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Development of Gesture Controlled Smartwheel Chair

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Abstract: This project Introduces a concept for gesture controlled wheel chair system designed to enhance mobility and accessibility for individuals having physical disabilities. It is an electrically operated wheel chair enabled with hand motion based movement control out of several inputs. An ATMEGA328p Micro-controller is used on an Arduino board to which 3 Hall Effect sensors are connected. These sensors read the hand positions. It also has a pair of relay units which switches the pair of motors. The setup also contains a LCD which shows the status in real time. The Hall sensors are kept at the corresponding directions (forward, right, left). As the hand moves to a particular direction, the Hall sensors connected to the hand detects the magnetic field as the controller detects it and enables it to move to the corresponding direction. As a result the patient is able to control it with his/her hand. Providing an oxygen and IR control makes it convenient and smart.

Keywords: ATMEGA328p, Micro-controller, Arduino Board, PAJ Sensors ,IR control module, Oxygen analyser.

I. INTRODUCTION

Gesture-Controlled Smart Wheelchair a revolutionary device designed to empower individuals with limited mobility. The wheelchair's advanced gesture recognition technology translates hand movements into precise commands, providing a fluid and responsive control system. With a gesture controlled navigation system and oxygen analyser and seamlessly connect the Smart Wheelchair to any electronic devicesn for enhanced control and customization that provides dignified moment and seamless health monitoring for users with challenges. Designed for practicality, the Smart Wheelchair features a foldable and compact design, facilitating easy transport and storage

II. EASE OF USE

The Gesture-Controlled Smart Wheelchair with Oxygen Analyzer prioritizes ease of use through its intuitive gesture-controlled navigation system. By interpreting subtle hand movements, users can navigate effortlessly, eliminating the need for traditional joystick controls. Additionally, the integrated Oxygen Analyzer provides real-time monitoring of blood oxygen levels, enhancing usability by offering valuable health insights in a user-friendly manner. This user-centric design approach ensures that individuals with mobility challenges can easily manage both their mobility and health needs with seamless integration and convenience

A. PROJECT OUTLINE

This project aims to create a Gesture-Controlled Smart Wheelchair with integrated Blood Pressure and Oxygen Analyzers. The first phase focuses on implementing an intuitive gesture control system and an obstacle detection mechanism. The second phase involves integrating noninvasive health analyzers for continuous monitoring of vital signs. The project also includes the development of a user-friendly interface for health data display, ergonomic design for user comfort, and security measures for data protection. Comprehensive testing will be conducted to ensure efficiency and practicality. The final phase involves creating detailed documentation and conducting knowledge transfer sessions for users and caregivers.

III. WORKING PRINCIPLE

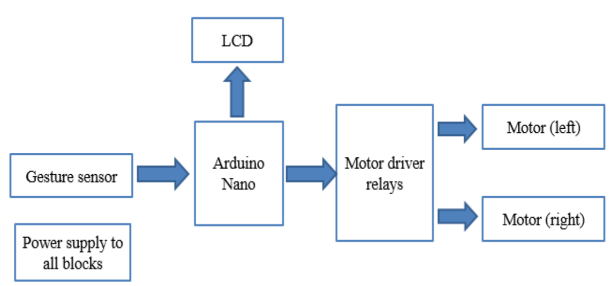

Fig1: working principle

The implementation of the smart wheel chair was broken into two halves, hardware and software. The hardware consists of the wheelchair itself and DC motors and battery. The software part is composed of programing. The hardware is designed in such a way that the wheel chair easily moves on a plane surface. The two DC motors provide necessary torque required to move flawlessly The motors are synced such that they both rotate at equal rpm to move the wheelchair in a straight line. To move the wheelchair to the right or left their respective motor rotates the wheel and the direction is easily and safely changed by the user. The battery also provides necessary power to the electronics of the project. A single Arduino mega is the brain of the smart wheel chair. The shaft of the motor is connected to the wheels via a strong chain sprocket mechanism. This mechanism was selected for its durability and ease of maintenance.

Here's how the system works:

- The user makes a gesture with their hand.
- The gesture sensor detects the movement and sends the data to the Arduino Micro controller.
- The Arduino Micro controller processes the data and determines which command it corresponds to.
- The Arduino Micro controller sends the command to the driver.

IV. METHODOLOGY

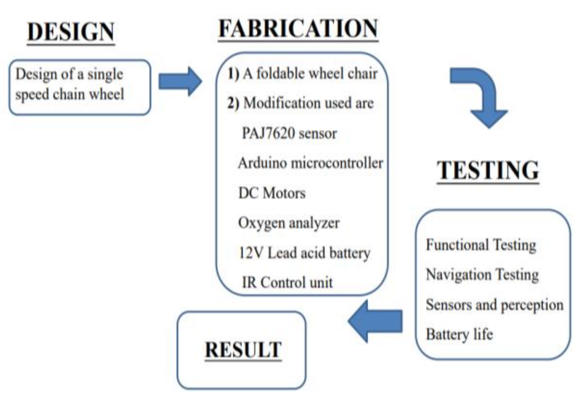

Fig 2: Methodology

A. ARDUINO UNO

Open-source micro controller platform for interactive projects. Simple programming, easy sensor integration, supports C/C++. Widely used in robotics, home automation, education. Fosters creativity in hardware prototyping

Fig 3: Arduino uno

B. PAJ SENSORS

The PAJ7620 sensor is an infrared based gesture recognition module widely utilized in electrical devices. It operates by detecting hand movements and gestures within its detection range, enabling touch less control in various applications. By interpreting infrared signals, the sensor can recognize a range of gestures such as swipes, circles and taps, making it suitable for integration into devices requiring intuitive and hands free interaction. Its versatility and ease make it popular in robotics, smart home devices and other interactive systems.

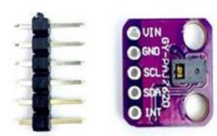

Fig 4: PAJ sensors

C. DC MOTOR

DC motor: Converts electrical energy into mechanical energy. Operates on principles of electromagnetism. Widely used in robotics, industrial automation, and electric vehicles. Features 12V operation, 55 RPM speed, 291.48 Nm stall torque. Basic components include stator and rotor. Uses commutator and brushes for continuous rotation. Applications range from household devices to industrial machinery.

Fig 5: DC Motor

D. BATTERY

12V Li-ion battery: Rechargeable with high energy density. Nominal voltage around 12 volts 7.2Ah. Consists of positive and negative electrodes and electrolyte. Voltage varies during discharge, typically 12.6-12.8 volts when fully charged. Used in portable electronics, power tools, solar energy storage, electric vehicles. Requires specific charging protocols for safety and longevity.

Fig 6: 12V lead acid battery

E. OXYGEN ANALYZER

Oxygen analyzer: Measures oxygen concentration in gas mixtures. Used in medical, industrial, environmental,and research applications. Sampling from the gas, sensing element reacts to oxygen presence, signal processed for numerical output. Requires periodic calibration for accuracy. Applications include medical monitoring, industrial processes, environmental studies, and combustion control

F. IR CONTROL UNIT

An Infrared (IR) control unit works by emitting IR signals that are received by the target device. The process involves fetching instructions, decoding them, converting into control signals, executing the operations, and controlling execution units.

V. HAND GESTURE

The operation of hand gesture control using wheel chair by operating the working module we can operate using our hand to go one place to another place without others help by programming in arduino we can operate the motor in our own direction the paj sensor is used to sense the motion of hand to give instruction to the recivier part we can move forward, backward ,right, left in different direction.

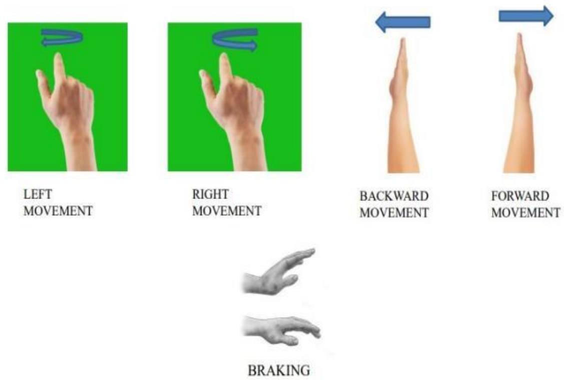

Fig 7: Hand gestures

TABLE 1: Direction of wheel chair

Direction of hand gesture	Movement of left motor	Movement of right motor
Up(backward)	BACKWARD	BACKWARD
Down(forward)	FORWARD	FORWARD
Left	BACKWARD	FORWARD
Right	FORWARD	BACKWARD

VI. SAMPLE CALCULATION

In order to select the motor to power the wheel chair, the following calculations were done

Rpm (N) = 55rpm

Diameter of the main wheel (D) = 0.6m

Then, speed = π x D x

= 3.14 x 0.6

= 103.62 m/min

= 103.62/ 60

= 1.727 m/s

Assume that the wheel chair takes 3 seconds for accelerating from 0 to 1.727 m/sec.

Then,

Velocity, V = u + at

Where U = initial speed = 0m/s

Acceleration a = V/ T V = 1.727 m/s

= 1.727 / 3 T = 3 sec

= 0.575 m/s

Total weight of the frame =15kg

Weight of the person = 70kg

Weight of the battery = 5kg

Weight of the motor = 5kg

Required force $F = M \times a$

$M = 95$ kg

$= 95 \times 0.575$

$a = 0.575$ m/s^2

$= 54.625$ N

To get a force of 54.625 N on outer diameter of the wheel, the torque required is

Torque = Force x radius of main wheel

= F x r

= 54.625 x 0.3

= 16.387 Nm [on the size of rotation]

Angular speed = (2xπxN)/60

= 2x3.14x55/60

= 5.75 rad/sec

Motor power required = Torque x Angular speed

=16.387 x5.75

= 94.22 W

Taking into consideration of friction, air resistance etc, 95 to 120 W motor will be considered

Motor specification

Type = **DC MOTOR**

Required power supply = **2A**

Speed = **55rpm**

Average Power = **100W**

Fig 8 Gesture controlled smart wheel chair

VII. RESULT AND ANALYSIS

The evaluation of wheelchair performance encompassed a weight range from 40kg to 80kg, focusing on the total weight inclusive of external components such as batteries, motors, and electrical devices. The wheelchair's velocity was scrutinized under two distinct conditions, initially in an unloaded state where it exhibited a straight-line speed of 1.7 m/s. Subsequently, with a load consisting of a 78kg individual seated onboard, the observed velocity reduced to 1.55 m/s.

Hand gesture commands were systematically examined, beginning with forward, backward, and stop movements, each executed accurately along a linear path. Furthermore, right and left turn commands were tested successfully, affirming the wheelchair's navigational capabilities.

In addition to hand gesture controls, the wheelchair integrates advanced features including an oxygen analyzer and an infrared (IR) module, necessitating meticulous testing. The initial assessment of the oxygen analyzer encountered an issue where the sensor failed to display the expected output upon fingertip contact, leading to an error. Upon closer examination, it was determined that the accuracy of the fingertip placement on the sensor was crucial. By ensuring a firm but brief press followed by a one-second delay, the oxygen levels promptly appeared on the LCD display. Subsequent tests with various individuals yielded accurate readings, validating the functionality of the oxygen analyzer.

Next the smart feature added to the wheel chair is the IR control module. The testing of IR module involves various gestures movements also. Not only that the transmitter and receiver area has a antenna to send and receive the signals so the alignment of the antenna is very important during the process. The receiver board has a set of LED lights that indicate the output. Each light represents a electrical equipment like fan,light,etc. So when the input gesture movements were given the receiver board show the perfect output of the lights getting ON as well as OF. So the working of the IR module was a great success.

Fig 9 :Person with 68 kg weight

Fig 10: Person with 76 kg weight

VIII. CONCLUSION

This ground breaking project not only exemplifies technological innovation but also embodies a deep commitment to enhancing the quality of life for individuals grappling with physical disabilities. The electrically powered wheelchair, driven by an ATMEGA328p Micro-controller on an Arduino board, stands as a testament to the convergence of advanced engineering and compassionate design. The utilization of three strategically positioned Hall Effect sensors represents a paradigm shift in hand-motion interpretation, providing users with a level of nuanced control that was previously unattainable

The orchestration of precise movements is facilitated by the perceptive Hall sensors, finely attuned to magnetic fields, thereby ensuring a seamless and responsive driving experience. Complementing this, a pair of relay units govern the motors, translating the subtleties of user gestures into fluid locomotion with unparalleled precision. The integration of a real-time status display on an LCD further elevates the user experience, offering immediate visual insights that foster heightened awareness and engagement.

Beyond its remarkable mobility features, this wheelchair transcends traditional boundaries by incorporating an oxygen and blood pressure analyzer. This addition transforms the system into a holistic health-monitoring solution, emphasizing a comprehensive approach to user well-being. By seamlessly integrating cutting-edge technology and empathetic design, this project sets a new standard for inclusivity and user empowerment.

In essence, this intelligently crafted solution not only empowers individuals with physical disabilities on the mobility front but also addresses broader aspects of their health, exemplifying a commitment to holistic well-being. As a beacon of excellence, this project signifies the dawn of a new era where technology and design converge to redefine conventional notions of mobility assistance, offering a transformative impact on the lives of those with physical disabilities.

IX. FUTURE SCOPE

Enhanced Gesture Recognition: Improving the accuracy and range of gesture recognition technology to enable more intuitive and precise control over the wheelchair. Navigation and Obstacle Avoidance: Implementing advanced navigation systems and obstacle avoidance mechanisms using sensors and computer vision to enhance the wheelchair's ability to move autonomously and safely through different environments.

Connectivity and IoT Integration: Integrating the wheelchair with the Internet of Things (IoT) for seamless communication with other smart devices, healthcare systems, and providing remote monitoring and control features. Global Accessibility: Working towards making gesture-controlled smart wheelchairs more affordable and accessible globally, ensuring that individuals with mobility challenges worldwide can benefit from these technologies.

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