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Tongue Operated Robotic Wheel Chair Using Tongue Drive Assistive Technology

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Abstract

People with spinal cord injuries, quadriplegic patients, are living a very painful life. Their families and their friends are also suffering from taking continuous care of the patients. People involved in this situation want to find any assistive technology to relieve their endless pain. A basic instinctive of life, moving around is an evidence of what they are still alive. Quadriplegic patients also have the right to move and want to move at all costs. There are some technologies designed to help quadriplegic patients escape from immovable world. One of those technologies, TDS (Tongue drive system) technology needs a head mounted Tongue Drive Power Wheelchair Controller which is designed by users' needs. This project is to develop a new type of advanced head mounted Tongue Drive Power Wheelchair Controller design that is focusing on general design attributes such as aesthetics, human factor and universal design.

This device could revolutionize the field of assistive technologies by helping individuals with severe disabilities, such those with high level spinal cord injuries, return to rich, active, independent and productive lives. The TDS provides people with minimal or no movement ability in their upper limbs with an efficacious tool for computer access and environ mental control. Tongue drive system consist of a small permanent magnet secured on the tongue by implantation, piercing or tissue adhesive is used as a tracer, the movement of which is detected by an array of magnetic field sensors mounted on a headset outside the mouth or on orthodontic brace inside. The sensor output signals are wirelessly transmitted to an ultraportable computer carried on the user's clothing or wheelchair and are processed to extract the user's commands. The user can then use these commands to access a desktop computer, control a power wheelchair or interact with his or her environment.

I. INTRODUCTION

Assistive technologies are critical for people with severe disabilities to lead a self supportive independent life. Persons severely disabled as a result of causes ranging from traumatic brain and spinal cord injuries to stroke generally find it extremely difficult to carry out everyday tasks without continuous help. Assistive technologies that would help them communicate their intentionsand effectively control their environment, especially to operate a computer, would greatly improve the quality of life for this group of people and even may help them to be employed.

II. EXISTING SYSTEMS:

A large group of assistive devices are available that are controlled by switches. The switch integrated hand splint, sip and puff device, chin control system, and electromyography (EMG) switch are all switch based systems and provide the user with limited degrees of freedom.

A group of head-mounted assistive devices has been developed that emulate a computer mouse with head movements. Cursor movements in these devices are controlled by tracking an infrared beam emitted or reflected from a transmitter or reflector attached to the user's glasses, cap, or headband. Tilt sensors and video-based computer interfaces that can track a facial feature have also been implemented. One limitation of these devices is that only those people whose head movement is not inhibited may avail of the technology. Another limitation is that the user's head should always be in positions within the range of the device sensors. For example the controller may not be accessible when the user is lying in bed or not sitting in front of a computer.

Another category of computer access systems operate by tracking eye movements from corneal reflections and pupil position. Electro-oculographic (EOG) potential measurements have also been used for detecting the eye movements. A major limitation of these devices is that they affect the users' eyesight by requiring extra eye movements that can interfere with users' normal visual activities such as reading, writing, and watching.

The needs of persons with severe motor disabilities who cannot benefit from mechanical movements of any body organs are addressed by utilizing electric signals originated from brain waves or muscle twitches. Such brain computer interfaces (BCI), either invasive or noninvasive, have been the subject of major research activities. BCIs that operate based on electroencephalography (EEG) signals are very slow and limited in bandwidth. Implantable BCI technologies, on the other hand, are highly invasive (require a brain surgery) and heavily rely on signal processing and complex computational algorithms, which can results in delays and bulky systems that may also be very costly.

III. PROPOSED SYSTEM:

Tongue and mouth occupy an amount of motor cortex in the human brain that rivals that of the fingers and the hand. Therefore, they are inherently capable of sophisticated manipulation tasks. The tongue is connected to the brain via hypoglossal cranial nerve, which generally escapes severe damage in SCIs. The tongue muscle is similar to the heart muscle in that it does not fatigue easily . Finally, the tongue is noninvasively accessible, and is not influenced by the position of the rest of the body, which can be adjusted for maximum user comfort. The above reasons have resulted in development of a few tongue-operated ATs, such as the Tongue-Touch-Keypad (TTK), which have not been widely adopted because of placing bulky objects inside the mouth . There are also a number of mouth-operated joysticks such as Jouse2 and Integra Mouse , which can provide proportional control. However, they can only be used when the user is in a certain position and require head movement to grab the mouth joystick. They also require tongue and lip contact and pressure, which can cause fatigue and irritation over long-term usage.

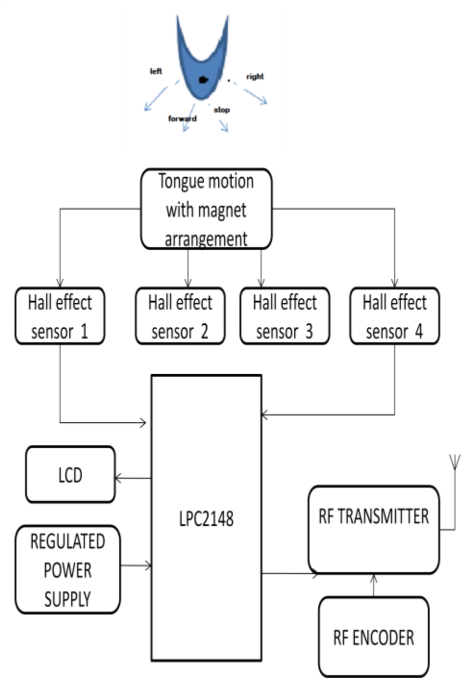


Figure1: Block Diagram for Transmitter Section

Tongue Drive system (TDS) is a noninvasive, unobtrusive, wireless, and easy to use tongue-operated AT that can potentially substitute some of the arm and hand functions, which are considered the highest priorities for individuals with severe disabilities, with tongue motion

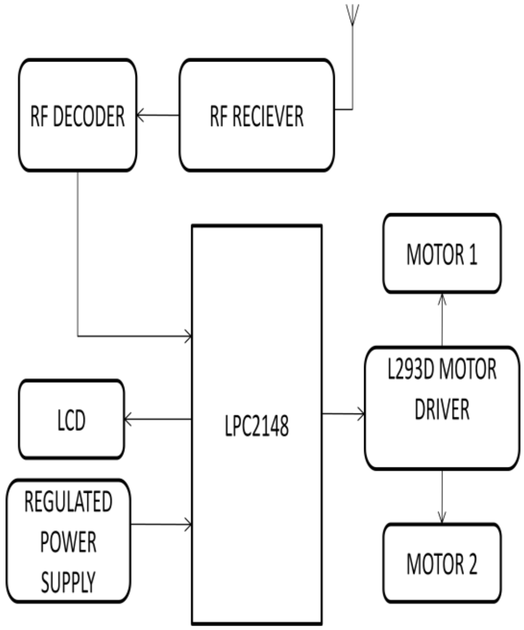


Figure 2: Block Diagram for Receiver Section

(a) Transmitter section:

The transmitter consists of the following parts like, LCD for displaying the activated Hall Effect Sensor, a led indication, an encoder like HT-640 and mainly the Transmitter TX. Four Hall Effect Sensors were used for generating the commands in order to control the wheel chair. Forward, Left, Right and Stop are the controlling directions for the wheel chair. Outputs from the sensors are fed to the microcontroller as inputs. The transmitting antenna has four connection pins like GND, V_{CC}, Antenna and Data. The GND pin is the ground connection for the transmitter, the Vcc should be given a 5V supply. Data and the Antenna pins will transmit the data in encoded format. Inputs from the user are given to LPC2148 controller and the corresponding command signal is transmitted through the transmitter section.

(b) Receiver Section:

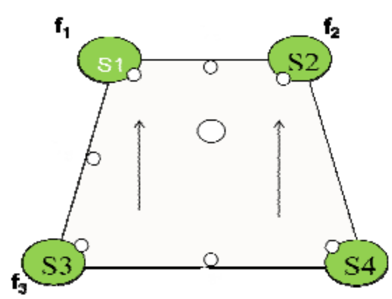
The receiver section consists of different modules like the microcontroller, serial interface, receiving section, LCD interface, decoder etc. The receiver section consists of a low power RF receiver possessing 8 pins whose operating frequency is between 315MHz to 434MHz. The section also includes a decoder, namely HT12D which will receive the data and decodes it and gives to the controller. Wheel chair direction is controlled by the commands which are received from the receiver section.

Working algorithm:

The algorithm for this project is very simple. A round robin algorithm that implement polling technique,the sensor values are always read one after the other in a continuous loop.There are few threshold values set for each sensor, if the actual reading from sensor reaches the threshold value then program triggers the change of state i.e. the operations on motion and direction of vehicle.

f1 - S1 > 750 // forward
f2 - S2 > 600 // turn left
f3 - S3 > 700 // turn right
f4 - S4 > 700 // stop

This is the actual alignment of the sensors and the permanent magnet around the mouth.The image is top view of the actual alignment.



S1 & S2 front sensor
S3 & S4 back sensors

The white circle in the middle is the resting position of the tongue implanted with small permanent magnet.

We have used different flag values in the algorithm for each sensor, if a sensor is high then the flag value of the particular sensor remain high until the operation is performed, then it is again reset

IV. RESULTS AND DISCUSSION

A tongue operated magnetic sensor based wireless assistive technology has been developed for people with severe disabilities to lead a self-supportive independent life enabling them to control their environment using their tongue. This technology works by tracking movements of permanent magnet, secured on the tongue, utilizing an array of linear Hall-effect sensors. The sensor outputs are a function of the position-dependent magnetic field generated by the permanent magnet. This allows a small array of sensors to capture a large number of tongue movements. Thus, providing quicker, smoother, and more convenient proportional control compared too many existing assistive technologies. Other advantages of the Tongue Drive system are being unobtrusive, low cost, minimally invasive, flexible, and easy to operate. A more advanced version with custom designed low-power electronics that entirely fit within the mouthpiece is currently under development.

CONCLUSION:

A tongue operated magnetic sensor based wireless assistive technology has been developed for people with severe disabilities to lead a self-support live independent life by enabling them to control their environment using their tongue. This technology works by tracking movements of a permanent magnet which is secured on the tongue, utilizing an array of hall effect sensors. The sensor outputs are a function of the position-dependent magnetic field generated by the permanent magnet. This allows a small array of sensors to capture a large number of tongue movements Thus, providing quicker, smoother, and more convenient proportional control compared to many existing assistive technologies.

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