Survey on Hand-Gesture-Controlled Biomedical Wheelchair: Components, Designs, and Challenges

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Abstract

The Finger-Controlled Wheelchair System presented in this project addresses the critical needs of individuals with mobility and communication challenges, particularly those who are unable to move, walk, or speak. The primary innovation within this project is a wheelchair control system that leverages finger movements, eliminating the need for conventional button-based controls and significantly improving user-friendliness. This project caters to a wide spectrum of users, with a special emphasis on individuals suffering from paralysis or severe motor limitations due to medical conditions. By employing the intuitive manipulation of fingers, users gain the ability to navigate the wheelchair in multiple directions, such as forward, backward, left, and right. In doing so, the system offers newfound independence and empowerment to individuals who would otherwise rely on constant assistance. Beyond its mobility-enhancing features, the project incorporates a comprehensive parameter monitoring system. This feature allows users to actively monitor critical parameters, including battery life and speed, providing real-time awareness of the wheelchair's operational status. This project goes beyond mere technological innovation; it represents a substantial improvement in the quality of life and autonomy for those with disabilities. It empowers individuals to regain control over their movements, explore their environments, and engage in essential interactions with newfound ease and independence. The project serves as a testament to the convergence of technology, healthcare, and accessibility. It opens up new horizons for individuals seeking greater autonomy and freedom, and its successful implementation promises to positively impact the lives of those facing mobility challenges. Further details and comprehensive insights into this project are available in the full documentation.

Index Terms

Assistive Technology, Wheelchair Mobility, Finger-Controlled Interface, Disability Assistance, Accessibility

1. Introduction

This innovative system proves to be profoundly advantageous for individuals with disabilities, especially those who have experienced partial paralysis. The system's groundbreaking feature allows for wheelchair mobility through simple finger movements, eliminating the need for manual button presses. At its core, the system comprises two key circuits: one on the wheelchair and another on the user's hand. The wheelchair circuit integrates an RF receiver in conjunction with an Arduino UNO micro-controller and a driver IC responsible for motor control. This intricate combination ensures seamless and precise control of the wheelchair's movements in response to finger gestures.

On the user's end, the hand circuit incorporates an ATMega family microcontroller connected to an Arduino UNO. This microcontroller efficiently interprets the finger movements, converting them into executable commands. These commands are then transmitted via an RF transmitter, effectively relaying them to the RF receiver on the wheelchair. The RF receiver, in turn, communicates the instructions to the wheelchair's microcontroller, which translates them into real-time movements in the specified direction. This process underscores the seamless communication and integration between the user's gestures and the wheelchair's mobility.

The system extends its functionality to include additional features that enhance the overall user experience. Notably, it integrates a Heart Rate Monitoring Sensor and a Temperature Sensor, allowing continuous health monitoring for the individual seated in the wheelchair. The collected heart rate and temperature data are prominently displayed on an LCD screen, providing

Critical health insights in real time. Furthermore, the system incorporates a Buzzer for immediate alerts and notifications, ensuring user safety and communication.

One of the standout elements of this system is the implementation of a Wireless Charger. This feature redefines convenience and autonomy by enabling the wheelchair to automatically charge itself wirelessly, further reducing the user's reliance on external assistance. This multifaceted system signifies a remarkable advancement in assistive technology, combining userfriendly control with comprehensive health monitoring and the convenience of autonomous charging.

2. Experimental

The System consists Transmitter and Receiver Section, in which Hands Act as a Transmitter and robot act as a Receiver. The system communicates in wireless domain [1]. In [2] a microcontroller-based Robot is implemented which can be controlled using Hand Gesture. Gesture Controlled Robot moves based on movement of hands gesture and voice commands for performing any operation [3]. The Accelerometer is used for detecting gesture of hands [5]. The Transmitter part is kept on palm and the beneficiary part on robot vehicle that moves as indicated by the hand development [8 , 10]. The RF module used in [8] is working on the Frequency of 433 MHz and has a range of 50 - 80 Meter. The hand gesture-controlled Wheelchair similarly works as a Hand gesture Controlled Robot [9, 11]. The Transmitter circuit is placed on hand gloves and Receiver circuit placed on Wheelchair [10]. The wheelchair moves easily with the help of movement of hand gestures [14]. The Robot is also very useful for any forest operation because it consists obstacle detection circuitry that can detect any object during forest operation [4]. For better use, Arduino can give good result in Robotics. By Using Arduino, a single circuit can perform different tasks [6]. Many disabled people require wheelchair for mobility and are not always able to control it themselves. Caretakers are not always able to actively monitor disabled individuals. Disable people need a way to control their wheelchair that meets their specific needs [3, 4].

3.Input table for moving wheelchair based on binary and led number

The following table is related to Moving Wheelchair using Movement of fingers. The Table consist Binary Number and LED Number which used to give the direction to the wheelchair.

Conditions	Input Conditions For Movement of Wheelchair					Directions
	Binary No	1	2	4	8	
	LED No	1	2	3	4	
Stop	0	0	0	0	0	Stop
Forward	1	1	0	0	0	Forward
Reverse	2	0	1	0	0	Reverse
Left	3	1	1	0	0	Left
Right	4	0	0	1	0	Right
Viseversa	5	1	0	1	0	Viseversa
Buzzer	6	0	1	1	0	-

Fig.1: Input Table for Moving Wheelchair Based on Binary and LED Number

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4. Finger-Controlled Wheelchair direction control and user interface:

To control the wheelchair's direction, we employ three Flex Sensors, which facilitate movement in various directions, including Forward, Backward, Left, Right, and their corresponding reversals.

Condition 1:

In the first condition, the wheelchair is set to move in Forward and Reverse directions. Initiating Forward movement requires adjusting Flex Sensor No. 1, prompting the wheelchair to move forward. Conversely, to initiate Reverse movement, Flex Sensor No. 2 is manipulated, causing the wheelchair to move in the opposite direction. To halt the wheelchair's movement, the Flex Sensor is positioned at a neutral state, effectively stopping the wheelchair.

Condition 2:

In the second condition, the wheelchair is programmed to move in Left, Right, and Vice-versa directions. To navigate Left, both Flex Sensor No. 1 and Flex Sensor No. 2 are adjusted simultaneously, resulting in a leftward motion. Adjusting Flex Sensor No. 3, on the other hand, directs the wheelchair to move Right. For Vice-versa movement, a combination of Flex Sensor No. 1 and Flex Sensor No. 3 is employed.

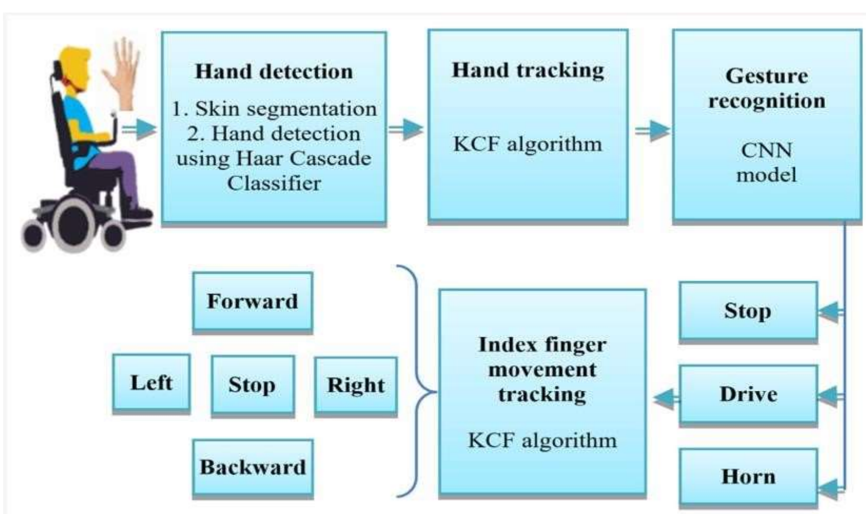
Condition 3:

The third condition introduces an integral Buzzer function in the wheelchair, allowing users to call for assistance when needed. To activate the Buzzer, users simply manipulate Flex Sensor No. 2 and Flex Sensor No. 3 using finger movements. This triggers the Buzzer, which emits an audible alert for seeking help. These input conditions are intuitively designed, making it easy for users to manoeuvre the wheelchair effortlessly. Furthermore, these conditions are prominently displayed on an LCD screen for user reference, providing real-time feedback. An LED indicator also complements the system, blinking to confirm commands as Flex Sensors are manipulated using finger gestures.

This configuration not only enhances the user's control over the wheelchair's movement but also ensures their safety through the Buzzer function and provides clear feedback via the LCD display and LED indicators.

5.Research Methodology

The system consists of flex sensors, microcontroller, LCD display, LEDs, motor driver and dc motors. The model consists of two components which are the model on the gloves and the model on the wheelchair. The model on the gloves consists of flex sensors and the other comprises of microcontroller, LCD display, motor driver, dc motors. The input is taken from the user in the form of finger gestures through the flex sensors and the flex sensors have a property that when they are bent their resistance changes and the current starts to flow through the input of the flex sensor which is given to the ATMega 32 microcontroller through the internal ADC. The microcontroller does the necessary calculations (works as an analogy to digital converter and converts the data into serial data) and sends the signals serially to the motor driver and the LCD display. The microcontroller is programmed according to the variation in the input. The output of the microcontroller is then given to the motor driver which drives the motor in the required direction. Hence, the wheelchair begins to move according to the movement or bending of the users' fingers.



6.Safety

Safety is of paramount importance in the development and deployment of the finger-controlled wheelchair system. Ensuring the well-being of users, particularly individuals with limited mobility and healthcare professionals, is a top priority. Several safety measures have been integrated into the system to guarantee its safe operation. The user-friendly finger-controlled interface is designed to minimize the risk of accidental movements, enhancing precision and control. Additionally, emergency stop mechanisms are in place to halt the wheelchair's movement in critical situations. The heart rate and temperature monitoring sensors serve as vital health indicators, enabling immediate response in case of distress. The inclusion of a buzzer function further enhances safety by providing users with a means to call for assistance when needed. Continuous monitoring, rigorous testing, and adherence to safety standards are integral to the development process, ensuring that the finger-controlled wheelchair system not only provides enhanced mobility but also safeguards the well-being and security of its users.

7.Proposed Work

The proposed work centres around the development of a finger-controlled wheelchair, a revolutionary advancement in assistive technology. This innovative system leverages the natural dexterity of the human hand, eliminating the need for traditional control methods such as buttons or joysticks. Instead, users can effortlessly control the wheelchair's movements with simple finger gestures.

The heart of this system lies in a transmitting device held in the user's hand, which houses an RF transmitter. The hand-held transmitter serves as the bridge between the user and the robot, transmitting a range of commands that enable the wheelchair to carry out a spectrum of tasks. These tasks encompass the essential functionalities required for mobility: moving forward, reversing, turning left, turning right, and coming to a complete stop.

In essence, this innovative system unshackles users from the constraints of conventional control interfaces. With their hands as transmitters, individuals with mobility challenges can command the wheelchair's movements with greater finesse, precision, and ease. This breakthrough promises to enhance the autonomy and quality of life for those who rely on wheelchairs for their mobility needs.

8.Benefits to society

The finger-controlled wheelchair system extends its utility beyond individual users and holds significant benefits for society as a whole, particularly within the medical and healthcare sectors. In medical settings and hospitals, this wheelchair serves as an invaluable tool for the transportation of critically ill patients from one location to another. Its advanced features, including finger-controlled movement, heart rate and temperature monitoring sensors, a wireless charger, and a buzzer, make it a versatile and indispensable asset.

The finger movement control feature offers a paradigm shift in wheelchair operation. By enabling users to manipulate the wheelchair with simple finger movements, it significantly enhances the ease and precision of mobility. Simultaneously, the integration of heart rate and temperature monitoring sensors provides real-time health status updates on an LCD display. This health monitoring capability is vital in the medical field, facilitating the continuous assessment and care of patients during transit.

Furthermore, the cost-effectiveness of this wheelchair system is a noteworthy feature. Despite its advanced functionalities, it remains affordable and accessible. This affordability ensures that even resource-constrained healthcare facilities and individuals can benefit from its capabilities.

9.Conclusion

The finger-controlled wheelchair system we've developed represents a significant leap forward in assistive technology. It offers an intuitive and user-friendly approach to mobility, allowing individuals with limited movement capabilities to control the wheelchair through simple finger gestures, eliminating the need for traditional control methods like buttons or joysticks. This system is not just about convenience; it's about empowerment.

The system comes equipped with advanced features, including heart rate and temperature monitoring sensors, a wireless charger, and a buzzer for emergency assistance. These features not only enhance mobility but also contribute to safety and health monitoring, making it a valuable asset in medical settings for efficient patient transportation and continuous health assessment during transit.

Affordability is a key feature, ensuring that this technology can benefit a wide range of users, even in resource-constrained environments. The commitment to safety and adherence to standards are integral, ensuring that the system prioritizes the well-being and security of its users.

Looking ahead, the inclusion of enhancements such as an advanced health monitoring system and wireless charging capabilities will make this technology even more accessible and user-friendly. Our finger-controlled wheelchair system exemplifies the convergence of technology and healthcare, leaving a profound impact on society and redefining the mobility and independence of those who rely on such technologies.

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