Design and Implement a Wheelchair by Moving the Head of People Who are Paralyzed

Merancang dan Mengimplementasikan Kursi Roda dengan Menggerakkan Kepala Orang yang Lumpuh

Mohammed Sameer Kadhim[1], Mustafa Majid Kamil[2], Ruqaya Dhyaa Kadhum[3], Mustafa Mahmoud[4]
Yggy9678@gmail.com

[1,2,3,4] Medical Instrumentation Techniques Engineering Department, Al-Hussein University College

Abstract. General Background: *Wheelchairs play a crucial role in enhancing mobility for individuals with disabilities, illness, or injury, with various designs tailored to meet specific needs.* ***Specific Background:*** *Among these, powered and manual wheelchairs serve distinct functions, with recent technological advancements promising improved user experience. Despite innovations, the market often struggles with overspecialization, leaving gaps in accessibility and usability, particularly for populations in developing regions.* ***Knowledge Gap:*** *While advancements like the Leveraged Freedom Chair and geared manual wheels have emerged, there remains a lack of comprehensive integration of modern technologies to enhance performance across diverse environments.* ***Aims:*** *This study aims to evaluate the technological evolution of wheelchairs, specifically focusing on design improvements and user-centric innovations, alongside the development of a prototype utilizing Arduino Nano and supporting components for enhanced functionality.* ***Results:*** *The findings indicate that integrating components such as the IBT-2 motor driver, MPU6050 motion sensors, and effective power management systems significantly improves maneuverability and adaptability of wheelchairs, particularly for users with tetraplegia.* ***Novelty:*** *The study presents a novel approach in wheelchair design that incorporates advanced microcontroller technology to facilitate independent mobility, thereby addressing limitations in traditional wheelchair functionality.* ***Implications:*** *The research contributes to the field of assistive technology by demonstrating that enhanced wheelchair designs not only promote physical mobility but also improve the overall quality of life for users, highlighting the importance of continued innovation and accessibility in wheelchair technology for diverse populations.*

Keywords *– wheelchair technology, tetraplegia, assistive devices, microcontroller, mobility innovation*

Abstrak. ***Latar Belakang Umum:*** *Kursi roda memainkan peran penting dalam meningkatkan mobilitas bagi penyandang disabilitas, penyakit, atau cedera, dengan berbagai desain yang disesuaikan untuk memenuhi kebutuhan khusus.* ***Latar Belakang Khusus:*** *Di antara semuanya, kursi roda bertenaga dan manual memiliki fungsi yang berbeda, dengan kemajuan teknologi terkini yang menjanjikan pengalaman pengguna yang lebih baik. Meskipun ada inovasi, pasar sering kali berjuang dengan spesialisasi yang berlebihan, sehingga menimbulkan kesenjangan dalam aksesibilitas dan kegunaan, khususnya bagi populasi di wilayah berkembang.* ***Kesenjangan Pengetahuan:*** *Meskipun kemajuan seperti Kursi Kebebasan Terungkit dan roda manual yang digerakkan telah muncul, masih terdapat kurangnya integrasi komprehensif teknologi modern untuk meningkatkan kinerja di berbagai lingkungan.* ***Tujuan:*** *Studi ini bertujuan untuk mengevaluasi evolusi teknologi kursi roda, khususnya dengan fokus pada peningkatan desain dan inovasi yang berpusat pada pengguna, di samping pengembangan prototipe yang memanfaatkan Arduino Nano dan komponen pendukung untuk fungsionalitas yang ditingkatkan.* ***Hasil:*** *Temuan menunjukkan bahwa mengintegrasikan komponen seperti penggerak motor IBT-2, sensor gerak MPU6050, dan sistem manajemen daya yang efektif secara signifikan meningkatkan kemampuan manuver dan kemampuan beradaptasi kursi roda, khususnya bagi pengguna dengan tetraplegia.* ***Kebaruan:*** *Penelitian ini menyajikan pendekatan baru dalam desain kursi roda yang menggabungkan teknologi mikrokontroler canggih untuk memfasilitasi mobilitas independen, sehingga mengatasi keterbatasan dalam fungsi kursi roda tradisional.* ***Implikasi:*** *Penelitian ini berkontribusi pada bidang teknologi bantuan dengan menunjukkan bahwa desain kursi roda yang disempurnakan tidak hanya meningkatkan*

mobilitas fisik tetapi juga meningkatkan kualitas hidup pengguna secara keseluruhan, yang menyoroti pentingnya inovasi dan aksesibilitas berkelanjutan dalam teknologi kursi roda untuk berbagai populasi.

Kata Kunci – *teknologi kursi roda, tetraplegia, alat bantu, mikrokontroler, inovasi mobilitas*

I. INTRODUCTION

Wheelchair

is a chair used when a disability, illness, or injury makes walking impossible or difficult, it is available in a vast array of forms to cater to the individual requirements of its customers. Similar to sports wheelchairs, these could feature special seating configurations, personalized controls, or be designed for only one activity. There are two types of wheelchairs that are commonly distinguished: powered wheelchairs, which are propelled by electric motors and batteries, and manually propelled wheelchairs, which require an attendant to push from behind or the wheelchair user to push the wheelchair by hand.

Figure 1: shown a Wheelchair

Wheelchair Types:

There are many different kinds of wheelchairs, with variations in technology, propulsion systems, and control mechanisms. Wheelchairs can be made for a variety of purposes; some are meant for single tasks or to meet certain access requirements. Although there is a fair amount of innovation in the wheelchair sector, many of these technologies eventually fail to find a market due to overspecialization or inability to reach a reasonable pricing. Probably the most well-known examples of this from recent times are:

A. Manual self-propelled wheel-chairs
B. Manual attendant-propelled wheel-chairs
C. Single-arm drive wheel-chairs
D. Standing wheel-chairs
E. Reclining wheel-chairs
F. Powered wheel-chairs
G. Sport wheel-chairs
H. Smart wheel-chairs

Tetraplegia

Tetraplegia, sometimes referred to as quadriplegia, is a type of paralysis brought on by disease or trauma that causes all four limbs and the torso to become partially or completely non-functional; Similar but unrelated to the arms is paraplegia. Usually, both feeling and control are lost because of the sensory and motor loss. Conversely, tetraparesis or quadriparesis refers to a condition in which all four limbs are affected by muscle weakness. It could be spastic or limp.

High degree of brain or spinal cord damage namely C1–C7 injuries to the spinal cord as a result of a cervical spine injury, results in tetraplegia. The damage, referred to as a lesion, results in individuals losing all or some of their function in all four limbs. Injury to the C1–C4 usually impacts arm movement more than a lesion to the C5–C7. Thus, it is not unusual to have a tetraplegic who lacks nerve control over their fingers and thumbs but whose arms are completely functioning.

Trauma (car accidents, diving into shallow water, falls, sports injuries), illness (polio, multiple sclerosis, transverse myelitis), or congenital conditions (muscular dystrophy) are common causes of this damage. If the spinal cord is unharmed and the vertebrae are shattered or displaced, a broken neck may occur without tetraplegia. On the other hand, when a bone spur or ruptured disc on a vertebra extends into the spinal column, Damage to the spinal cord is possible without breaking the spine.

Technological developments of wheelchairs

Technology for wheelchairs and powerchairs is gradually getting better thanks to recent developments.

The MIT Mobility Lab created the Leveraged Freedom Chair (LFC), a variant on the manually driven wheelchair. It is made with inexpensive, locally sourced materials with the intention of serving users in underdeveloped nations; Hand-controlled levers have been added to the chair's engineering to allow users to move it over small impediments and uneven terrain—like the bumpy dirt roads that are frequent in underdeveloped nations. It is being developed and has so far undergone testing in Kenya and India (13).

A recent advancement in wheelchair technology involves the incorporation of a hypocycloidal reduction gear into the design of geared, all-mechanical wheels intended for manual users. A manual wheelchair can have the 2-gear wheels fitted to it. Through the use of gearing, the geared wheels give the user more assistance—think of them more like a bicycle than a motor. Two speed ratios are available for the two-gear wheels: 1:1 (no assistance, no additional power) and 2:1 (100 percent greater force for climbing hills). When descending, the low gear also helps with downhill control.

II. WHEELCHAIR COMPONENTS

Wheelchair mechanical components

1. Wheelchair Frame Types
   Because a folding frame can fold flat thanks to a cross bracing mechanism located beneath the seat material, it is a particularly practical tool for storage and transit. The folding mechanism makes it more difficult to maneuver, which is a drawback for individuals who are very active. Similar to a folding frame, a compact folding frame can be folded even smaller and has the same benefits and drawbacks. Although a rigid frame requires more effort to move than a folding one, it is lighter and hence more appropriate for an active user because it loses less energy in the frame design.
2. Wheelchair Frame Materials
   Steel is reasonably priced and offers excellent strength. But it's also incredibly hefty, which makes it difficult to maneuver. Although aluminum costs a little more, it is more lighter and easier to work with. Aluminum is inferior to titanium in terms of strength to weight ratio. It might not be as robust. Strongest and lightest material is carbon fiber. pricey and prone to breaking. Strength is gone as soon as it is harmed. It is also possible to have composite frames, which combine the advantages of various materials.
3. Wheelchair Seat
   To determine the ideal seat size for comfortable seating, stability, and excellent posture, the user must be thoroughly evaluated (17). The ideal fit for the user is for the seat to be as comfortable as possible; a seat that is too wide may promote bad posture, and a seat that is too tight may cause pressure sores. excessively much weight will be forced onto the user's buttocks rather than being distributed along the length of their thighs by a seat that is excessively shallow. If it is too deep, pressure points may form behind the knees and the user may not receive the desired support from the backrest. An uncomfortable situation that might result in pressure sores occurs when a user's legs roll together due to sagging seats.
4. Wheelchair Backrests
   When using a chair for extended periods of time, the user's posture and comfort are affected by the dimensions, angle, and height of the backrest. There are several other kinds:
   a. Easy to store and carry thanks to the backrests' foldable forward and backward motion.
   b. Although some are optional extras, pushing handles are primarily a part of the backrest.
   c. Pushing handles with adjustable heights are useful for individuals pushing chairs since they may be modified to lessen back pain.
5. Wheels
   Two big driving wheels with hand rims for pushing at the back and two small wheels, or castors, at the front make up a manual wheelchair that can propel itself. A single front wheel is included in several sports and high-performance wheelchairs (18). The ease of propulsion is determined by the size of the driving wheels; the larger the wheels, the less effort needed. Transport or transit chairs have smaller rear wheels and

sometimes slightly larger front castors because they are meant to be pushed by an attendant. They are not able to move themselves. When being transported or stored, the size and weight can be decreased with the aid of detachable drive wheels.

Components of Electric wheelchair

Most wheelchairs, whether they are powered or manual, share similar parts. The wheelchair's most crucial parts are these ones. The list of parts that make up a wheelchair includes Armrest, Backrests, Brakes, Frames and footplates, Growth capacity, Battery life and drive, The controller of a powered wheelchair.

III. DESIGN

Design

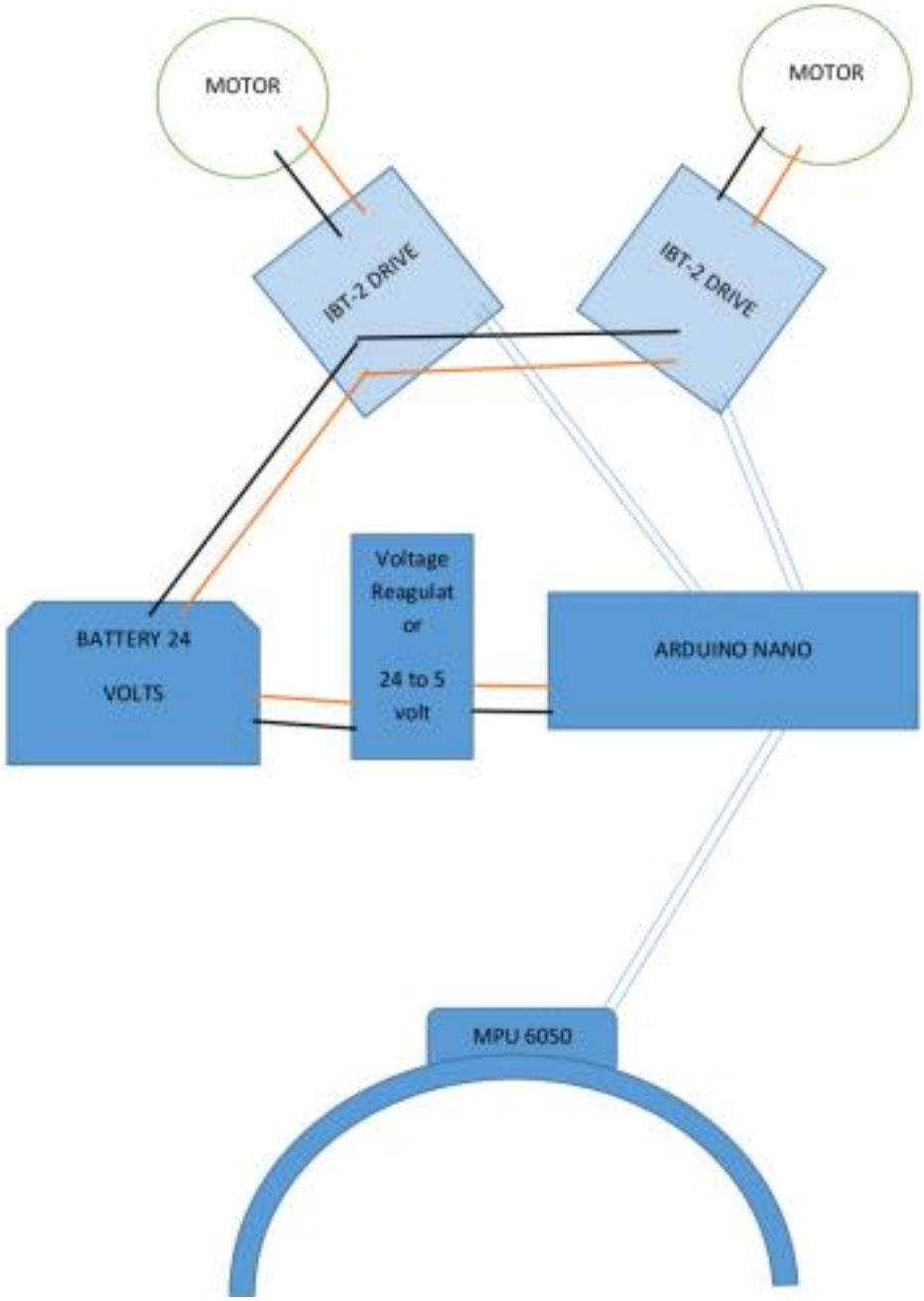

Figure 2: shown research design.

components of circuit

1. Arduino nano
   A compact, feature-rich bread board, the Arduino Nano is built on the ATmega328P (Arduino Nano 3.x). The Arduino Duemilanove's functionality is essentially the same, however it comes in a different packaging. It lacks only a DC power jack, and works with a Mini-B USB cable rather than a typical one.
   There are several ways that the Arduino Nano can communicate with other microcontrollers, computers, or other Arduinos. The ATmega 328 provide UART TTL (5V) serial communication, this serial communication is channeled over USB by an FTDI FT232RL on the board, and a virtual serial port is provided to the computer's software by the FTDI drivers (which come with the Arduino software). Simple textual data can be transferred to and from the Arduino board using the serial monitor built into the Arduino software. The RX and TX LEDs on the board will flash when data is being transmitted via the FTDI chip and USB connection to the computer. Any of the digital pins on the Nano can be used for serial communication with the help of a software serial library, The ATmega 328 support I2C (TWI) and SPI communication. To make using the I2C bus easier, the Arduino software comes with a wire library.

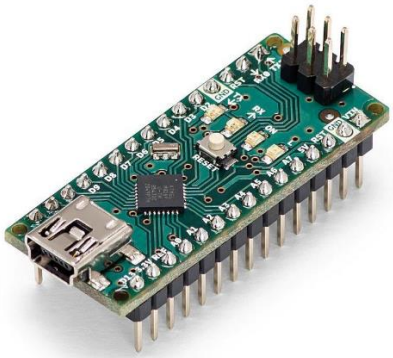

Figure 3: shown Arduino nano

2. DC - DC voltage regulator
   A gadget that uses electricity or electromagnetism known as a DC to DC converter is employed to alter a direct current DC source's voltage level.. This kind of power converter is electric. High-voltage power transmission and tiny batteries are examples of very low power levels.

Figure 4: shown a DC to DC voltage regulator

3. Ibt2 motor drive
   A low-cost strong motor driver built on two BTS7960 processors is the IBT-2 H-bridge module by Wingxin. An electrical circuit known as an IBT-2 H bridge is used to change when a voltage is applied to a load, its polarity. By utilizing these circuits, DC motors can operate either forward or backward which are frequently employed in robotics and other applications (1)
   H bridges are used in the majority of motor controllers, the majority of power inverters, or DC–AC converters, the majority of AC/AC converters, the push-pull DC-to-DC converter, and numerous other power electronics. Specifically, a motor controller with two H bridges almost always drives a bipolar stepper motor.

Figure 5: shown a Ibt2 motor drive.

4. mpu6050 module
   A three-axis accelerometer and three-axis gyroscope are internal components of the Micro Electro-Mechanical Systems (MEMS) MPU6050. This facilitates the measurement of a system's or object's acceleration, velocity, orientation, displacement, and many other motion-related parameters. Additionally, this module contains a Digital Motion Processor (DMP) that can do complex calculations, freeing up the microcontroller's workload. Two additional pins on the module are optionally utilized to interface external IIC modules, such as a magnetometer. It is possible to link multiple MPU6050 sensors to a microcontroller by using the AD0 pin of the module since its IIC address is customizable.

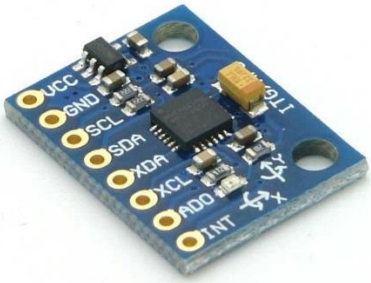

Figure 6: Shown the MPU 6050 module

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