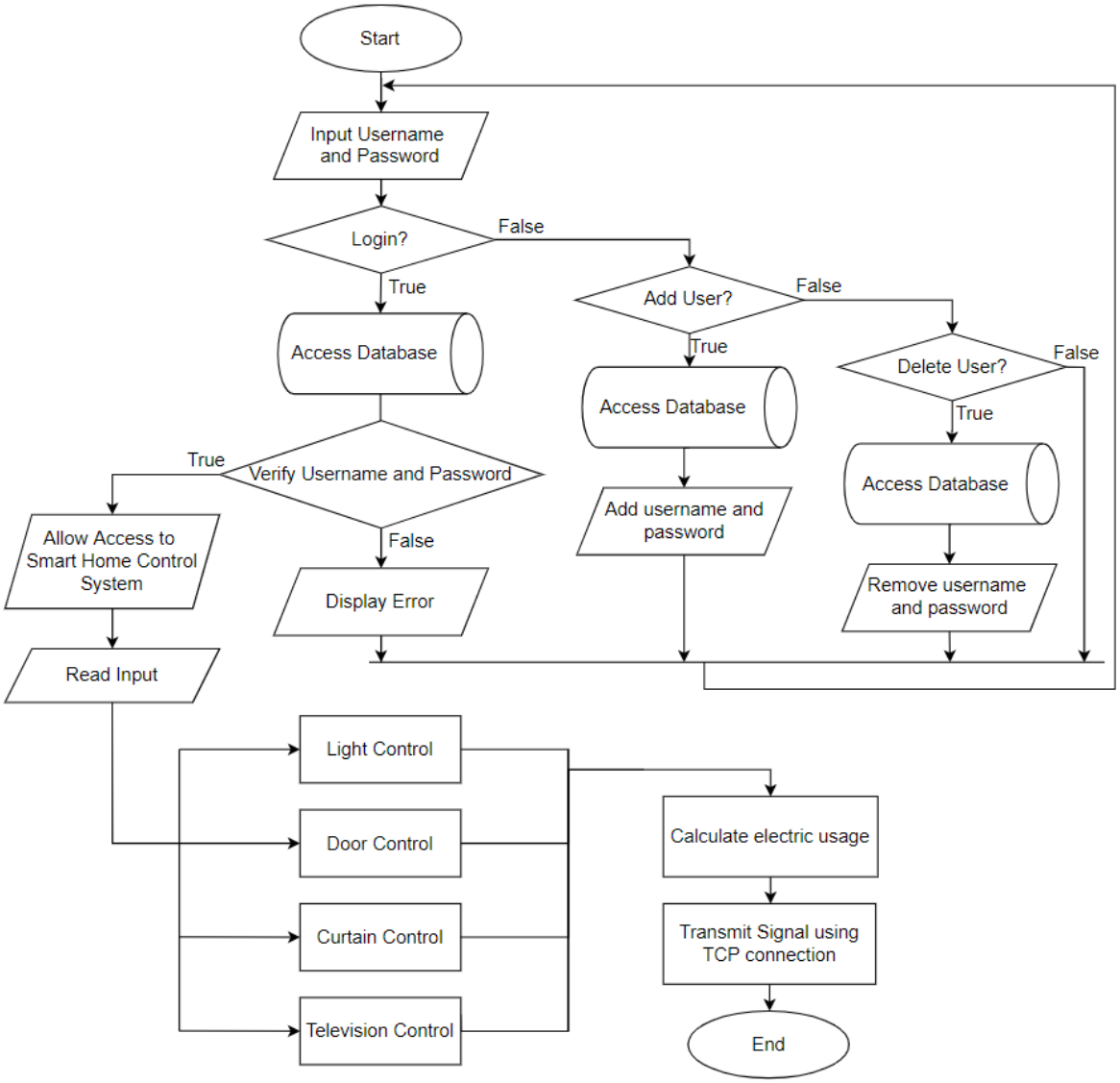


*Figure 8: Client-Side Flowchart*

The flowchart above shows the sequence of actions of the client side of the smart home control system. The flowchart starts when the user has input the username and password. Then, the user is required to access either login, add or delete user button. All these buttons will access the login file to carry out their specific features accordingly. Once the user successfully login to the system, the user is allowed to access to light control, door control, curtain control and television control. All the mentioned features allow the user to manage the appliances of the house via the control pad. The action of the user will automatically transmit to the server side using TCP connection to execute further procedure.

## 5.2 Server-Side Flowchart

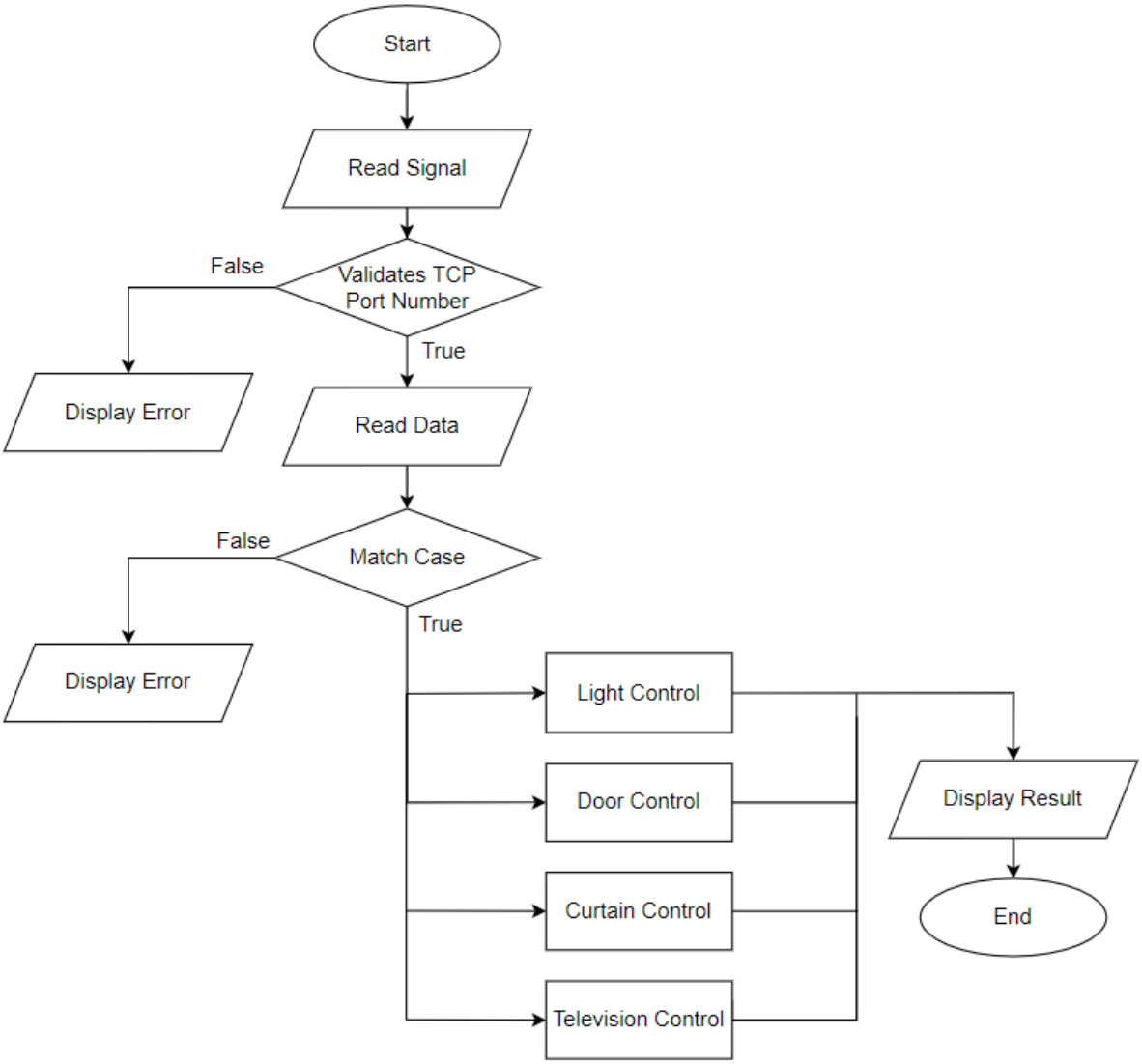


*Figure 9: Server-Side Flowchart*

The flowchart above shows the sequence of actions of the server side of the smart home control system. The flowchart starts when the server receives signal from client side. After getting the signal, the system will validate the TCP port number and read the received data. Then, it will use the data to match the case structure and execute the designated functions accordingly. Lastly, the system will display the output of the carried-out function.

## 5.3 Implementation

### 5.3.1 Login

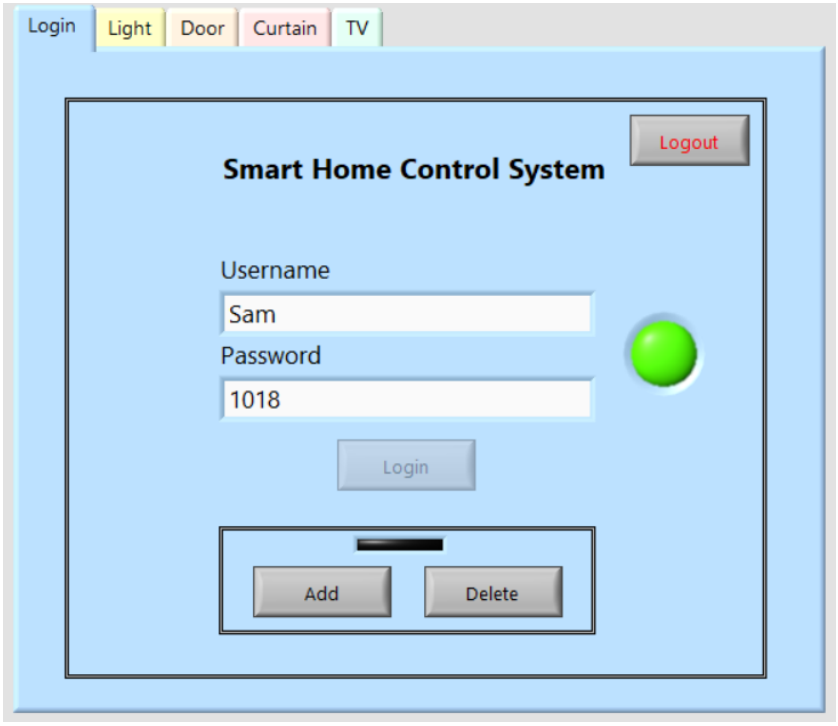


*Figure 10: Login Page of Smart Home Control System*

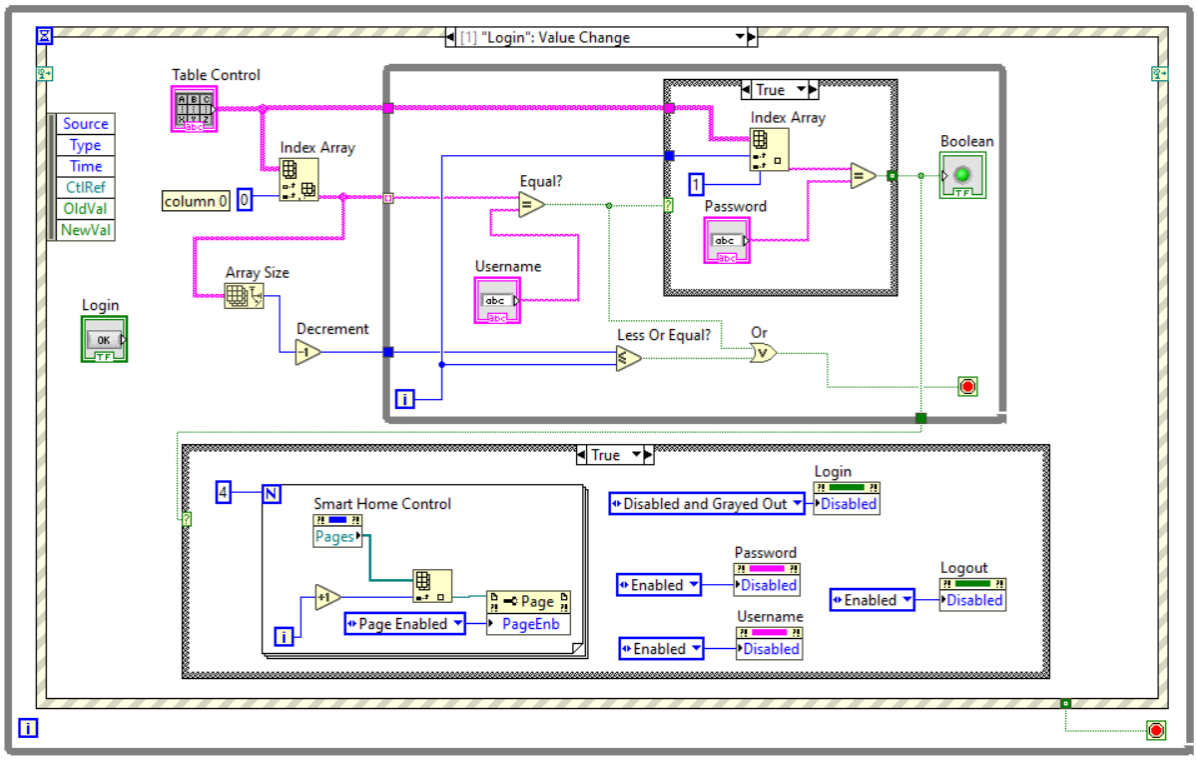


*Figure 11: Login page code*

On the login page it consists of a table control that are able to store usernames and password in the table. By using index array, the code is able to identify the username and password

available in the table and validate it with the user's inputted username and password. If the username and password are found in the table, the user will be logged into the system and granted authorisation to access Light, Door, Curtain, TV control pages.

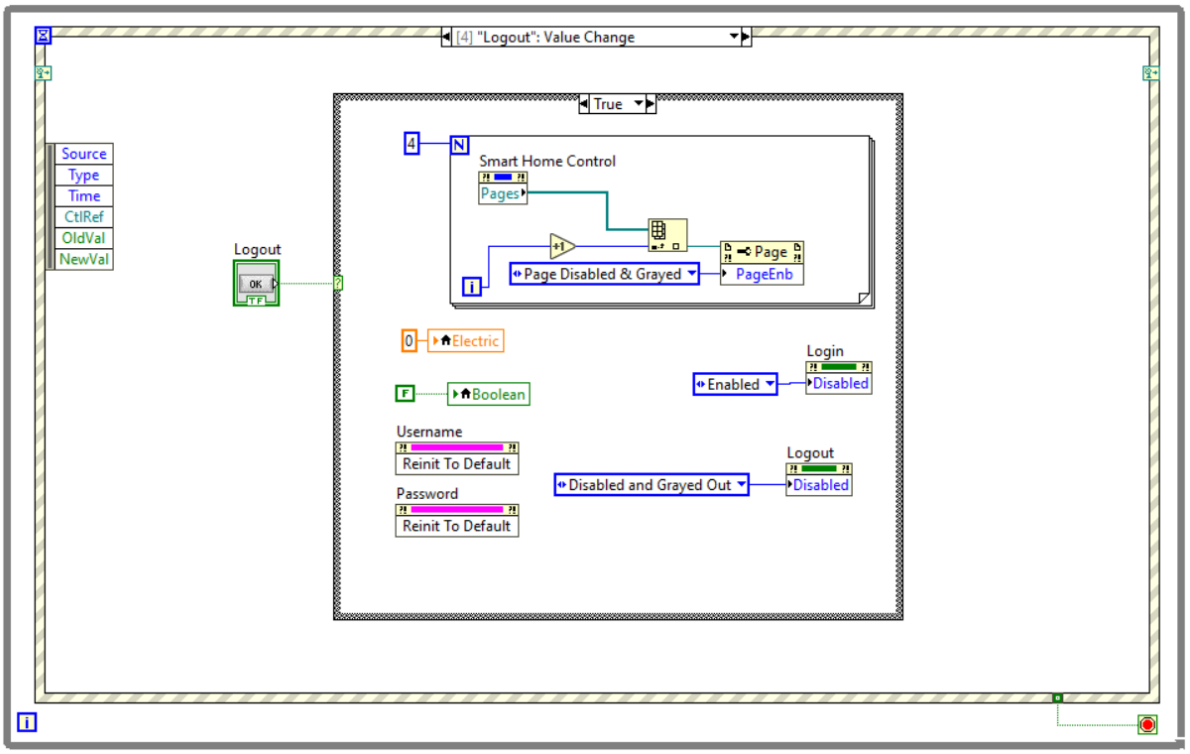


*Figure 12: Logout Page Code*

To avoid the user double log in the system, the login button will be disabled when the user successfully logged in and logout button will be enabled for the user to logout from the system. Once the user logged out, smart home control system pages such as Light, Door, Curtain and TV will be disabled and grayed.

### 5.3.2 Registration

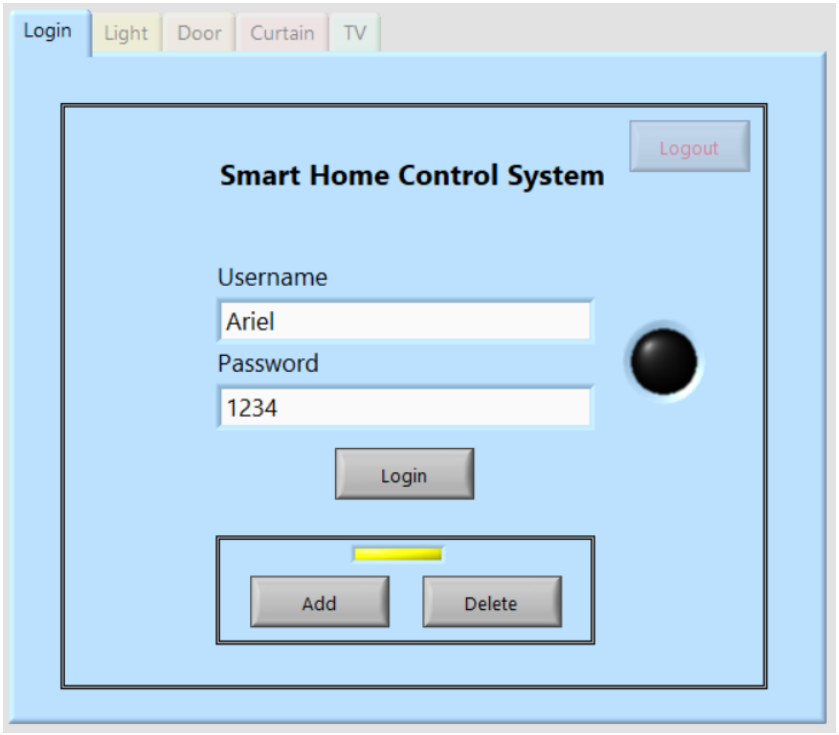


*Figure 13: Registration Page of Smart Home Control System*

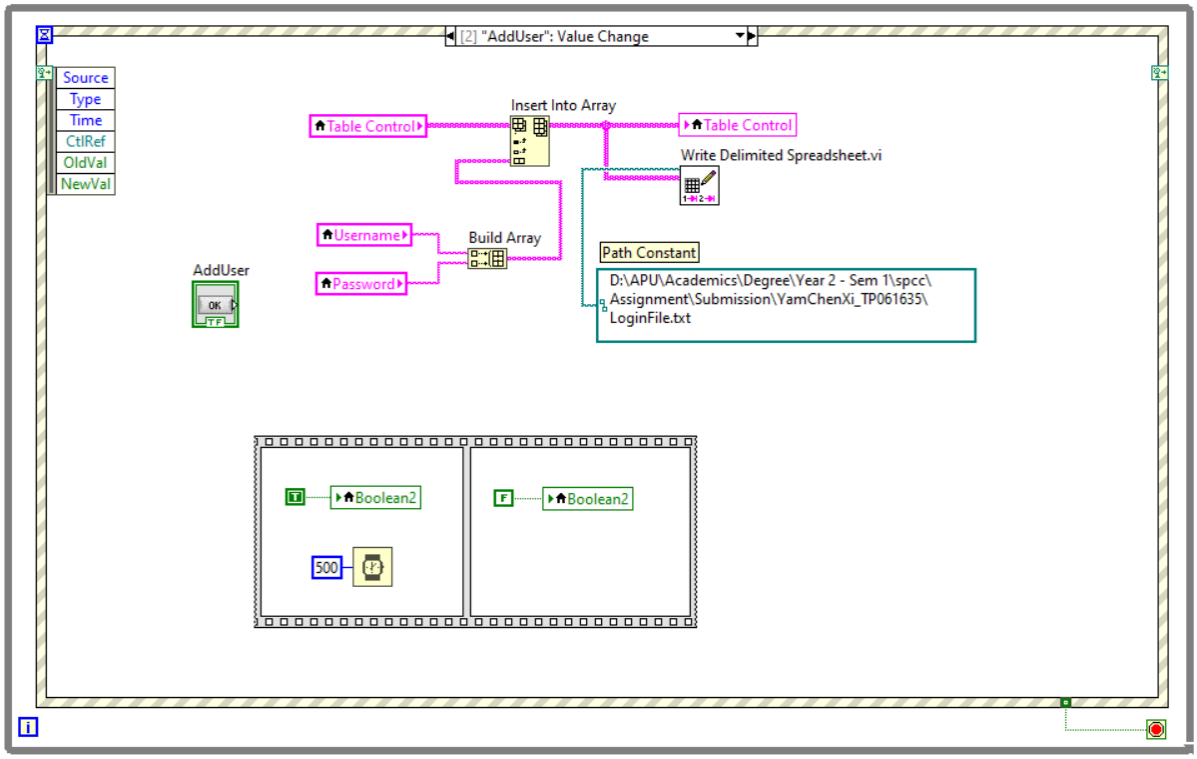


*Figure 14: Registration Page, Add User Code*

To allow the system to have a login system, it requires function to register and delete user login data. Registration function can be carried out when the user inputted their username and password for their new account and clicked on Add button, the system will user Write

Delimited Spreadsheet control to write the user data into LoginFile.txt. When the Add button is clicked, the Boolean LED will bright up in yellow for 5 seconds indicating registration successful.

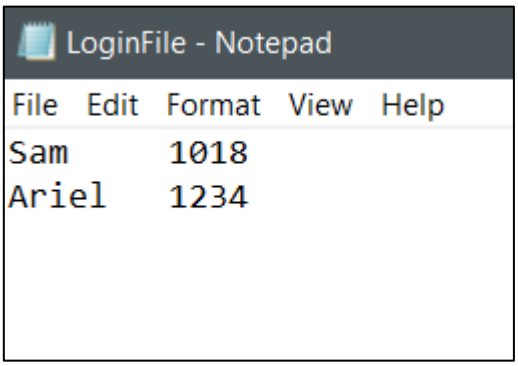


*Figure 15: Content of LoginFile.txt*

The figure above shows the content written into LoginFile.txt, the text file consist of the username and password of the registered users.

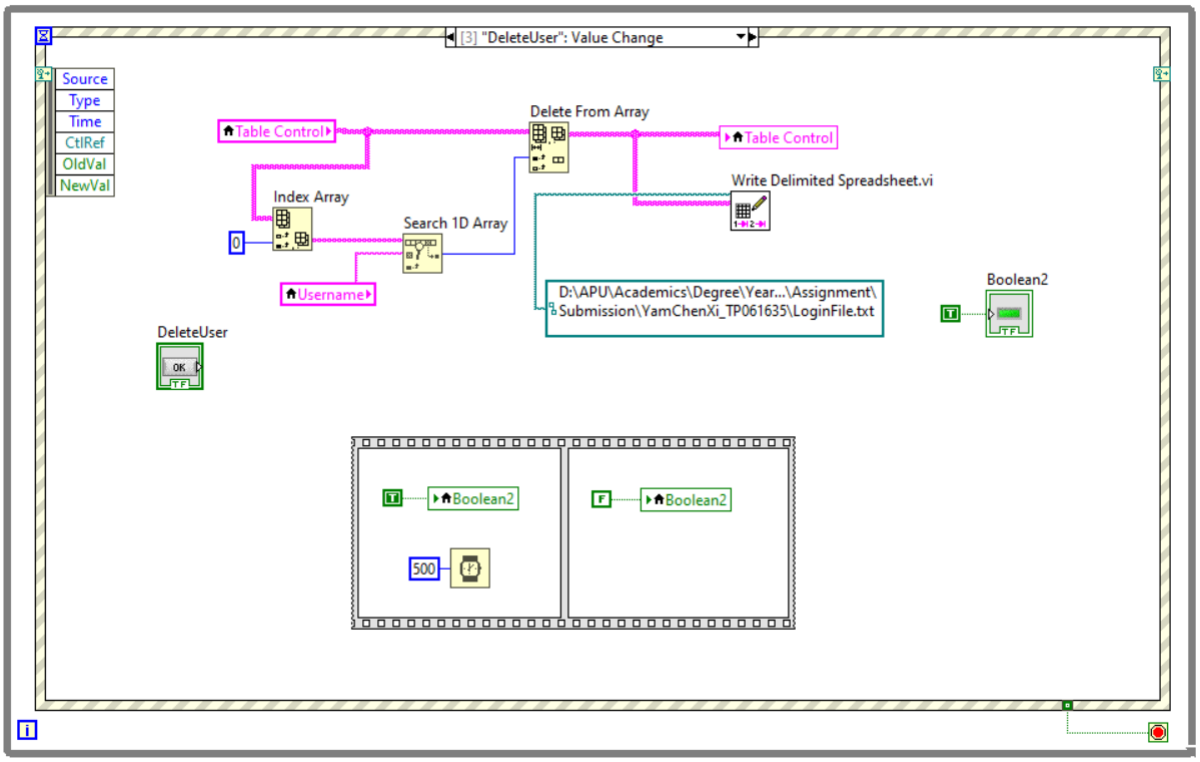


*Figure 16: Registration Page, Delete User Code*

Logout function can be executed when the user inputted their username and password for the account to be removed and clicked on Delete button, the system will user Write Delimited Spreadsheet control to delete the user data into LoginFile.txt. When the Delete button is clicked, the Boolean LED will bright up in yellow for 5 seconds indicating delete account successful.

### 5.3.3 Light Control

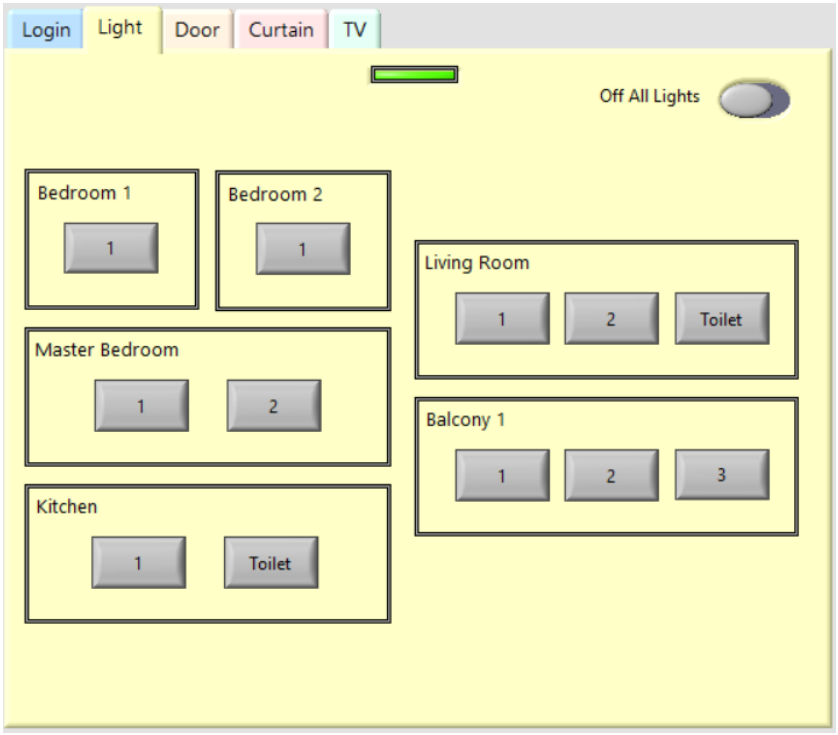


*Figure 17: Light Control Page of Smart Home Control System*

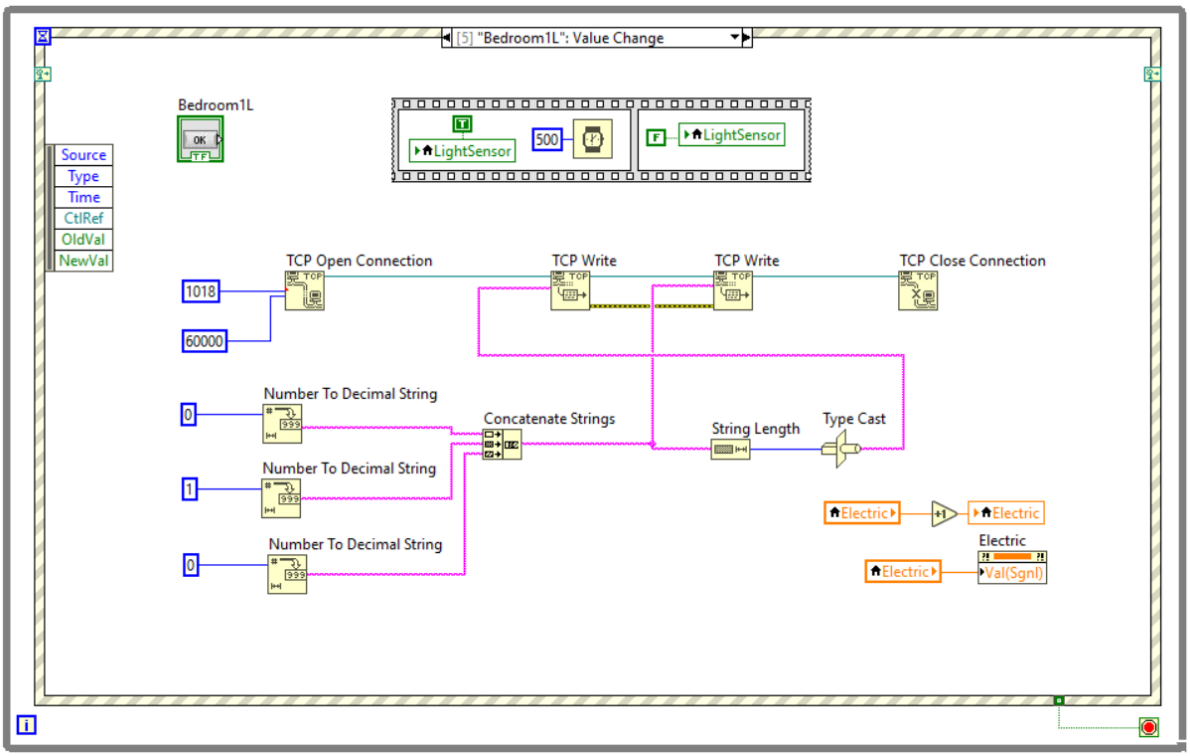


*Figure 18: Example of Light Control Code on Client*

One of the function available in the system is Light control. Light control allows the user to remotely switch on and off the selected lights. The function is called when the user clicked on the available button in the box named with room names. Once the button is clicked, the system

will transmit signal to Server using TCP/IP connection and signalling Electric Usage Indicator function. Once the button is clicked, the Light button sensor LED will light up in green for 5 seconds indicating signal transmitted successfully.

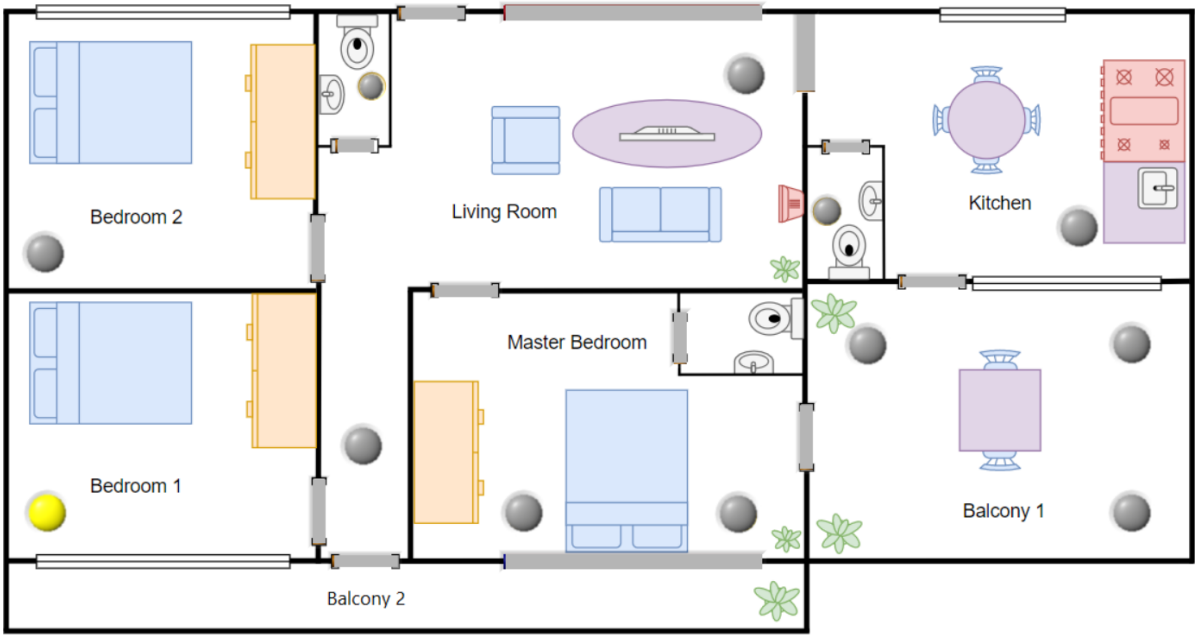


*Figure 19: Example Output of Light Control*

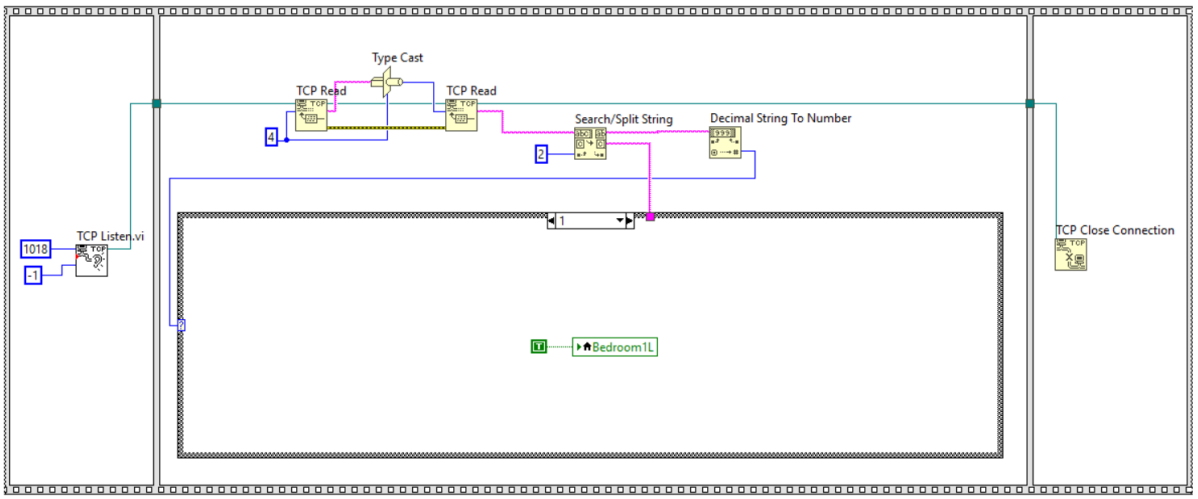


*Figure 20: Example Light Control Code on Server*

The Server side will be reading from the TCP signal and get the data to select case. Each of the case consisting different function, as of the example above shows case 1 lights up Bedroom1 light on the Server front panel.

### 5.3.4 Door Control

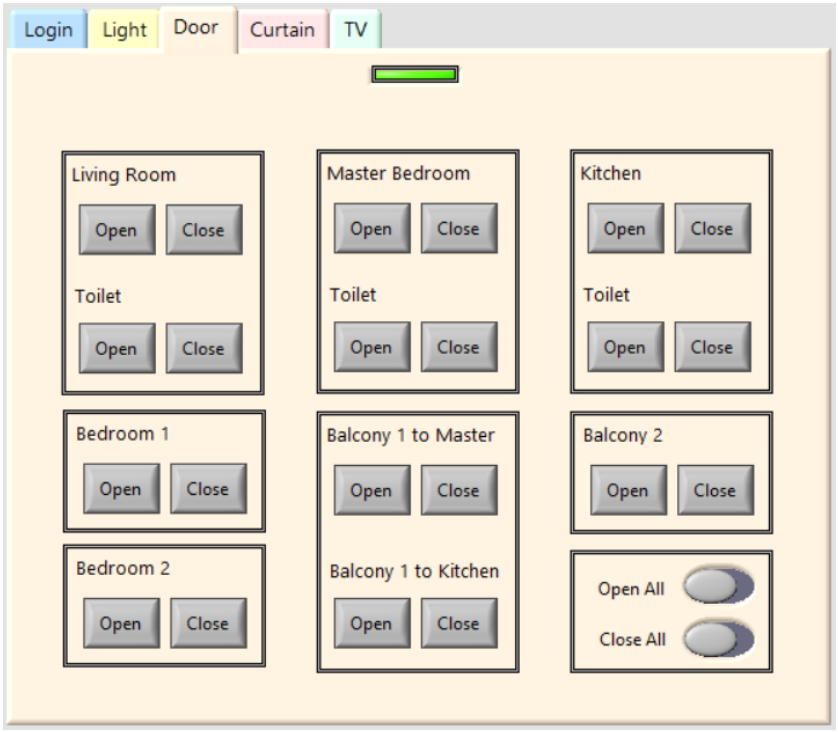


*Figure 21: Door Control Page of Smart Home Control System*

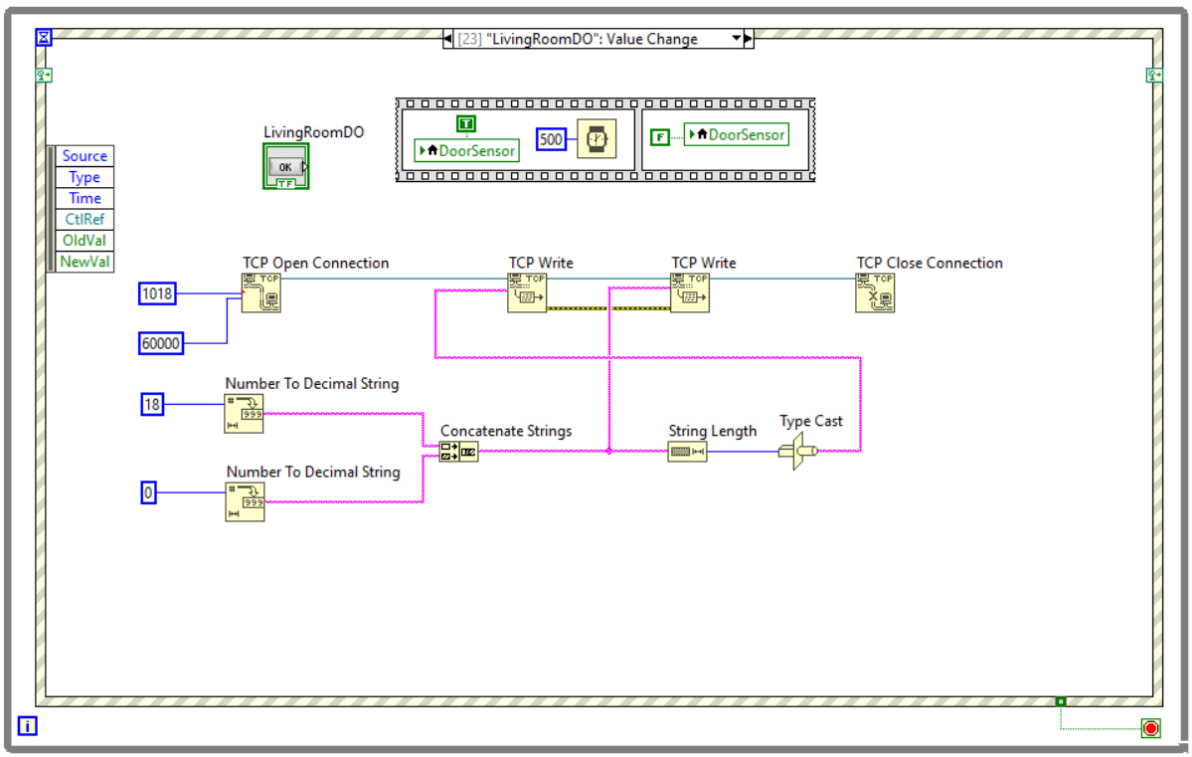


*Figure 22: Example of Door Control Code on Client*

Door control allows the user to open and close doors in the house remotely. The function is triggered when the user clicked on the available button in the box named with room names. Once the button is clicked, the system will transmit signal to Server using TCP/IP connection.

Once the button is clicked, the Door button sensor LED will light up in green for 5 seconds indicating signal transmitted successfully.

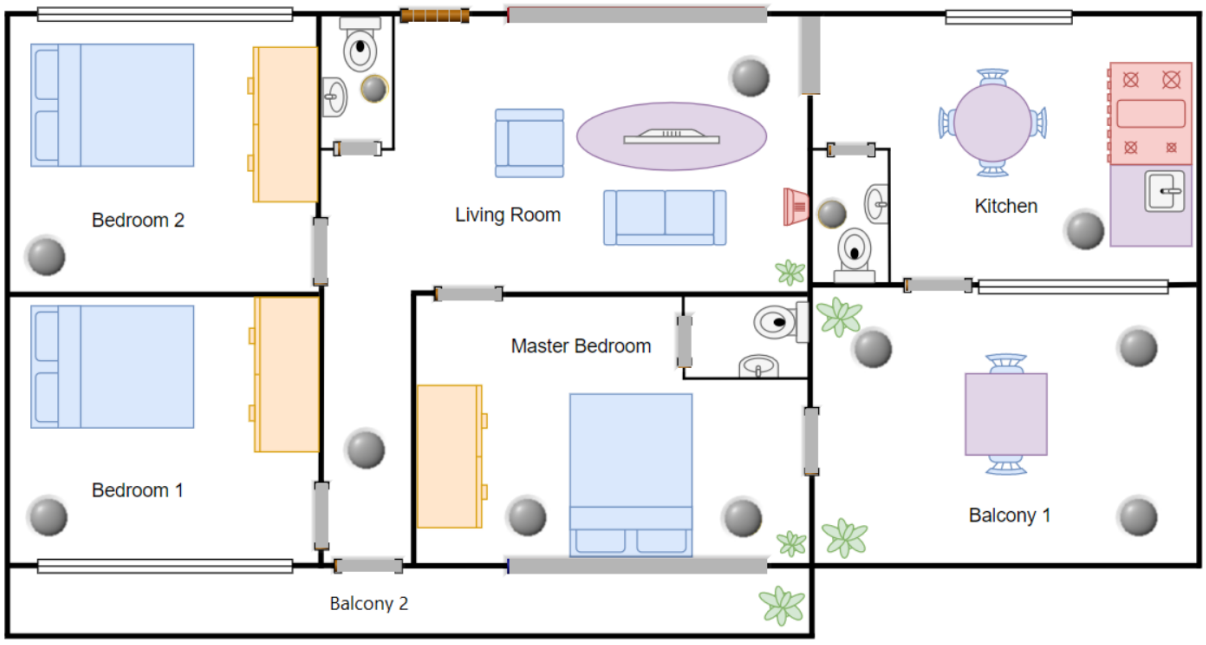


*Figure 23: Example output of Door Control*

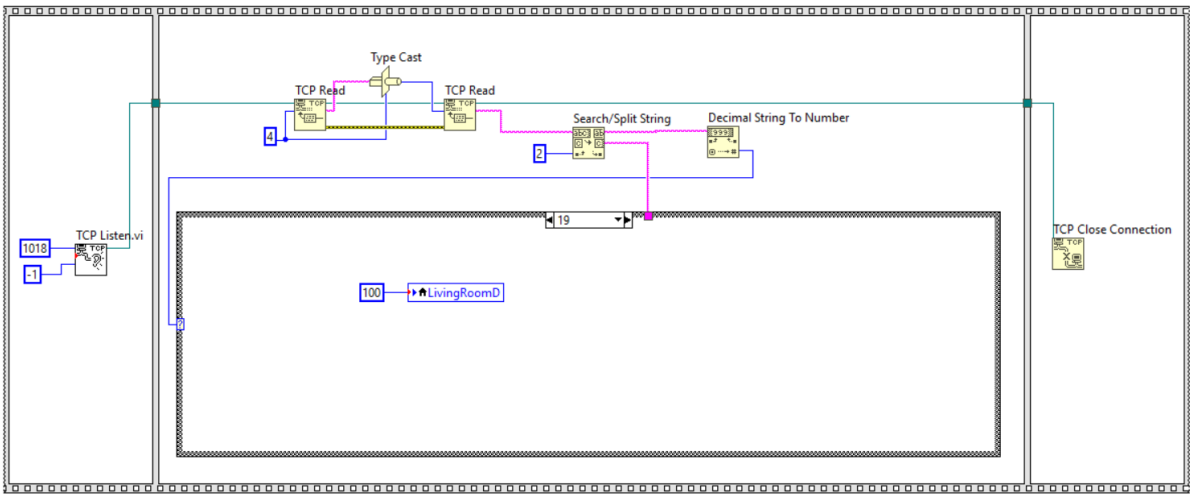


*Figure 24: Example of Door Control Code on Server*

The Server side will be reading from TCP signal and get the data to select case. As of the example above shows case 19 will close Living Room door on the Server front panel.

### 5.3.5 Curtain Control

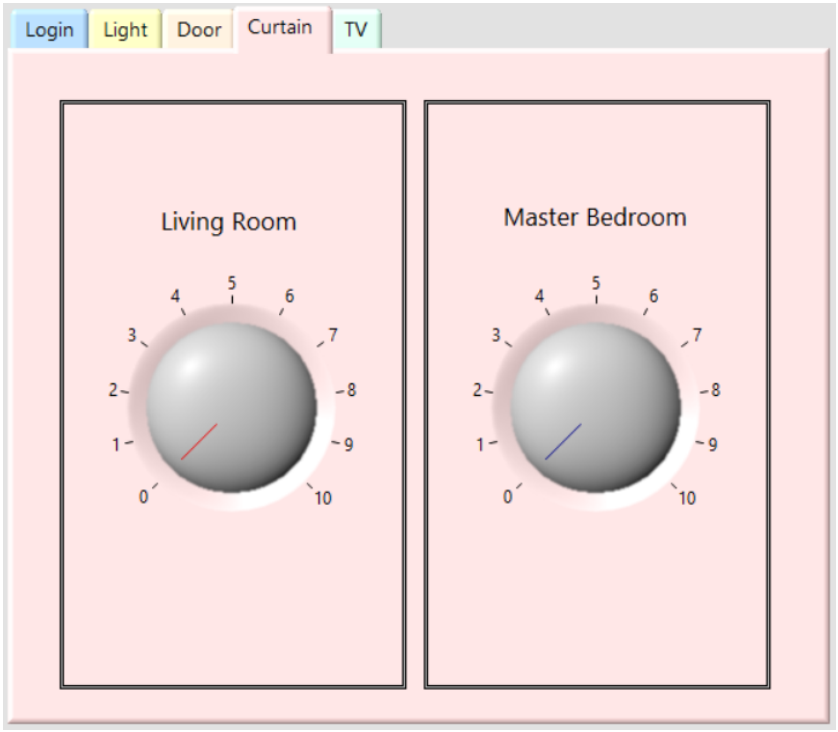


*Figure 25: Curtain Control Page of Smart Home Control System*

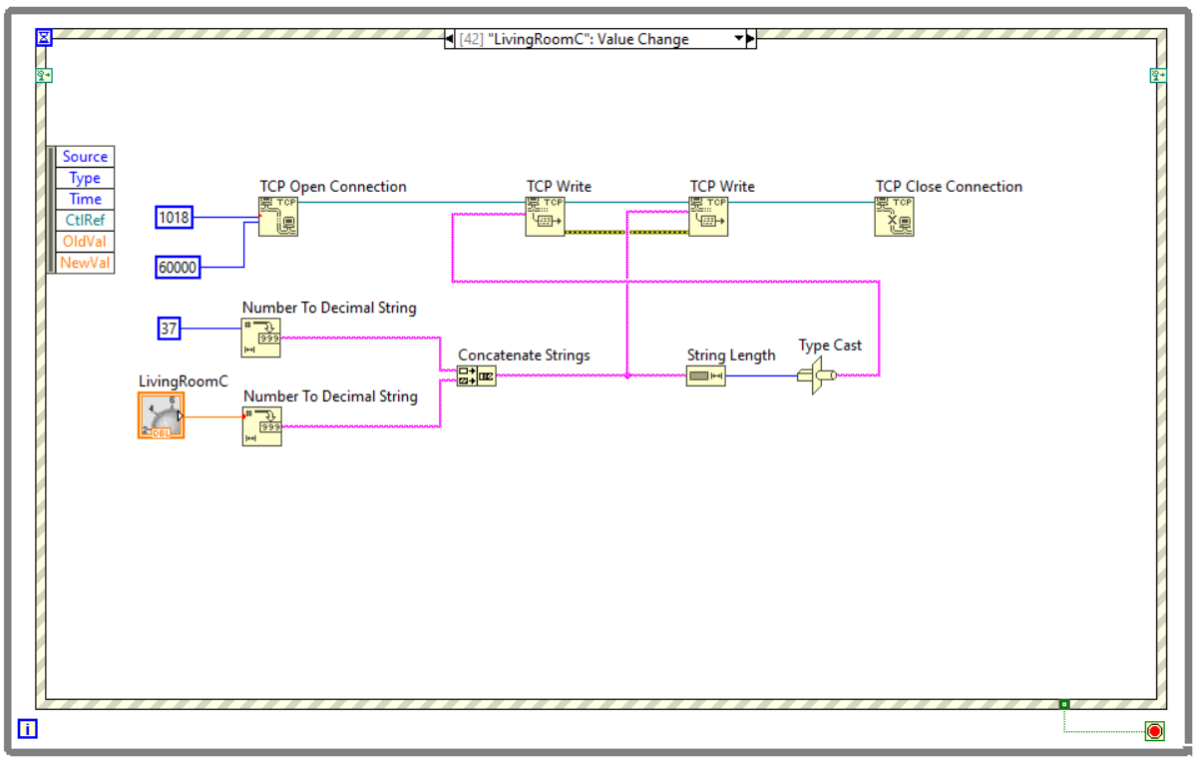


*Figure 26: Example of Curtain Control Code on Client*

Curtain control allows the user to open and close curtain from the scale 1 to 10 remotely. The function is triggered when the user turns the knob available in the panel. The system will transmit signal to Server using TCP/IP connection.

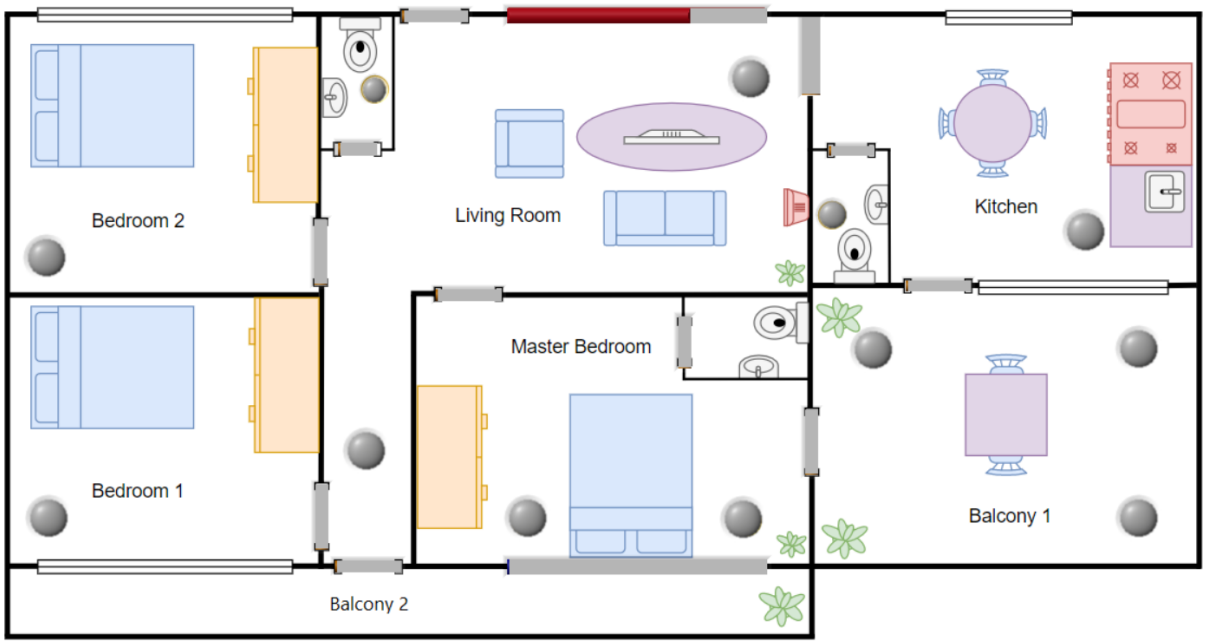


*Figure 27: Example Output of Curtain Control*

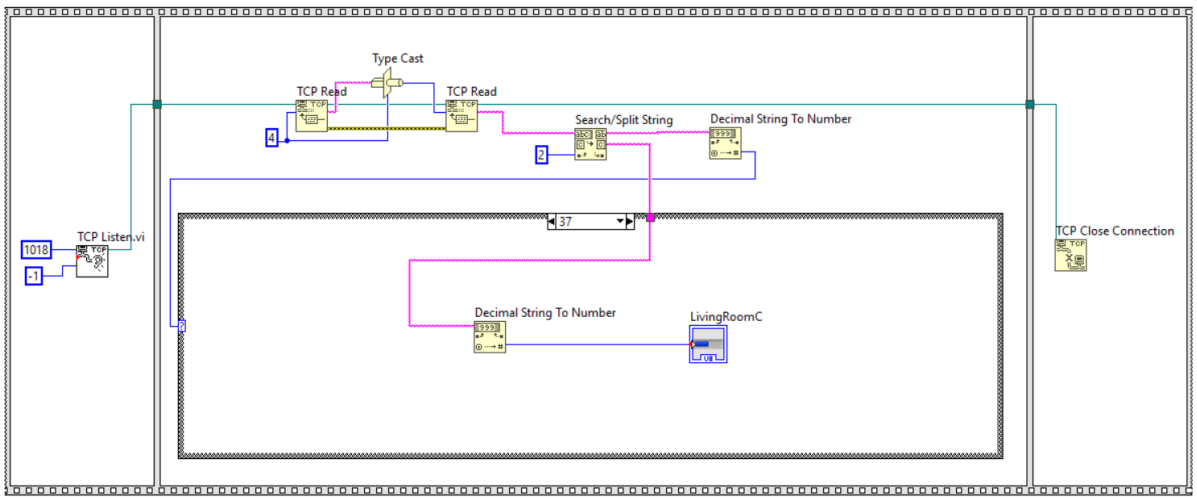


*Figure 28: Example of Curtain Control Code on Server*

The Server side will be reading from TCP signal and get the data to select case. The example above represents case 37 which it will convert the Client-side decimal string data into number and display it on the Living Room Curtain slider on Server front panel.

### 5.3.6 Television Control

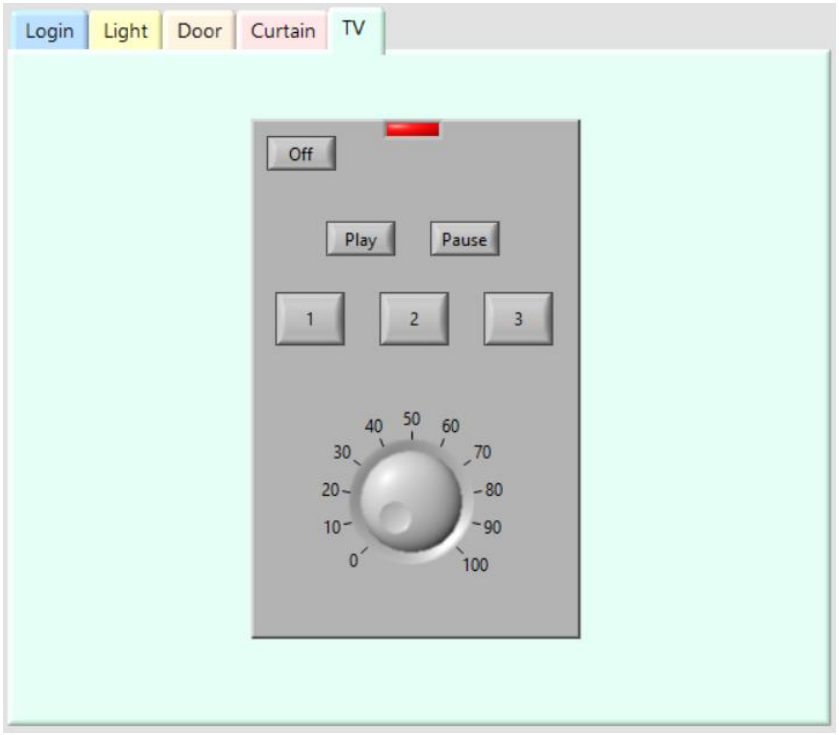


*Figure 29: Television Control Page of Smart Home Control System*

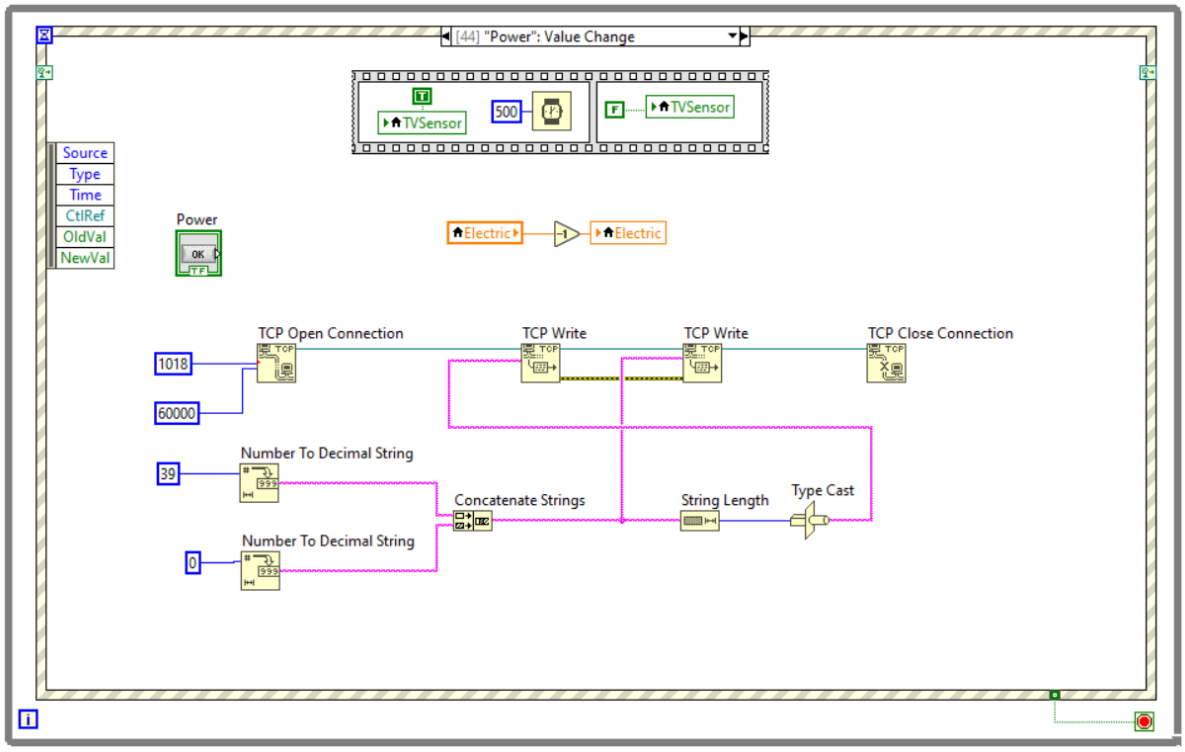


*Figure 30: Example of Curtain Control Code on Client*

Television control allows the user to off, play, pause, select channel and adjust volume of the television remotely. The function is triggered when the user clicked on the available button or

knob on the tab control. Once a button or knob is access, the system will transmit signal to Server using TCP/IP connection. Simultaneously, the Television remote sensor LED will light up in red for 5 seconds indicating signal transmitted successfully.

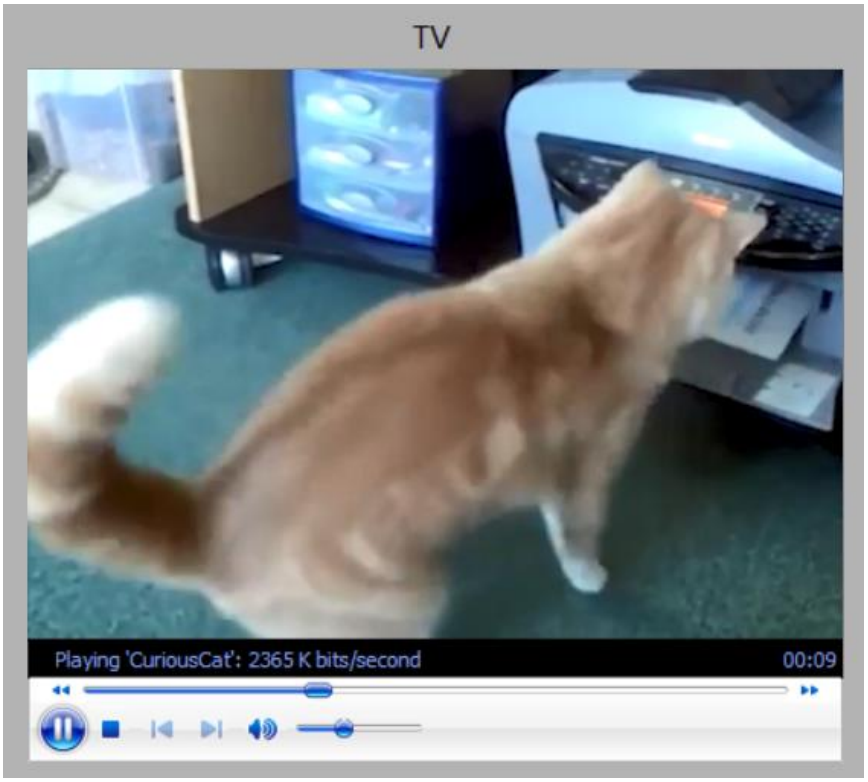


*Figure 31: Example Output of Television Control*

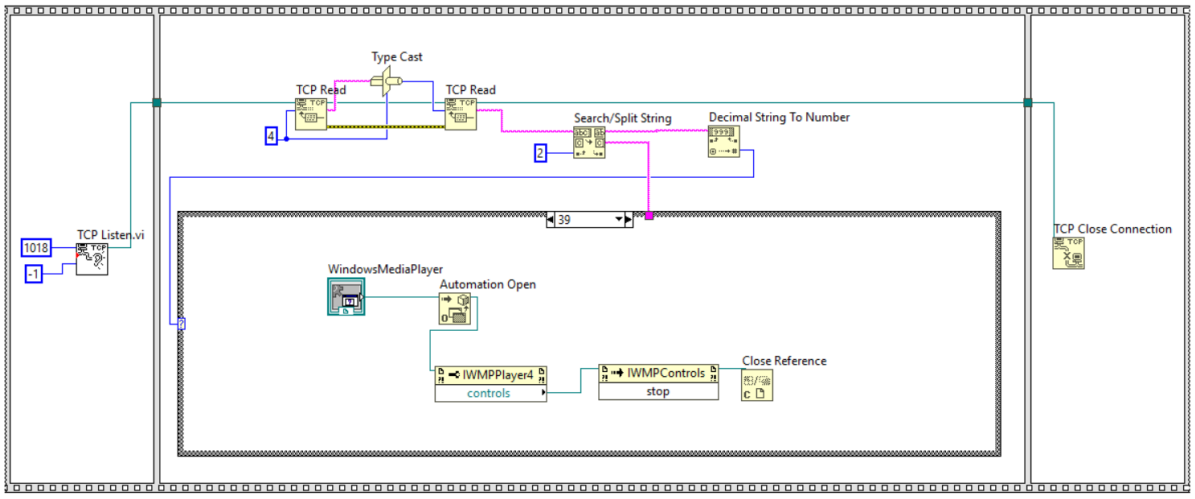


*Figure 32: Example of Television Control, Stop Code on Server*

The Server side will be reading from TCP signal and get the data to select case. The example above represents case 37 which it will convert the Client-side decimal string data into number and display it on the Living Room Curtain slider on Server front panel.

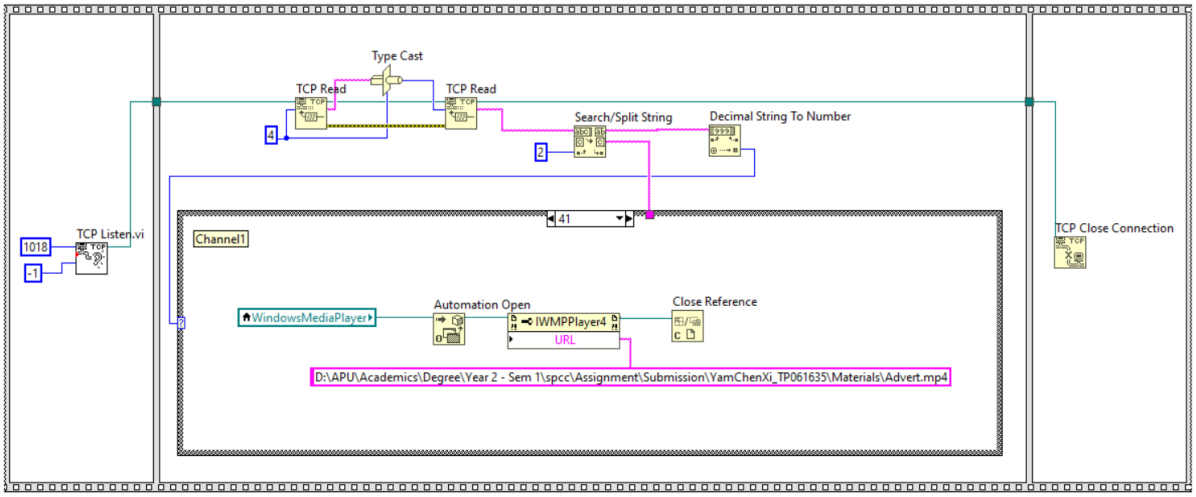


*Figure 33: Example of Television Control, Channel Code on Server*

To display video on WindowsMediaPlayer, it is required to provide video URL or video location from laptop. This is shown in case 41 which it gets the video from the designated path and display it on WindowsMediaPlayer.

### 5.3.7 Electric Usage Indicator

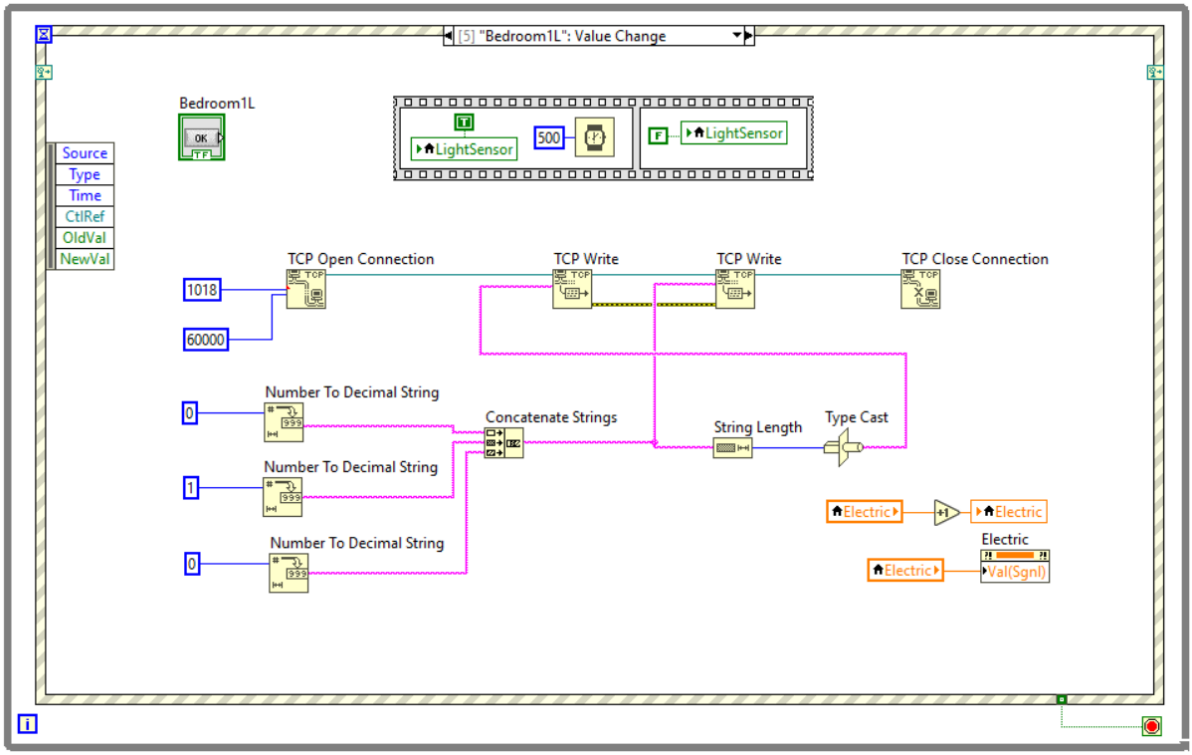


*Figure 34: Example Code to Trigger Electic Value Change Event on Client*

All the lights in the house consumes electricity and affecting the electric usage indicator. When light is switched on local variable Electric will be incremented and send signal to trigger Electric Value Change event.

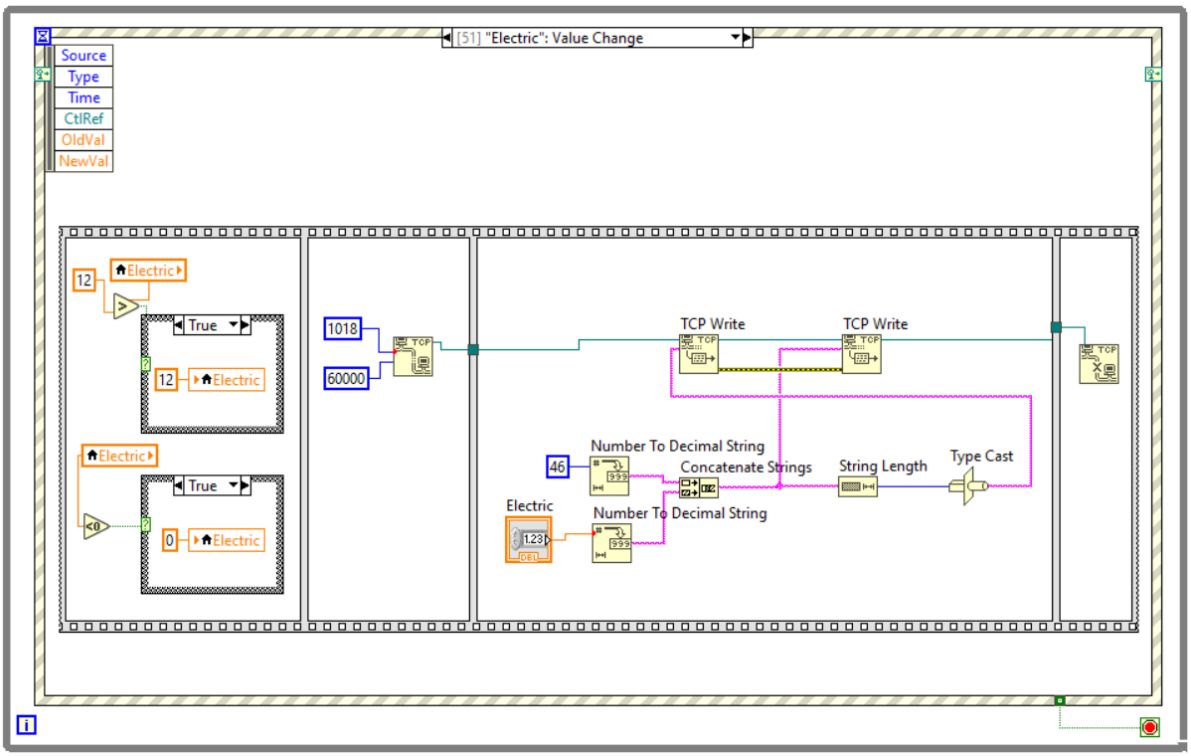


*Figure 35: Electric Usage Indicator Code on Client*

When Electric Value Change event is triggered, it will first check the local variable Electric is ranged within 0 to 12. Then, it will transmit signal to Server using TCP/IP connection.

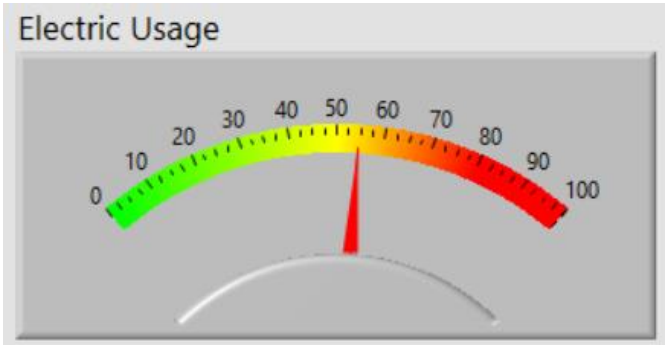


*Figure 36: Example Output of Electric Usage Indicator*

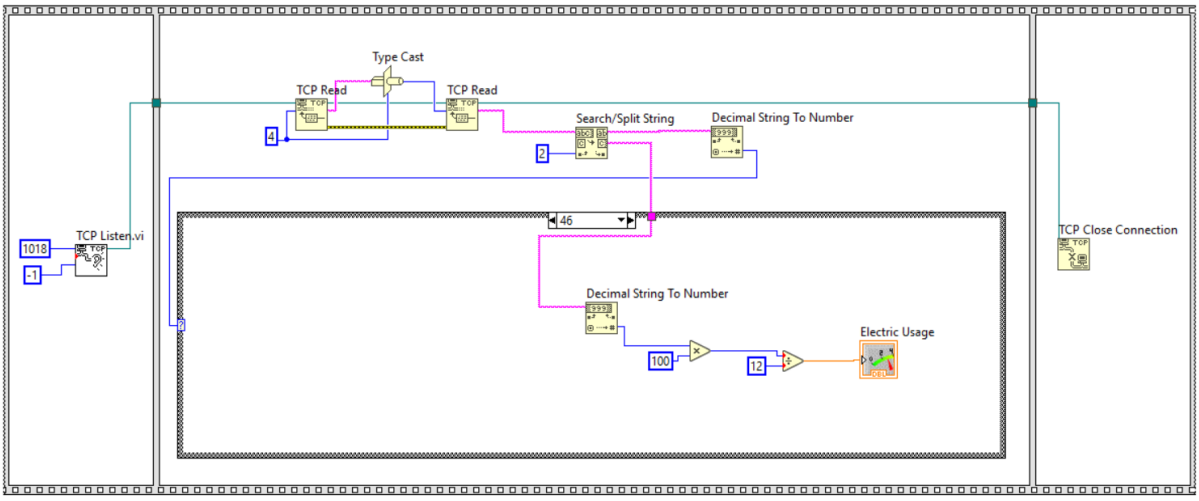


*Figure 37: Electric Usage Indicator Code on Server*

The Server side will be reading from TCP signal and get the data to select case. Electric Usage Meter Indicator is located at case 46, in this case it converts the decimal string from the data into number and calculate the electric usage into percentage to display it on the meter. The higher the meter is, the higher the electric usage.

# 6.0 Protocol Design

## 6.1 TCP/ IP

Transmission Control Protocol, or TCP, is a communications standard that permits computer hardware and software to communicate over a network. It is intended to transmit data through the internet and ensure that messages and data are transferred accurately across the networks. Packets are organised by TCP before being sent between a server and a client. It ensures the accuracy of the data transmitted through a network. TCP builds a link between a source and destination before sending data, and it assures that connection is active until data transmission occurs. Then, it divides enormous volumes of data into smaller chunks while preserving data integrity (fortinet, 2021). Additionally, Data is transmitted from one device to another via the internet uses Internet Protocol (IP). All device with IP address allows it to be uniquely identified and permits data interchange with other internet-connected devices (fortinet, 2021).

On a network like the internet, devices can interact due to a set of predetermined protocols called Transmission Control Protocol/Internet Protocol (TCP/IP). The various communications chores are divided into four layers by TCP/IP, namely datalink layer, internet layer, transport layer and application layer. Each of the layers carry out different functions to handle the received data (Fisher, 2019).

To allow data interaction within the Smart Home Control System, TCP/IP was applied to establish the connection between Server module and Client module. With the use of TCP/IP, it convenience private network to have interconnection between control panel and smart home appliances.

## 6.2 Client Model

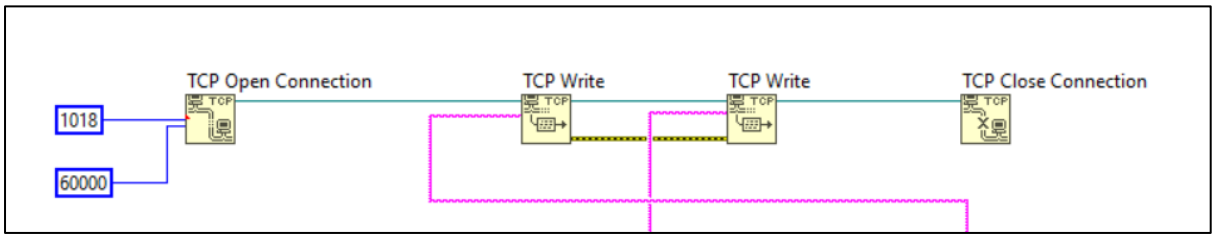


*Figure 38: TCP Connection on Client Model*

To establish TCP connection in Client Model, TCP Open Connection, TCP Write and TCP Close Connection are used in the model. Firstly, opening the connection with the port number of 1018 and timeout m/s of 60000. The port number is utilised to distinguish the unique port connection for signal transmission. While using TCP Write, it allows the data to be sent according to the data that were input by the user and store it in memory. Then, the data is sent to the server side for further processing. Lastly, TCP Close Connection is applied to close the interaction between Server and Client model. The data that was stored in the memory will be instantly erased as soon as the connection is cut off.

## 6.3 Server Model

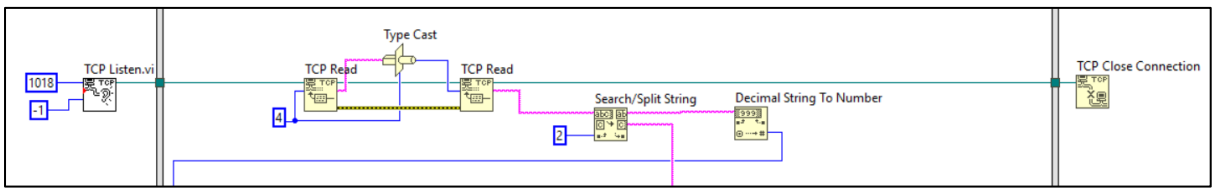


*Figure 39: TCP Connection on Server Model*

The TCP connection in Server Model consists of TCP Listen, TCP Read and TCP Close Connection. The connection starts with listing for port number of 1018 and timeout m/s of -1. If the signal from port number 1018 was found, it will proceed the data to TCP Read. With TCP Read it will get the signal from Client Model and send to Search/Split String to find the unique number given to each function. The found string will be converted into number so that the Server Model can connect the data to a case structure. Lastly, TCP Close Connection is applied to cut off the communication between Server and Client model.

# 7.0 Limitation

The limitation found in the developed Smart Home Control System will be discussed according to categories of the appliances.

The constraint found on the Light control is that the system can only switch on all lights one by one but having to switch off all lights at once. This will cause the user to need more time whenever they are required to only switch off one light at the time. There are also no functions to allow users to adjust the brightness and colour of the light.

As for Door control, it has a more complete functionalities, but it does not allow the user to only open the door halfway. Which able to provide air ventilation without having all doors wide open.

For Curtain control, it only allows the user to control one knob at a time. It will take up a lot of time, if the user only desired to have the curtain to either all curtain fully closed or opened.

Television control however, it consists of numerous functions but lacks special features such as speeding up and skip video. The mentioned extra features will allow the user to have a more complete setting to enjoy television.

The limitation found in Power Usage Meter Indicator is that the system does not have any eye-catching signal when the power usage is too high. The user will not be able to notice the meter even it is alarming high.

# 8.0 Future Enhancement

The Smart Home Control System has great potential to be improved tremendously. This is due to the reason that technology and people demand are rapidly changing day to day. Hence, the developers will surely be required to conduct more research on user needs and update the system with features that are currently trending.

One of the enhancements that can be implemented is to connect the smart home control system to the internet. This will allow users to monitor or manage their house across the globe. With the help of internet, the user will be able to constantly aware of the situation of their house at anytime and anywhere.

Besides, a stronger security system should be executed on the smart home control system. This will prevent having unauthorized users to access the house control and causing harm to the property. A strong security system will secure the homeowner privacy and prevent being monitored by uninvited individuals.

Other than that, a backup system should be prepared and constantly on standby. Assuming the homeowner has all the door closed and the system are not able to access due to system malfunction, the homeowner will not be able to get outside of the house until the system is up or getting help from others. Hence, with backup system, it will instantly temporarily replace the malfunction system until the system is repaired and keep the homeowner safe.

# 9.0 Conclusion

A smart home is a functional home design where electronics and appliances can be remotely controlled via the internet. To achieve a functional smart home control system, LabVIEW is utilised in the development process. The goal of this project is to utilise LabVIEW programming language to develop a Smart Home Control System for the given floor plan. In this project, a smart home control system is created using LabVIEW software to manage household devices. Using a TCP/IP connection, the second module which is Server.vi will get the user commands from the first module and execute the selected function on the targeted houseware. Arduino Nano, Relay Circuit, Voltage Measurement Sensors, Light Switch, Smart Door Opener, and Curtain Motor are the components.

# Reference

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# Appendix

## A: User Manual

### A1: Server

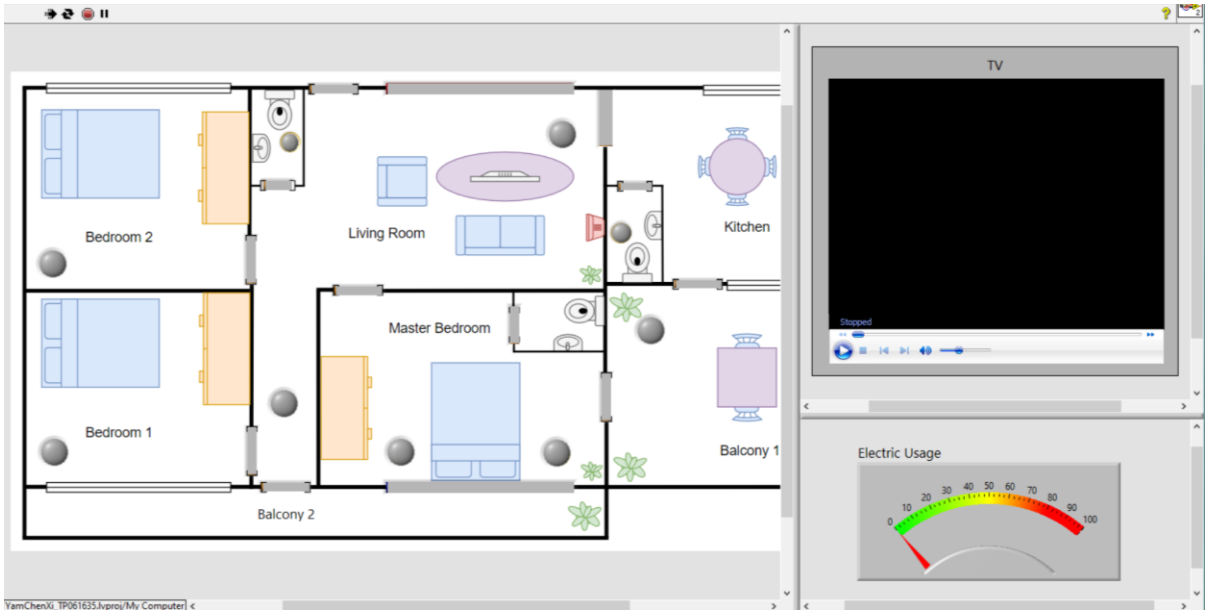


*Figure Apx 1: Server Front Panel*

The figure above shows the overall front panel of Server model. It has the floorplan on left side of the front panel, television on top right and electric usage meter indicator on bottom right. User are not able to make changes or change the value of the objects on Server model.

### A2: Client

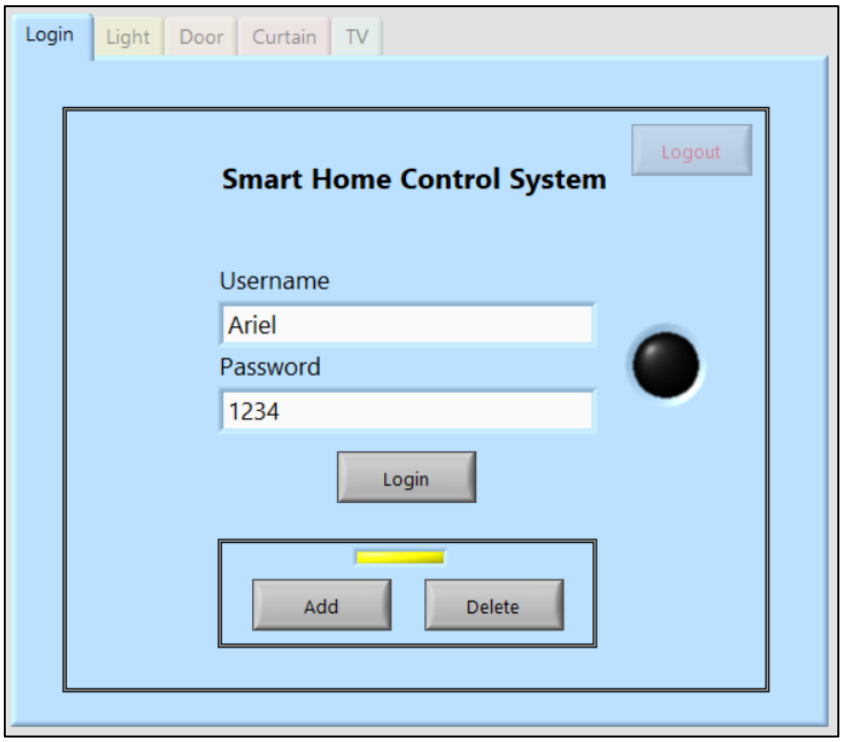


*Figure Apx 2: Login Page, Registeration*

1. The user is required to register for an account by input username and password to be registered into the database and click “Add” button.
    a. If the user wanted to delete an account, the user can input username and password of the account to be deleted from database and click “Delete” button.
    b. If the user has an existing account, the user can skip step [1] and proceed to step [2].

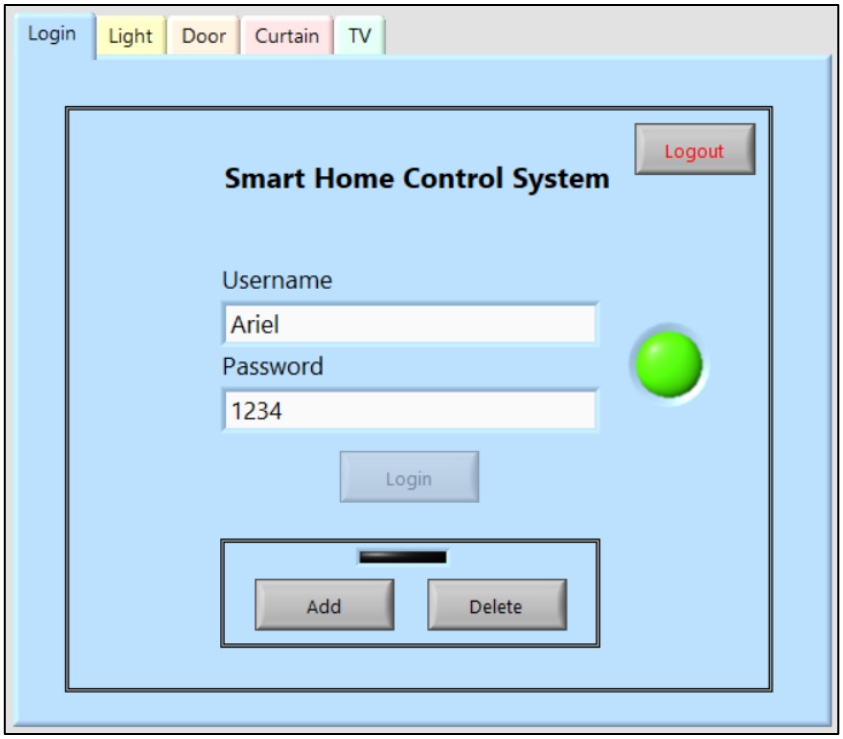


*Figure Apx 3: Login Page*

2. The user login the system by input username and password.
3. Click on "Login" button to login to the system.

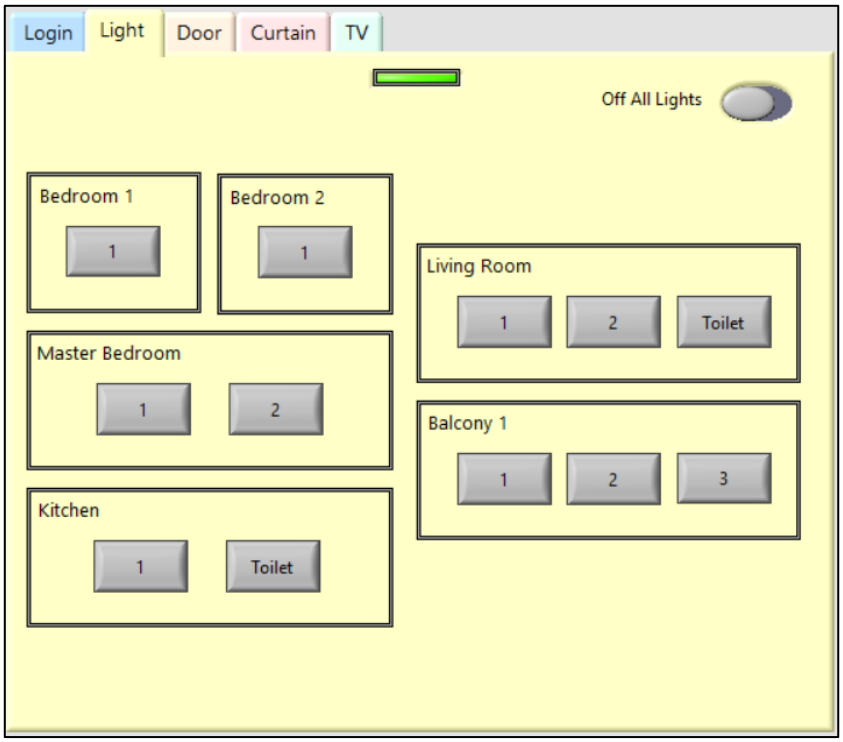


*Figure Apx 4: Light Control Page*

4. To access Light control, user click on "Light" on the menu bar on top of the control panel.

a. To switch on light of a specific room, user click on “1”, “2”, “3” or “Toilet” button provided on the panel according to the user choice.
b. To switch off all lights, user click on “Off All Lights” button on the panel.

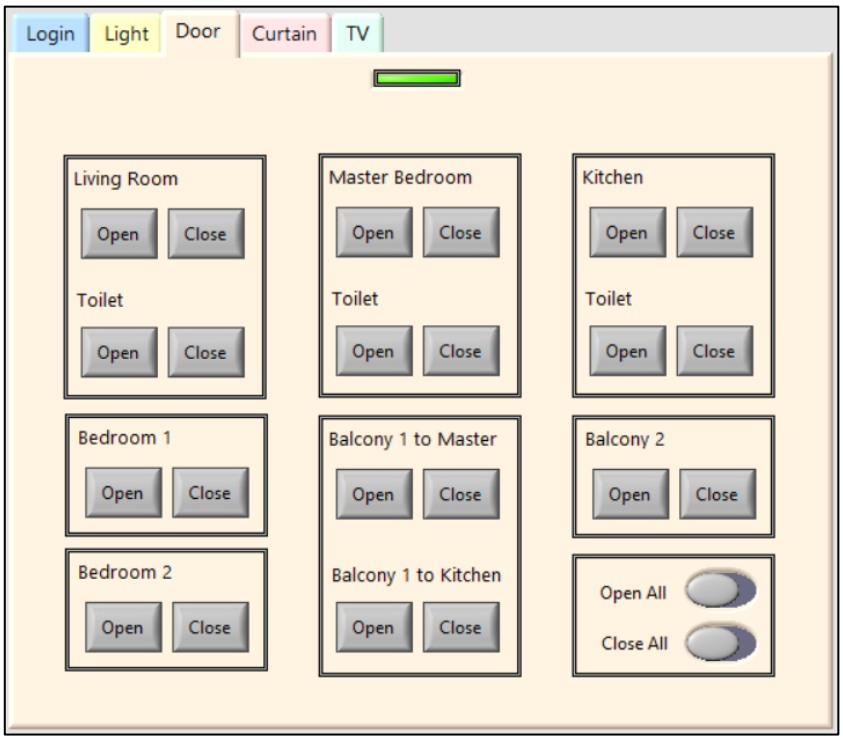


*Figure Apx 5: Door Control Page*

5. To access Door control, user click on “Door” on the menu bar on top of the control panel.
   a. To open a specific door in the room, user click on “Open” button provided on the panel.
   b. To close a specific door in the room, user click on “Close” button provided on the panel.
   c. To open all doors in the house, user click on “Open All” button.
   d. To close all doors in the house, user click on “Close All” button.

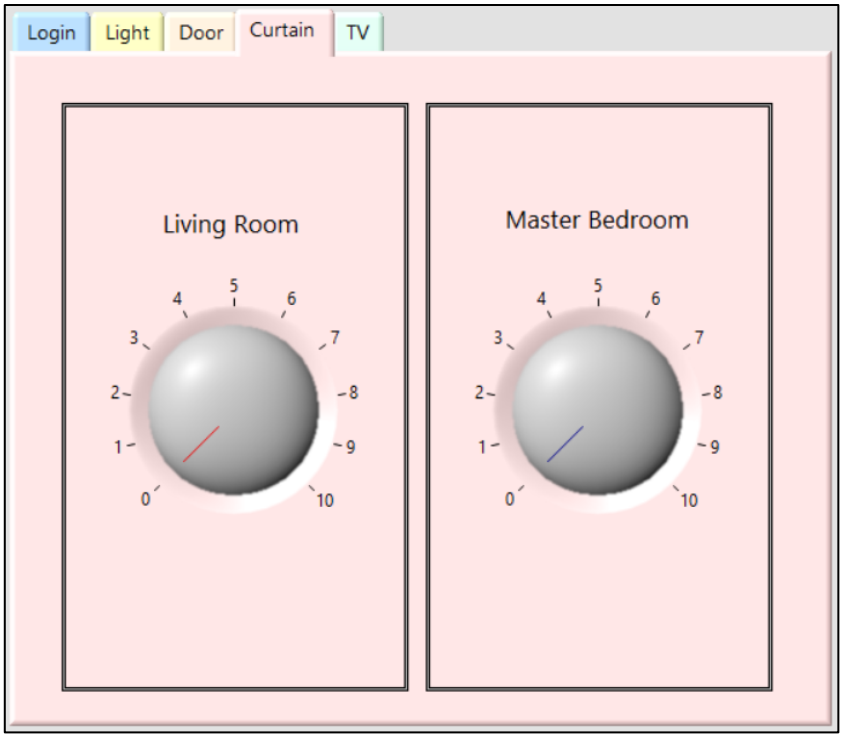


*Figure Apx 6: Curtain Control Page*

6. To access Curtain control, user click on “Curtain” on the menu bar on top of the control panel.
    a. To adjust curtain of a specific room, user turn the knob to the desired number to close or open the curtain.

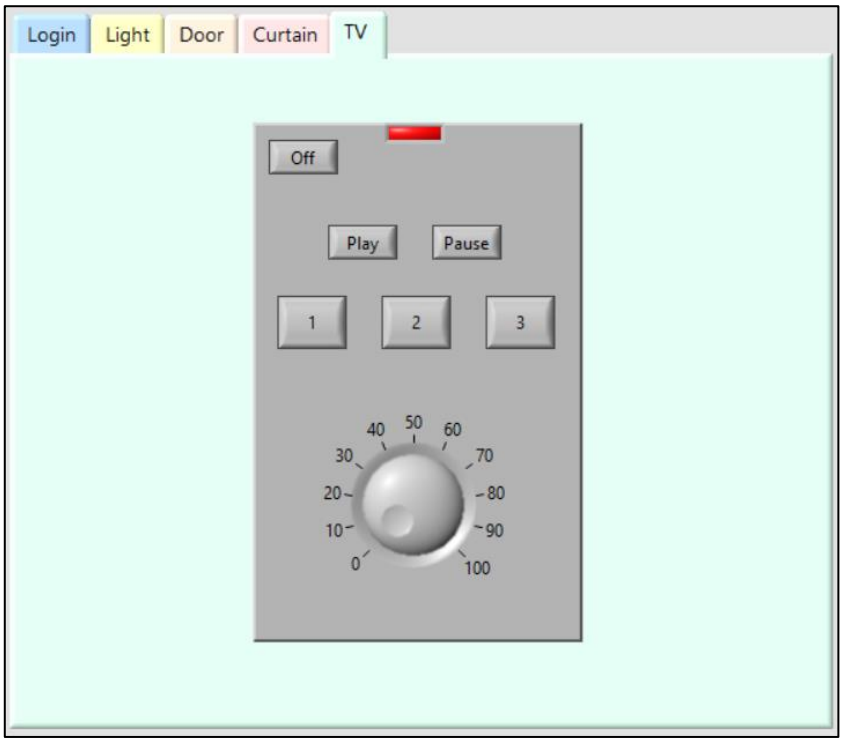


*Figure Apx 7: Television Control Page*

7. To access Television control, user click on “TV” on the menu bar on top of the control panel.
    a. To off television, user click on “Off” button on the remote control.
    b. To play the video, user click on “Play” button on the remote control.
    c. To pause the video, user click on “Pause” button on the remote control.
    d. To switch channel, user click on “1”, “2” or “3” to change channel.
    e. To adjust volume, user turn the volume knob to desired volume.

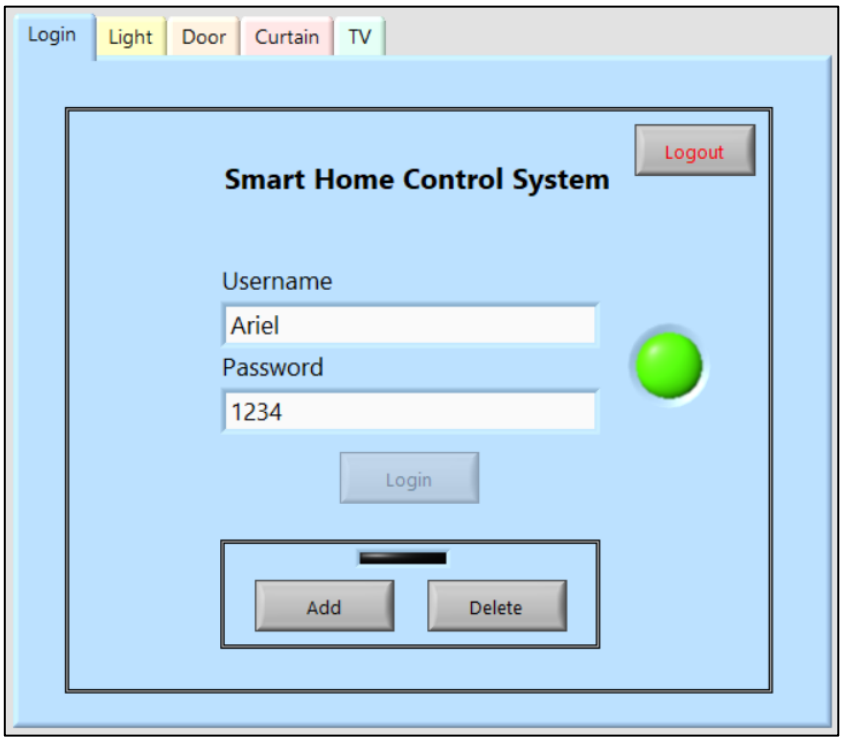


*Figure Apx 8: Logout Page*

8. To head back to login page, user click on “Login” on the menu bar on top of the control panel.
    a. To logout from the system, user click on “Logout” button.

## B: Gantt Chart

The attached gantt chart shows the tasks carried out to develop the Smart Home Control System using LabView. It included stages such as Planning, Design, Coding and Documentation. With the use of gantt chart, the development process can be more organised and able to keep track of the progress.

| | Task Name | Duratio | Start | Finish | Predeces |
|---|---|---|---|---|---|
| 1 | **Planning** | **4 days** | **Mon 8/8/22** | **Thu 11/8/22** | |
| 2 | Design and Planning | 3 days | Mon 8/8/22 | Wed 10/8/22 | |
| 3 | Analyse Requirement | 1 day | Thu 11/8/22 | Thu 11/8/22 | 2 |
| 4 | **Design Smart Home System** | **13 days** | **Fri 12/8/22** | **Tue 30/8/22** | |
| 5 | Design User Interface | 5 days | Fri 12/8/22 | Thu 18/8/22 | 3 |
| 6 | Implement Functions | 5 days | Fri 19/8/22 | Thu 25/8/22 | 5 |
| 7 | Debug System | 2 days | Fri 26/8/22 | Mon 29/8/22 | 6 |
| 8 | Testing | 1 day | Tue 30/8/22 | Tue 30/8/22 | 7 |
| 9 | **Code Refactoring** | **9 days** | **Wed 31/8/22** | **Mon 12/9/22** | |
| 10 | Implement Additional Features | 3 days | Wed 31/8/22 | Fri 2/9/22 | 8 |
| 11 | Testing | 2 days | Mon 5/9/22 | Tue 6/9/22 | 10 |
| 12 | Refactoring Code | 4 days | Wed 7/9/22 | Mon 12/9/22 | 11 |
| 13 | **Documentation** | **7 days** | **Tue 13/9/22** | **Wed 21/9/22** | |
| 14 | Finalise and Document | 7 days | Tue 13/9/22 | Wed 21/9/22 | 12 |

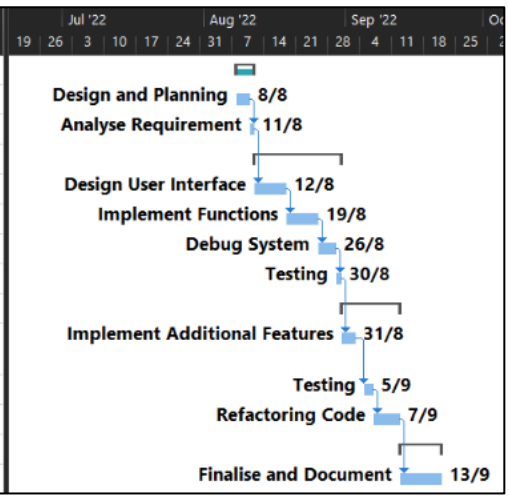


*Figure Apx 9: Development of Smart Home Control System, Gantt Chart*