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# Voice Command Wheelchair Control Using Bluetooth For Disabled Patients

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**Abstract**

Disability is a physical or mental condition that limits a person's ability to fully participate in daily activities. Disabilities can occur to anyone and may be temporary or permanent. Examples of physical disabilities include vision loss, deafness, or mobility limitations, while examples of mental disabilities include autism spectrum disorders, anxiety disorders, or depression. People with disabilities often require environmental adjustments and community support to participate fully in daily life. This study focuses on individuals with leg disabilities, and one of the tools used by those with such disabilities is the wheelchair. There have been numerous studies on wheelchairs for individuals with leg impairments. In this research, the wheelchair is controlled using voice commands, which include forward, backward, left, right, and stop commands. To implement the wheelchair control, an Arduino Uno is used to process voice commands from the user, which are converted into text on an Android device. The text is then sent via Bluetooth and received by the Arduino Uno through serial communication. The control from Android to Arduino Uno is conducted in real-time, allowing the wheelchair to move according to the commands given. The result of this research shows that wheelchair control using voice commands was 100% successful.

*Keywords:* Disability, Wheelchair, Voice, Bluetooth

## 1. Introduction

A wheelchair is a mobility aid designed to assist individuals who have difficulty walking or are unable to walk. It typically consists of a padded seat with two large wheels and several smaller wheels, allowing it to be controlled by the user or by someone pushing the wheelchair. Wheelchairs can be used both indoors and outdoors, helping individuals with mobility impairments perform daily activities such as shopping, walking, or visiting the doctor [1], [2].

Generally, wheelchairs are categorized into two types: manual wheelchairs, which are operated by the user sitting in the chair or someone pushing it, and electric wheelchairs, powered by electric motors and batteries. Manual wheelchairs are usually lighter and easier to transport but require greater physical effort to use [3]. Electric wheelchairs, on the other hand, are easier to operate as they do not require significant physical exertion but tend to be heavier and require periodic battery recharging. They also offer greater speed and range than manual wheelchairs [4].

Functionally, platform model wheelchairs are suitable for users without a guide. These wheelchairs are motor-driven and easily controlled via joystick, allowing them to move forward and turn, although they are heavier than standard wheelchairs. Due to their automatic controls, platform model wheelchairs are expensive and rarely found in Indonesia [5].

Several studies have addressed wheelchair control systems. For example, "Design and Development of a Smart Wheelchair Controller Using EEG Signals" utilizes electroencephalogram (EEG) signals to control electric wheelchairs autonomously, demonstrating that EEG-controlled wheelchairs can be effectively used by individuals with physical impairments [6]. Similarly, "Robust Adaptive Control of Electric Wheelchairs for People with Severe Motor Impairments" evaluates adaptive control for electric wheelchairs, showing that it significantly improves control for people with severe motor disabilities [7]. Another study, "Control of an Electric Wheelchair Using Eye-Gaze Tracking," investigates eye-tracking systems for electric wheelchair control, with results indicating that it can be effectively used by physically impaired individuals [8]. Additionally, the study "Fuzzy Control System for Intelligent Electric Wheelchair Navigation in Dynamic Environments" developed a fuzzy logic system that helps electric wheelchairs avoid obstacles and ensure rider safety [9]. Finally, "Wireless Control of an Intelligent Electric Wheelchair" explores wireless systems for remote wheelchair control, demonstrating effective remote operation [10].

The research above highlights various approaches to wheelchair control, including EEG signals, eye movements, and electric control. This study aims to implement voice signals to control wheelchair movement. Challenges include ensuring signal connections, creating hardware capable of detecting voice signals, and classifying voice commands to enable forward, backward, left, right, and stop movements. The specific objective of this research is to help patients operate a wheelchair using only voice commands, offering greater independence for individuals with physical disabilities.

In this study, an Arduino Uno system was developed to enable standard electric wheelchair control through voice signals [11]. A system prototype was implemented and tested experimentally. The prototype includes both a digital system and mechanical actuators. The digital output is connected to mechanical actuators that adjust the wheelchair's position based on user commands. Voice signals are processed through several commands implemented in the Arduino Uno. These voice signals are then translated into motor positions for the electric wheelchair. The mechanical actuators are compatible with various standard electric wheelchair models. Through experiments, the system's ability to correctly interpret user commands was verified. The results of these experiments are presented and discussed in this study. The system block diagram is shown in Figure 1.

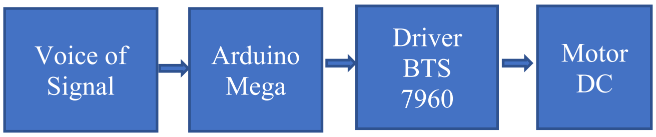


**Figure 1. Wheelchair Drive System**

## 2. Method

The research methodology for controlling a wheelchair using Bluetooth-based voice commands for disabled patients can be carried out through the following steps:

1. Literature Review:

A literature review is conducted to explore previous research in this field, including the latest technologies, methods, and outcomes from earlier studies. This step also helps identify gaps and unresolved issues in the existing research.

2. Sample Selection:

The study includes a sample of 10 subjects who will participate in the research. These participants will help assess the effectiveness and usability of the voice-command wheelchair control system.

3. Research Design:

The design phase involves outlining the hardware and software system required for the wheelchair control. This includes the integration of an Android device for voice input, the Bluetooth HC-05 module for wireless communication, the Arduino Uno for processing commands, motor drivers for wheelchair movement, and the mechanical components (DC motors and actuators) for controlling the wheelchair's mobility.

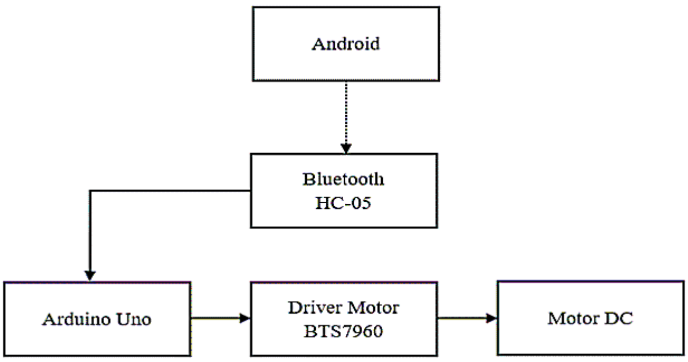


**Figure 2. Block diagram of Wheelchair Drive System**

In this study, spoken commands are used to control the movement of a wheelchair. The spoken commands include forward, backward, left, right, and stop. The research utilizes both hardware and software components, as depicted in the system block diagram in Figure 2. The hardware consists of five main parts: an Android device, Bluetooth HC-05 module, Arduino Uno, BTS7960 motor driver, and DC motors. In the system's block diagram, the Android device acts as the transmitter [12], while the Bluetooth HC-05 module functions as the receiver, which is processed by the Arduino Uno to send input signals to the BTS7960 motor driver, enabling the DC motors [13].

This research application requires software to convert the voice commands received by the Android device into text, which is then sent to the HC-05. The Android output, in serial form, is received by the HC-05, processed by the Arduino Uno, and forwarded to the motor driver, which then generates the motion force for the DC motors. The Android application used to convert voice to text can be created using the MIT App Inventor platform, which is available on Google [14]. MIT App Inventor is a platform that simplifies the process of developing simple applications without requiring extensive programming knowledge [15].

4. Data Collection

Data collected in this study include battery tests, step-down voltage tests, Bluetooth connection tests, DC motor movement data, and wheelchair operation tests.

5. Data Analysis

The collected data is analyzed to derive relevant and significant research findings.

6. Conclusion and Recommendations

Conclusions and recommendations are drawn based on the research results and data analysis. The findings and recommendations can be used to improve existing wheelchair control systems and to develop new technologies that more effectively assist disabled patients with their daily mobility.

### 2.1. Android

Android is an operating system (OS) developed by Google for mobile devices such as smartphones, tablets, and wearable devices (such as smartwatches). The Android operating system is based on the Linux kernel and uses the Java programming language as its primary language for application development. Android has a vast ecosystem and supports thousands of applications that can be downloaded through the Google Play Store. It also supports many advanced features such as integration with Google services, multitasking, notifications, voice recognition, and more. Android has released many versions since its initial launch in 2008. Each version is typically named after a dessert or snack, such as Cupcake, Donut, Gingerbread, KitKat, Lollipop, and so on. Each new version usually brings many new features, performance improvements, and security and privacy enhancements.

Android can be connected to an Arduino Uno through a serial connection (UART) using Bluetooth or USB OTG (On-The-Go), which supports serial protocols like CP2102 USB to UART converter or FTDI FT232RL USB to UART converter. To connect via Bluetooth, Arduino Uno can be paired with Bluetooth modules like HC-05 or HC-06 and then connected to an Android device via Bluetooth. In this case, the Android device can use a serial terminal application such as Bluetooth Terminal or Serial Bluetooth Terminal to communicate with the Arduino Uno via Bluetooth. For USB OTG connections, the Android device needs to be equipped with a USB OTG port and cable to connect to the Arduino Uno. Arduino Uno must also be programmed correctly to receive and transmit data via the USB serial connection. On the Android device, a serial terminal application such as Serial USB Terminal can be used to communicate with the Arduino Uno via USB OTG. In both cases, the Android device and the Arduino Uno must be configured with the same serial connection settings such as baud rate, data bits, parity, and stop bits to ensure proper communication between the devices.

### 2.2. Bluetooth HC-05

Bluetooth HC-05 is a Bluetooth module that enables electronic devices such as microcontrollers or Arduino to communicate wirelessly with other Bluetooth-enabled devices. The module can be configured as either a master or slave device in a Bluetooth connection. HC-05 can be used in applications requiring wireless communication between devices, such as remote control, environmental monitoring, or home automation. The HC-05 module has a serial interface (UART), making integration with microcontrollers or other devices simple. The module can be configured through AT commands, allowing the user to set various parameters such as baud rate, device name, and connection mode.

In this study, the Bluetooth HC-05 module is used to establish a connection between the Android device and the Arduino Uno [16], [17]. First, the user speaks a command into the Android device, which captures the voice and converts it into text. This text is then sent to the HC-05 module wirelessly via Bluetooth. Figure 3 shows the flowchart of the connection between Android and Arduino Uno.

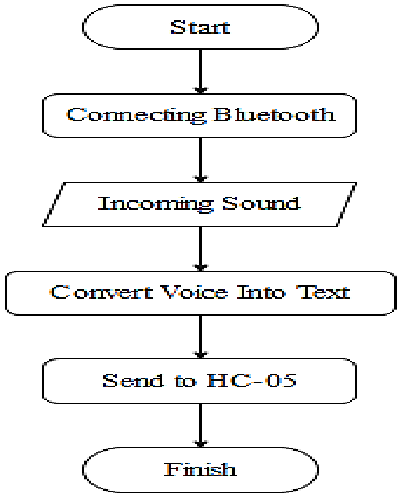


**Figure 3. Flowchart of Android connection to Arduino Uno**

The text sent by the Android device is received by the HC-05 module. The data is then processed by the motor driver, which produces forward, backward, right turn, left turn, and stop movements. If the HC-05 receives the "stop" command, the wheelchair stops. If it receives "go," the wheelchair moves forward. The "back off" command moves the wheelchair backward, "right" turns it to the right, and "left" turns it to the left. Figure 4 shows the flowchart of text-based command processing for motor movement.

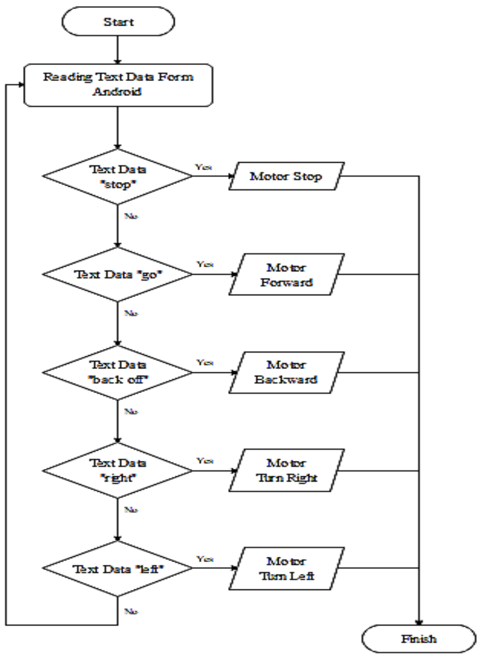


**Figure 4. Flowchart for reading text for motor movement**

## 2.3. Hardware Design

The hardware design for voice-controlled wheelchair movement requires several key components, including a microphone, sound processor, Bluetooth module, power supply, Arduino Uno, DC motor driver, and the motor for wheelchair movement.

1. Microphone

A microphone converts sound into electrical signals. It captures sound waves and converts them into electrical signals that can be processed by electronic devices like sound processors or amplifiers. There are various types of microphones available, such as condenser, dynamic, and ribbon microphones, each with different characteristics and uses. In this study, the microphone is used as an input device for controlling wheelchair movement. The microphone will be connected to the sound processor.

2. Sound Processor

After sound is captured by the microphone, the sound processor processes it and converts it into commands to control the wheelchair's movement. The sound processor can be a standalone unit or integrated into the wheelchair's control system.

3. Bluetooth

Bluetooth is a wireless technology used to connect electronic devices, including Arduino. A Bluetooth module, like the HC-05, can be attached to an Arduino board to enable wireless communication with other devices such as smartphones or tablets. The module communicates through the Arduino's serial pins and is configured using AT commands.

4. Arduino Uno

Arduino Uno is a microcontroller board developed by Arduino.cc. It features the ATMega328P microcontroller and I/O interfaces to connect various sensors, actuators, and electronic components. It also has a USB port for programming and communication. Arduino Uno is widely used in hobbyist projects due to its ease of use and flexibility. It is commonly applied in projects like robotics, automation, and monitoring systems. The specifications of Arduino Uno include:

- Microcontroller: ATMega328P
- Operating Voltage: 5V
- Clock Speed: 16 MHz
- Program Memory: 32 KB (including boot loader)
- SRAM: 2 KB
- EEPROM: 1 KB
- I/O Interfaces: 14 digital pins (6 can be used as PWM outputs), 6 analog pins, and 1 serial pin
- USB port for communication and programming
- Support for various operating systems like Windows, mac OS, and Linux.

5. DC Motor Driver

A DC motor driver controls the speed and direction of a DC motor. It accepts control signals from a microcontroller or other control sources and generates the appropriate current to drive the motor. Motor drivers often feature speed control, polarity control, and current limiting capabilities. There are various types of DC motor drivers, including brushed and brushless drivers, and they are widely used in robotics, automation, and electric vehicles.

6. DC Motor

A DC motor is an electric motor commonly used in electric vehicles, including wheelchairs. It produces high torque and can be easily speed-controlled, making it ideal for powering a wheelchair. DC motors typically have sufficient power to handle the heavy loads of a wheelchair and its user. The motor's speed and direction are controlled by a motor driver, and feedback sensors such as encoders ensure accurate and stable control.

7. Power Supply

The power supply required for a DC motor depends on the motor's specifications. Most DC motors need a constant DC voltage, and the appropriate power supply must provide adequate voltage, current, and capacity to match the motor's needs. Power supplies should also have overvoltage, overcurrent, and overheating protections to prevent damage to the motor.

Hardware design is necessary to understand and test the components required for the wheelchair system. Figure 5 illustrates the hardware design for voice-controlled wheelchair movement.

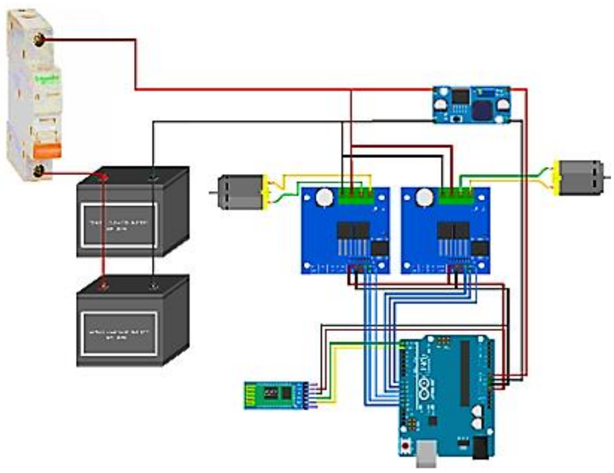

**Figure 5. Hardware design for wheelchair movement**

In Figure 5, the system comprises several components, including a 12-volt battery, DC motor, MCB DC 10°, BTS7960 motor driver, 5-volt DC step-down converter, Arduino Uno, and HC-05. The 12-volt battery is commonly used as a power source to drive electric wheelchairs. These wheelchairs are typically equipped with DC motors that require reliable and long-lasting power. A 12-volt battery provides sufficient electrical energy to power the motor for extended periods. Due to its size and capacity, the 12-volt battery can supply enough power to drive an electric wheelchair over long distances and for extended durations, enabling users to perform daily activities with ease and comfort. Additionally, 12-volt batteries are widely available at electronic or automotive stores, making replacement convenient when needed. The 12-volt battery in an electric wheelchair is also equipped with a simple recharging system, ensuring users do not need to worry about the battery depleting quickly.

The DC motor is another key component used as a power source for driving electric wheelchairs. In this context, the DC motor moves the wheelchair wheels, allowing the user to navigate more easily and swiftly compared to manual wheelchairs. Mounted beneath the wheelchair and connected to a 12-volt battery, the DC motor can produce sufficient power to move both the wheelchair and its user with ease. With its relatively low energy consumption and high torque output, the DC motor extends the wheelchair's range on a single battery charge, contributing to energy efficiency. The motor's compact size, light weight, and durability also make it ideal for electric wheelchair applications, giving users greater independence and mobility.

MCB DC 10 is a type of Miniature Circuit Breaker (MCB) designed specifically for DC (direct current) electrical systems, rated for 10°C. It is an essential component in electrical systems, responsible for cutting off electrical flow in case of a short circuit or overcurrent. Unlike MCBs used for AC (alternating current) systems, the MCB DC 10° is tailored for DC systems. It provides precise and rapid protection by cutting the circuit when necessary, helping to prevent damage to connected electronic devices. The MCB's breaking capacity varies depending on the type and brand, and it is available in different sizes and current ratings (A) to meet the needs of various DC electrical systems.

The BTS7960 motor driver is critical for controlling the wheelchair's DC motor. This driver regulates both the direction and speed of the motor with precision and efficiency, enhancing performance and safety. The motor driver allows the wheelchair to move forward and backward, with speed adjusted to the user's needs. In this context, the BTS7960 motor driver helps ensure smooth and responsive control using signals from the input system. The BTS7960 driver is also equipped with protective features such as overcurrent and overheat protection, safeguarding the motor and connected components from potential damage. This makes it a reliable choice for managing the motor's operation in electric wheelchairs.

The 5-volt DC step-down converter is a voltage regulator used to lower a higher input voltage to a stable 5V output, suitable for powering electronic devices like microcontrollers, sensors, and modules. In electric wheelchairs, the step-down converter ensures that the voltage from the battery is reduced to 5V, which is necessary for powering various electronic components. The benefits of using the step-down converter include:

- Voltage regulation: Ensuring stable input for sensors, microcontrollers, and modules, critical for consistent system performance.
- Battery life extension: By reducing operating voltage, the step-down converter helps prolong battery life.
- Increased safety: It mitigates the risk of high voltage damaging devices or posing a safety threat to users.

Arduino Uno and HC-05 are crucial electronic components often used in electric wheelchair systems. Arduino Uno, an open-source microcontroller board, is designed for interactive electronic projects. Equipped with multiple I/O (input/output) ports, it allows for controlling various electronic devices such as motors and sensors. In electric wheelchair systems, Arduino Uno acts as the central control unit, managing motor movements and interacting with sensors and actuators. With simple programming in the Arduino IDE, users can code commands to control the wheelchair's functions.

HC-05 is a Bluetooth module used to wirelessly connect electronic devices like Arduino to external devices (smartphones, tablets). In an electric wheelchair system, HC-05 interfaces between Arduino Uno and the user's smartphone or tablet, enabling wireless control of the wheelchair. Through the smartphone app, users can control the wheelchair's speed and direction, enhancing ease of use and interaction. The combination of Arduino Uno and HC-05 creates a more interactive and user-friendly control system, allowing for precise operation through mobile applications.

## 3. Results And Discussion

In the process of testing the hardware installed on the wheelchair, several steps were conducted, including testing the 12-volt battery, step-down voltage testing, Bluetooth connection testing, motor driver testing, Android control testing, and overall system testing.

### 3.1. Volt Battery Testing

Table 1 shows the results of 10 tests performed on the 12-volt battery using a multimeter. In this study, two batteries were connected in parallel [18], [19], ensuring a constant voltage of 12 volts. The test results showed a deviation of 0.43 and an accuracy of 96.7%, meaning the battery output did not significantly affect the system's operation, as 12V is the minimum voltage required. Higher voltages do not impact system performance. The 12-volt supply will be used for the DC motor and will be stepped down to power the control circuitry [20], [21].

**Table 1. 12 Volt battery test**

| Trial to | *Voltage needed* (V) | Multimeter (V) | *Deviation* (V) | *Accuracy* (%) |
|---|---|---|---|---|
| 1 | 12 | 12,5 | 0,5 | 96 |
| 2 | 12 | 12,5 | 0,5 | 96 |
| 3 | 12 | 12,5 | 0,5 | 96 |
| 4 | 12 | 12,4 | 0,4 | 97 |
| 5 | 12 | 12,4 | 0,4 | 97 |
| 6 | 12 | 12,4 | 0,4 | 97 |
| 7 | 12 | 12,4 | 0,4 | 97 |
| 8 | 12 | 12,4 | 0,4 | 97 |
| 9 | 12 | 12,4 | 0,4 | 97 |
| 10 | 12 | 12,4 | 0,4 | 97 |
| *Average* | 12 | 12,43 | 0,43 | 96,7 |

### 3.2. Step Down Voltage Testing

To test the 5-volt step-down converter, the following steps were carried out:

1. Prepare the necessary tools and materials: a step-down converter, power source (e.g., DC adapter), multimeter, breadboard, and connecting wires.
2. Assemble the step-down converter on the breadboard and connect it to the power source using the connecting wires.
3. Connect the output terminals of the step-down converter to the multimeter using connecting wires.
4. Turn on the power source and ensure that the step-down converter is functioning.
5. Read the voltage value on the multimeter and confirm that it is at the desired 5-volt output. If the voltage is too high or too low, adjust the output voltage on the step-down converter using the trim pot or potentiometer typically available on the module.
6. Ensure that the 5-volt output from the step-down converter is stable and does not fluctuate significantly.
7. Test the voltage stability of the step-down converter by adding a load to the output. For instance, place a resistor on the breadboard to draw output current. Recheck the voltage value on the multimeter and confirm that the output voltage remains stable and as desired.

By conducting this test, it ensures that the 5-volt step-down converter functions correctly and provides a stable output voltage. This is crucial in electronic applications, particularly for maintaining system stability and preventing damage to components connected to the step-down converter. Table 2 shows the results of 10 tests conducted on the 5-volt step-down converter using a multimeter. The test results show a deviation of 0.0 and an accuracy of 100%, indicating that the 5-volt output used in this device is accurate. The 5-volt power supply will be used to power the control circuitry [22], [23], [24].

**Table 2. Five Volt Stepdown Test**

| Trial to | Voltage needed (V) | Multimeter (V) | Deviation (V) | Accuracy (%) |
|---|---|---|---|---|
| 1 | 5 | 5 | 0 | 100 |
| 2 | 5 | 5 | 0 | 100 |
| 3 | 5 | 5 | 0 | 100 |
| 4 | 5 | 5 | 0 | 100 |
| 5 | 5 | 5 | 0 | 100 |
| 6 | 5 | 5 | 0 | 100 |
| 7 | 5 | 5 | 0 | 100 |
| 8 | 5 | 5 | 0 | 100 |
| 9 | 5 | 5 | 0 | 100 |
| 10 | 5 | 5 | 0 | 100 |
| **Average** | 5 | 5 | 0 | 100 |

### 3.3. Bluetooth Connection Testing

To conduct Bluetooth connection testing with the Arduino Uno, the following steps should be taken:

1. Connect the Bluetooth HC-05 module to the Arduino Uno by placing the Bluetooth module on a breadboard and connecting the TX pin of the Bluetooth module to digital pin 0 (RX) on the Arduino Uno. Then, connect the RX pin of the Bluetooth module to digital pin 1 (TX) on the Arduino Uno. Finally, connect the VCC and GND pins of the Bluetooth module to the corresponding VCC and GND pins on the Arduino Uno.
2. Ensure that the necessary drivers or software for the Bluetooth module are installed.
3. Open the Arduino IDE and create a new program.
4. Add the Software Serial library to the Arduino IDE program. This library allows serial communication to be used on digital pins other than pins 0 and 1, which are used by the Serial port.
5. Create a new instance of the Software Serial class with the syntax: `SoftwareSerial mySerial(0, 1);` in the first line of the `loop()` function.
6. Activate serial communication in the program with the following syntax: `Serial.begin(9600);`
7. Enable serial communication for the Bluetooth module with the syntax: `mySerial.begin(9600);`
8. Add code to the `loop()` function to read data received from the Bluetooth module and display it on the Serial Monitor using the following syntax:
   lessCopy code
   ```
   if (mySerial.available()) { Serial.write(mySerial.read()); }
     Serial.write(mySerial.read());
   ```
9. Upload the program to the Arduino Uno by selecting Sketch -> Upload.
10. Turn on Bluetooth on the device that will connect to the HC-05 module.
11. Open a serial terminal or Bluetooth application on your device and establish a Bluetooth connection to the HC-05 module using the default PIN 1234.
12. Once connected, you can send data from your device to the Bluetooth module and view the data displayed on the Serial Monitor in the Arduino IDE.

Table 3 shows the results of 10 tests conducted on the Bluetooth HC-05 with an Android device [25], [26]. The results indicated that the connection wait time ranged from 4 to 6 seconds, suggesting a moderate connection speed. As shown in Table 3, all 10 Bluetooth connection tests were successful, confirming that the Bluetooth connection operates normally.

**Table 3. Bluetooth Connection Trial**

| Trial to | Connection bluetooth master and slave | | Speed |
|---|---|---|---|
| | Condition | Waiting Time (s) | |
| **1** | Connected | 6 | Currently |
| **2** | Connected | 5 | Currently |
| **3** | Connected | 4 | Currently |
| **4** | Connected | 4 | Currently |
| **5** | Connected | 5 | Currently |
| **6** | Connected | 6 | Currently |
| **7** | Connected | 4 | Currently |
| **8** | Connected | 5 | Currently |
| **9** | Connected | 5 | Currently |
| **10** | Connected | 6 | Currently |

### *3.4.* Motor Driver Testing

To test the DC motor driver for the wheelchair, the following steps were conducted:

1. Prepare the DC motor driver for testing, ensuring it is properly installed on the wheelchair.
2. Connect the DC motor driver to a power source that meets the specifications of the motor driver.
3. Activate the DC motor driver and verify that it functions correctly. Ensure that the wheelchair wheels move smoothly both forward and backward.
4. Test the DC motor driver by assessing the speed and torque produced. Confirm that the DC motor driver generates the desired speed and power.

5. Conduct trials while monitoring the duration of use and the energy efficiency of the DC motor driver. Ensure that the DC motor driver operates efficiently with respect to its power consumption.

Table 4 presents the results of 10 tests conducted on the BTS7960 motor driver. The results indicate that the instructions provided were executed accurately. This testing demonstrates that the BTS7960 motor driver operates normally.

**Table 4. Motor Driver Trial**

| Trial to | *Driver motor BTS7960* | | *Description* |
|---|---|---|---|
| | *Input* | *Output* | |
| 1 | *Low-Low* | *Stop* | Succeed |
| 2 | *High-Low* | *Cw* | Succeed |
| 3 | *Low-High* | *Ccw* | Succeed |
| 4 | *High-High* | *Stop* | Succeed |
| 5 | *High-Low* | *Cw* | Succeed |
| 6 | *Low-High* | *Ccw* | Succeed |
| 7 | *Low-Low* | *Stop* | Succeed |
| 8 | *High-Low* | *Cw* | Succeed |
| 9 | *Low-High* | *Ccw* | Succeed |
| 10 | *High-High* | *Stop* | Succeed |

### 3.5. Wheelchair Testing

The voice-controlled wheelchair represents an evolving technology designed to enhance the independence and mobility of individuals with special needs or physical disabilities. Testing of the voice-controlled wheelchair can be conducted using voice recognition technology and a specially designed control system. The testing process must account for both the safety and effectiveness of the voice-controlled wheelchair. Several factors to consider include:

1. Voice Recognition Accuracy: The voice recognition system must accurately recognize commands and distinguish between voices from different users.
2. Response Speed: The wheelchair should respond promptly to voice commands to minimize the risk of accidents.
3. Ease of Use: The wheelchair must be designed to be user-friendly, ensuring that users can operate it effectively.

After conducting the tests, developers can evaluate the reliability and effectiveness of the voice-controlled wheelchair, making necessary improvements or enhancements. This aims to ensure that the wheelchair provides maximum benefits to its users and can be used safely and effectively in daily life.

Table 5 presents the results of 10 operational tests conducted with 10 different subjects. The results indicate that the wheelchair can be operated effectively.

**Table 5. Wheelchair Trial**

| *Subject* | *Wheelchair operating* | | | | |
|---|---|---|---|---|---|
| | *Forward* | *Backward* | *Turn right* | *Turn left* | *Stop* |
| 1 | Succeed | Succeed | Succeed | Succeed | Succeed |
| 2 | Succeed | Succeed | Succeed | Succeed | Succeed |
| 3 | Succeed | Succeed | Succeed | Succeed | Succeed |
| 4 | Succeed | Succeed | Succeed | Succeed | Succeed |
| 5 | Succeed | Succeed | Succeed | Succeed | Succeed |
| 6 | Succeed | Succeed | Succeed | Succeed | Succeed |
| 7 | Succeed | Succeed | Succeed | Succeed | Succeed |
| 8 | Succeed | Succeed | Succeed | Succeed | Succeed |
| 9 | Succeed | Succeed | Succeed | Succeed | Succeed |
| 10 | Succeed | Succeed | Succeed | Succeed | Succeed |

## 4. Conclusion

Based on the testing results conducted, it can be concluded that the Bluetooth and Android connection tests function optimally, allowing the input signal from the Android device to be successfully transmitted to the Arduino Uno system used for output. The connection tests showed a wait time of 4 to 6 seconds before establishing a successful connection. Overall, the device operated effectively with a 100% success rate for all commands executed by the subjectsThese should be brief and placed at the end of the text before the funding.

## 5. Acknowledgments

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