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Voice Controlled Home Automation System Design

Thangavel Bhuvaneswari*, Venugopal Chitra, Goh Chee Cheng

Abstract **- The primary objective of this home automation study is to facilitate the implementation of a voice-controlled capabilities, primarily designed to assist individuals with disabilities or seniors. The system presented in this research enables wireless control of various household devices, such as lights, fans, and any electrical appliances through a dedicated mobile application. This voice-controlled home automation system leverages an android smartphone and a microcontroller using an android application to manage household appliances. The system can be accessed by user name and password. This system is designed with three main control interfaces such as Bluetooth connectivity, voice recognition, and manual control switching. The google cloud speech API which can convert spoken words into text is utilized for voice recognition. This generated text is then transmitted to the designated slave device, facilitating home automation through Bluetooth communication. Additionally, the system provides a manual control switch for user convenience. To control high-voltage appliances safely, an enhanced microcontroller is employed, incorporating a relay circuit for ON/OFF functionality. The developed prototype, encompassing both hardware and software components, has undergone comprehensive testing, validating its security features and compatibility with various home appliances. This innovative home automation system not only offers enhanced convenience but also prioritizes security, providing an attractive alternative to commercial solutions.**

Keywords— Voice control, Home automation, wireless control, microcontroller

I. INTRODUCTION

Nowadays, voice control has become a powerful alternative way to pressing a button and a switching ON/OFF condition. Therefore, it is good for people with physical disability to operate electrical appliances with voice control. With the continuous growth of smart phones and advanced recognition systems, smart phones are more than just a normal phone we use to communicate with other people or as entertainment. Smart phone has become a popular device that is able to wirelessly control electric appliances. In this work, android application is used to control appliances using voice recognition or remote control with the help of Bluetooth technology. Bluetooth technology acts as the transmission medium to the microcontroller to control the appliance. Besides, this Android application has a security system that only allows the owner to operate a voice control home automation system.

In Ref [1], a smart home automation system using AVR Microcontroller is realized by Bulbul Bhaskar et al.,. For this system, homeowners have at least one smart phone that has Bluetooth. With the help of Bluetooth technology, smart home automation system can control wirelessly over the electronic device. This system uses Code-Vision-AVR software to program the AVR MCU.

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In Ref [2], a ubiquitous smart home system using Android application is introduced by Shiuu Kumar. This stand-alone smart home system based on Android app is cost effective. The Android app able to communicate with micro-web server for switching functionalities. Gas sensors, intrusion detection sensors, humidity sensors, power plugs, light switches and current sensors have been integrated into the system. The app is developed using Android Software Development Kit (SDK).

In Ref [3], an algorithm for gender voice recognition implemented in LABVIEW proposed by Rakesh K et al.,. A sound analysis is performed after receiving an input through microphone from a consumer. It involves Framing, Windowing, Pre-emphasis, Mel Cepstrum analysis, Recognition (Matching) and other spoken words.

With voice command, people with programming skills can do programming. Mubbashir Ayub et al., proposed a methodology on how to do programming using voice commands is discussed in Ref [4]. The Voice command based wireless home automation system (WHAS) for disabled people is discussed in Ref [5]. The system developed can respond to voice commands in seven (7) Indian languages.

Ref [6] presents a home automation system that uses WIFI technology. The proposed system is better from the scalability and flexibility point of view than the commercially available home automation systems. In Ref [7] home automation system using GSM technology is proposed by Sadia Sumaiya et al.,. This GSM is using SMS to control home appliances at home. GSM has the advantage of low cost, less investment and high reliability.

Moreover, many researchers address the smart systems developed using Arduino, Zigbee, and Raspberry PI devices to read inputs - light on a sensor, a finger on a button, or a Twitter message or in building facial and voice recognition models [8, 9, 10]. Google API is a group of application programming interfaces developed by Google [11]. This API can be used by third-party app for enhancement and increase functionalities of their app. Google Cloud Speech API is one of the applications that enables third-parties to make use of this function. Google Cloud Speech API can convert speech to word and it manages to recognizes more than 80 types of variants and languages thus it can support the global user.

Google Cloud Speech API can return text results in milliseconds which means the results return in real time. When using Google Cloud Speech, API user does not need to perform signal processing or even noise cancellation before sending speech to Speech API. This is because Speech API itself is able to handle noisy speech from different kinds of environments. In Ref [12] a MIT app is introduced and how the MIT app inventor makes use of the Google Cloud Speech API to perform voice recognition is explained in a step-by-step procedure. Bauman explained the voice recognition process in detail and the importance of voice recognition in virtual reality in ref [13].

Since the real-world signal is analog, it has to be converted to digital signal [Analog to Digital Conversion] using digital signal processing [14]. It involves the process of measuring, filtering, sampling. The error handling both detection and correction are easy in digital signal. Tasker [15] is an Android application which performs various tasks based on application, time, date, location, event, gestures in user-defined profiles or in clickable or timer home screen widgets.

In Ref [16] design and implementation of voice-based system that helps users to operate the home electrical appliances using android mobile phones is proposed by Mohammed Akour et al.,. The developed prototype is used to control doors, light, and audio system remotely.

In Ref [17], Nur et al. proposed an IoT based smart home system security equipped with sensors and controlled by a microcontroller and Raspberry PI microcomputer. The developed system has increased security for homes which reduced crime rates. LPG gas leakage detection and level monitoring for smart home using wireless network is proposed by Thangavel Bhuvaneswari et al., in ref [18]. The proposed system monitors the level of the gas present in the LPG cylinder alerts the user using LCD display. It alerts the user if there is any LPG gas leakage to ensure safety and prevent accidents due to LPG leakage in smart homes.

This paper is organized as follows: section 2 gives the details of the proposed methodology and in section 3, the results of the prototype developed for voice control and manual control are demonstrated and the paper ends with conclusion and recommendations.

II. METHODOLOGY

The proposed methodology is shown in Figure-1 and explained as follows; This voice-controlled home automation system leverages an Android smartphone and a microcontroller to manage household appliances. An Android application has been developed, incorporating essential security features. To access the system, users must input a predefined username and password stored in the system's memory by the owner. Upon successful authentication, users gain access to the control interface, offering three main functions: Bluetooth connectivity, voice recognition, and manual control switching. Bluetooth technology serves as the wireless communication medium, ensuring seamless device interaction. Voice recognition is achieved through the utilization of the Google Cloud Speech API,

which effectively converts spoken words into text. This generated text is then transmitted to the designated slave device, facilitating home automation through Bluetooth communication. Additionally, the system provides a manual control switch for user convenience. To control high-voltage appliances safely, an enhanced microcontroller is employed, incorporating a relay circuit for ON/OFF functionality. The overall connectivity of the proposed system is shown in Figure-2.

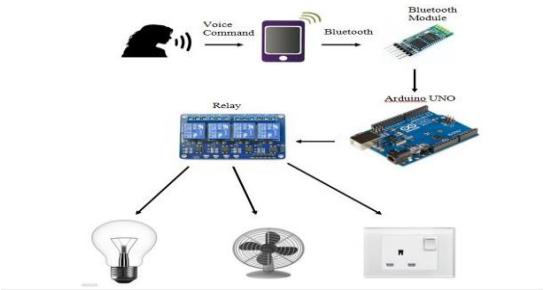

Figure-1 Proposed System architecture

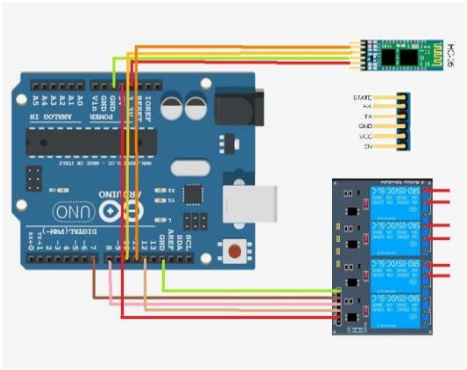

Figure-2 Overall Connectivity of the system

Figure-3 is a function to recognize user id and password before allowing the user to enter the next interface to use the voice control home automation system. If the username and password match with the saved id and password, the system can automatically enter the next interface to control function. If the username and password are not matched, the interface will display the message “username and password not match”.

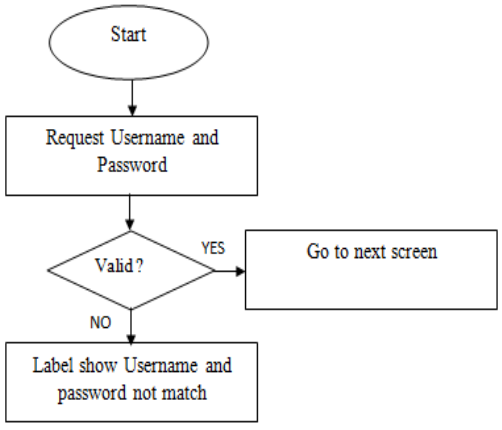

Figure-3 Function for recognizing user Id and password

Figure-4 is the function to request to change password. When the customer requests to change password, a new textbox will pop up and request user to key in old password and new password. If the old password and the existing password do not match, the function will go back to the previous step. If the old password is valid then the new password will be changed as the log in password then it will display the message “password changed” as shown below.

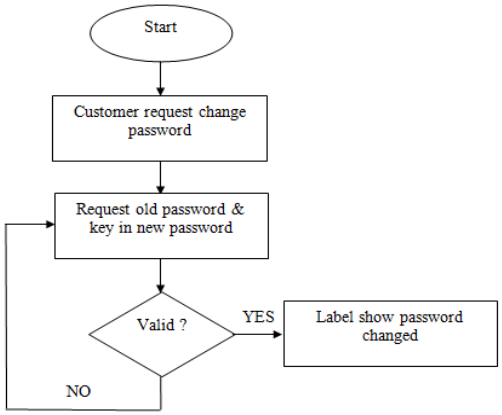

Figure-4 Function to request change of password

Figure-5 is the function for customers who forgot the password and need to reset the password. When the customer requests for resetting password, a text-box will pop up and requests user to key in pin number that is given by the manufacturer. If the pin number does not match with the pin number that is saved in the program, the function will go back to the previous step. If the pin number is valid, then the password will change to the pin number and then, “password already reset” label will be shown below.

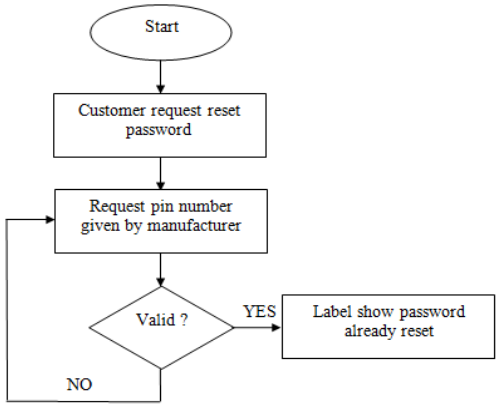

Figure-5 Function for resetting password

Figure-6 is the function for home automation control function. Connecting the Android Bluetooth with the Bluetooth module by using list picker in MIT App Inventor. A list picker is a button when selected on, it

can display choices of texts for the user to choose from. After the Bluetooth is connected, the main function of this system is able to use i.e. customer's speech is recognized and converted to text. Then the text will be sent to a Bluetooth module.

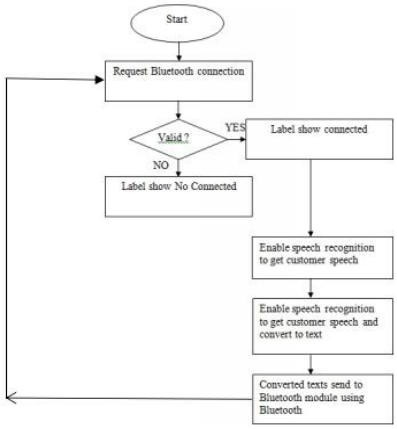

Figure-6 Home automation Control Function

A. Android app Interface

Interface of the Android app is created by the MIT App Inventor. Figure-7(a) is the logging interface for the home automation system. The interface shown in Figure-7(b) happens when a customer enters a username and password that does not match with the interface of the application. It will show the label “Username and Password doesn't match”. While in Figure-8(a), when customers forgot password and request for reset password. Customers only need to press the reset button and key in the pin number that is given by the manufacturer, then the password will automatically change to the pin number. Figure-8(b) shows the label customer that password already reset.

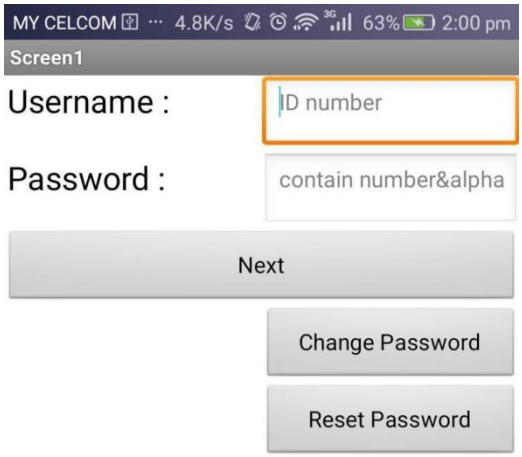

Figure-7(a) Logging Interface

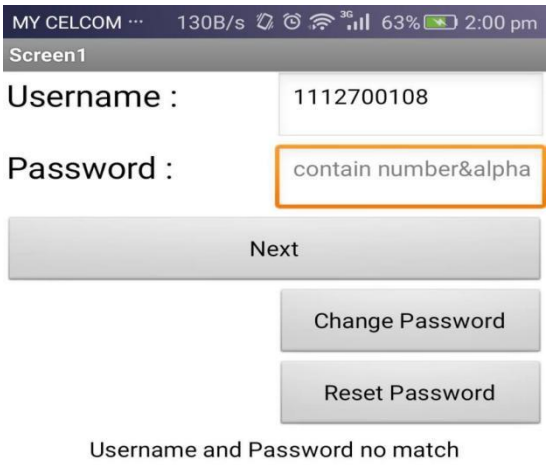

Figure-7(b) Username and Password don’t match

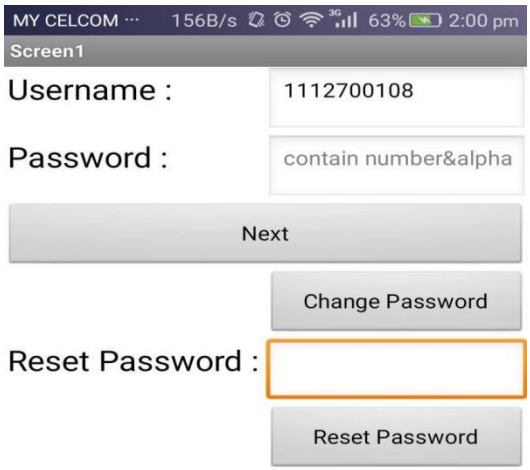

Figure-8(a) Customer request to reset password

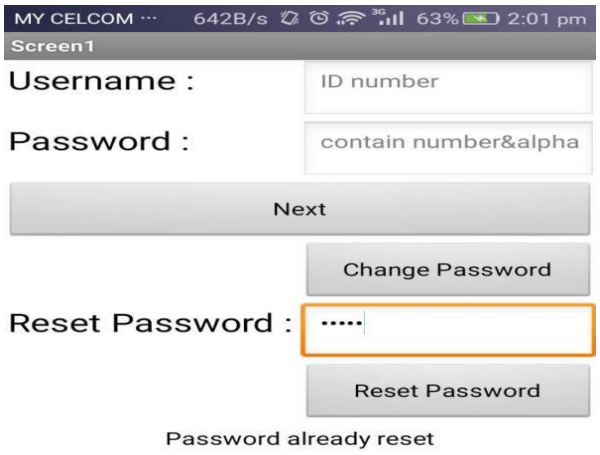

Figure-8(b) Password reset

For customers who wish to change a new password, they can change their password by pressing the change password button. After the button is pressed, the interface will change as shown in Figure-9(a). The application will request customer to key in an old password and new password that the customer wishes to change. After the password is changed, the system

will inform the customer that the password has changed as shown in Figure-9(b).

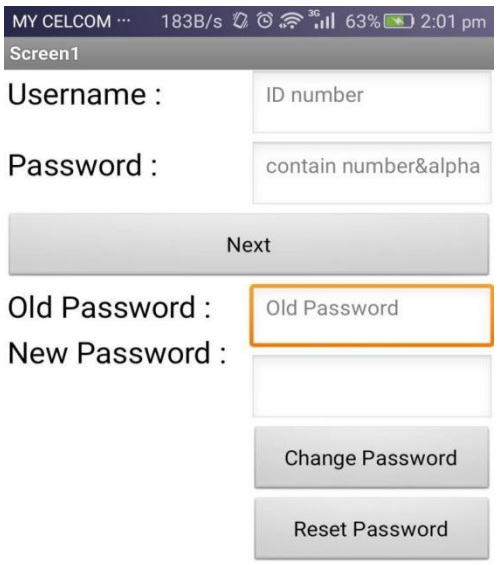

Figure-9(a) Customer request to change password

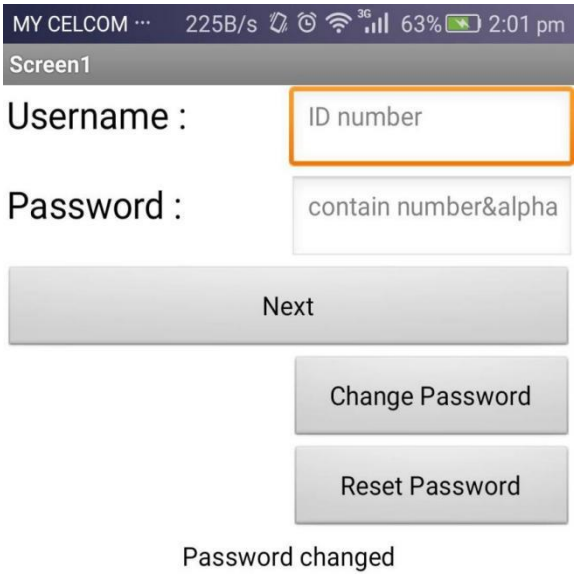

Figure-9(b) Password changed

III. RESULTS AND DISCUSSION

The prototype developed for the proposed system with front view and back view are shown in Figure-10(a) and Figure-10(b) respectively. It includes a HC-05 Bluetooth module, Adapter, Arduino UNO and Relay. The front view of the wood box consists of a yellow light, white light, plug socket, two toggle ON/OFF switches and a selector switch.

Assuming the yellow light as a fan and its ON/OFF toggle switch is the first switch, while the white light ON/OFF toggle switch is the second switch. Plug socket is designed in such a way that the customers can plug in any device. The selector switch is to select a voice-controlled automation system or manual system. The customer can use voice control home automation system by turning the switch to the left or by turning the switch to the right, they use a normal mode (manual switches). The advantage of designing a selector switch in this system is that the customer is still able to control the appliances manually, if there is some problem with the voice control home automation.

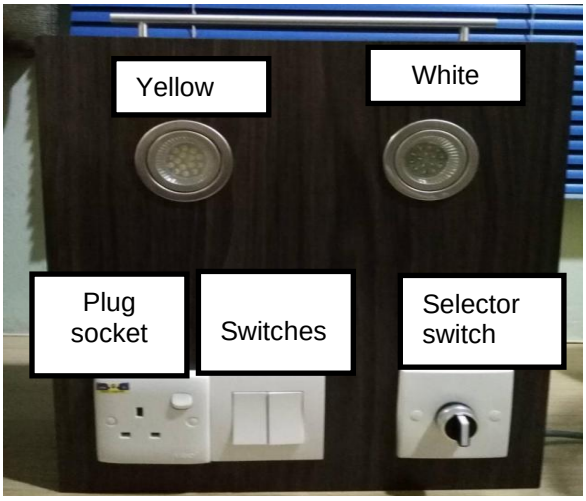

Figure-10(a) Prototype developed: Front view

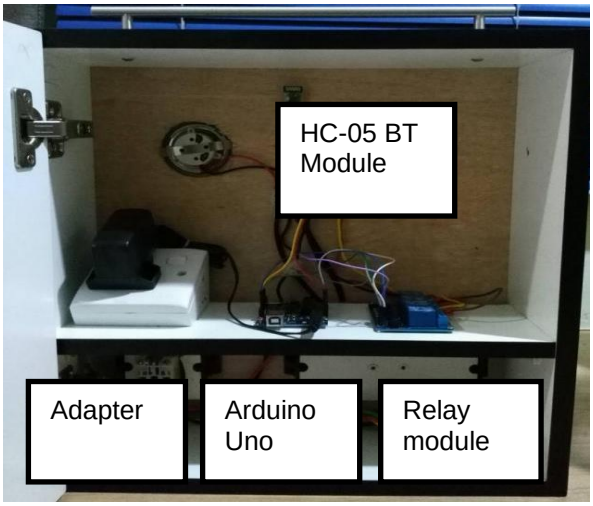

Figure-10(b) Prototype developed: Back view

Figure-11(a) shows the manual control of electrical appliances since the selector switch is turned to the right. Both the switches are in ON condition and Yellow light and white light are activated. Figure-11(c) shows the first switch is ON to activate the yellow light. While in Figure-11(d) second switch is ON to activate the white light. Figure-11(b) shows the voice control of electrical appliances since the selector switch is turned to left. When customer say “all on” the both the appliances (Fan and Light) are turn ON as shown in Figure-11(b).

While when customer say “Fan ON” the yellow light will turn on as shown in Figure-11(e) and if the customer says “Light ON” the white light will turn on as shown in Figure-11(f).

Figure-11 (a), (c), (d) Manual switch to control appliances

Figure-11(b), (e), (f) Voice control the appliances

Figure-12 is the voice control and manual switch interface. This function interface contains Bluetooth, voice recognition, manual switches and an exit button.

Figure-12 Voice Control and Manual Switch Interface

IV. CONCLUSION

Voice controlled home automation using an Android app and microcontroller is proposed. The prototype with the hardware and software designed and tested with the security features and home appliances. The objective of this work is achieved successfully. To create a similar app for Apple users and the system can operate in a wider range (Zig Bee module) are the future recommendations for the developed voice control home automation system.

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