Bluetooth And Arduino Uno-Based Voice-Controlled Home Automation System

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Abstract: **People nowadays seek strategies to improve their lifestyles by utilizing the most up-to-date technologies. Also, the physically challenged find it difficult to do minor tasks alone in the home. Home automation systems are getting more attention coinciding with developments in the Internet of Things. In line with assistive technology, this project demonstrates the implementation of a low-cost home automation system by designing and building a microcontroller-based system for controlling and monitoring home devices with the use of a voice remote control system that allows data to be transferred through wireless media. The technology is simple to use and is built on an Android-based smartphone with an easy interface. Demonstrations reveal that the system makes it easier for the system's intended users (the elderly and the disabled) to operate lighting, heating, cooling, and security systems in their homes.**

***Keywords*: Arduino, home automation, voice, internet of things, disabled**

I. INTRODUCTION

Automation is becoming increasingly important in daily life and the global economy. Engineers try to construct complicated systems by combining automated equipment with mathematical and organizational tools for a continuously growing range of applications and human activities. As technology and intelligent services have developed, people's expectations and ideas about how services should be offered and accessed at home have changed significantly. This has enabled the transformation of the traditional home into a smart home; thus, the concept of home automation systems has evolved. Home automation refers to integrating all domestic amenities and equipment. The term "home automation system" allows end-users to control and manage their electric appliances [1]. For instance, a centrally controlled microcontroller panel can handle everything from heating and air conditioning to security systems, lighting, and other electrical appliances [2]. Controlling components of our home remotely via a computer or mobile device, programming electrical items to respond automatically to certain conditions or scenarios, or centralizing the control of a range of the home's appliances into a single control point are all examples of home automation [3]. Many well-known home automation systems, such as Arduino-based home automation systems, rely on wired connections. This is not a problem until the system is developed ahead of time and installed during the building's physical construction. However, the cost of implementation for existing structures is relatively expensive.

On the other hand, wireless systems can benefit from automation systems such as Bluetooth, Wi-Fi, and IoT-based home automation systems (Internet of things). In recent years, wireless technologies like Wi-Fi and cloud networks have progressed, and wireless systems are now utilized daily and everywhere [4].

Home automation has grown popular over the last few decades, improving comfort and quality of life [5]. Some people require a home automation system to meet their demands and comfort. Integrating speech recognition technology for paralyzed people's home automation systems can make the system more user-friendly and straightforward to manage and control.

Traditionally, most controlling has been done manually, such as walking to the switch and turning it on. However, as time progressed, the development of remote controls provided users with an alternate method of controlling such appliances without walking to the unit. [6]. As a result of the preceding, several advancements in the controlling method have been researched by some scientists and engineers such as [5], [7]-[10].

A noteworthy achievement is using the voice as the initiating or controlling medium for the appliance. Home automation allows people to save energy, be more convenient, and be more efficient in their homes [11]

This project aims to design and create a home automation system using the Arduino microcontroller that is open-source, simple to use, and inexpensive. The project is restricted to a residential mode to allow for prototyping.

II. METHODS

In this project, a speech function to control home devices is employed. It makes use of a Bluetooth module and a microcontroller. In an embedded system, a microcontroller is a small integrated circuit that governs a certain operation. The application is free and easy to use. This project is relatively simple to implement in the real world. It may be controlled by anyone of any age just by uttering the orders. The range of this Arduino-based project is greater than that of Infra-Red and PC-based projects.

1) Power Supply Unit: Figure 1 shows the 12 V power source used in this project, which is one of the system's relay functions. It is to control or switch on and off a much larger current with a relatively small current

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Figure 1: Power source used (12 V DC and 230 V AC)

2) Voice Recognition Unit: The voice recognition unit consists of the HC-05 Bluetooth module and the ARM software application. This unit oversees the voice commands, which are sent to the microprocessor (Arduino Uno) to be interpreted and executed with help from the 12V relays.

3) Control Unit: This component manages the general functionality of the system. It consists of an Arduino Uno board with an ATMEGA328P microcontroller IC as shown in Figure 2. It contains a non-volatile FLASH program memory that is parallel programmable. Along with ATMEGA328P, the Arduino Uno board consists of other components such as a crystal oscillator, serial communication, voltage regulator, and so on to support the microcontroller. Arduino Uno has 14 digital input/output pins (out of which six can be used as PWM outputs), six analog input pins, a USB connection, A power barrel jack, an ICSP header, and a reset button.

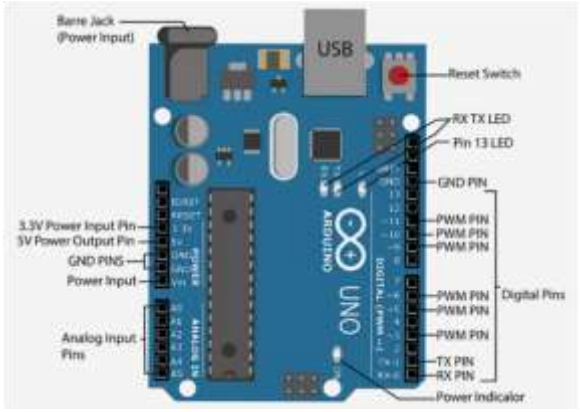

Figure. 2: Pins And components on the Arduino board

When the ATMEGA328P chip is used instead of the Arduino board, the pins have their mapping configuration as the microcontroller has 28pins. Figure 3 shows the mapping diagram for connecting the pins of the ATMEGA328P microcontroller.

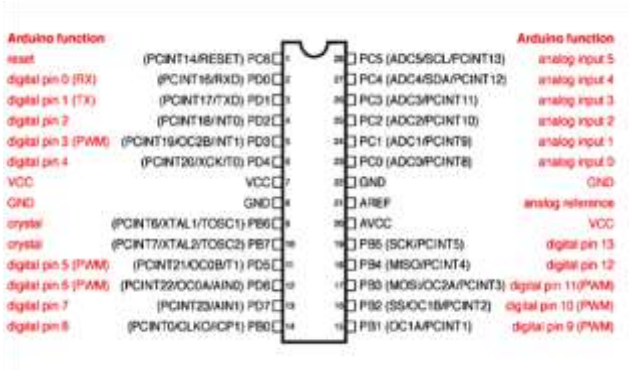

Figure. 3: The mapping of the Atmega328p microcontroller.

4) Programming the Microcontroller

When programming the microcontroller from pc, a cable for serial, parallel, or USB communication and an Arduino Uno board is used with Arduino IDE software. The Arduino IDE software is a specialized program in the Windows environment for writing programs for the microcontroller. The program is written in Assembly language. The main work here is to write all instructions so that they should be executed sequentially by the microcontroller. For the Assembly language compiler to run the program successfully, the source file must have the extension ino after its name, for example, (automation.ino).

The steps for programming the microcontroller are as follows;

1. Connect the device to pc using the USB serial cable.
2. Open and load the written code document.
3. Click the upload icon to upload the written code to the microcontroller through the Arduino Uno board.

Below is the modified code used in this project work and displayed on the PC screen in Figure 4:

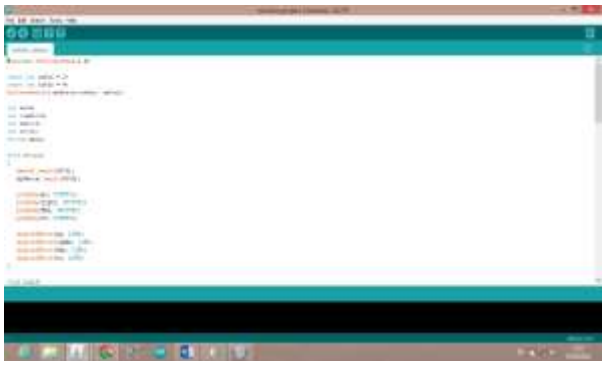

Figure 4: The codes on the arduino ide microcontroller

5) Component arrangement

The key parts of this project's use are the HC-05 Bluetooth module, the 12v relays, the ARM software, and the Arduino Uno microcontroller board. These components are arranged on a breadboard using a circuit diagram stimulated on proteus, and the schematic diagram is presented in Figure 5.

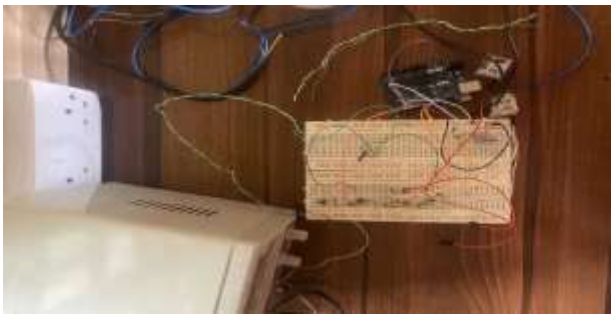

Figure 5: Components on breadboard

III. CIRCUIT DESCRIPTION

Figure 6 shows the schematic diagram of the voice recognition home automation system using Arduino. The figure explained in detail, the function of each component involved in the circuit.

DUINO1 is the microcontroller that controls the circuit. RL1, RL2, RL3, and RL4 are 12 V relays. The relay provides complete isolation between the low-voltage circuit on DUINO1 and the high-voltage side controlling the load. It gets activated using 5V from DUINO1, which controls electrical appliances like fans, lights, and air-conditioners. The RL1, RL2, RL3, and RL4 are all 1 K resistors attached to the 12 V relay, and they absorb excess voltage given off when the relay is activated. This would protect any other components in the circuit from voltage spikes. The resistors are connected to pins 9, 10, 11, and 12 on the DUINO1. The HC1 is the HC-05 Bluetooth module used in the project. It is connected to pins 2 and 4 on the DUINO1. It aids in sending commands received by the HC-05 through the ARM software, the DUINO1, for processing and execution. D1, D2, D3, and D4 are diodes connected in parallel to the relay coil, preventing huge voltage spikes from arising when the power supply is disconnected. Q1, Q2, Q3, and Q4 are transistors. They are used as the main switching devices. It provides fast DC switching (ON-OFF) control relay coil from an input source. L1, L2, L3, and L4 are 230 V ac bulbs representing appliances controlled by voice commands. The 10 K and 20 K connected to the RX pin of the HC1 are used as a voltage divider because the RX pin can accept only 3.3 V, and the voltage provided by the DUINO1 is 5 V.

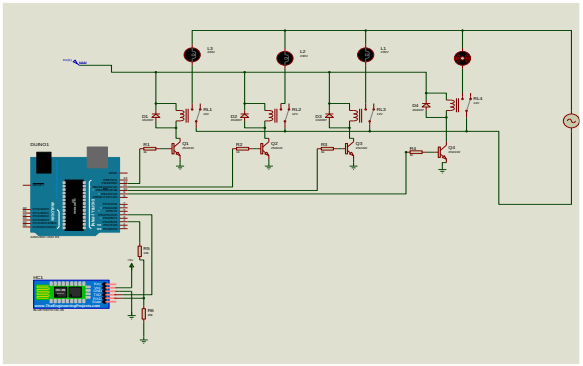

Figure 6: Schematic diagram of a Voice Recognition Home Automation System Using Arduino and Bluetooth.

IV. RESULT AND DISCUSSION

We put our system together using the above components. The Arduino Uno (DUINO1) is the system's main component, as it has a microprocessor (Atmega328). The Atmega 328 has a 32KB flash memory.

The voice-controlled Arduino system uses a 12 V output power supply adapter as an input. Relays are attached to the Arduino Uno's output pins and serve as switches for the loads.

A Bluetooth module HC-05 is utilized as a remote for the wireless communication system, which is attached to the control unit for sensing the signals sent by the android voice application.

The switchboard was connected to the microcontroller device with the Bluetooth module and relay circuit. Then, on our smartphone, we launched the android-based program AMR voice. Voice commands were given to the appliance using the application. The microcontroller sends a signal to the relay board after receiving the command from the Bluetooth module.

Figure. 7: The software application on android device receiving commands

The application began by looking for a Bluetooth device. It starts the voice recognizer module and senses its availability. It reads the voice and turns the audio stream to a string of characters as displayed on the smartphone. It assigns a value to each appliance that is fed into the microcontroller. The serial port is used by the microcontroller. It decodes the input value after receiving the data and sends a signal to the parallel port, which activates the relay circuit. The relay then turns on the bulbs, which represents the load as shown in Figure 8.

Figure 8: Diagram of the loads responding to voice commands to turn on

V. CONCLUSION

The deployment of a low-cost home automation system within the context of assistive technology was demonstrated in the current project. The Arduino microcontroller is used in the system's implementation, which has been programmed to control a range of home automation devices based on sensor signals and on direct commands by the user. The system has been programmed to have Bluetooth communication capability. Demonstrations of the system show that it facilitates the control of home-based devices such as electrical appliances, lights, heating, cooling systems, and security devices by the intended users especially the elderly and handicapped persons. Overall, this project's implementation has been successful. The goal of making the project user-friendly and cost-effective is considered and accomplished.

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