Voice User Interface(VuI) Smart Office Door Application in the Context of Covid-19 Pandemic

Muhammad Zharif Aiman Alias, Wan Norsyafizan W. Muhamad
School of Electrical Engineering, College of Engineering, University Teknologi MARA, Malaysia

Darmawaty Mohd Ali
School of Electrical Engineering, College of Engineering, University Teknologi MARA, Malaysia

Azlina Idris
School of Electrical Engineering, College of Engineering, University Teknologi MARA, Malaysia

E-mail:syafizan@uitm.edu.my

Abstract

Nowadays, all countries around the globe are trying their best to prevent the spread of Covid-19 from reaching their people. However, the virus spread is through the transmission of close contact with the infected person and touching a surface that already contains the virus. This project presents Voice User Interface (VUI) Smart Office Door System that interact with the Internet of Things (IoT) to execute the command given by the user. This project use Raspberry Pi as microcontroller which Thonny Python software used for running the coding script of the system. The electrical components such as dc motors and LEDs are connected to General-Purpose Input Output (GPIO) pin of Raspberry Pi and motor driver. One of the dc motors used for controlling the lock and another one used for controlling the door. Blue LED used as locked door notification while green LED used as unlocked notification. Microphone and speaker connect to the Raspberry Pi through usb port and Bluetooth. This system used Google Assistant as its VUI to control the smart door contactless. The user can give the command to the system through microphone to control the output of the system. The purpose of this project is to invent the smart door with IoT technology that help prevent the spread of Covid-19 at the workplaces.

Keywords:Voice User Interface (VUI), Internet of things (IoT), Google Assistant, voice command and dc motor

1 INTRODUCTION

Nowadays, the novel coronavirus, also known as COVID-19, became unpredictable and caused a massive loss to people worldwide. Coronavirus can be spread through the surface appliances that have been touch by the infected person. The virus can live on that surface at most 48 hours. The workers get affected by the virus when using the same appliances at the workplace such as door, switch, water dispenser and photostat machine. The invention of contactless appliance has been emphasized as it will help reduce the possibility of the people get affected by the virus caused by touching appliance's surfaces. The appliance can be controlled by voice command with the help of Voice User Interface (VUI), Internet of Thing (IoT) and smart controller [1].

Voice user interface (VUI) is a speech recognition technology that allows people to interact with a computer, smartphone, or other devices through voice commands [2][3]. Google Assistant is one of the VUI that are available in the market today [4]. This project propose the voice command to control the smart office door when interacting with the Internet of Things (IoT). The smart door will help people to eliminate the needs to touch the surface. To develop a voice-based command controller, a microphone will be used in data transmission communication and a voice signal processor to implement the voice recognition method.

Google Assistant is an artificial intelligence-powered virtual assistant developed by Google[5][6]. Users interact with the Google Assistant through natural voice or keyboard input. The Google Assistant can search the Internet, schedule events and alarms, adjust hardware settings on the user's device, and show information from the user's Google account. In the future, Google says that the Google Assistant will identify objects, gather visual information through the device's camera, support purchasing products and identify songs. For this project, Google Assistant will

be used as VUI to control the smart office door with the help of IoT technology.

The Internet of Things brings a new node to a marketplace and knocks on the door with new options for innovations[7]. IoT is a system that integrates with sensors, computers, and digital devices through the internet and connects with each other to exchange and transmit information via special Identifications (IDs). The emphasis on automation technology has risen significantly with the new invention of automation appliances [8]. Some automation technology use voice command as input because it is more efficient compared to the sensors. In IoT, the voice command signal must be transmitted immediately between adjacent nodes throughout the IoT-enabled network. Thus, the nodes must be in the overlapping communication range of one another for this to occur. The IoT-based system helps the user to control the smart home system without ever having any physical contact [9][10]. The IoT emphasizes the use of ambient technology, robotics and IoT to reduce screen-based interaction, meaning that the user interface is blended with the physical gadget. Besides IoT, microcontroller such as Raspberry Pi plays the main role for the whole system.

The Raspberry Pi is a Linux single-board computer which use SD card as storage. It has an Ethernet, two USB interfaces, a USB interface, HDMI (support sound output) and RCA terminal output support. One of the applications of Raspberry pi is to operate a system that operates itself and can access the wireless network and Bluetooth chips[11].The Raspberry Pi has also been used as a processing chip and underlying architecture to build up a personal assistant[12][3][13]. The proposed voice-operated personal assistant focused on Raspberry Pi gives individuals more comfort and ease.

There are several works in literature that proposed the voice command system to control appliances. Mtshali et al presented a smart home appliance control system for physically disabled people [14]. The system consists of a smart plug, smart camera, smart power strips and digital assistants such as Google Assistant, Siri, or Alexa. This system captured the voice command from the user and provide the output signal for controlling the targeted appliances, such as turning it on/off. Having this system could be a tremendous benefit for disabled people. This system also helps to enhance the quality of nondisabled people.

Nefy Puteri Novani and Mohamad Hafiz proposed electrical household appliances control using voice command based on a microcontroller [1]. In this system, EasyVR Commander been used as a sensor that can receive voice input to control electrical appliances such as fan, light, and door. Then, voice recognition method been implemented to captured voice signal to recognize the type of voice pattern. This method is important to provide safety feature to the system. This system only allows the homeowner to give the command to control electrical appliances in that house.

Yash Mittal et al proposed a voice-controlled multi-functional smart home automation system [2]. This system allows users to use voice command to control the home appliances and gadgets for different functions and purposes. This system can adapt to the user's voice and recognize the voice command, depending on the speakers' accents. Arduino microcontroller and dedicated hardware module used in this system for commands processing and control the appliances. This system aims to be affordable, flexible, and robust.

For the propose smart office door, the office door, microcontroller, motor driver, dc motor, LED and microphone are integrated as a smart door control system. The proposed smart office door system provides users with a feature that can control the office door contactless using voice command [15]. This system consists of several modules: LED, dc motor, motor driver, microphone, IoT, operating system device, voice user interface (VUI), and Raspberry pi. The Raspberry Pi 400 is the the microcontroller for the whole system. The Google Assistant is implemented into the microcontroller and provide the ability of voice command controller with the help of IoT. For the door system, there will be two parts that will be controlled by the user, which are the lock of the door and the door itself. User can control the system's lock through the voice command system by giving the specific command and opening the door only when the door is unlocked by given a specific command. There will be an LED notification to let the user know either the door is locked or unlocked. This system provides touchless feature for opening/closing of the door which prevent spread of Covid-19.

2 METHODS

2.1. Block Diagram

As mentioned, the proposed Voice User Interface (VUI) Smart Office Door provides user with the feature to control the office door using voice command. Figure 1 shows the block diagram of the VUI Smart Office Door system. This block diagram consists of several modules: voice command, Raspberry Pi, Cloud, Google Server, LED, motor driver, and dc motor. In this project,

Raspberry Pi 400 is used as a microcontroller for the system.

Figure 1 shows the Block diagram of the proposed VUI smart door system. A microphone captures the voice command from the user and convert it into an input signal for the system. Raspberry Pi which is a microcontroller for the system will receive the input signal and sent it to the Cloud through the internet. Cloud refers to the servers that are accessed over the internet, and software and databases that run on those servers. The Cloud will directly transfer the signal to the Google Server for processing. Google Server function is to execute the coding script when the event fulfils the condition. In this system, when Google Server received the signal, it executes the output signal based on the function setup. The output signal will be sent to the Raspberry Pi via an internet connection. Following that, the microcontroller distributes the output signal to the user and the targeted components such as LED and DC motor to execute the command given by users. For controlling the dc motor, the signal should be sent to the L298N motor driver as it controls the movement of the motor.

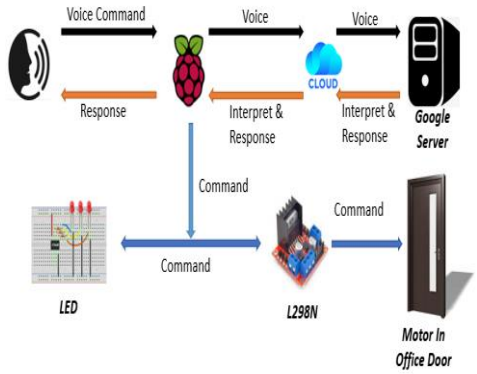

Figure 1: Block diagram show the operation of Voice User Interface Smart Office Door *Flowchart*

Figure 2 illustrate the flowchart of the proposed system. To access the Smart Office Door system, user needs to say “Hello Friend”. This command is used as a password for security purpose to the Smart Office Door system. When password command been detected by the system, GPIO pin 21 at Raspberry Pi will produce the high output signal to turn on the LED notification for the locked door and give the user access to the Smart Office Door system. This LED notification will let the user know the door is locked. After getting access to system, the user needs to give the command “Unlock the Door” to the system. When this command is detected, the lock motor will rotate to the right to unlock the door. The GPIO pin 3 will produce a high output signal, and GPIO pin 2 will produce the PWM wave output signal with half of the max value for 0.7 seconds. These output signals will be sent to the L298N motor driver to rotate the lock motor in the right direction with half of the speed for 0.7 seconds to unlock the door. Next, GPIO pin 2 will produce the PMW wave signal with zero value, and this signal will be sent to the motor driver to stop the lock motor rotation. Then, GPIO pin 21 will produce the low output signal to turn off the LED notification for the locked door, and GPIO pin 20 will produce the high output signal to turn on the LED notification for the unlocked door. This LED notification will let the user know the door is unlocked.

Users need to give command “Open the Door” to open the smart door. When this command is detected by the system, the smart door will open, and after several seconds, the smart door will automatically close. The GPIO pin 22 will produce a high output signal, and GPIO pin 7 will produce a PWM wave output signal with half of the max value for 0.8 seconds. Both signals will be sent to the motor driver to rotate the door motor in the left direction with half the speed for 0.8 seconds to open the door. Next, the GPIO pin 7 will produce the PWM wave output signal with zero value for 2 seconds. This signal will be sent to the motor driver to stop the door motor rotation for 2 seconds. Then, the GPIO pin 22 will produce the low output signal, GPIO pin 25 will produce the high output signal, and GPIO pin 7 will produce the PWM wave output signal with half of the max value for 0.8 seconds. These signals will be sent to the motor driver to rotate the door motor in the right direction with half of the speed for 0.8 seconds to close the door. Lastly, GPIO pin 7 will produce the PMW wave signal with zero value, and this signal will be sent to the motor driver to stop the door motor rotation.

Users need to give the command “Lock the Door” to lock the smart door. When the system detects this command, the lock motor will rotate to the left side to lock the smart door. The GPIO pin 3 will produce a low output signal, GPIO pin 4 will produce high output signal and GPIO pin 2 will produce the PWM wave output signal with half of the max value for 0.7 seconds. These signals will be sent to the motor driver to rotate the lock motor in the left direction for 0.7 seconds to lock the smart door. Next, GPIO pin 2 will produce the PMW wave signal with zero value, and this signal will be sent to the motor driver to stop the lock motor rotation. Then, the GPIO pin will produce a high output signal to turn on the LED notification of the locked door, and GPIO pin 20 will produce the low output signal to turn off the LED notification for the unlocked door.

This LED notification will notify user that the door is locked.

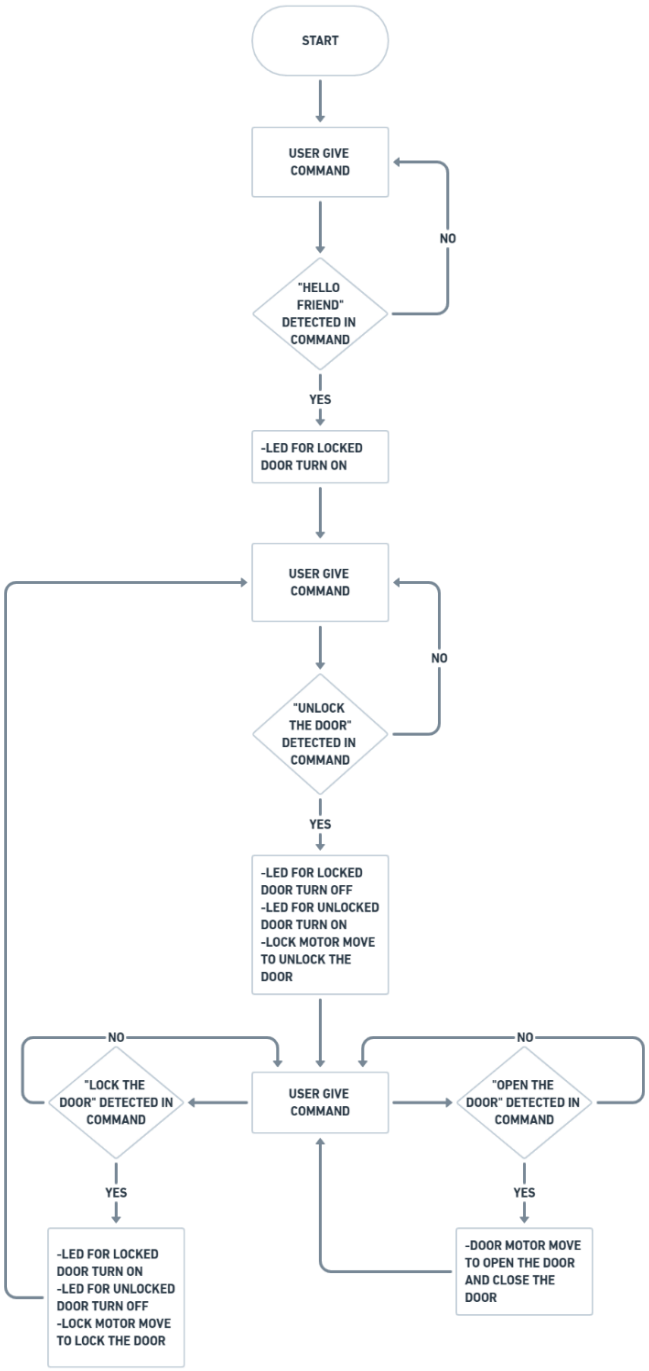

Figure 2: Flowchart of VUI Smart Office Door.

2.2. Circuit Diagram

Figure 3 illustrates the circuit diagram of the Voice User Interface (VUI) Smart Office Door system. As mentioned, this system has one input which is the microphone. Microphone used to capture the voice command from the user. This microphone will be connected to the Raspberry Pi 400 using a USB port.

As for the internet connection, the system will use the build-in Wi-Fi receiver in Raspberry Pi to interact with the Google server to execute the user's command. For the output part, this system will have four output which are 2 LEDs for notification purpose and two dc motors for controlling the lock and the door. LEDs notification will connect to GPIO pin 20 and 21, and dc motors will connect to the motor driver.

Then, the motor driver will connect to GPIO pin 2, 3 and 4 to control the lock motor and connect to the GPIO pin 7, 22 and 25 to control the door motor. The resistor used in this circuit reduce the voltage that are received by the LEDs notification.

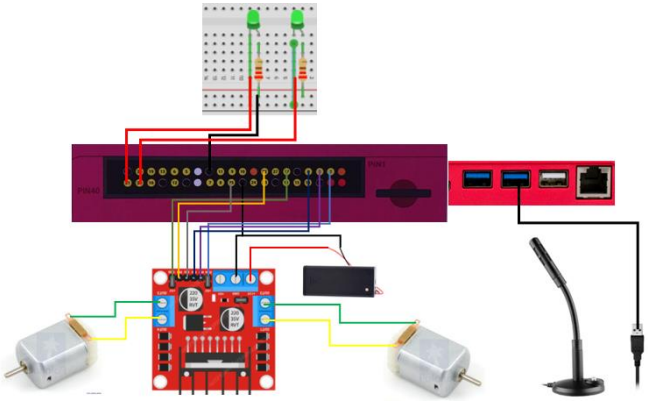

Figure 3: Circuit diagram of Smart Office Door Combine with Voice User Interface (VUI) and Internet of Things (IoT)

3 RESULTS AND DISCUSSIONS

3.1. Hardware Development

For hardware development, the initial stage is shown in Figure 4.1, where the dc motors are connected to the motor driver. Then, motor driver, microphone, and LEDs are connected to the microcontroller. The Voice User Interface Smart Door system used power supply 5A from the power socket to run the system. As

for controlling the dc motors, the motor driver will connect to an extra power supplier, which is batteries with 6V, as shown in Figure 4.2.

Dc motors is connected to the door and lock using gears as a connecter to transfer the rotation movement from motors to the door and lock. Connection of dc motor with the door is shown in Figure 4.3 and connection for dc motor with lock shown in Figure 4.4. LEDs notification is placed above the door, as shown in Figure 4.5. The connection between LEDs and motor driver with Raspberry pi is executed using breadboard as shown in Figure 4.6. The breadboard and motor driver are mounted below the model. Figure 4.7 shows the microphone is connected to Raspberry Pi via the USB port.

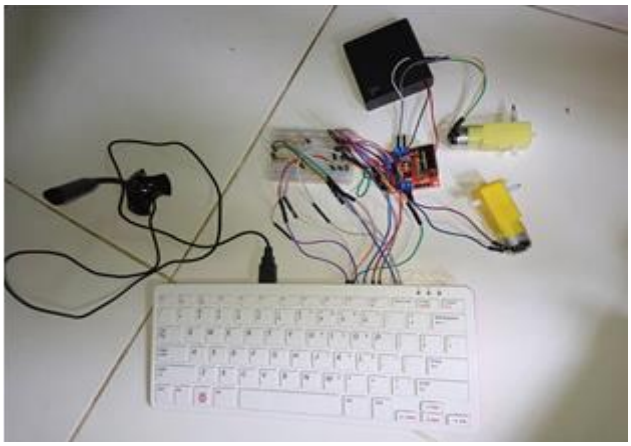

Figure 4.1: Hardware before mounted to Smart Office Door model

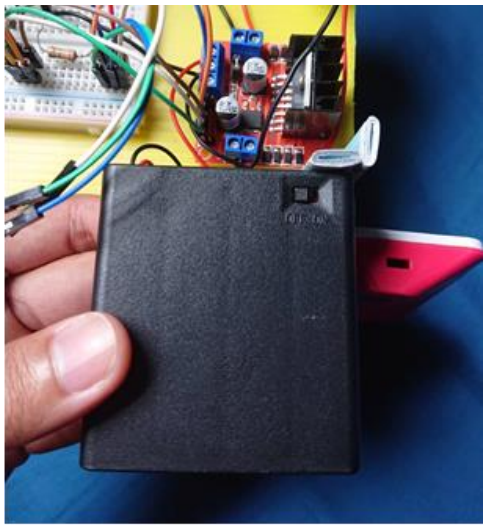

Figure 4.2: Batteries supply to motor driver.

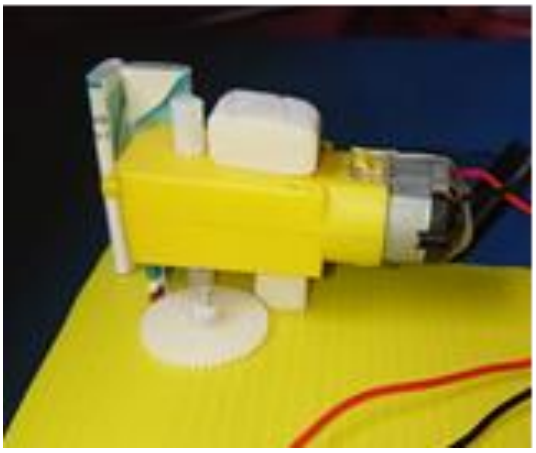

Figure 4.3: Dc motor connect to the door.

Figure 4.4: Dc motor connect to the lock.

Figure 4.5: Office room model with LED's positioned above the door.

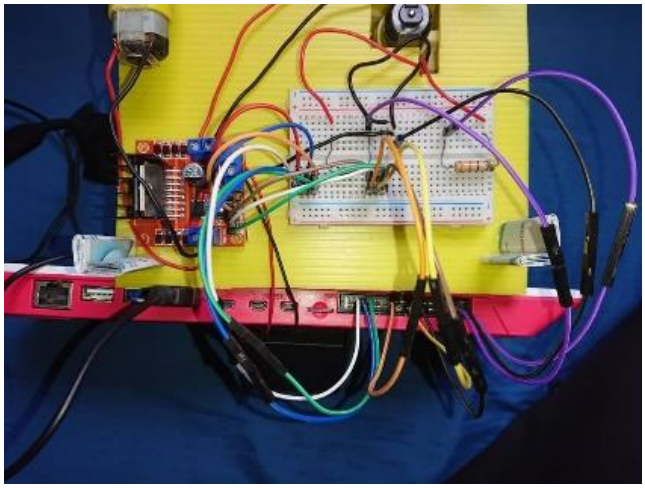

Figure 4.6: The circuit connection in the model.

Figure 4.7: Microphone connect to the Raspberry Pi

3.2. VUI Smart Office Door locked state

The model of the VUI Smart Office Door in the locked condition is shown in Figures 5.1 and 5.2. The blue LED notify users that the door has been locked. Figure 5.2 demonstrates the lock's position, which the door is in the locked state. This state is executed with voice user's command 'lock the door'. When this command is detected, the green LED is turned off and blue LED is turned on to notify user that the door has been locked.

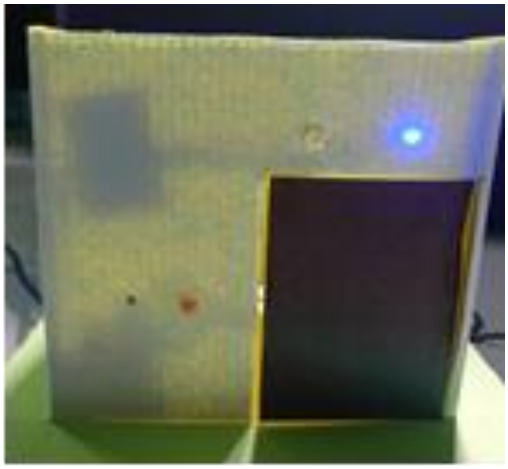

Figure 5.1: Notification for locked door condition.

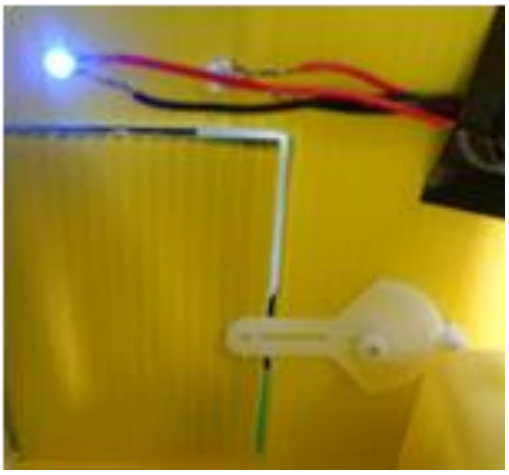

Figure 5.2: Position of the lock in locked door state.

3.3. VUI Smart Office Door unlocked state

Figure 6.1 and Figure 6.2 illustrates the model of VUI Smart Office Door in unlocked state. For this condition, the blue LED is turned off and the green LED is turned on to alert the user that the door has been unlocked. Figure 6.2 illustrates the lock's position, which permits the door to be opened. This state is executed with voice user's command 'unlock the door'. In unlocked state, user can give command in order to open the door. When the command of "opens the door" has been detected, the door will be opened as shown in Figure 6.3 and it will be closed automatically after 2 seconds, as set in the algorithm.

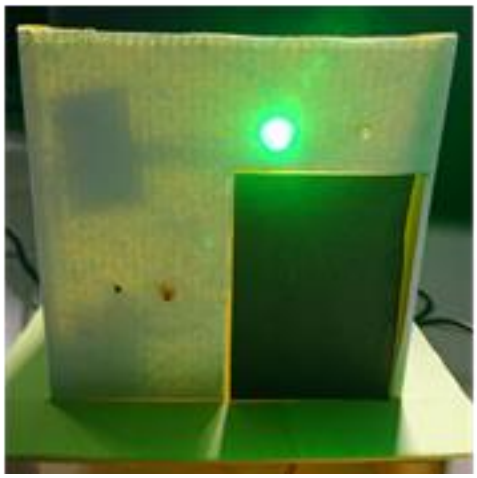

Figure 6.1: Notification for unlocked door condition.

Figure 6.2: Position of the lock in unlocked state.

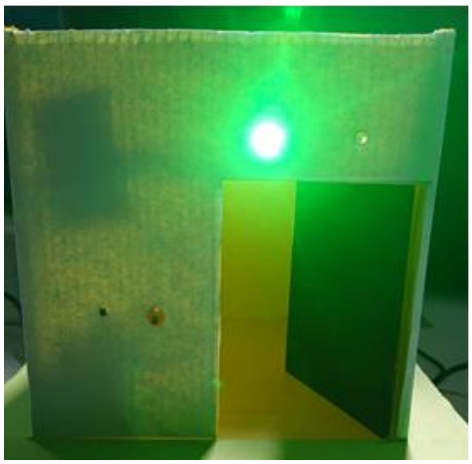

Figure 6.3: The door position when been opened.

4 CONCLUSION AND RECOMMENDATION

There are many ways to control the office door, such as using an infrared sensor or using a weight sensor. In this project, Voice User Interface Smart Office Door had been proposed to control the office door using voice command. The use of IoT technology in this system provides the feature of controlling the office door just by using voice command with the help of Google Assistant. This system helps to eliminate the need for the workers to touch the appliances. This system also helps prevent the spread of coronavirus among the workers and provide a safer environment for working in the office during this pandemic.

For the recommendation, this system still has a room that can be further upgraded by linking the system with the apps that allow user to monitor the appliances from long distances and control them for emergency purposes. This system also needs to add a special controller for mute people to use. As known by everyone, mute people cannot talk thus they will have difficulties when using this system.

REFERENCES

[1] N. P. Novani, M. H. Hersyah, and R. Hamdanu, "Electrical household appliances control using voice command based on microcontroller," *2020 Int. Conf. Inf. Technol. Syst. Innov. ICITSI 2020 - Proc.*, pp. 288–293, 2020,

[2] S. Sharma, D. Singhal, and R. Gupta, "A Voice-Controlled Multi-Functional Smart Home Automation System," pp. 1–6, 2015.

[3] D. Yang, L. Ma, and F. Liao, "An Intelligent Voice Interaction System Based on Raspberry Pi," *Proc. - 2019 11th Int. Conf. Intell. Human-Machine Syst. Cybern. IHMSC 2019*, vol. 1, pp. 237–240, 2019,

[4] V. Kepuska and G. Bohouta, "Next-generation of virtual personal assistants (Microsoft Cortana, Apple Siri, Amazon Alexa and Google Home)," *2018 IEEE 8th Annu. Comput. Commun. Work. Conf. CCWC 2018*, vol. 2018-Janua, no. c, pp. 99–103, 2018,

[5] K. Bhanuabhiram, L. T. Kumar, and N. Srinivasan, "Google assistant controlled home automation," *J. Comput. Theor. Nanosci.*, vol. 16, no. 8, pp. 3259–3264, 2019,

[6] L. K. Vanathi, B. Mahalakshmi, S. Madhusudan, M. Srinivasaperumal, S. Srikanth, and R. Sathish Kumar, "Smart Control of Home Amenities Using Google Assistant and Clap Switch Circuit," *2019 5th Int. Conf. Adv. Comput. Commun. Syst. ICACCS 2019*, pp. 350–352, 2019,

[7] S. Chaudhary, R. Johari, R. Bhatia, K. Gupta, and A. Bhatnagar, "CRAIoT: Concept, Review and Application(s) of IoT," *Proc. - 2019 4th Int. Conf. Internet Things Smart Innov. Usages, IoT-SIU 2019*, pp. 2–5, 2019,

[8] S. K. Vishwakarma, P. Upadhyaya, B. Kumari, and A. K. Mishra, "Smart Energy Efficient Home Automation System Using IoT," *Proc. - 2019 4th Int. Conf. Internet Things Smart Innov. Usages, IoT-SIU 2019*, pp. 17–20, 2019,

[9] A. K. Gupta and R. Johari, "IOT based Electrical Device Surveillance and Control System," *Proc. - 2019 4th Int. Conf. Internet Things Smart Innov. Usages, IoT-SIU 2019*, 2019,

[10] A. Jain, P. Tanwar, and S. Mehra, "Home Automation System using Internet of Things (IOT)," *Proc. Int. Conf. Mach. Learn. Big Data, Cloud Parallel Comput. Trends, Prespectives Prospect. Com. 2019*, pp. 300–305, 2019,

[11] P. Vashistha, J. P. Singh, P. Jain, and J. Kumar, "Raspberry Pi based voice-operated personal assistant (Neobot)," *Proc. 3rd Int. Conf. Electron. Commun. Aerosp. Technol. ICECA 2019*, pp. 974–978, 2019,

[12] P. Singh, P. Nayak, A. Datta, D. Sani, G. Raghav, and R. Tejpal, "Voice Control Device using Raspberry Pi," *Proc. - 2019 Amity Int. Conf. Artif. Intell. AICAI 2019*, pp. 723–728, 2019,

[13] C. Y. Peng and R. C. Chen, "Voice recognition by Google Home and Raspberry Pi for smart socket control," *Proc. - 2018 10th Int. Conf. Adv. Comput. Intell. ICACI 2018*, pp. 324–329, 2018,

[14] P. Mtshali and F. Khubisa, "A smart home appliance control system for physically disabled people," *2019 Conf. Inf. Commun. Technol. Soc. ICTAS 2019*, pp. 1–5, 2019,

[15] M. D. A. P. Mummaka Sai Srinath, Manepalli Nanda Kishore, "Interactive Home Automation System With Google Assistant," *Int. J. Pure Appl. Math.*, vol. Vol 119, no. 12, p. Page 12, 2018.

Authors Introduction

Mr. Muhammad Zharif Aiman bin Alias

He received his B. Eng. degree in Electrical Engineering from MARA University of Technology in 2021. He is currently a Technical Trainee under BriTay MyStep programme at BriTay Asia (M) Sdn Bhd. His final year project about Voice User Interface (VUI) SMART Office Door.

Dr. Wan Norsyafizan W.Muhamad

She received her Bachelor in Electrical Engineering from the Universiti Malaya, Malaysia in 2002. She completed her Master of Electrical Engineering from Universiti Malaya, Malaysia in 2009. She obtained her Ph.D in 2017 from University of Newcastle, Australia. Currently, she is a Senior Lecturer in Faculty of Electrical Engineering at Universiti Teknologi MARA, Shah Alam, Malaysia.. Her current research interests is in the area of wireless communication (Physical and MAC cross layer optimization),

Dr, Darmawaty Mohd Ali

She is an Associate Professor in the Department of Communication Engineering, Universiti Teknologi MARA (UiTM). She obtained her Ph.D in 2012 from Universiti Malaya, Malaysia. She has received the Master of Engineering in Electrical in 2002 from Universiti Teknologi Malaysia. Previously, she obtained her first degree from Universiti Kebangsaan Malaysia with Honours, in Electrical, Electronic and System, graduating in 1999. She is a member of Wireless Communication Technology (WiCOT) Research Interest Group (RIG) and her research interests include Wireless Access Technology and Quality of Service in Wireless Broadband.

Dr. Azlina Idris

She is a Senior Lecturer in the Universiti Teknologi MARA (UiTM). She obtained her Ph.D in 2012 from Universiti Malaya (UM), Malaysia. She has received the Master of Engineering in Electrical from Universiti Teknologi Malaysia (UTM). Previously, she obtained her first degree from Leeds Metropolitan University, United Kingdom with Honours, in Applied Computer. She is a member of Wireless Communication Technology (WiCOT) Research Interest Group (RIG) and her research interests include OFDM/OFDMA transmission, single and multiuser precoding, modulation, MIMO transmission techniques and receivers, channel coding, interference management and mitigation, and channel modelling (channel estimation).