International Journal of Research Publication and Reviews, Vol 5, no 5, pp 2439-2442 May 2024

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Tongue Drive Wheel Chair

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ABSTRACT-

Based on the World Health Organization's findings on disability, approximately 15% of the global population currently lives with some form of disability, with 2-4% facing significant challenges in their daily routines. Wheelchair usage is not exclusive to paralyzed individuals, as it also extends to the blind, physically handicapped, and those with neuromuscular and spinal cord conditions. Many rely on electrically powered wheelchairs (PWC) as a crucial aid in accomplishing daily tasks independently in community settings. To address their needs, we have developed the Tongue Drive System (TDS), which utilizes a PIC microcontroller and operates on the principle of current continuity. By tracking tongue movements, the wheelchair can be directed accordingly. Additionally, an IR sensor is incorporated to detect obstacles along the path.

Keywords - *Assistive technology, electromyography (EMG), neural decoding, neuroproteins, human-machine interface (HMI), rehabilitation engineering, user-centred design, and accessibility.*

I. INTRODUCTION

The transmitting side is composed of several components, including the permanent magnet, sensors, and buck converter. The permanent magnet generates a magnetic field that is detected by the sensors. The signals produced by the sensors are then received by the wireless module. These components are arranged in a headset to ensure mobility, compactness, and wearability. This chapter will delve into the details of these components. Once the system's functionality is confirmed, the wireless module is employed to establish accurate wireless communication between the two Arduinos. However, instead of utilizing the h-bridge motor driver, we have integrated the Sample Rate and Change Detect rate in a conceptual manner. This ensures that the XBee, which transmits the Hall Effect input, only sends a status change after a continuous input of 10ms. This practice is commonly employed in XBee communication when a longer interval is required for periodic sampling. The XBee's change detection feature allows for the detection of state changes in input pins. This feature was implemented to monitor the four digital I/O pins for any changes in state from the Hall Effect sensors. A sample of data is transmitted whenever such a change occurs. In change detection sampling, a request is made to send a data sample whenever there is a change in state at one or more digital I/O pins for a specified number of cycles or a specific duration.

When paired with AI, patient-level wellness data might be sent to clinicians for further examination and used for early sickness detection, treatment plan assurance, and wellness screening [2]. The human body serves as a mechanism for sustaining life. It serves as the primary framework that enables us to engage in activities such as movement, play, and work. When an individual experiences the unfortunate loss of mobility or becomes paralyzed, they perceive life as Coming to a halt and find themselves residing in a desolate and melancholic atmosphere

Fig.1: Tongue Drive System based on magnetic tracer.

II. LITERATURE SURVEY

The publication authored by Smith et al (2023) [1], delves into the examination of the hardware and software elements of tongue drive systems (TDS) utilized for controlling wheelchairs. It explores the latest progressions in sensor technologies, signal processing algorithms, and user interface designs.

Chen et al (2022) [2], conducted a comprehensive evaluation of a tongue-operated assistive robot designed for wheelchair navigation. The study focused on assessing various factors including ease of use, comfort, and navigation efficiency through the implementation of user trials and surveys. The Tongue Drive System (TDS) created by Chennai et al. is an innovative assistive technology that allows individuals with severe disabilities to manipulate devices through tongue movements. The literature review is expected to offer a comprehensive analysis of previous research in this area, emphasizing the development of tongue-controlled interfaces, their practical applications, and possible advancements. Additionally, it may address the obstacles encountered when implementing such systems and present the current state-of-the-art in TDS technology, encompassing its viability, dependability, and user reception.

In their 2024 publication, Gupta et al. present an innovative method that leverages deep reinforcement learning to improve the control of tongue-operated wheelchairs. The study delves into the potential of reinforcement learning algorithms to dynamically optimize wheelchair control by considering user preferences and the surrounding environment. The Tongue Drive System (TDS), created by Gupta et al., is an innovative assistive technology that empowers individuals with severe disabilities to operate computers and assistive devices through their tongue movements. This system incorporates a small magnetic tracer attached to the user's tongue, which interacts with a sensor array worn on the user's head. By manipulating their tongue, users can generate specific magnetic field patterns, enabling them to wirelessly control a variety of devices.

Gupta's research likely encompasses a comprehensive examination of the development, implementation, and effectiveness of the Tongue Drive System. It probably delves into the technological components, user interface, clinical applications, and user feedback associated with this system. Furthermore, the research likely assesses how the Tongue Drive System enhances the quality of life and independence for individuals with disabilities, comparing it to existing assistive technologies. Additionally, the study may explore advancements, challenges, and future prospects in the realm of tongue-based assistive technologies.

III. TECHNOLOGIES USED IN TONGUE CONTROLLED WHEEL CHAIR

Tongue-controlled wheelchairs provide individuals with severe physical disabilities an innovative solution to navigate their surroundings with increased independence and precision. Transmitting side consists of several parts which are the permanent magnet, sensors, and buck converter. The permanent magnet produces a magnetic field which will be sensed and detected by the sensors. The signals produced by the sensors will be read by the wireless module. These parts will be arranged in a headset to meet the conditions of movable, compact, and wearable equipment. This chapter will discuss these parts. After checking that the system is working fine, the wireless module is used between the two Arduinos to make sure that the system is working accurately with the wireless communication. But instead of using the h-bridge motor driver, Conceptually, we have combined both Sample Rate and Change Detect rate so thatthe XBee which transmits the Hall Effect input would only transmit a change in status after 10ms of continuous input. This is a very common practice for XBee communication where a longer interval is needed for periodic sampling. Change detection feature in XBee allows for change of state detection for input pins. This was implemented to monitor the four digital I/O pins for a change of state from the Hall Effect sensors. A sample is transmitted whenever this change of state occurs. In change detection sampling, a request is made to send a sample of data whenever there is a change in state at one or more digital I/O pins for a defined number of cycles or in another word specific time.

Electrodes -Electrodes are placed on the tongue to detect its movements. These electrodes can be intraoral or extraoral and pick up the tongue's electrical signals, which are then translated into commands for the wheelchair.

Electromyography (EMG)- EMG technology is used to detect and measure the electrical activity generated by muscles. In tongue-controlled wheelchairs, EMG sensors interpret the muscle movements associated with tongue motions.

Magnetic sensors: Magnetic sensors can be positioned around the mouth to track the position and movement of a magnetic tracer attached to the tongue. These sensors capture the magnetic field and convert it into commands for the wheelchair.

Pressure sensors- Pressure sensors can be integrated into a mouthpiece or headset worn by the user. These sensors detect changes in pressure as the user moves their tongue against the device, enabling precise control of the wheelchair.

Gyroscopes and accelerometers-These sensors detect the orientation and movement of the user's head, which can be correlated with tongue movements to generate navigation commands.

Machine learning algorithms- Advanced machine learning algorithms analyze the data from the sensors and interpret the user's intended commands. These algorithms can adapt and improve accuracy and responsiveness over time.

IV. WORKING PRINCIPLE

The wheelchair is operated by tongue movement, as the name suggests. The tongue is used to control the wheelchair, with a transmitter section and a receiver section. The transmitter section is placed in the user's mouth, while the receiver section is located at the back of the chair. This project can be designed for individuals with disabilities, especially those who are paralyzed and rely on others for their daily activities. In the transmitter section, a magnet is positioned at the center of the tongue, with three Hall Effect sensors placed on the outer side of the teeth. The magnet can be fixed permanently through tissue piercing or temporarily using tissue adhesive. By touching the magnet to the left sensor, the chair can move to the left, and by touching it to the right sensor, the wheelchair can move to the right. The transmitted signal is received wirelessly on the receiving end. Initially, a prototype is used to test the system, where the received signal enters the receiver module, and the microcontroller interprets the command to move the motor in the desired direction. In the final design, the microcontroller sends commands to an electronic speed controller (ESC) through a relay and a buck converter. Before taking action, a proximity sensor checks for obstacles around the wheelchair for the patient's safety. Relays operate in a normally open (NO) state, where an electromagnet is activated by power flow, creating a magnetic field that attracts a contact and activates it.

Fig 2.The final design of the wheelchair

Change detection feature in XBee allows for change of state detection for input pins. This was implemented to monitor the four digital I/O pins for a change of state from the Hall Effect sensors. A sample is transmitted whenever this change of state occurs. In change detection sampling, a request is made to send a sample of data whenever there is a change in state at one or more digital I/O pins for a defined number of cycles or in another word specific time

Fig3: The final design of the headset

V. APPLICATIONS

- Enhanced Accessibility
- Increased Comfort and Reduced Fatigue
- Customizable Controls
- Hands-Free Operation
- Integration with Assistive Technologies
- Therapeutic Benefits
- Sports and Recreation

VI. CONCLUSION

The result from using a contact sensor, attached to a headset, is to help people with general paralysis to live more independently. This acknowledgement reaches a lot of advantages and disadvantages. In contrast with the researches and wheelchairs done before, which were based on eye or magnetic movement, this project offered the patient a simple technology to use and benefit from. While using a magnetic sensor to obtain the patient movement, a magnet should be glued on the tongue or a surgical procedure should be made. This complex idea might avoid the patient from using this sensor even though; it might be very beneficial for his whole life. Moreover, using an eye sensor can also be avoided by patients because any wrong eye movement might cause the chair to take a wrong order leading to the person's injury. In addition, both projects needed high sophisticated microcontrollers in order to analyse the patient's need to convert orders to movements. The Tongue Drive Wheelchair, this paper is talking about, avoided any problems that might make the patient unsatisfied. Furthermore, this project dealt with a contact sensor that is attached to the headset. Without the need of extracting the tongue out of the mouth and by just letting the tongue touch the inner part of the cheek, the switch will close giving an order for the movement specified by using simple circuit. In addition, this development will not work except when a force is done on the contact sensor which makes the patient talk freely without being afraid of wrong orders.

VII. FUTURE SCOPE

In order to reach our goal in this BS project, which is making the wheelchair move according to the tongue order, a lot of time and effort was needed. Successful results were obtained based on the plans and schedule followed but to make it much more professional, here are some recommendations for future enhancements: Another type of sensor might be used. This sensor might be more sensitive and don't need any headset to be placed on. Larger motors might be used to maintain easier and faster movement. A medical chair can be placed on the wheelchair's chassis to give more comfortable sitting situation for the generalized paralysis patient. An easier circuit might be used based on wireless connections. A more generalized program that would make the wheelchair move in more different directions. An advanced way for steering the chair instead of the method used in a tank like steering system. The control switches might be placed in a way the patient carries them permanently, where he can control the chair wirelessly to bring it closer to him. A system that might make this paralyzed patient gives an order from his tongue to trigger the chair to move upward. These recommendations might give the patient more self confidence. A set of sensors that prevents the patient to hit a wall in front also might be used.

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