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Research Article

Smart Interactive Virtual Assistant System for Office Door Applications in the Situation of the COVID-19 Pandemic

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ABSTRACT

COVID-19 has now spread to every continent around the world. The virus is spread through the transmission of close contact with the infected person as well as by touching a surface that has been contaminated with the virus. Touchless switches must be utilized especially in office and home environments to reduce the spread of COVID-19. This paper presents the Smart Interactive Virtual Assistant for Smart Office Door Application. The proposed system uses voice recognition and artificial intelligence by applying the open-sourced API of Google Assistant to control the smart door contactless. The user can give the command to the system via voice to either open or close the door. This smart interactive voice assistant system uses Raspberry Pi as the brain or computer for the interface and Python is used as the software for running the coding script. The components used such as LED lights and DC motors are connected through the General-Purpose Input Output of Raspberry Pi and the relay module. One of the DC motors is used for controlling the lock and another one is used for controlling the door. Blue LED is used as a locked door notification while a green LED is used as an unlocked notification. A pair of microphones and speakers are also connected with the Raspberry Pi as input and output voice commands through a USB port and Bluetooth. With the smart interactive virtual assistant solution, office spaces will move towards a more touch-free control which could prevent the spread of COVID-19.

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 touched by the infected person. The virus can live on that surface for at most 48 hours. People can get affected by the virus when using the same appliances at the workplace such as doors, water dispensers, switches and photostat machines.

In order to minimize the chance of people getting infected due to touching appliance surfaces, the voice assistant or speech recognition technology has been implemented. The appliance can be controlled by voice command with the help of a smart virtual assistant, Internet of Things (IoT) and smart controller [1]. The smart interactive virtual assistant is a speech recognition technology that allows people to interact with a computer, smartphone, or other devices through voice commands [2][3]. Smart virtual assistants such as Amazon Alexa, Apple’s Siri, Samsung’s Bixby and Google Assistant are primarily used for daily tasks [4].

Google Assistant is an artificial intelligence-powered virtual assistant developed by Google [5][6]. Users interact with the Google Assistant through keyboard input or natural voice. The Google Assistant is commonly used for daily tasks such as searching the Internet, scheduling events and alarms, adjusting hardware settings on the user's device, and showing

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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 is used as a voice for innovations[7]. IoT is a system that integrates with voice command to control the office door with the help of IoT technology.

The technology of IoT brings a new node to a marketplace and knocks on the door with new choices of computers, and digital devices via the internet and interacts with each other to exchange and transfer information through special Identifications (IDs). The emphasis on automation technology has risen significantly with the new invention of automation appliances[8]. Some automation technology apply voice commands 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 office system without ever having any physical contact [9][10]. It emphasizes the use of ambient technology, robotics and reduce screen-based interaction, meaning that the user interface is blended with the physical gadget. Besides IoT, microcontroller such as Raspberry Pi plays a central role in the whole system. Raspberry Pi is a Linux single-board computer which uses an SD card as storage. It has two USB interfaces, a USB interface, an Ethernet, 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].In addition to that, the Raspberry Pi has also been used as a processing chip and underlying architecture to activate a personal assistant[3][12][13]. The proposed voice-operated personal assistant which uses a Raspberry Pi gives individuals more comfort and ease.

Few works in literature proposed the smart virtual assistant system to control appliances. Mtshali et al proposed 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 Siri, Google Assistant, or Alexa. This system captured the voice command from the user and provides the output signal to control the targeted appliances, such as turning it on or off. Having this system could be very advantageous for those with disabilities. In addition to that, this system also helps to enhance the quality of nondisabled people. Next, Yash Mittal et al presented a voice-controlled multi-functional smart home automation system[2]. This system allows users to use voice commands to control 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 of the appliances. This system aims to be affordable, flexible, and robust.

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

Mummaka et al [15] proposed an interactive smart home automation system using voice recognition system which applied the Google assistant SDK. The proposed system uses voice commands to automatically control the appliances for the smart home such as lighting, air conditioner, TV as well as communicates to google assistant to get news and information.

This project proposes a smart interactive virtual assistant system to control the office door. The proposed system will help people to eliminate the need to touch the surface. To develop a voice-based command controller, a microphone is used in data transmission, data communication and a voice signal processor to implement the voice recognition approach.

For this proposed work, the office door, microcontroller, motor driver, DC motor, LED and microphone are integrated as a smart door control system. The proposed system provides users with a feature that can control the office door contactless using a voice command. This system consists of several modules which are LED, DC motor, motor driver, microphone, IoT, operating system device, smart virtual assistant and Raspberry pi. The Raspberry Pi 400 is the microcontroller for the whole system. The Google Assistant is implemented into the microcontroller and provides the ability of a 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. Users can control the system's lock through the voice command system by giving a specific command and opening the door only when the door is unlocked by giving a specific command. There will be an LED notification to let the user know whether the door is locked or unlocked. This system provides a touchless feature for opening or closing the door which prevents the spread of the COVID-19 virus.

2 METHODS

2.1. Block Diagram

Figure 1 shows the block diagram of the proposed system consisting of several modules which are voice command, Raspberry Pi, Cloud, Google Server, LED, motor driver and DC motor. In the beginning, a microphone will capture the voice command from the user and converts it into an input signal for the system. The Raspberry Pi will receive the input signal and send it to the Cloud through the internet. Next, the Cloud will directly transfer the signal to the Google Server for processing. Google Server's 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.

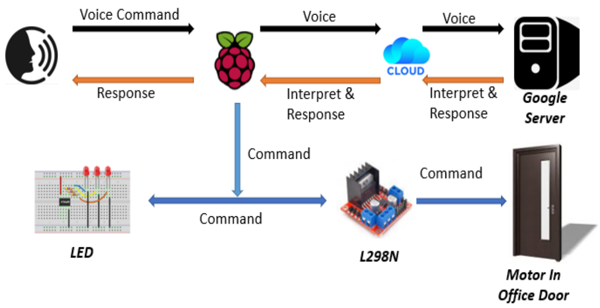

Figure 1: Block diagram of the proposed smart virtual assistant system

2.2. Flowchart of the System

While Figure 2 illustrates the flowchart of the proposed system. To access the smart office door system, the user needs to say *"Hello Friend"*. This command is used as a password for security purposes for the system. When a password command has 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 system. This LED notification will let the user know the door is locked. After getting access to the 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 that the door is unlocked.

Next, the user needs to give the command *"Open the Door"* to open the smart door. The door will be opened once this command is detected by the system, and following few 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 duration of 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.

Further, the user needs 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 duration of 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 the user that the door is locked.

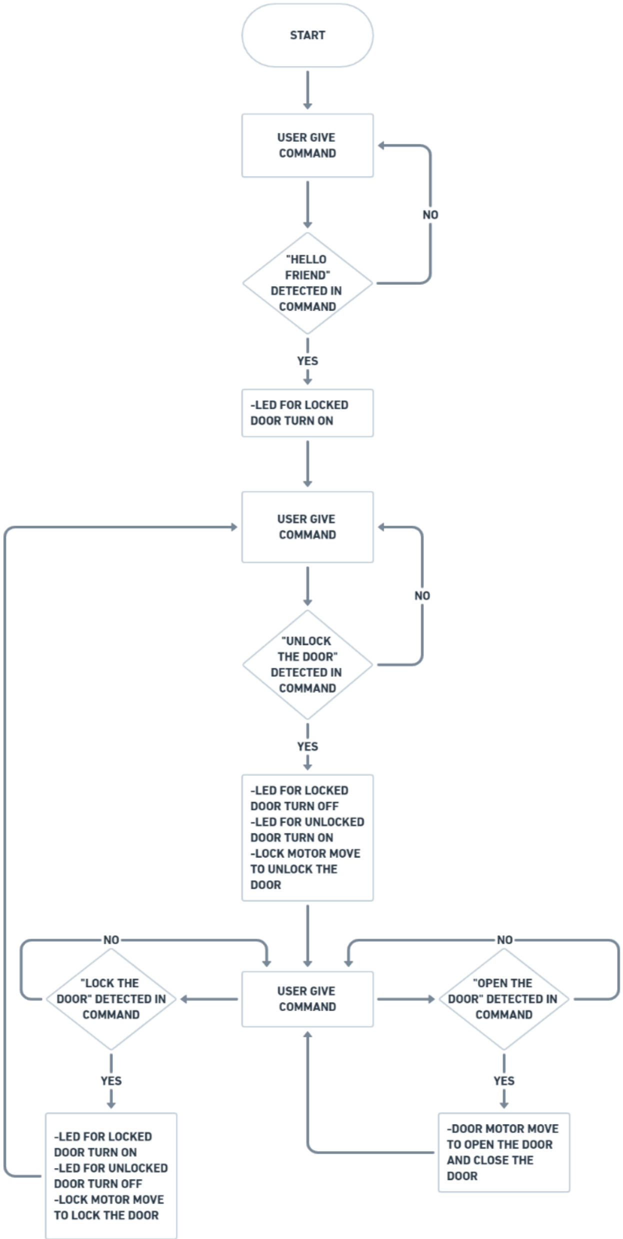

Figure 1: Flowchart of the proposed smart virtual assistant system

2.3 Circuit Diagram

Figure 3 illustrates the circuit diagram of the proposed smart virtual assistant system. As stated earlier, this system has one input which is the microphone. A microphone is used to capture the voice command from the user and it 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 in order to execute the user's command.

For the output part, this system will have four outputs including two LEDs for notification and two DC motors for locking and unlocking the door. LEDs notification will be connected to GPIO pins 20 and 21, and DC motors will be connected to the motor driver. Then, the motor driver will connect to GPIO pins 2, 3 and 4 to control the lock motor and connect to the GPIO pins 7, 22 and 25 to control the door motor. The resistor used in this circuit reduces the voltage that is received by the LEDs' notification.

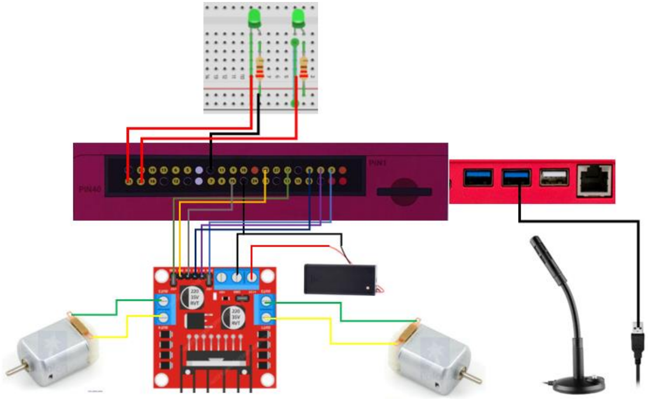

Figure 2: Circuit diagram of the proposed smart virtual assistant system

3 RESULTS AND DISCUSSIONS

3.1. Hardware Development

For hardware development, the initial stage is shown in Figure 4 where the DC motors are connected to the motor driver. The motor driver, microphone and LEDs are connected to the microcontroller. This system used a power supply of 5A from the power socket to run the system. As for controlling the DC motors, the motor driver will be connected to an extra power supply with 6V batteries, as shown in Figure 5. Next, DC motors are connected to the door and lock using gears as a connecter to transfer the rotation movement from motors to the door and lock. The connection of the DC motor with the door is shown in Figure 6 and the connection for the DC motor with the lock is shown in Figure 7. LEDs notification is placed above the door, as shown in Figure 8. Next, the connection between LEDs and motor driver with

Raspberry Pi is executed using a breadboard as shown in Figure 9 where the breadboard and motor driver are mounted at the bottom. Lastly, Figure 10 shows the microphone that is being connected to Raspberry Pi via the USB port.

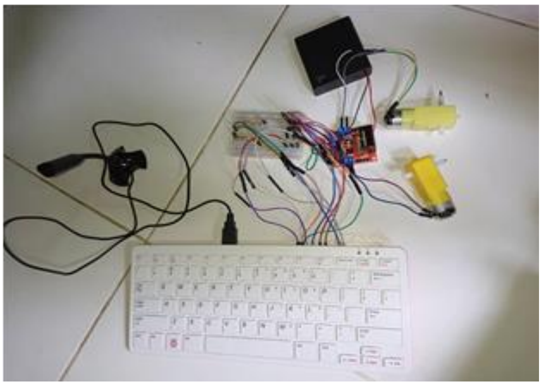

Figure 4: Hardware before mounted to smart office door model

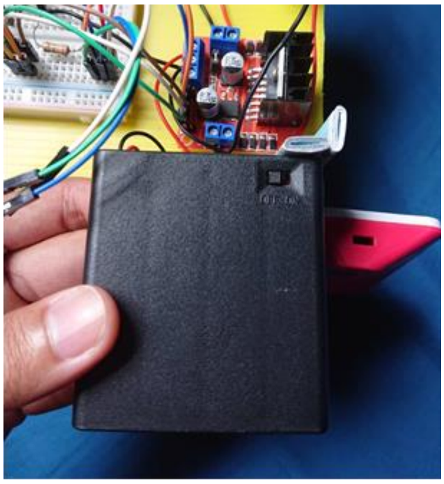

Figure 5: Batteries supplied to the motor driver

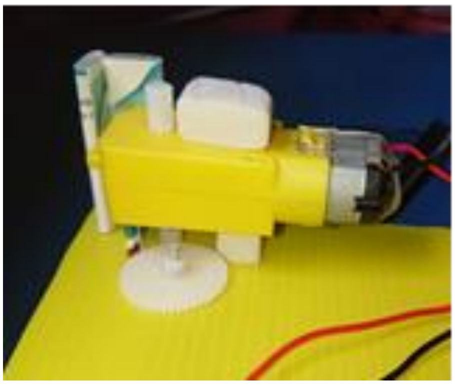

Figure 6: DC motor connected to the door

Figure 7: DC motor connected to the lock

Figure 8: Office room model with LEDs positioned above the door

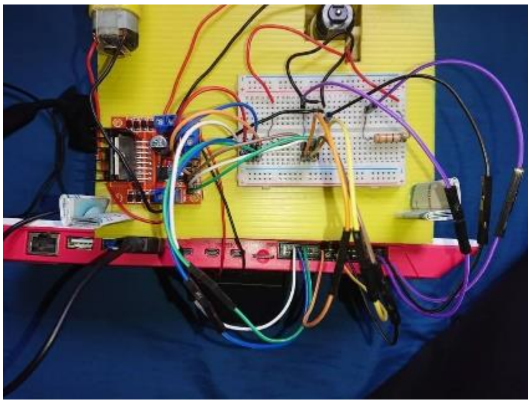

Figure 9: The circuit connection in the model

Figure 10: Microphone is connected to a Raspberry Pi

3.2. In the Condition of Locked State

The model of the smart virtual assistant system in the locked condition is shown in Figure 11 and Figure 12. The blue LED notifies users that the door has been locked. Here, Figure 12 demonstrates the lock's position, in which the door is in the locked state. This state is executed with the voice user's command *"Lock the Door"*. When this command is detected, the green LED is turned off and the blue LED is turned on to notify the user that the door has been locked.

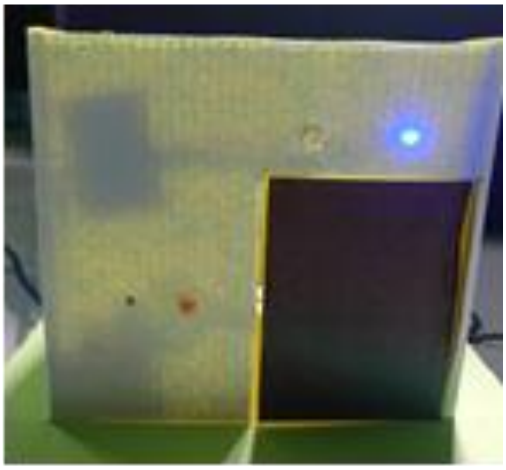

Figure 11: Notification for locked door condition

Figure 12: Position of the lock in locked door state

3.3. In the Condition of Unlocked State

Next, Figure 13 and Figure 14 illustrate the model of the system in an 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. Here, Figure 14 illustrates the lock's position which permits the door to be opened. This state is executed with the voice user's command *"Unlock the Door"*. In the unlocked state, the user can give the command to open the door. When the command *"Open the Door"* has been detected, the door will be opened as shown in Figure 15 and it will be closed automatically after 2 seconds, as set in the algorithm.

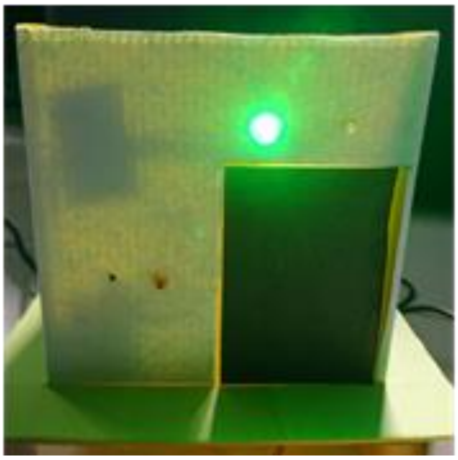

Figure 13: Notification for unlocked door condition

Figure 14: Position of the lock in an unlocked state

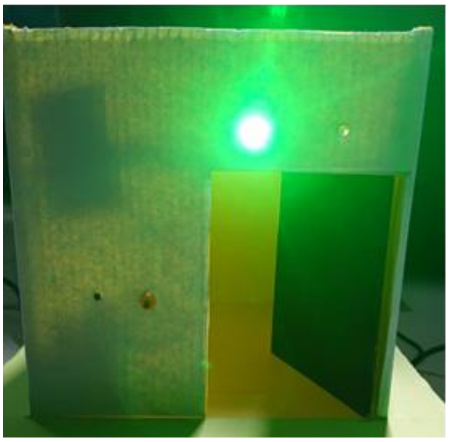

Figure 15: The door position when been opened

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, a smart virtual assistant for a 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 commands with the help of Google Assistant. This system helps to eliminate the need for the workers to touch the appliances. This system also helps to prevent the spread of coronavirus among the workers and provides 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 the 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.

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