International Research Journal of Education and Technology
ISSN 2581-7795

Interactive Voice-Controller Applied to Home Automation with Motion Detection

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Abstract

In this modern age of technological advancements, everything seeks smarter and simpler approach. Home is a place for people needing professional care or supervision. Home automation is necessary to assure comfort, ease and convenient purposes. It refers to the automation of appliances, security and other residential functions that can be remotely controlled using devices like mobile phone, computer etc. This work resembles the design and implementation of voice controlled home automation system. The design attempts for wireless control over multi- functional devices such as light, fan and door. The proposed design provides a way in which the user is able to control the magnitude of the properties and ensures the suitable brightness and intensity of the appliances. Moreover, the design consists of an automatically operated wheel chair which can be navigated to different rooms in a house by voice commands. An android app has been developed to receive and process the voice commands from Google assistance. This proposed system uses an embedded system (ES) as the controller which is connected to android app via Bluetooth communication for data transferring. The system can provide a huge assistance for physically challenged people with a very low cost.

Keywords: Automated home, fan, light, automated guided carrier, proteus and Arduino.

1. Introduction

Automated home refers to the “Zero Energy Building” which supplies the electrical energy through a minimum losses. Every year a huge amount of electrical energy is wasted across the world. This amount of loss occurs for various reasons, among which negligence in proper maintenance of home appliances is a notable one [1]. Studies show that people are stressed and busy life forces them in this respect. This paper is inspired by the urgency to make a rational solution. A voice controlled system having smart phone provides the solution for the above mentioned problems. The system deploys Bluetooth device integrated with Android devices which ensures a minimum cost of the system. The entire thing that the user has to do is to deliver a voice command. Google assistant converts the speech into text which is matched to the text command with defined action. The android device sends an integer number via Bluetooth connection towards the ES that receives the task requirement and performs the action.

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Number of researches has been done in the field of home automation system. A GSM (Global System for Mobile Communication) based wireless network system is proposed in [2] & [3]. The system manages home automation by wirelessly controlling appliances. It can't help the user in getting rid of complexities like license issue, bandwidth lagging.

GSM uses transmission technology which causes the unwanted interferences with objects [4] & [5]. A voice-activated automation and a universal remote control application on an Android platform are presented in [6-8]. An Android app "AMR-Voice" is interfaced with Arduino through Bluetooth communication technology. The system does not include regulating the intensity or magnitude of devices outputs. The irregulating output makes the inconvenience environment for human and also responsible to waste more power.

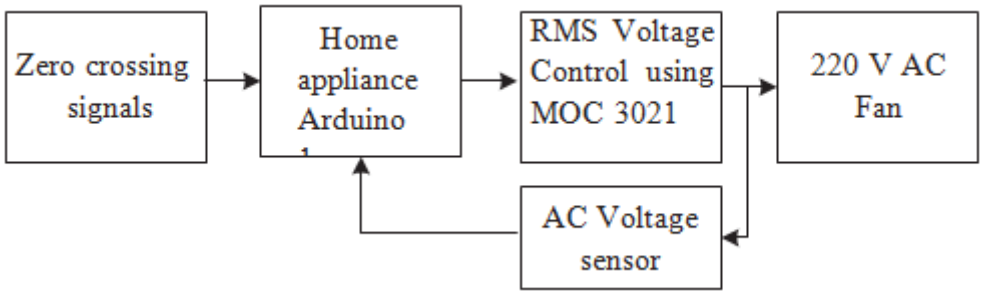

Figure 1 Detailed configuration of subsystem-1

Motivated by above problems, this paper presents a voice controlled wireless home automation system. This work illustrates an integrated approach to control the home appliances and provide autonomous line guided wheel-chair for physically disabled people. It doesn't only come up with the switching on and off the appliances. Rather the design system gives the user a privilege to control the magnitude and intensity of the home appliances. The design of proposed system is done by putting an array of five IR sensors for tracing the line automatically. It is able to send a feedback signal to the ordering center for confirmation. The rest of this paper is organized as follows. In Section II presents the system overview that includes the software design, home automation system and autonomous line guided system. The experimental evaluation of proposed system is studied in Section III. The paper is concluded in Section IV.

2. System Overview

The entire system architecture consisting project flow and its segments has been illustrated in Fig. 1. The user can choose to regulate the appliances and navigate a wheelchair by giving voice command in the Android app. At the home screen, a user has to select a mode between "home automation" and "wheel-chair control". The selection step is followed by pop-up window that requests to choose a device for pairing via Bluetooth.

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If the user selects “home automation” mode, the “Automation screen” is appeared and the user needs to input voice command while touching the mic icon. Different actions correspond to different commands given on the screen. Customized commands can be set by pressing “Set command” icon. The user initiates the fan rotation with an average speed by saying the “fan on”. The speed can be increased by saying “faster” and decreased by saying “slower”. Voltage is controlled by using Arduino and Triac output optocoupler. Fig. 2 shows how AC voltage sensor is used to provide feedback to the Arduino. This assists in continuous monitoring of voltage across the fan. The fan can be turned off by the voice command “fan off”. The exact procedure but different set of commands is followed for controlling and regulating AC light bulb which is used as a subsystem-2. Now if the door control is considered, it does not need its speed to be controlled. An encoder is mechanically coupled with the door. The output of the encoder is sent back to the Arduino for sensing the position. The control block diagram of the door is shown in Fig. 3. Whenever the user chooses wheelchair control mode, the Android device gets paired with the wheelchair. The user can command the wheelchair where to go while touching the mic icon.

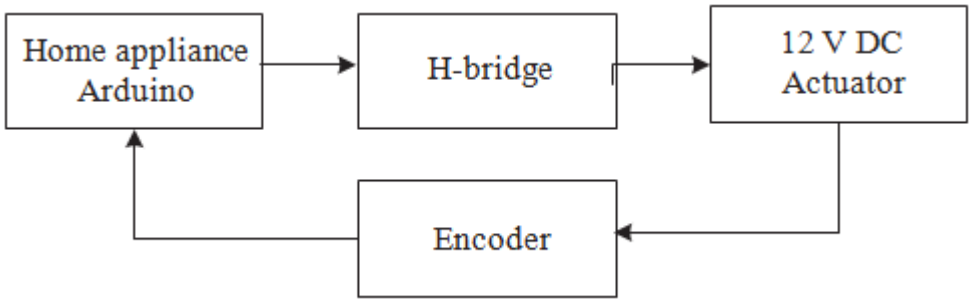

Figure 2 Detailed configuration of subsystem-3

The wheelchair is an IR (Infra-Red) sensor based line following robot. It follows a black line on a white surface. The black line covers each room inside the house and forms a loop. Different line patterns (like cross section, L-shape) are used for navigation purpose. An ultrasonic sonar sensor is implemented at the front portion of the wheelchair so that it can sense and stop in case of any obstacle within range. For safety purpose, the system can be immediately stopped by saying the voice command stop. In the case of connectivity failure, the appliances and the wheelchair can be controlled manually.

3. Software Design

This system receives voice commands by using Android app. Programming for the Android app is done with an integrated development environment (IDE) and Arduino studio. Fig. 4 delineates an image of the Android application. It is an advantage that the Android IDE has an in-built speech to text conversion feature. Whenever a user presses the mic icon, an intent called Recognizer intent gets triggered.

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This intent asks for speech input which is later sent through the speech recognizer. The response is returned via activity results in on activity result. The structure of the coding stands on switching statement. The response of speech recognizer is set as switch expression and corresponding commands for desired actions are set as case constant. As the case constant gets matched with any switch expression, the app commands the Bluetooth client to send a one-byte number. The sent number is then received by the HC-05 Bluetooth module. Arduino then reads the number from the module and executes the required operations.

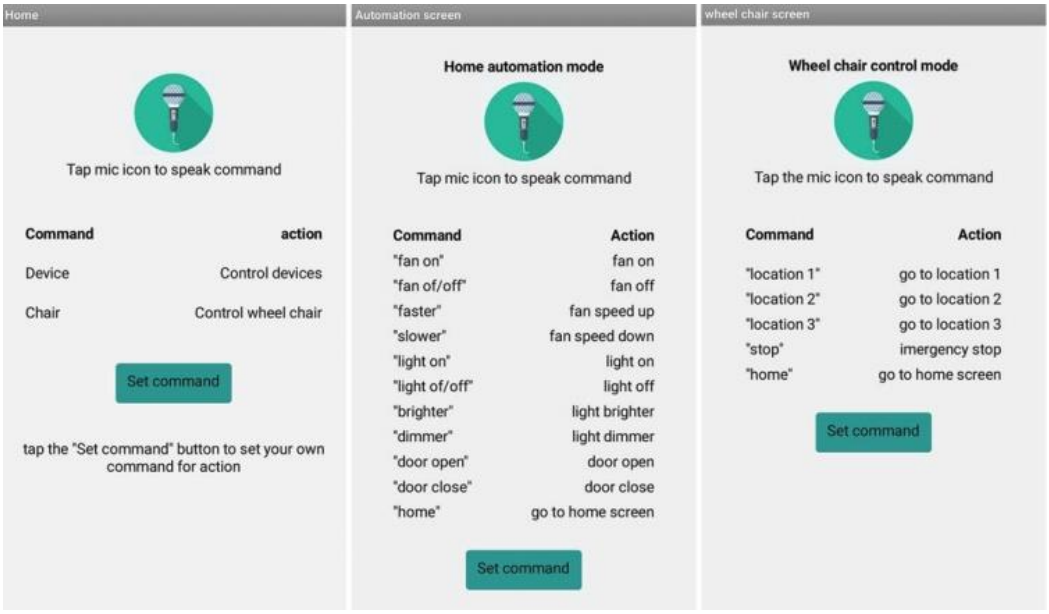

Figure 3 Basic block diagram of fault analysis system

4. Home Automation System

In addition to controlling the state of the electrical appliances, a user is capable of regulating the intensity and properties of the appliances such as fan speed and brightness of a light bulb. The overall schematic diagram of home automation is shown in Fig. 5. A 220V AC incandescent light bulb and a 220V AC single phase induction motor for fan is used for demonstration purpose. A 12V DC linear actuator has been used for door control. Both the fan speed and the brightness of the light are directly proportional to the RMS value of applied voltage across the terminals. For controlling the RMS value of the voltage, phase control method is used which consists of a combination of an opto-triac, Arduino and a zero crossing detector. The function of zero crossing circuit is to generate a 5V DC pulse when the voltage passes zero volts. After detecting a zero crossing event, Arduino delays for a controlled amount of time to trigger the triac. If a user says “light on”, the light glows with an average voltage. An Arduino needs to delay 5000 micro second to obtain the average voltage for 50 Hz transmission line. Now, if the user says “brighter”, Arduino checks the present voltage of light bulb with an AC voltage sensor. Following that, a decrement value gets subtracted from the present delay time.

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The decrease of delay time results in more conduction time for triac. Hence, the RMS value of voltage as well as the brightness is increased. On the other hand, if the user says “dimmer”, an increment value is added with the present voltage. This results in increased delay time and decreased brightness. As soon as the user says “light off” no triggering pulse is sent. The control of fan speed follows the same procedure with an exception. Since the fan is an inductive load, a snubber resistance is added across the triac. The snubber resistance helps preventing any sudden change of inductance. For door control, a 12V DC actuator has been used. The direction of the actuator is controlled by an H-bridge circuit. The open and close state of the door is determined when the encoder is feed backed to the Arduino.

6. Autonomous Wheelchair System

Fig. 6 shows the trajectory of the wheelchair. An automated wheelchair traces a path passed through each room in the house. It moves in clockwise direction. Different rooms are recognized by different patterns. For instance, if a user says “room three”, the wheel-chair follows the path until it detects black in all the sensors. It uses an array of five IR sensors to sense and follow a black line on the white surface. The IR sensor consists of an IR LED (TX) and an IR diode (RX). A Light signal is sent from IR LED which is reflected from the surface. The reflected light is received by the diode in the receiver end. The signal from the sensor depends on the amount of light reflected from the surface. Arduino receives analog signal from sensors and compares it with a threshold value.

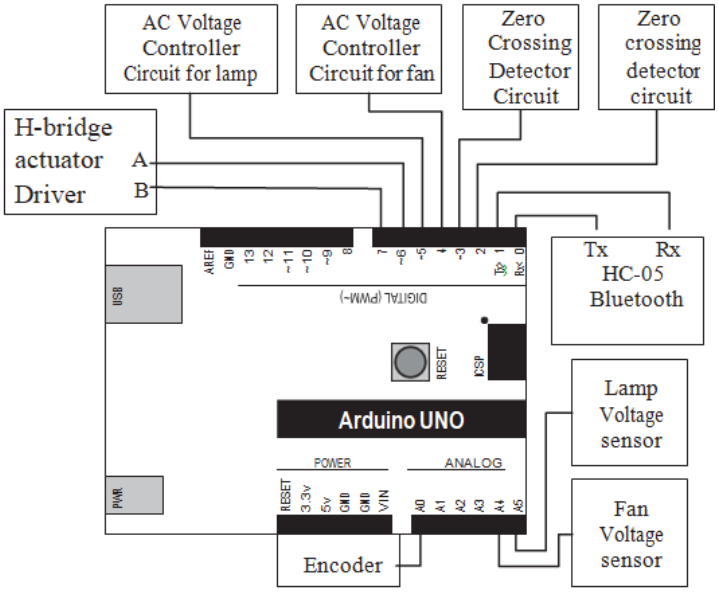

Figure 4 Voice-controlled home automation circuit

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International Research Journal of Education and Technology
ISSN 2581-7795

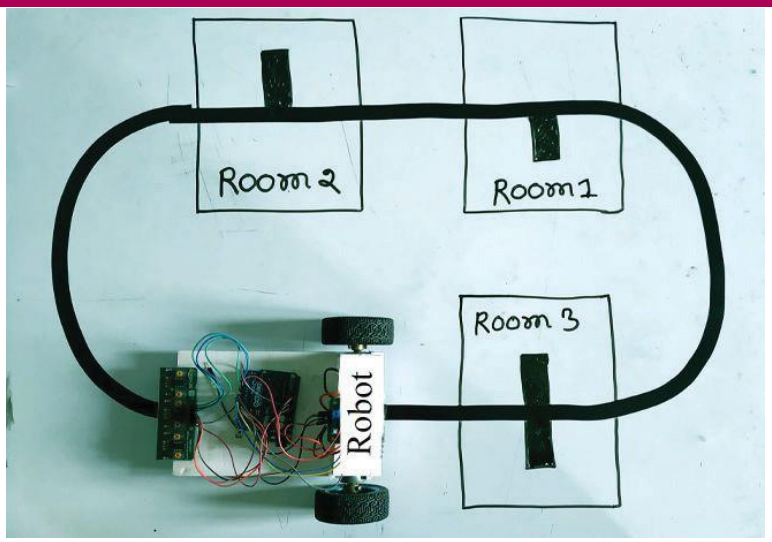

Figure 5 Map of the wheel-chair in a house

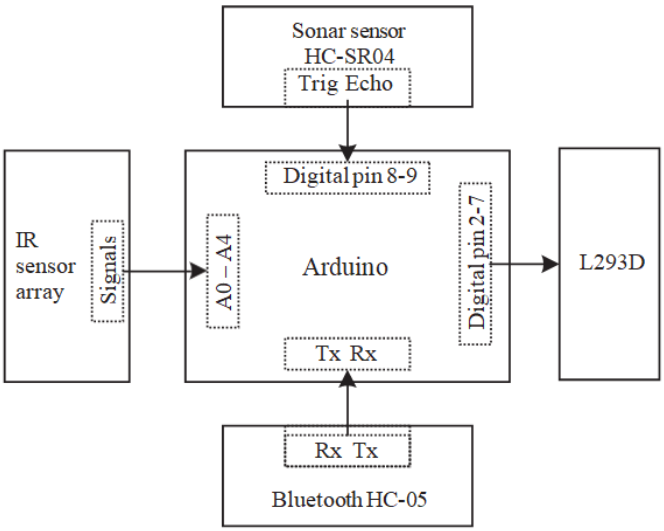

Figure 6 A Schematic diagram of autonomous wheel-chair

A schematic diagram of autonomous wheel-chair with all the sensors is given in Fig. 7. A motor driver, L293D is connected with Arduino for controlling the motor speed and direction. A PID controller continuously checks how much does the chair deviate from the set point. This calculation gives the error value. On the basis of the error value Arduino manages to rectify the error by varying the motor speed for “room three”. Likewise, each of the other rooms has differences in pattern to generate different indications. Fig. 8 shows the behaviour of the chair in case it finds any obstacle. A proximity sensor with a detection range of one meter is used for checking the obstacles. When it finds one, the wheelchair stops and makes an alarm. As the obstacle moves away, the wheelchair starts moving again.

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IR sensor 1 to 5					Sonar proximity Sensor	Condition detected
0	0	1	1	1	0	Room 1
1	1	1	0	0	0	Room 2
1	1	1	1	1	0	Room 3
X	X	X	X	X	1	Obstacle

Figure 7 Sensors state for different condition

7. Experimental Results

The experimental analysis is done to confirm the effective- ness of proposed system. When the user says “fan on”, an integer value 1 is sent to Arduino through Bluetooth module HC-05. The ASCII value of 1 is 49 which are 110001 in binary form. Arduino communicates with the Bluetooth module with a baud rate of 9600. In the beginning of communication, the start bit arrives first and it is always zero. Then the last bit arrives first, which means 110001 arrives as 10001100 as an eight-byte number.

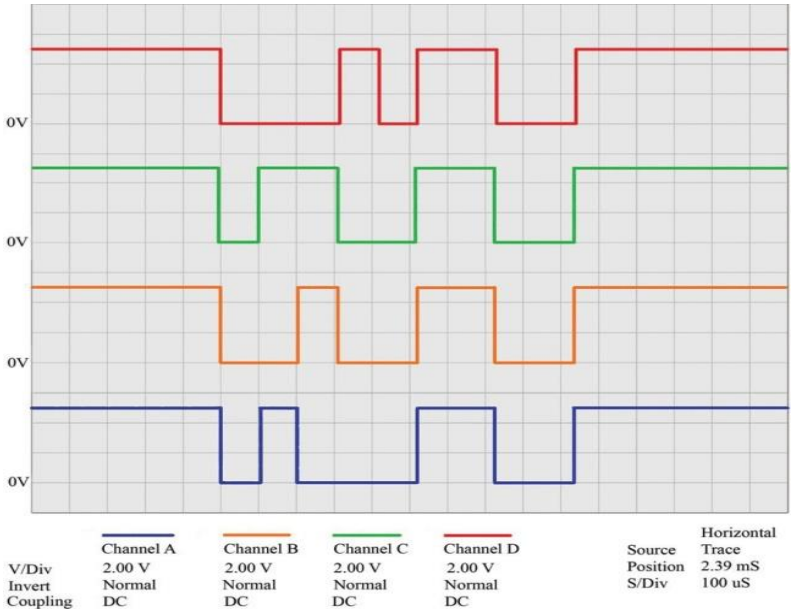

Figure 8 Wave shape of 1 with start and stop bit in channel A

Then a stop bit comes and it is always high. Fig. 9 shows the wave shape of 1 with start and stop bit in channel A. Similarly, the wave shapes for “fan off”, “faster” and “slower” are shown in channel B, C and D respectively. For voice command fan on, the fan starts with an average voltage as shown in Fig. 10(c) for channel A. Fig. 10(a) presents the increased supplied voltage with faster command for channel C. The slower command decreases the voltage across the fan as shown in fig.10 (b) for channel D. All of results confirms the efficiency of proposed system. The rest considering system shows the similar performance as like speed control of fan.

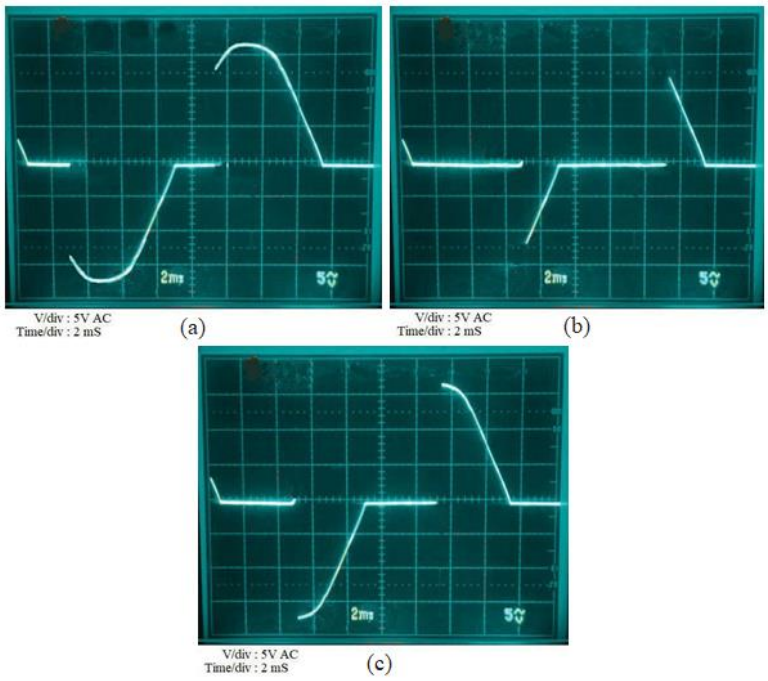

Figure 9 (a) increased voltage, (b) decreased voltage (c) average voltage

8. Conclusions

Voice controlled home automation system for multifunctional devices have been tested successfully. The bright part of this paper is that with widespread use of such a system, energy wastages can be significantly cut short. The system is easy to build and use. It attempts to reduce the dependency of physically challenged people on others. This system can be very handy considering that it is built in available components. The ranges of sensor operations and the patterns have been elaborated in this paper. The experimental analysis is studied to measure the efficiency of proposed system. The obtained results guarantee that the proposed system is able to control the home appliances in a convenience way.

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