HEAD OPERATED WHEELCHAIR

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Abstract— An electric wheelchair, driven by an electric motor, offers a vital means of mobility for individuals with physical disabilities, particularly those with quadriplegia. Quadriplegia arises from spinal cord injuries, resulting in the loss of function in limbs. However, for some with severe quadriplegia, there remains limited movement, often in the head. Making use of this residual movement, a head-motion controlled wheelchair emerges as a promising solution, affording users the freedom to navigate through tilting motions: forward, backward, right, left, or stable. This innovative robotic wheelchair integrates essential components such as an accelerometer sensor, IR sensor, Raspberry Pi Pico, converter, DC motors, and a motor driver IC. The Raspberry Pi Pico serves as the controller, processing signals from the sensors to initiate wheelchair movement. The wheelchair, designed with cost-effectiveness in mind, prioritizes safety, adaptability, and mobility for its users. By capitalizing on head movements, this wheelchair system empowers individuals with severe quadriplegia, enabling them to independently traverse their surroundings. It represents a significant advancement in assistive technology, tailored to meet the unique needs and challenges of those with mobility impairments.

Index Terms **- Accelerometer, Raspberry Pi Pico, Wheelchair Chassis, Quadriplegia**

INTRODUCTION

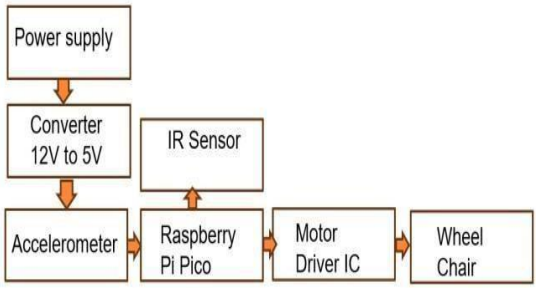
As the population requiring assisted mobility continues to grow due to various health conditions and accidents, there is a pressing need for increasingly sophisticated solutions that leverage technological advancements. These solutions aim to enhance the quality of life for individuals with mobility impairments by simplifying and strengthening their ability to move, akin to those without disabilities. Quadriplegia, also known as tetraplegia, results from spinal cord injuries in the neck area, leading to the loss of sensation and movement in the arms, legs, and trunk. Damage to nerve fibers passing through the injured area can further impair muscle and nerve function below the injury site. For individuals with severe quadriplegia, head movement remains as the only residual form of mobility. Therefore, harnessing these head movements becomes crucial for enhancing patient mobility, particularly in controlling the movement of wheelchairs. Today's advanced electronic and robotic systems offer promising solutions to address mobility challenges faced by individuals with specific needs. This project introduces a head-controlled assistive system designed with electronic and mechanical components, centrally controlled by a Raspberry Pi Pico. An accelerometer sensor, strategically placed on the patient's head, detects head tilts, translating them into analog voltage signals. These signals are then used to generate control signals corresponding to four directions of wheelchair movement.

LITERATURE SURVEY

[1] In this paper, “Wheelchair Control by Head Motion” Aleksandar Pajkanović1, Branko Dokić1, Electric wheelchairs are designed to aid paraplegics. In this paper a microcontroller system that enables standard electric wheelchair control by head motion is presented. The system comprises electronic and mechanic components. A novel head motion recognition technique based on accelerometer data processing is designed. The wheelchair joystick is controlled by the system’s mechanical actuator. [2] In this paper, “Design and development of a robust joystick controller for a powered wheelchair” by Trinayan Saharia, Jyotika Bauri, Mrs. Chayanika Bhagabati. This paper presents the design and development of a robust joystick controller suitable for environments various and users. [3] In this paper, “Design and Implementation of Voice Controlled Wheelchair” by Harsh Sharma11 Arjun Gadhavi2 Parth Pandya3 Parth Methaniya4 Purvdeep Jadeja5. This paper discusses the design and implementation of voice-controlled wheelchair system based onBluetooth module. [4] In this paper, "Eye-Gaze Controlled Wheelchair Based on Deep Learning" by Jun Xu 1, Zuning Huang 2, Liangyuan Liu 2, Xinghua Li 2 and Kai Wei 2, In this paper, they design a technologically intelligent wheelchair with eye-movement control for patients with ALS in a natural environment. The system consists of an electric wheelchair, a vision system, a two- dimensional robotic arm, and a main control system. The smart wheelchair obtains the eye image of the controller through a monocular camera and uses deep learning and an attention mechanism to calculate the eye- movement direction. In addition, starting from the relationship between the trajectory of the joystick and the wheelchair speed, we establish a motion acceleration model of the smart wheelchair, which reduces the sudden acceleration of the smart wheelchair during rapid motion and improves the smoothness of the motion of the smart wheelchair.
[5] In this paper, "Voice Controlled Wheelchair " by Khyati Meena, Shubham Gupta, Vijay Khare. This paper presents an automatic wheel chair using voice recognition. A voice-controlled wheelchair makes it easy for physically disabled person who cannot control their movements of hands. The powered wheel chair depends on motors for locomotion and voice recognition for command. The circuit comprises of an Arduino, HM2007 Voice recognition module and Motors.

METHODOLOGY

Block Diagram Explanation



The block diagram for the wheelchair project features a power supply providing 12V, with converters ensuring 5V supply for each component. It incorporates sensors like the accelerometer for detecting head movements and an IR sensor for obstacle detection. Additionally, it includes a Raspberry Pi Pico microcontroller for data processing, along with a motor driver IC for controlling wheelchair movement. The power supply maintains stable voltage levels, while the converters ensure compatibility with 5V components, enabling seamless integration of sensors and other critical elements.

DESIGN AND WORKING

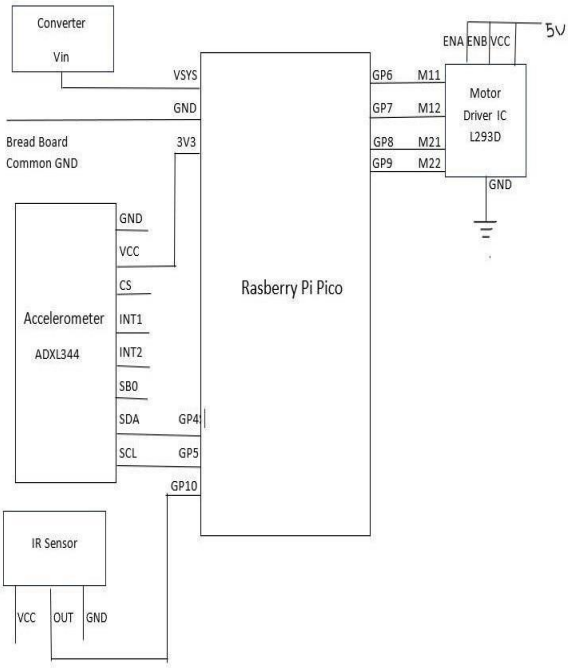


fig. 2. circuit diagram of wheelchair

The circuit diagram illustrates the power supply system and connections between various components within the system. Here's an explanation of the circuit diagram:

Power Supply:

The power supply unit provides electrical power to the entire system. It typically receives a 12V input supply.

Converter:

The converter is responsible for transforming the 12V supply from the power source into a 5V supply, which is suitable for the system's components. It ensures that the voltage level is compatible with the requirements of the components connected to it.

Fig.3 Converter

Accelerometer (ADXL345);

The 5V supply from the converter is connected to the accelerometer. The accelerometer measures acceleration and is crucial sensor in many applications, including motion detection, orientation sensing, and vibration monitoring.

table 1 accelerometer specification

Specification	Value
Input Supply Voltage (VDC):	3.3-5
Bandwidth	DC-400Hz
Acceleration Range	+-10kg

Fig 4. accelerometer

Raspberry Pi Pico:

The 5V supply from the converter is also connected to the Raspberry Pi Pico. The Raspberry Pi Pico is a microcontroller board that can be programmed to perform various tasks. It serves as the central processing unit in this system.

Specification	Value
Memory Storage capacity	16MB
Connectivity Technology	12C
Operating System	Raspberry Pi OS

table 2 raspberry pi pico specification

fig.5. Raspberry Pi Pico

IRSensor:

The Raspberry Pi Pico is connected to an Infrared (IR) Sensor. IR sensors detect

table 3 ir sensor specification

Specification	Value
Power source	3.6-5VDC

fig. 6. ir sensor

Motor Driver IC Module(L239D):

The Raspberry Pi Pico is also connected to a Motor Driver IC (Integrated Circuit). The motor driver IC controls the operation of motors based on signals received from the Raspberry Pi Pico. It is responsible for driving and controlling the speed and direction of motors in the system.

table 4 motor driver ic specification

Specification	Value
Operating Voltage (VDC)	4.5 to 12
Peak Current (A)	0.6
No. of Channels	1

fig. 7. motor driver ic module

In summary, the power supply unit provides power to the converter, which converts the voltage to 5V suitable for the accelerometer and the Raspberry Pi Pico. The Raspberry Pi Pico interfaces with both the IR Sensor and the Motor Driver IC, enabling the system to sense its environment using the IR sensor and control motor actions through the motor driver IC based on programmed logic.

DC Motor

This 12 Volt DC Motor – 100 RPM can be used in all-terrain robots and a variety of robotic applications. These motors have a 3 mm threaded drill hole in the middle of the shaft thus making it simple to connect it to the wheels or any other mechanical assembly.

Specification	Value
Rated Speed (RPM)	100
Operating Voltage (VDC)	12
Rated Torque(kg-cm)	2.9
Load Current Max (mA)	300

table 5 dc motor specification

fig. 8. dc motor

Working

The wheelchair operates with head movement, taking motion as an input signal for the movement of the wheelchair in a particular direction. An accelerometer (motion sensor) is used to track these motions. This sensor is fitted to the cap head. The variations of the sensor are trapped, and those signals are fed as inputs to the Raspberry Pi Pico. Based on these variations, the Raspberry Pi Pico is now programmed to make decisions that, in turn, control the movement of a wheelchair. When a person tilts his head in a forward direction, a wheelchair will move in a forward direction, and when his head is tilted in a backward direction, a wheelchair will move in a backward direction. If a person tilts his head in the left direction above, a wheelchair will move in the left direction, and if his head is in the right direction above, a wheelchair will move in the right direction. If a person has stopped the wheelchair, then stabilize his head. If a person wants to move in a forward direction, they have to make their head tilt forward. That disabled person cannot keep their head in only one direction continuously, so an IR sensor is used to continuously go in one direction, and afterward, he can move his head in any direction, but it will not affect the direction of the wheelchair.

PROTOTYPE MODEL

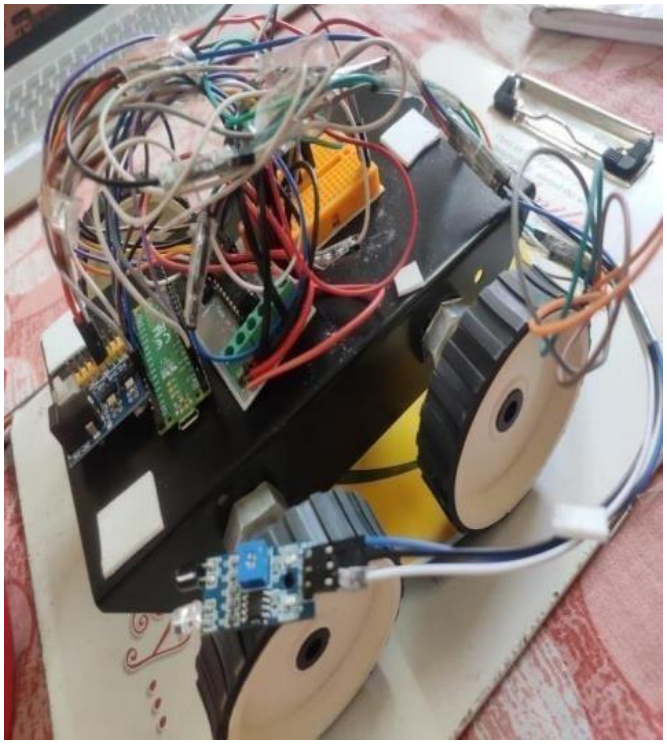


fig. 9. prototype model

RESULT AND DISCUSSION

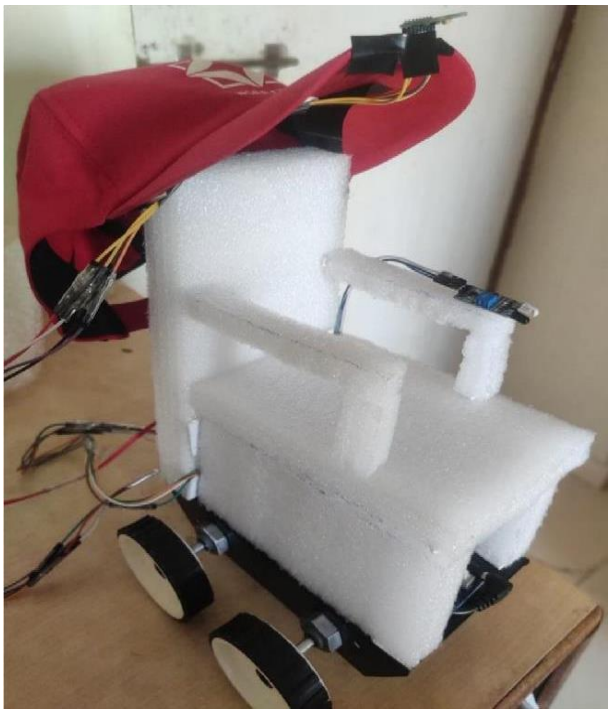


fig. 10. wheelchair model

The head-operated wheelchair project combines an accelerometer and IR sensor for precise control, detecting both head movements and obstacles. Raspberry Pi Pico handles real-time data processing, ensuring smooth and safe operation. A DC motor, controlled by a motor driver IC, enables responsive movement based on detected inputs. This integrated system provides a reliable and user-friendly solution for individuals with mobility impairments, offering improved independence and maneuverability in navigating their surroundings with the ease of head movements.

CONCLUSION

The wheelchair project is a big step forward in helping people move around more easily. It uses a special sensor called an accelerometer to understand how a person's head moves. By connecting it to a small computer called a Raspberry Pi Pico, the system can turn those movements into commands for the wheelchair. The wheelchair understands four simple commands: "forward," "backward," "left," and "right." It also recognizes six different states, like when it's still or moving in a certain direction. By making the wheelchair easy to control and understand, it gives people with mobility issues more freedom and independence. With more improvements, projects like these can make a big difference in people's lives all over the world.

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