A Control System Using Speech Recognition AMR in Robotic System

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Abstracts: Voice command is currently a vital task for developing smart assistive devices, especially since the frequency of accidents continues to climb, posing a huge shift in handicapped people's lifestyles which makes producing a material to support them in their daily lives a significant challenge. One of the proposed options is to add an embedded system with a machine learning algorithm represented by voice recognition to assist handicapped people. In this paper, we have implemented a voice command control system in Arabic through an AMR Voice application in Smartphone with a microcontroller demonstrates a sophisticated integration of hardware and software technologies. The utilization of Bluetooth technology which acts as a communication channel with the LED light circuit , which will then be connected to the Arduino to create a system based on voice commands.

Keywords: Arduino, Speech Recognition, Voice command, AMR Voice.

1. INTRODUCTION

Since 1970, the scientific and industrial world has always focused on the study and creation of controlled and autonomous mobile machines and robots [1]. The goal of man is to free himself from work in all its demanding, tiring and uninteresting aspects, and therefore to simplify life. Mobile robots will be able to move anywhere, especially in a hostile environment where humans cannot access, and to carry out tasks in place of humans, especially in a domestic environment [2]. Today, researchers are trying to find different ways to facilitate the control of robots, such as control by speech recognition in robotics [3]. The field of application extends into home automation, automation and automobile mechanics to make a machine or robot obedient and automaton [4]. One option available to us is to miniaturize this project at the hardware level to be able to implement it in the future in large projects. This choice allows us to explain the minimum functioning of the project so as not to go into details.

This project is an excellent demonstration of how voice commands can be used to control LED lights, wirelessly, providing a convenient and intuitive interface for users. The Android application, functioning as a transmitter, sends commands to the robot via a Bluetooth link. . Once the Arduino is programmed, the necessary connections are established for the LED lights circuit to function. The link between the Android application (AMR Voice) and the LED lights circuit is achieved through Bluetooth module (HC-05). When the user issues commands through AMR Voice, they are transmitted to the Bluetooth module, which in turn instructs the Arduino to carry out the corresponding operation. These commands encompass movements such as Left, Right, Backward, and Forward. With a range of up to 2 meters, this circuit is well-suited for various applications. If required, the range can be extended for specific purposes. Overall, this project showcases the effective integration of voice recognition technology and wireless communication in robotics, opening up exciting possibilities for future applications.

2. RELATED WORK

In this section, we conducted a systematic evaluation of the presented material in order to extract the investigated problem and recommended solution from each document, followed by a critical analysis of the articles to be able to

provide novel ideas. The study in [5] attempt to develop a voice-activated robotic vehicle that can pick up and drop down an object in an unmanned environment. We intend to aid persons with disabilities in their daily routines by using a robotic arm. Voice instructions can control the robotic arm, which can assist people who are unable to walk. The robotic arm is controlled by three motors. Automatic voice recognition technology can be used with a microphone and a mobile app. The microcontroller's output signals are delivered to the robotic arm's three motors. The Arduino microcontroller aids the robotic arm's interaction. [6] The robotic arm and vehicle are implemented using the 8051 microcontroller, which is controlled through voice commands. The Bluetooth receiver receives the vocal commands from the android device, and the robotic arm vehicle obeys them. The Bluetooth receiver is connected to the 8051 microcontroller. The paper's main focus is on a robotic vehicle with two wheels and a gripper that picks and places an object from one spot to another using an Arduino board. The robot is referred to in the report as a rescue robot that can assist humans in disaster zones. Showed a robotic arm controlled by voice. This system allows the user to utilize voice commands to control the actions of a robotic arm via an Android application.

By merging MATLAB and ARDUINO, this project provided by [7] demonstrates a new technique of voice processing. Through Arduino, a speech is processed, and a door lock system is controlled. The voices are detected using FFT. In this case, the FFT compares the pitch of the input speech to a database sample voice. Any application can be added to the output of this project. The main goal of this project is to open and close a door lock for personnel use. The authors in [8] add a new dimension to the robotic vehicle. It is easily recognized by voice commands and runs without hiccups. Furthermore, the project can be upgraded to be used for home security, hospitals, and military purposes, where commands can be given to the robot by increasing the range and installing cameras. The use of long-range Bluetooth modules and other connectivity devices such as WIFI will result in long-distance connectivity with the robot. For improved accuracy, an image processing method can be implemented in this robot to detect color and objects.

Saravanan et al devlopp in [9] a robot that is controlled by voice commands. For required tasks, an android application with a microcontroller is used. Bluetooth technology facilitates communication between the Android app and the vehicle. The robot is controlled by the application's buttons or the user's spoken commands.

The articles we reviewed focus on English compared to Arabic. This prompted us to introduce the Arabic language into the remote control system via speech. Incorporating the Arabic language into the remote control system through speech recognition can greatly enhance usability for Arabic-speaking users.

3. METHODOLOGY

In this project, we are merging two elements: hardware and software. So, according to this, we must be mindful of each action that must be taken. As we code in the microcontroller, we must be mindful of the application's development process and, of course, the hardware that is attached to it. The Arduino, Bluetooth module and smartphone (Android) are the main components of this project. The AMR Voice application is installed in smartphone which plays a crucial role as the interface for controlling the Arduino-based system. The commands are given by this android application. The smartphone then sends an instruction to the Arduino through the Bluetooth for control the LED lights. Six distinct voice commands are used to turn on and off these LED lights. Figure 1 illustrates the fundamental concept of a voice-com

mand asked system.
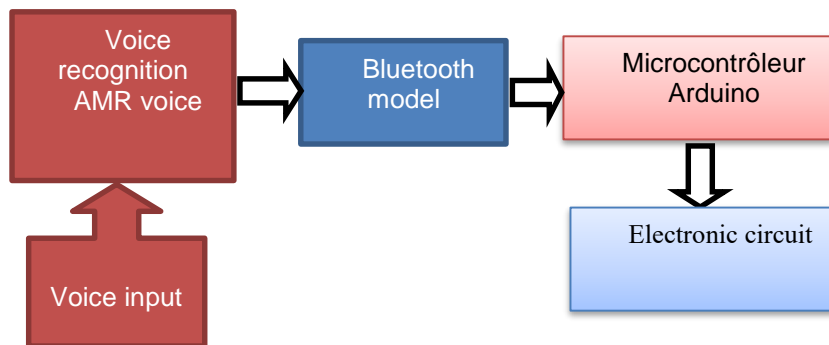
Figure 1. The system's flowchart.

The following are some of the steps that we followed for our project:

3.1. The Arduino Uno

The Arduino consists of both a physical circuit board and software (IDE). The Arduino (shown in Figure 2) is a system that resembles a computer: it has memory, a processor (microcontroller) and interfaces with the outside world [10]. The Arduino board uses an open-source programmed electronics platform that is based on a microcontroller and an IDE integrated development environment to write, compile and transfer the program to the microcontroller board.

Figure 2. Arduino UNO.

3.2. AMR Voice Control

The AMR Voice Control is a mobile application available on the Google Play Store (shown in Figure 3). This application is designed to enable users to control devices or robots using voice commands [11,12]. It specifically utilizes Bluetooth technology for communication between the mobile device and the controlled device or robot. Key features of AMR Voice Control include:

- The application is capable of recognizing specific voice commands provided by the user.

- It establishes a connection with Bluetooth-enabled devices or robots, allowing for wireless control.

- The app typically provides an intuitive interface, making it easy for users to navigate and issue voice commands.

- Users have the ability to customize or define specific voice commands for controlling their devices.

- The application may be designed to work with a variety of devices and robots equipped with Bluetooth

communication capabilities.

- Users can give voice commands in real-time, allowing for immediate control of connected devices.
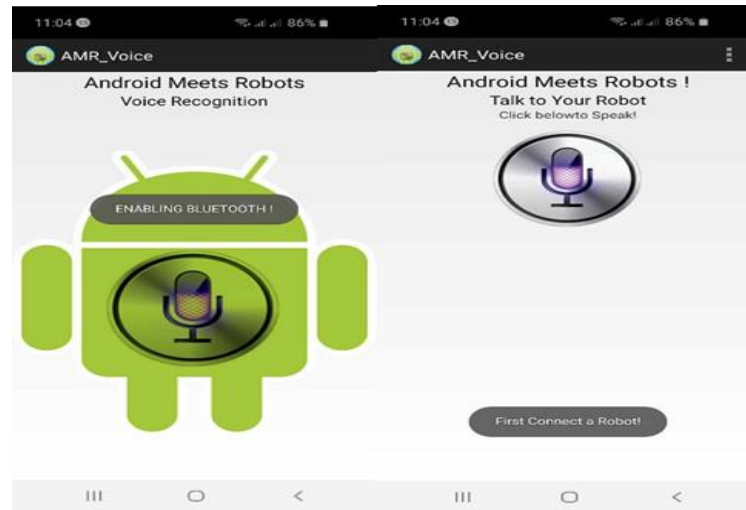

Figure 3. AMR Voice.

3.3. Testing the hardware with Arduino UNO and Debugging

The instruction must go to Arduino to conduct an action after the application's speech to text conversion procedure is complete. In order to do this, we have an intelligent Arduino Uno that can carry out incoming commands. Since the microcontroller is used to controller utilities in accordance with the instruction obtained from the user's mobile application, programming was done in it to enable it to comprehend and carry out the incoming orders.

3.4. Implementing the Hardware

The usage of linking the final product, which must be handled, is a part of this development process. Lights LED appliances will be linked to the relay board as part of our project. This board is connected to the Arduino, and Arduino, in turn, is connected to the program that will receive user input. In essence, the process is input-driven by the application, and after being run by the Arduino, an action (or output) is carried out by the Bluetooth utilities. For our project, we used all the boards that were needed and all the connecting equipment that went with them.

3.5. Hardware and Software Synchronization During Testing

This stage of our project's development lifecycle is very important since it indicates how well the entire system is functioning. Its functionality is entirely dependent on the hardware utilized, as well as the development of the software and codes on the microcontroller and the mobile application. Testing and troubleshooting can reveal if synchronization and the overall system's functionality support the system's accuracy. In the event that anything appears, such as clearly detectable bugs. Figure.4 is a basic flowchart for controlling LED lights using voice commands by Arabic language.
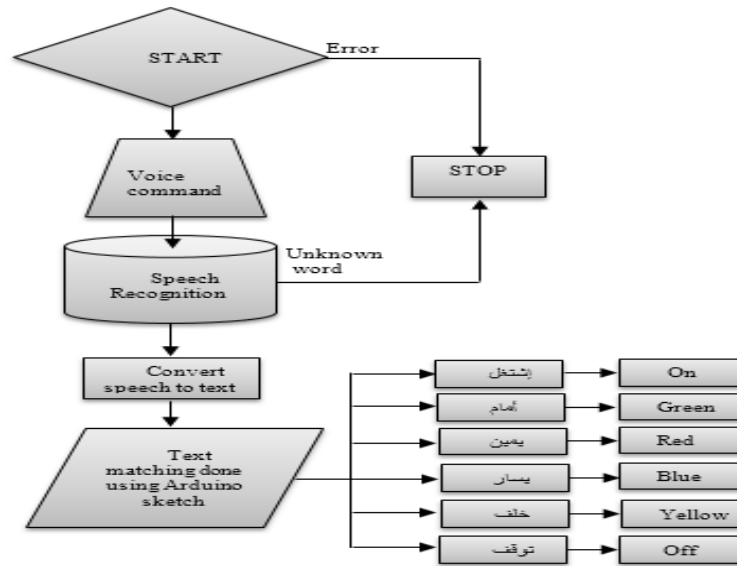
Figure 4. Block diagram of voice control

4. RESULTS AND DISCUSSIONS

Test of voice commands for LED light using the android AMR Voice is tested for 5 fixed commands. All commands responded accordingly by the commands mentioned above. LED light receiver was synchronized to the android transmitter which is the mobile phone at various ranges until the maximum range obtained was 2 m depending on the location. The final voice control mounted manipulator is shown in Figure 4.

Once the Arduino programming is complete, we establish all necessary connections for LED lights circuit. This involves linking the Android application (AMR Voice) and the Bluetooth module (HC-05). The AMR Voice app allows users to issue commands, which are then received by the Bluetooth module. The Arduino processes these commands, converting them into digital form. These commands include speech Arabic it can be extended further for specific applications.
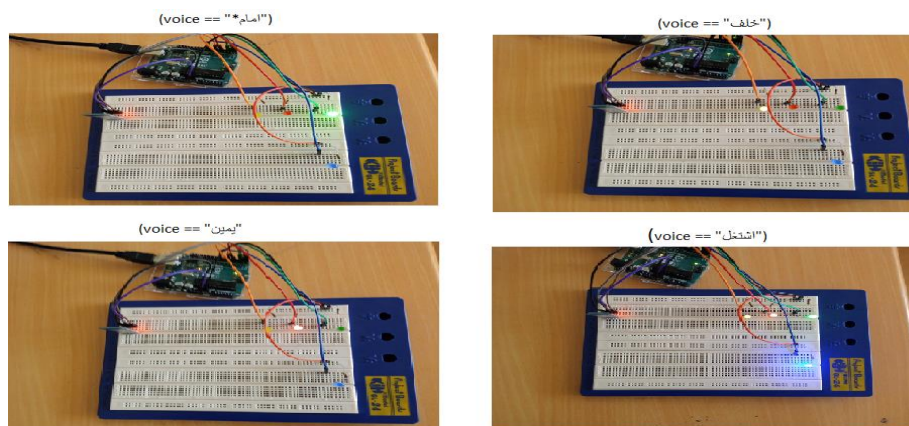

Figure 5. Prototype of voice controlled LED light.

The Arduino is responsible for processing incoming commands from the Bluetooth module and controlling the LED lights accordingly it's programmed to interpret the signals sent by the HC-05 module. Bluetooth Module acts as a bridge between the Android application and the Arduino it receives commands from the Android app via Bluetooth and transmits them to the Arduino. The AMR Voice allows users to give voice commands in Arabic. The voice recognition application (AMR Voice) processes the received audio data and matches it with the pre-trained

commands. When the voice commands are successfully matched, the Arduino sends an activation signal to LED light. The specific commands, along with their explanations, are defined:

"أمام" is used to turn on the green light.

"يمين" is used to turn on the red light.

"يسار" is used to turn on the blue light.

"خلف" is used to turn on the yellow light.

"توقف" command is used to all the lights off.

"اشتغل" command is used to all the lights on.

The testing also demonstrated that there was no significant difference in recognition rates between male and female speakers. This indicates that the system is robust and capable of accurately interpreting voice commands regardless of the speaker's gender. Overall, the project has successfully achieved its goal of designing an efficient automatic speech recognition system for controlling an electric LED light. The integrated processing units, including the speech kit and microcontroller, demonstrate the project's commitment to providing a complete and autonomous solution for differently abled individuals. The recognition rate of above 90% is a strong indicator of the system's effectiveness. This indicates that the system reliably translates voice commands into string inputs for the Arduino, resulting in precise control of the LED lights.

CONCLUSIONS

Through rigorous testing and validation, the system has demonstrated its reliability and effectiveness for speech Arabic in control of LED lights. By enabling control through a smartphone application, this project empowers differently abled and older individuals, promoting self-dependency and enhancing their quality of life. The implementation of this technology represents a substantial step towards creating inclusive and accessible environments for those with mobility challenges. Overall, the successful development and testing of this Smart Electronic project signify a meaningful contribution to the field of assistive technology, with potential benefits for a wide range of users. This project stands as a testament to the positive impact that innovative technology can have on the lives of individuals with disabilities.

Future work: Train a machine learning model to improve the accuracy of Arabic speech recognition over time, adapting to different accents and speech patterns. Extend the project to control other smart devices within a home automation system, allowing for a more comprehensive voice-controlled environment. Design voice controlled wheelchair or help people with lower limb disability.

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