Arduino Voice Control for Arabic Speech Recognition using Smartphone*

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Abstract

Engaging with our surroundings through voice control has emerged as an increasingly intriguing aspect. This technology is gaining prevalence in our daily lives, whether applied in smart homes, mobile phones, or the control of comfort features in vehicles. The pertinent inquiry is whether voice control will find its place in the production industry, as its reliability remains a critical concern. This project showcases an alternative approach to voice processing by integrating Arabic speech recognition in MIT App Inventor for voice command control. In this setup, voice signals undergo processing, enabling the operation of a LED light circuit through Bluetooth technology. The voice command is given in Arabic through the smartphone device having Bluetooth and the command is transferred and converted to string by the BT Voice Control for Arduino and is transferred to the Bluetooth Module connected to the Arduino board for the control of the LED light circuit. The voice command Arabic is given through a Smartphone device.

Keywords

Arduino, MIT App Inventor, Speech recognition, voice command

1. Introduction

The voice control known as voice recognition or voice command, is a cutting-edge technology that enables users to interact with devices, applications, and systems using spoken commands [1],[2]. This transformative capability harnesses the power of natural language processing and artificial intelligence to understand, interpret, and execute spoken instructions, providing a hands-free and intuitive user experience [3]. In a world increasingly characterized by smart homes, connected devices, and advanced digital assistants, voice control stands out as a pivotal interface between humans and technology. Users can simply articulate their requests, inquiries, or commands, and the underlying systems respond accordingly, offering convenience, efficiency, and accessibility. Voice control has found widespread application across various domains, ranging from smartphones and virtual assistants to smart home devices, automobiles, and industrial settings. Voice-enabled technologies such as Amazon Alexa, Google Assistant, Apple's Siri, and others have become integral parts of daily life, shaping the way we interact with our digital environments. The technology's impact extends beyond personal convenience, as it plays a crucial role in enhancing accessibility for individuals with disabilities. Voice control empowers users to engage with technology irrespective of physical limitations, fostering inclusivity and equal access to digital resources [4]. However, the evolution of voice control is ongoing, with ongoing advancements in natural language understanding, machine learning, and cloud computing. As voice-enabled systems become more sophisticated, they continue to redefine the boundaries of human-machine interaction, opening new possibilities for innovation across industries. In this era of rapid technological progress, voice control serves as a gateway to a more seamless and connected future, where human communication with machines mirrors the simplicity and fluidity of everyday conversation. This introduction merely scratches the surface of the transformative potential that voice control holds in shaping the next wave of user-centric, intelligent technologies [5] [6]. The study in [7] aims to build a voice-controlled robot car for the elderly and disabled using Arduino and Bluetooth technology. The system allows the user to wirelessly control the car's movements through voice commands sent from an Android phone via an application. In [8] presents the development of a voice controlled wheelchair prototype using an Arduino microcontroller and a commercially available manual wheelchair. The voice commands are processed by the Arduino microcontroller, which controls the motor movement of the wheelchair. A Bluetooth module is used to eliminate messy wiring, and an optional joystick command is also incorporated into the design. The success rate of the wheelchair in recognizing voice commands in English, Chinese, and Malay was high. In

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[9] 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. Through rigorous testing and validation, the system has demonstrated its reliability and effectiveness for speech Arabic in control of LED lights.

In this paper, we have implemented a voice command control system in Arabic through an MIT inventor in Smartphone with a microcontroller (Arduino). The Arduino board serves as the brain of the operation, executing commands received from the Bluetooth module. The programming logic on the Arduino enables it to interpret these commands and control the attached LED lights circuit accordingly. The HC-05 Bluetooth module acts as the bridge between the Arduino and the MIT App on the Android device. It facilitates wireless communication, allowing users to send commands from the app to the Arduino remotely. The MIT App incorporate voice recognition technology, given the mention of commands issued through MIT App [10]. This feature adds an extra layer of interactivity and user convenience, allowing users to control the robotic system through voice commands. This project demonstrates a cohesive integration of hardware and software technologies, offering a glimpse into the possibilities that arise from combining Arduino, Bluetooth, and voice recognition in the field of robotics. As technology continues to advance, such projects pave the way for innovative applications with broader implications.

2. System Design

In this undertaking, we are amalgamating two elements: hardware and software. Consequently, it is imperative to be mindful of each step involved. While coding in the microcontroller, attention must be given to the application's development process and, naturally, the connected hardware. The principal components of this project include the Arduino, Bluetooth module, and an Android smartphone. The MIT App Inventor application, installed on the smartphone, serves as a crucial interface for controlling the Arduino-based system. Commands are issued through this Android application, prompting the smartphone to send instructions to the Arduino via Bluetooth to manipulate the LED lights. Six distinct voice commands are employed to toggle these LED lights on and off. Figure 1 illustrates the fundamental concept of a voice-command-driven system.

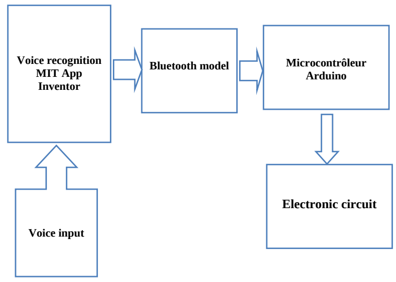

Figure 1: The system's flowchart.

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

2.1. Hardware Components

To build a Voice Command System based on Arduino and MIT App Inventor, you'll need a set of hardware components. Here's a list of essential hardware components for such a system:

1. Arduino Board: Functions as the microcontroller, responsible for executing commands received from the MIT App Inventor.
2. Bluetooth Module (e.g., HC-05): Acts as a wireless communication bridge between the Arduino and the smartphone.
3. Android Smartphone: Hosts the MIT App Inventor application and serves as the user interface for interacting with the voice command system.
4. LEDs or Output Devices: Include LEDs or other output devices that can be controlled by the Arduino. These devices will respond to voice commands, demonstrating the system's functionality.
5. Suitable resistors to protect the LEDs or output devices used from overcurrent.

2.2. Software Components

The following is a list of essential Software components for implementing such a system:

1. Arduino Code: Develop the Arduino code using the Arduino IDE or any compatible platform. Implement a Bluetooth communication protocol to receive and interpret commands from the MIT App Inventor.
2. MIT App Inventor: Design the user interface for the Android application. Integrate voice recognition components for capturing user voice commands. Implement logic to convert voice commands into actionable instructions for the Arduino.

3. Hardware and software synchronization during testing

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 and for the software, we must be mindful of the application's development process and, of course, the hardware that is attached to it. We will use the SDLC (Systems development life cycle) technique to show the hardware and software development processes. The following are some of the steps that we followed for our project, which included the creation of the application (software) as well as the development of the hardware.

3.1. Phase one: software development

We are working on a graphical user interface (GUI) program for translating speech to text and transmitting commands via the internet / Bluetooth. This GUI will show for the user to utilize while performing a certain task by speech. Our project's software development is specialized in taking input and converting it to computer readable format (text), after which the voice is to be delivered over the Internet/Bluetooth to the Arduino board and the action is to be done.

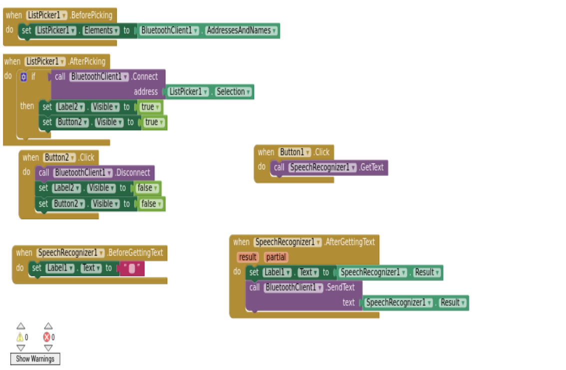

Figure 2: MIT App Inventor.

The program we're using is called App Inventor, and it was created by MIT. This web-based IDE will enable online code execution. It can only be used to develop Android software. We choose this since we can create an application in a distinctive and superior manner. Additionally, creating applications with graphical logics, methods, and functions is more enjoyable.

3.2. Phase two: 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 manage the house 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. Because the code we used in Arduino and the code in the application are perfectly compatible in terms of understanding one another, the same reference code is run as intended and an action is taken with regard to the home utilities.

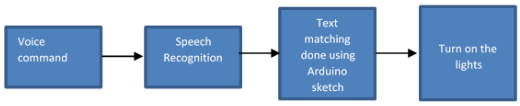

Figure 3: MIT App Inventor.

4. Results and discussion

The voice command testing for LED light control using the Android MIT App Inventor was conducted with four predetermined commands. All commands were executed successfully, aligning with the predefined instructions. The synchronization between the LED light receiver and the Android transmitter (mobile phone) was achieved at varying distances, with the maximum operational range determined to be 1 meters, contingent on the specific location. The culmination of this project is exemplified in the figure showcasing the final voice-controlled manipulator, as illustrated in Figure 4. Once the Arduino programming is finalized, the essential connections for the LED lights circuit are established. This process involves linking the Android application developed with MIT App Inventor and the Bluetooth module (HC-05).

Within the MIT App Inventor interface, users can seamlessly issue commands that are then transmitted to the Bluetooth module. Subsequently, the Arduino interprets and processes these commands, converting them into digital signals to control the LED lights.It's noteworthy that this system has been specifically tested for speech commands in Arabic, and the flexibility of the MIT App Inventor allows for potential extensions to cater to specific applications. This adaptability underlines the project's potential for further customization and

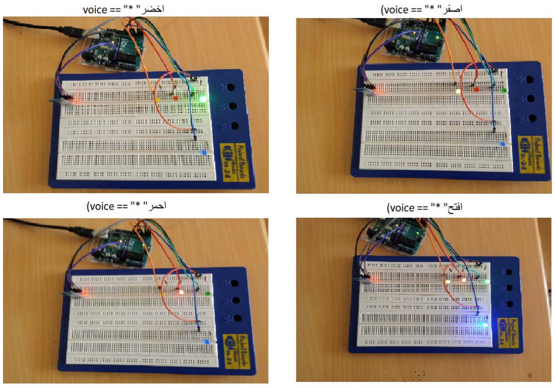

Figure 4: Prototype of voice controlled LED light.

Table 1
Voice command and rate recognition

Voice command	Condition	RSR
\Akthar	Turn on the green light	87%
\Ahmar	Turn on the red light	90%
\Azrak	Turn on the blue light	89%
\Asfar	Turn on the yellow light	85%

expansion, making it a versatile and scalable solution for various contexts.

The voice commands are interpreted and translated to string and provided to the Arduino that in turn produces and actuates the LED lights circuit accordingly as shown in Table 1. The testing also demonstrated that there was no significant difference in rate speech recognition RSR between male and female. Action designing a simple and efficient automatic speech recognition system for isolated command words to satisfy the motion control of an LED lights for differently abled persons is the interest of this project. The processing units (the speech kit and the microcontroller) are directly attached to the LED lights in one package that made the design representing a complete autonomous and smart LED lights. The speech recognizer is tested to prove its performance to generate exact movement of the LED lights. It proved a recognition rate RSR of above 87.75%

5. Conclusion

The rigorous testing and validation of the system have demonstrated its reliability and efficacy in Arabic speech control of LED lights. By enabling control through a MIT App Inventor application smartphone, this project serves as an empowering tool for differently-abled and elderly individuals, fostering self-dependency and enhancing their overall quality of life. The implementation of this technology represents a significant stride toward establishing inclusive and accessible environments for those facing mobility challenges. The successful development and testing of this Smart Electronic project mark a meaningful contribution to the field of assistive technology, promising broad benefits for diverse users. Looking ahead, future work could involve training a machine learning model to enhance the accuracy of Arabic speech recognition progressively, adapting to various accents and speech patterns. This advancement would contribute to a more personalized and efficient user experience. Additionally, expanding the project to control other smart devices within a home automation system could create a more comprehensive voice-controlled environment, further improving the convenience and accessibility of daily tasks.

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