DEVELOPMENT OF A SENSOR-CONTROLLED WHEELCHAIR SYSTEM USING MEMS FOR DISABLED ASSISTANCE

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ABSTRACT

Physically disabled people's freedom and quality of life are greatly impacted by mobility problems. Micro-Electro-Mechanical Systems (MEMS) technology is used in this study's design and development of a sensor-controlled, automated wheelchair system that improves user autonomy and mobility. The suggested system combines gyroscopic sensors and MEMS-based accelerometers to recognise hand or head movements and convert them into directional instructions for moving a wheelchair. The system offers a more user-friendly and accessible interface by doing away with the requirement for manual control, which is particularly beneficial for users who lack upper body strength or dexterity.

A microprocessor unit, motor drivers, and safety features including obstacle detection and emergency stop mechanisms are all part of the hardware structure. The system is dependable under a range of operating situations because to the MEMS sensors' excellent motion detection accuracy and real-time responsiveness. In both indoor and outdoor settings, experimental testing showed responsiveness to user inputs, smooth directional control, and general usability.

This clever mobility aid seeks to improve user dignity, lessen reliance on carers, and provide an affordable mobility option. Wheelchair automation using MEMS technology demonstrates the possibility of creative, sensor-driven techniques in assistive healthcare equipment, which will eventually enhance the quality of life for those with physical limitations.

I. INTRODUCTION

One essential component of human freedom and well-being is mobility. Mobility restrictions may result in decreased self-sufficiency, social isolation, and a lower feeling of autonomy for people with physical impairments, especially those with compromised upper limb function. Although conventional wheelchairs provide rudimentary mobility options, many users find it difficult to operate them by hand, particularly if they lack the strength or dexterity necessary for prolonged usage. In this regard, assistive technologies have emerged as vital resources for enhancing the quality of life for those who are physically disabled.

More intelligent, portable, and responsive mobility solutions are now possible because to recent developments in micro-electromechanical systems (MEMS). Because MEMS sensors, such gyroscopes and accelerometers, provide accurate orientation, tilt, and motion detection, they are perfect for developing user-friendly control systems that need little input from the user. These sensors, when incorporated into an autonomous wheelchair, may allow mobility based on basic hand or head movements, doing away with the need for intricate or taxing control systems.

The goal of this project is to develop and deploy a sensor-controlled, MEMS-based autonomous wheelchair system that will help people with restricted motor function. Users may control the wheelchair's mobility without using physical effort by employing hand gestures or head tilts that are picked up by MEMS accelerometers. To guarantee dependability and user safety, the system also includes motor drivers, microcontrollers, and safety features including obstacle detection and emergency pausing mechanisms.

The main goal is to provide people with physical disabilities an affordable, easy-to-use mobility device that increases their freedom and accessibility. Furthermore, the experiment shows how MEMS technology may be used in healthcare automation and assistive robots. By offering safe, user-friendly, and respectable mobility options, this invention seeks to empower people with impairments.

IR SENSOR

Small microchips containing a photocell that is adjusted to detect infrared light are known as infrared detectors. Every TV and DVD player has one of these on the front to listen for the infrared signal from the clicker, and they are almost always utilised for remote control detection. A corresponding infrared LED in the remote control sends out infrared pulses to instruct the TV to switch channels or turn on or off. Testing a setup requires a bit more effort since infrared light is invisible to the naked eye.

There are several distinctions between them and, for example, CdS Photocells:

• IR detectors are not very good at detecting visible light; they are specifically filtered for infrared radiation. Photocells, on the other hand, are better at detecting yellow and green visible light than infrared light. Infrared detectors have a demodulator that searches for modulated infrared at 38 kHz. An IR LED must be PWM blinking at 38KHz in order to be identified; just illuminating one won't do. Photocells can detect any frequency, even DC, within their reaction speed, which is around 1KHz, and they lack any kind of demodulator.

• Digital out IR detectors either detect an IR signal at 38 kHz and output low (0V) or they do not detect any and output high (5V). Depending on how much light they are exposed to, photocells behave similarly to resistors.

Fig 1. IR detector

LDR

Streetlights, outside lighting, and the majority of household appliances are typically controlled and maintained by hand. In addition to being risky, this electrical equipment wastes energy when it is turned on and off because of staff carelessness or unforeseen circumstances. As a result, we may use a light sensor to automatically turn off the loads according to the amount of daylight.

Fig. 2.Typical LDR Sensor

A light sensor generates an output signal that represents the intensity of light by detecting the radiant energy contained in a very narrow range of frequencies often referred to as "light," which spans from the "infra-red" to the "visible" to the "ultraviolet" actrum. The light sensor is a passive part that uses this "light energy," whether it be in the visible or infrared regions of the spectrum, to generate an electrical signal. Light sensors are more often known as "Photoelectric Devices" or "Photo Sensors (electronal)" because they convert light energy (iphotons) into electrical current.

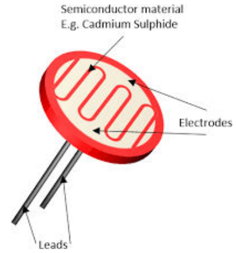

Fig 3. parts of an LDR

Photovoltaics and photoemissions, as well as photo-resistors and photo-conductors, are the two main groups that alter their electrical characteristics.

II. DC MOTORS

DC Motors Introduction:-

DC motors are compact, powerful for their size, frequently utilised, and reasonably priced. They are easiest to manage. Just two signals are needed for a single DC motor to function. Since they are non-polarized, the motor won't be harmed if the voltage is reversed. The leads of DC motors are +ve and -ve. When they are connected to a DC power source, the motor rotates in a clockwise manner; when the polarity is reversed, the DC motor rotates anticlockwise. A DC motor's maximum speed is expressed in rpm (rotation per minute). There are two rpms: loaded and no load. When transferring a load or when the load rises, the rpm lowers. Voltage and current ratings are additional DC motor requirements. The motor specs utilised in the project are shown in the table below.

Characteristics	Value
Operating Voltage	12V DC
Operating Current	150MAmps
Speed	30/10 RPM

III. BLOCK DIAGRAM

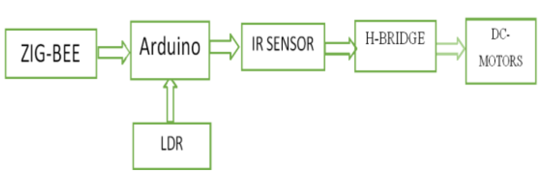

Fig 4:block diagram

Zigbee

Low-cost, low-power wireless machine-to-machine and jot networks are made possible by Zigbee, a standards-based wireless technology. Zigbee is an open standard for low-data-rate, low-power applications. In theory, this makes it possible to combine implementations from many manufacturers; but, in reality, Zigbee products have been expanded and altered by vendors, leading to interoperability problems. Because Zigbee uses a mesh networking protocol to eliminate hub devices and establish a self-healing architecture, it allows far lower data rates than wi-fi networks, which are used to link endpoints to high-speed networks.

Arduino-One of the standard Arduino boards is the Arduino UNO. 'One' in Italian is what UNO stands for here. The first version of Arduno Software was dubbed UNO. Additionally, it was the first Arduino USB board to be published. It is regarded as the most potent board used in a variety of applications. The Arduino UNO board was created by Arduino.cc. The ATmega1ZEP microprocessor serves as the foundation for the Arduino UNO. In contrast to other boards, such as the Arduino Mega board, etc., it is simple to use. Children, other circuits, and the board coastline of digital and analogue input/output pins (1/0). Six analogue pin inputs, fourteen digital pins, a USB sector, a power connector, and an ICSP (In-Circuit Serial Programming) header 1 are all included in the Arduino UNO. It is programmed using an IDE, or Integrated Development Environment. Both offline and internet platforms are compatible with it. All Arduino boards that are available share the same IDE.

IR sensor-An electrical gadget that analyses and picks up infrared radiation in its surroundings is called an infrared (IR) sensor. William Herchel, an astronomer, made the unintentional discovery of infrared radiation in 1800. He found that the temperature was greatest just beyond the red light when he measured the temperature of each colour of light (separated by a prism). Despite being on the same electromagnetic spectrum as visible light, infrared light has a longer wavelength, making it invisible to the human eye. Infrared radiation is released by everything that generates heat, which includes anything with a temperature of 500 degrees Kelvin or above.

H-Bridge-An electrical circuit known as an H-bridge may change the polarity of a voltage supplied to a load. These circuits are often used to enable DC motors to move forward or backward in robotics and other applications. Its usual schematic diagram representation—four switching components arranged as the branches of the letter "H" and the load linked as the cross-bar—is where the name originates. H bridges are used in the majority of DC-to-AC converters, the majority of AC/AC converters, the DC-to-DC push-pull converter, isolated DC-DC converters, the majority of motor controllers, and several other types of power electronics. Specifically, a motor controller with two H bridges is almost usually used to operate a bipolar stepper motor.

DC-motors-One kind of rotary electrical motor that transforms electrical energy from direct current (DC) into mechanical energy is called a DC motor. The most popular kinds depend on the forces generated by induced magnetic fields inside the coil as a result of current flow. Internal mechanisms, either electrical or electromechanical, allow almost all DC motor types to periodically alter the direction of current flowing through a portion of the motor.

LDR-Photoresistors, often referred to as light dependent resistors (LDR), are light-sensitive devices that are most frequently used to detect light intensity or to signal whether light is present or absent. Their resistance is very high in the dark, often reaching 1 M2, but depending on the light intensity, it drastically decreases when the LDR sensor is exposed to light, sometimes even dropping to a few olums. LDRs are nonlinear devices having a sensitivity that changes depending on the light's wavelength. Although they have various uses, other devices like photodiodes and phototransistors often carry out this light detecting function. Due to worries about environmental safety, certain nations have outlawed LDRs composed of lead or cadmium.

Explanation-This is the project's receiver portion.The zigbee first receives signals from the transmitter component. Following simplex-type communication between our two zigbees, an Arduino in the receiver section regulates the H-bridge and DC motors. The wheelchair moves with the help of a DC motor, and its direction may be changed via an H-bridge.Any obstacles in the wheelchair's path are detected by an infrared sensor, which then stops the wheelchair. Additionally, our project includes LDR, which might be useful when there is little light.

ARDUINO UNO

One of Arduino's standard boards is the Arduino UNO. 'One' is what UNO signifies in Italian. The Arduino software's first version was dubbed UNO. Additionally, it was Arduino's first USB board. It is regarded as a strong board that is used in many different tasks. The Arduino UNO board was created by Arduino.cc. Developed by Arduino.cc, the Arduino Uno is an open-source microcontroller board that was first made available in 2010. It is based on the Microchip ATmega328P microprocessor.

A variety of expansion boards (shields) and other circuits may be interfaced with the board's sets of digital and analogue input/output (I/O) pins.

The ATmega328P microprocessor serves as the foundation for the Arduino UNO. In contrast to other boards, such the Arduino Mega board, etc., it is simple to use. The board is made up of shields, various circuits, and digital and analogue input/output (I/O) pins.

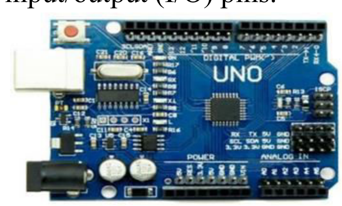

Figure 5 Arduino UNO Board

It has a 16 MHz ceramic resonator, 6 analogue inputs, 14 digital input/output pins (six of which may be utilised as PWM outputs), and a USB port.ICSP header, reset button, and power jack. It has all the components required to support the microcontroller.

BRIEF DESCRIPTION ABOUT RF COMMUNICATIONS

Since Alexander Popov and Sir Oliver Lodge laid the foundation for Guglielmo Marconi's wireless radio innovations in the early 20th century, radio frequency (RF) and wireless technology have existed for more than a century. Marconi carried out his most well-known experiment in December 1901, successfully transmitting Morse code from Cornwall, England, to St. John's, Canada.

Radio signal physics in general In order for radio frequency (RF) communication to function, electromagnetic waves must be generated at a source and detected at a certain location. The speed at which these electromagnetic waves move through the atmosphere is almost equal to that of light. An electromagnetic signal's wavelength and frequency are inversely correlated; the greater the frequency, the shorter the wavelength.

Radio frequencies are measured in gigahertz (GHz, or billions of cycles per second), megahertz (MHz, or millions of cycles per second), and kilohertz (KHz, or thousands of cycles per second). Frequency is measured in Hertz (cycles per second). Wavelengths become shorter at higher frequencies. A device operating at 900 MHz has a greater wavelength than one operating at 2.4 GHz.

Longer wavelength signals may generally go further and pass through and around things more effectively than shorter ones.

IV. ADVANTAGES AND DISADVANTAGES ADVANTAGES

ADVANTAGES

Operation is made easier by wireless; design and manufacturing are made simple by readily accessible components; and Arduino may be reprogrammed if necessary.

Disadvantages

- The system won't function if the power source fails.
- If a device or component fails, there might be deadly accidents and serious repercussions.

Applications

- Applications in the construction industry,
- Gaming,
- Military robots control,
- Industrial trolley and lift control, and

V. Result

Fig 6: Result

VI. CONCLUSION

An important breakthrough in assistive mobility technology for people with physical limitations is the creation of a wheelchair that is sensor-controlled and MEMS-based. For individuals with restricted upper limb capability, the suggested system offers an easy-to-use interface by using the accuracy and responsiveness of MEMS accelerometers and gyroscopes. Wheelchair navigation in a variety of settings is made possible by the effective fusion of microcontroller-driven motors and gesture-based controls.

This research tackles important user-centric issues including price, safety, and convenience of use in addition to proving the scientific viability of using MEMS in real-time motion control. The system's ability to convert basic hand or head movements into directed movement is confirmed by experimental findings, providing a substitute for conventional manual or joystick-operated wheelchairs.

Furthermore, adding safety features like obstacle detection and emergency stop capabilities makes the gadget more useful and gives users more confidence while using it. For those with mobility limitations, the system serves the overarching objective of fostering independence, dignity, and an enhanced quality of life.

In summary, the MEMS-controlled automated wheelchair is a viable option that combines cutting-edge sensor technology with the ideas of human-centered design. The system's usefulness and flexibility may be further improved with future additions like voice commands, IoT connectivity, and AI-based route planning, opening the door for more intelligent and inclusive mobility aids.

REFERENCES:

While designing and fabrication of this project work, we gathered information from websites & consulted experts in various fields. The information is gathered from yahoo.com search Engine. Regarding micro controllers plenty of books are available, the following are the references made during design, development and fabrication of the project work.

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