Developing wheelchair mobility: Wireless control via mobile devices

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***Abstract*: Micro electromechanical systems (MEMS) (also written as microelectronic and micro electro mechanical systems) is the technology of very small mechanical devices driven by electricity and it merges at the nano scale into nano electromechanical systems (NEMS) and nanotechnology. The main aim of this project is to control the wheelchair using MEMS. The MEMS will be fixed to the hand. Whenever the hand moves in a particular direction, the mechanical movement of the hand will be recognized by MEMS. MEMS converts this mechanical hand movement into equivalent electrical signals (X, Y, Z coordinates) and send it to the microcontroller. The communication between microcontroller and MEMS takes place based on i2c protocol. In this protocol microcontroller acts as a master and MEMS acts as a Slave. The master receives the signals from slave and based on them it controls the wheel chair. Wireless Wheel chair has two D.C gear motors. These motors move in 2D direction with the help of driver IC L293D according its input signals. This driver acts as H-bridge. This project uses regulated 5V, 500mA power supply. 7805 three terminal voltage regulator is used for voltage regulation.**

Keywords: wheelchair control mechanism, Arduino UNO, HC-05 module, motor driver circuit, Android Mobile.

I. INTRODUCTION

Wheelchair control using Android mobile devices is an innovative solution designed to enhance the mobility and independence of individuals with disabilities. Traditional powered wheelchairs typically rely on physical controls or joysticks, which can be difficult for people with limited hand or arm mobility. By integrating mobile technology, such as an Android smart phone or tablet, with a wheelchair, users can control the movement of their wheelchair in a more convenient, intuitive, and flexible way. This system involves a combination of mobile apps, microcontrollers like Arduino, and motor control mechanisms to provide precise movement control.

The wheelchair control mechanism uses Android mobile apps to send commands to an Arduino microcontroller via Bluetooth or Wi-Fi, enabling users to control the wheelchair's direction, speed, and other functions remotely. Arduino, an open-source electronics platform, serves as the central hub for processing these commands. It connects to the DC motors that drive the wheelchair, allowing for smooth and responsive control. The use of Arduino in this system is cost-effective and reliable, making it an ideal solution for assistive technology.

DC motors play a crucial role in the wheelchair's movement, converting electrical signals into mechanical motion to power the wheels. These motors can be controlled with high precision using Pulse Width Modulation (PWM) techniques, which are integrated into the Arduino system. The PWM signals adjust the speed and direction of the DC motors, providing the user with fine control over the wheelchair's movements, such as accelerating, decelerating, or turning.

The Android mobile device functions as a remote control, transmitting the user's input (such as directional commands) through the Bluetooth or Wi-Fi interface. The mobile app's user-friendly interface allows for easy adjustments of movement parameters like speed, turning radius, and other settings. Some advanced systems may also incorporate voice commands, offering hands-free control for users with more limited mobility. The combination of Arduino, DC motors, and Android mobile control offers a low-cost yet effective solution to improving the lives of people with mobility challenges.

II KEY COMPONENTS OF THE SYSTEM

- MEMS Accelerometer in Mobile Device:The MEMS (Micro-Electro-Mechanical Systems)

accelerometer inside the mobile device detects hand or body gestures. MEMS sensors measure changes in acceleration along three axes (X, Y, Z), which allows for tracking the orientation and movement of the mobile device. When the user moves or tilts their smart phone in a certain direction, the MEMS sensor detects the corresponding acceleration along the X, Y, and Z axes. This data is then processed to recognize the user's gesture.

- Mobile Application:A custom mobile app installed on the user's smart phone or tablet processes the accelerometer data from the MEMS sensor and converts it into commands that control the wheelchair . The app communicates wirelessly with the wheelchair's control system to transmit the movement instructions. The app can offer a user-friendly interface where gestures are mapped to specific wheelchair movements (e.g., forward, backward, left, right).
- Wireless Communication Module:Wireless communication allows the mobile device to send control signals to the wheelchair's control system. Bluetooth, Wi-Fi, or other wireless communication protocols can be used to send data between the mobile device and the wheelchair. The mobile app sends gesture data (processed from the MEMS sensor) wirelessly to a receiver on the wheelchair. This can be done using Bluetooth Low Energy (BLE) for low-power consumption or Wi-Fi for a broader range.

- Wheelchair Control System:

The wheelchair control system is responsible for receiving the wireless commands from the mobile device and interpreting them into actionable movements. The control system decodes the wireless signals and processes the gesture data to command the motors of the wheelchair to move forward, backward, or turn. The system might use a microcontroller to manage this process.

- Actuators

The actuators (usually motors) control the movement of the wheelchair. The motors receive commands from the control system (based on gesture input) and rotate the wheels of the wheelchair in the appropriate direction (forward, backward, left, or right).DC motors, stepper motors, or other types of motors can be used depending on the wheelchair's design.

III TYPES OF GESTURES FOR CONTROL

- Forward/Backward Movement: The user tilts the mobile device forward or backward, corresponding to forward or backward movement of the wheelchair.
- Turning Left/Right: The user tilts the mobile device left or right to turn the wheelchair in that direction.
- Speed Control: The tilt angle or intensity of the movement can be mapped to the speed of the wheelchair (e.g., a larger tilt might increase speed).
- Stop/Start Command: The user could make a specific gesture, such as shaking the mobile device or tapping the screen, to stop or start the wheelchair.

IV PROCESSORS

Processors are the ones which performs some specific task or operation. These are divided in to several types like

1. Micro Processors.
2. Micro Controllers.

Microprocessors: These are the ones which perform arithmetic and logical operations. Arithmetic and logical unit performs arithmetical and logical calculations. Control unit controls all the peripheral devices connected to the microprocessors. Memory is a one which is used to store some data or information.

Micro Controllers: These are the ones which are similar to that of a microprocessor which performs arithmetic and logical calculations. These have additional advantage to that it is having additional inbuilt features like:

1. Electrically Erasable Programmable Read Only Memory (EEPROM)
2. Universal Synchronous Asynchronous Receiver and Transmitter (USART).
3. Analog to Digital Converter (ADC).
4. Digital to Analog Converter (DAC).
5. Oscillators.
6. Timers.
7. Many others.

V ARDUINO

In simple words, Arduino is a small microcontroller board with a USB plug to connect to your computer

and a number of connection sockets that can be wired up to external electronics, such as motors, relays, light sensors, laser diodes, loudspeakers, microphones, etc., Arduino is an open-source electronics platform based on easy-to-use hardware and software. It's widely used for building digital devices and interactive objects that can sense and control the physical world. Arduino projects can sense inputs (such as light, sound, or temperature) and turn them into outputs (such as turning on a motor or displaying something on a screen). It is popular among hobbyists, educators, and professionals for building prototypes and products that require sensors, actuators, and microcontrollers.

Arduino Uno: The most popular and widely used board, featuring an ATmega328P microcontroller.

LABELED COMPONENTS

1. RX + TX LEDs (Pin 13 LED): These LEDs indicate serial communication activity. RX (Receive) blinks when data is received, and TX (Transmit) blinks when data is sent.

2. Digital Pins: These are general-purpose input/output (GPIO) pins used to interact with other components like LEDs, sensors, and buttons.

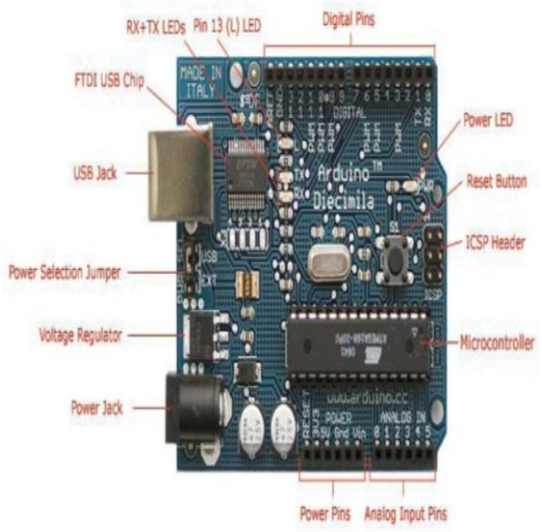

Figure 1 Arduino

3. FTDI USB Chip: This chip converts USB signals into serial communication (UART), allowing the Arduino to be programmed via a USB cable.

4. USB Jack: A USB port for connecting the Arduino to a computer for programming and power supply.

5. Power Selection Jumper: Allows switching between USB power and external power (via power jack).

6. Voltage Regulator: Ensures the Arduino gets a stable voltage (5V or 3.3V) from an external power source.

7. Power Jack: A barrel jack used to power the board via an external power adapter.

8. Power LED: An LED indicator that lights up when the board is powered.

9. Reset Button: Pressing this button restarts the Arduino program from the beginning.

10. ICSP Header: In-Circuit Serial Programming (ICSP) pins used for programming the microcontroller directly.

11. Microcontroller (ATmega168/328): The brain of the Arduino, responsible for executing code and processing data.

12. Power Pins: These provide power (3.3V, 5V, GND) to external components.

13. Analog Input Pins: Used for reading analog sensor values (e.g., potentiometers, temperature sensors).Arduino is an open-source electronics platform based on simple software and hardware. It's designed to make it easy for anyone, from beginners to advanced users, to create interactive projects involving sensors, motors, lights, and more.

ADVANTAGES OF ARDUINO

1. Open Source: Both the hardware and software are open source, which promotes community development and sharing of ideas and projects.
2. User-Friendly: The easy-to-use IDE and wide availability of tutorials make it accessible for beginners and advanced users.
3. Wide Range of Applications: Suitable for a wide variety of projects, from simple prototypes to complex systems.
4. Large Community: Arduino has a vast online community, offering support, tutorials, and shared projects.

5. Affordable: Compared to other microcontroller platforms, Arduino is relatively low-cost, making it an excellent option for learning and prototyping.

APPLICATIONS OF ARDUINO

1. Home Automation – Controls smart lighting, temperature sensors, and security systems.
2. Robotics – Powers autonomous robots, robotic arms, and drones.
3. Internet of Things (IoT) – Enables remote monitoring and control of connected devices.
4. Education – Used for hands-on learning in electronics, coding, and engineering projects.
5. Healthcare – Helps create low-cost medical devices like heart rate monitors and prosthetic controllers.
6. Wearable Technology – Supports smart wearables like fitness trackers and biometric sensors.
7. Interactive Art & Installations – Used by artists and designers for creative projects.
8. Environmental Monitoring – Measures air quality, weather conditions, and pollution levels.
9. Automotive Applications – Used in vehicle automation, diagnostics, and smart navigation systems.
10. Agriculture – Helps in smart irrigation, soil monitoring, and automated farming systems.

3.6 DC MOTOR

A DC motor (Direct Current motor) is an electrical machine that converts direct current (DC) electrical energy into mechanical energy. It operates based on the interaction between a magnetic field and an electric current in a conductor, producing rotational motion.

Working Principle

When current flows through the rotor, it generates a magnetic field that interacts with the stator's magnetic field, producing a force that causes the rotor to rotate. The commutator ensures continuous rotation by reversing the current direction at appropriate intervals.

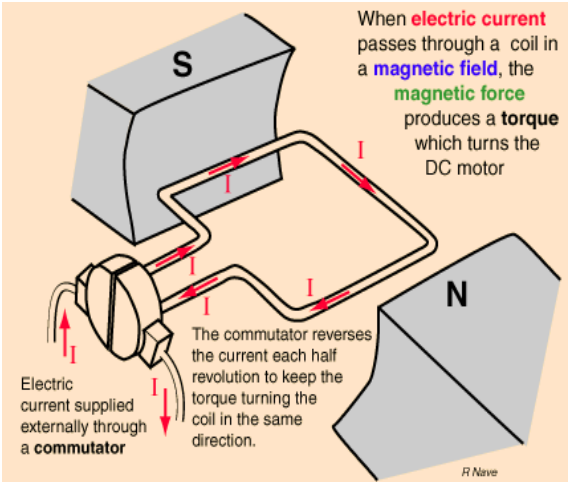

Figure 2 Dc motor

APPLICATIONS OF DC MOTORS

- Robotics and automation
- Electric vehicles (EVs)
- Industrial machinery
- Fans and pumps
- Small household appliances

Light Emitting Diode (LED)

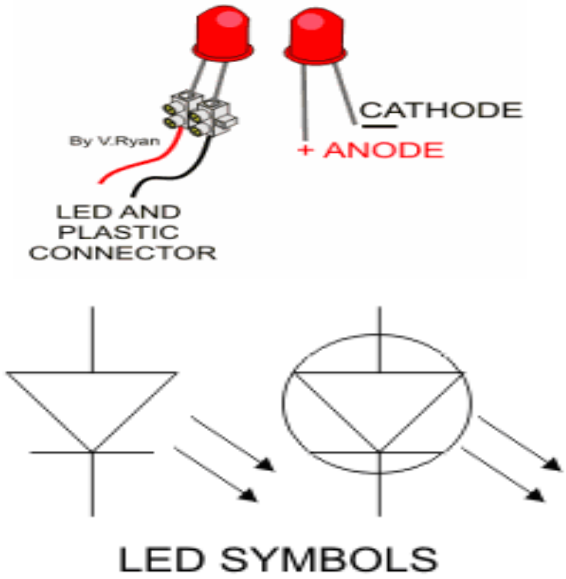

Figure 3 Light Emitting Diode (LED)

A light-emitting diode (LED) is a semiconductor diode that emits incoherent narrow spectrum light when electrically biased in the forward direction of the pn-junction, as in the common LED circuit. This

effect is a form of electroluminescence. While sending a message in the form of bits such as 1,the data is sent to the receiver side correspondingly the LED glows representing the data is being received simultaneously when we send 8 as a data the LED gets off .

MAX 232 PIN DIAGRAM:

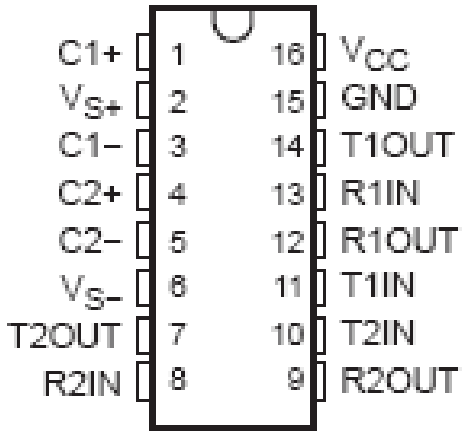

Figure 3 Max232 Pin

SPECIFICATIONS:

- Meets or Exceeds TIA/EIA-232-F and ITU Recommendation V.28
- Operates from a Single 5-V Power Supply With 1.0-_F Charge-Pump Capacitors
- Operates up To 120 Kbit/s
- Two Drivers and Two Receivers
- 30-V Input Levels
- Low Supply Current 8 mA Typical
- ESD Protection Exceeds JESD 22
- 2000-V Human-Body Model (A114-A)

RESULT

Wheelchair control through mobile devices has become an innovative approach to improving mobility for individuals with disabilities. By integrating sensors, Bluetooth, and specialized apps, users can control their wheelchairs with ease via smartphones or tablets. This technology allows for greater independence, as users can navigate their environment without needing external assistance. The mobile-controlled wheelchairs often come with features such as speed adjustment, directional control, and the ability to operate in different modes based on the user's preferences. Additionally, the system may incorporate voice commands or touch-screen functionalities, enhancing accessibility. Overall, mobile-controlled wheelchairs represent a significant step forward in assistive technology, providing users with more freedom and flexibility in their daily activities.

CONCLUSION

Controlling a wheelchair with an Android mobile device offers a revolutionary solution for enhancing the independence and mobility of individuals with disabilities. By integrating Android smartphones with Arduino microcontrollers and DC motors, users can precisely control their wheelchair's movement through an intuitive mobile interface. This system empowers individuals with limited mobility to navigate their environment more easily, providing greater flexibility and autonomy. The use of wireless communication, such as Bluetooth or Wi-Fi, ensures seamless control from a distance. Additionally, incorporating sensors for obstacle detection and real-time feedback further enhances safety and usability. As technology continues to evolve, mobile-controlled wheelchairs are set to become even more advanced and accessible. This integration represents a significant step forward in assistive technology, improving the overall quality of life for wheelchair users. The adaptability and cost-effectiveness of such systems make them a promising solution for many. Ultimately, mobile control mechanisms offer a more efficient and user-friendly alternative to traditional wheelchair controls.

REFERENCES

[1] "Doctors nurses and staff dangerously exposed", *The Daily Star*, Mar 2020, [online] Available: https://www.thedailystar.net/frontpage/news/4-dmch-doctors-sent-home-quarantine-1882627.

[2] S. U. Aiman, "Covid-19 and Rights of the healthcare workers", *The Daily Star*, Jun 2020, [online] Available: https://www.thedailystar.net/law-our-rights/news/covid-19-and-rights-the-healthcare-workers-1922485

[3] A. Z. M. Tahmidul Kabir et al., "An IoT based Intelligent Parking System for the Unutilized Parking Area with Real-Time Monitoring using Mobile and Web Application", *2021 International Conference on Intelligent Technologies (CONIT)*, pp. 1-7, 2021.

[4] A. Z. M.T. Kabir, A. M. Mizan, P. K. Saha, M. S. Hasan and M. Pramanik, "An IoT Based Intelligent Parking System for the Unutilized Parking Area With Real-Time Monitoring Using Mobile and Web Application", *AJCT*, vol. 7, no. 2, pp. 107-113, Aug. 2021.

[5] A. Z. M.T. Kabir, A. M. Mizan, P. K. Saha, K. M. M.R. Songlap, A. J. Ta-Sin and N. A. Chisty, "IoT Based Smart Home Automation and Security System Using Mobile App With Assistant Robot for Developing Countries", *2021 International Conference on Electronics Information and Communication (ICEIC)*, pp. 1-4, 2021.

[6] A. Z. M. Tahmidul Kabir, A. M. Mizan, N. Debnath, A. J. Ta-sin, N. Zinnurayen and M. T. Haider, "IoT Based Low Cost Smart Indoor Farming Management System Using an Assistant Robot and Mobile App", *2020 10th Electrical Power Electronics Communications Controls and Informatics Seminar (EECCIS)*, pp. 155-158, 2020.

[7] *A. Z. M. Tahmidul Kabir, A. Mamun Mizan, P. K. Saha, G. Kibria, A. J. Ta-sin, M. Saniat, et al., "A Comprehensive Smart IoT Tracker for the Children Elder and Luggage With the Assistance of Mobile App", 2020 International Conference on ICT for Smart Society (ICISS), pp. 1-5, 2020.*

[8] *A*. Z. M. Tahmidul Kabir, A. M. Mizan and T. Tasneem, "Safety Solution for Women Using Smart Band and CWS App", *2020 17th International Conference on Electrical Engineering/Electronics Computer Telecommunications and Information Technology (ECTI-CON)*, pp. 566-569, 2020.

[9] K. Joshi, R. Ranjan, E. Sravya and M. N. A. Baig, "Design of voice-controlled smart wheelchair for physically challenged persons" in Advances in Intelligent Systems and Computing, Singapore:Springer Singapore, pp. 79-91, 2019.