Wheelchair Operated by Tongue Motion

Miss. Amrita Chavan[1] Miss. Bhagyashri Patil[2] Miss. Sayali Jadhav[3]
[1,2,3]B.E. Student
[1,2,3]Department of Electronics & Telecommunication Engineering
[1,2,3]Dr. Daulatrao Aher College of Engineering, Karad, Dist-Satara, Maharashtra, India

Abstract— Tongue driven system is a new wireless assistive technology which is used for handicapped or it is specially designed for paralyzed person. Tongue driven system consists of Hall Effect sensor. Tongue driven system provides people with minimal or no movement ability in their upper limbs with an efficious tool for environment controle.tongue driven system consists of an array of hall effect magnetic sensors and permanent magnet which is held on tongue using tissues adhesive and tongue piercing. as as a result of tongue movement magnetic field generated by magnet that will vary around the mouth. These variations are sensed by an array of magnetic sensor which is mounted on the headset outside the mouth. the sensors output are wirelessly transmitted to the microcontroller and microprocessor will process the signal to control the movement of power wheel chair. This technology provides faster advanced smoother and more convenient control.

Key words: Assistive Technology (AT), Hall Effect Sensors, Tongue Motion

I. INTRODUCTION

Tongue motion control wheel chair technology is critical for people with severe disabilities to a lead a self-supported independent life. The person who is parallised has effect on its spinal cord and brain so his body parts cannot work without taking continuosly helped of another. This assistive technology would help these parallised people for their environment, especially improved the quality of life for this group of people. This assistive technology is controlled by swithes. The types of switches are switch integrated hand splint blow-n-sunk (sip-n-puff) device chin control system and electromyography. The project consists of two microcontroller units wheel chair and hall effect sensor and wireless communication through RF. The device must be easy to learn and require minimum effort on the users time. The device should be small unabstractive, low cost and minimally invasive. [1]

A. A Tongue Operated Magnetic Sensor Based Technology

1) Use of Tongue for Manipulation:-

Since the tongue and mouth is the very sensible organs we can use here the tongue to operate wheel chair. So the tongue is capable of sophisticated motor control and manipulation tasks with many degrees of freedom. Tongue muscles are similar to heart muscles in that it does not fatigue easily. Tongue is not influenced by the position of the rest of the body which can be adjusted for maximum Comfort. Tongue is connected to the brain by cranial nerve which escapes severe damage in spinal cord injuries. Tongue can move very fastly and accurately within the mouth cavity. The tongue can function during random or during neurological activities such as muscular spasms etc.The above reasons have resulted in tongue driven assistive technology such tongue touch keypad(TTK)which is switch based.[2]

2) Tongue Driven System:

Hall effect sensor is the most popular assistive technology for controlling wheel chair. This study is the first to show that the wireless and wearable tongue drive system waveforms hall-effect sensor in controlling wheel chair. The tongue driven system is controlled by position of the user's tongue stud let's them use their tongue as a joystic to drive the wheel chair.[2]

Sensors in the tongue stud realy the tongue's position to a headset, which then excutes up to three commands based on the tongue position. The tongue driven system holds promise for patients who have lost the use of their arms and legs a condition known as tetraplegia or quadriplegia. The idea for piercing the tongue with the magnet was inspiration of Anne Laumann M.D.Processor of dermatology at Feinberg and a lead investigator of the north western trial. The tongue drive system is a novel technology that empowers people with disability to achieve maximum independence at home and in the community by ending them to drive a power wheel chair and control their environment in a smoother and more inductive way,"said north western co-lead investigator Elliot Ruth M.D,chair of physical medium. [3]

3) Tongue Drive System Advantages

For tongue drive system operation magnetic sensors provide signals. it is continuous position dependant property. but very few sensors are able to capture a wide variety of tongue movements. this system provide a advantages over switch based devices. the permanent magnet which generates the magnetic field is small, passive and inherently wireless component leading to user convince and additional power saving .tongue drive system is expected to be more robust against noise, interference and involuntary movements compared to alternative technologies [4]

II. PROTOTYPE SYSTEM

A. Mouthpiece

For tongue drive system various design system are available. The front two sensor outputs were used to control the cursor movements along the x direction and rear two movements along the y direction. The arrangement of sensors was very carefully at the carriers of a parallelogram as would be in real setting .a set of 3 wires are needed for supply and sensor output connections.[5]

B. Control Hardware and Wireless Link

The ADC and wireless link both are implemented by using crossbow Telos Research Platform. In this platform low power microcontroller including 8 channels ADC and IEEE 802.15.4 for transreceiver is used for transmission and reception\of digitized sensor array data.TPR2400 and TPR2420ca mote are used as either transmitter or receiver. The prototype system which placed in mouth only incorporates the hall sensors .These hall sensors are hard wired to the transmitter mode and powered by 4size AA battery pack which carried in a shirt pocket. The receiver mode which placed in the USB port of personal computer that runs tongue drive system software in LAB-VIEW. Open source TinyOS operating system runs the mots which are written in the Nesc language.

C. Software

An array of 4 ADC channels scans the transmitter mode in round-robin fashion. The data is transmitted wirelessly to the receiver which organized into packets. Radio to serial link programmed which running on the receiver motes sends the packets. We can write the code for TELOS-B/LAB-VIEW serial access resources. Before passed to the cursor control GUI code the packet data is deciphered to interrupt the sensor reading. The GUI has two modes of operation: 1] proximity detection mode (PD) 2] motion detection mode (MD).first see the proximity detection mode:

1) Proximity Detection Mode:

the sensor which is closer to the magnet control the cursor movement .if the sensor is in dead zone then for the resting operation of the tongue none of the sensors have control over the cursor. for example if the magnet is in the range of left sensor then chair moves to the left and if the magnet is in the range of right sensor then chair moves to the right.2] motion detection: for well operation the requirement is magnet to be in motion .system movement is depend upon magnet, in addition to its position relative to the sensor. We have kept the magnet steady for better control over the cursor movements. Motion detection which is performs by comparing the derivatives of each sensor movement to a threshold.

The system is divided into two sections:

a) Transmitter Section:

It includes three Hall Effect sensors (HS1, HS2, and HS3) microcontroller unit, RF transmitter and power supply while receiver section includes RF receiver, microcontroller unit dual full bridge driver power supply and dc motor namely left motor and right motor. Arrays of Hall Effect sensor are the two components of tongue driven wireless assistive technology. It translate users intension into control commands by using small permanent magnet held on the tongue using tissue adhesive and tongue piercing technique. According to the movement of the tongue of the user the magnetic field is generated inside or outside the mouth. Three Hall Effect sensors sense these variations which are placed as an array outside the mouth. Sensor will vary depending upon the strength. If the sensor output is analog first it is converted into digital. To convert from analog to digital ADC channel is used. The sensor output compared with the predefined threshold value and depending upon this it will check user has issued which command. As per the command microcontroller send particular character to the transmitter. Transmitter will transmit the encoded data wirelessly and receiver will receive this data then decode it and feed it to the microcontroller unit. To controlee the movement of wheelchair microcontroller is used. For the movements of wheels of wheelchair dc motor is used. Depending upon the input microcontroller provide predefined logic dual full bridge driver which is loaded in microcontroller by using embedded c program. To control the rotation of dc motor driver IC is used which is responsible for the movement of wheel chair left right and forward direction. five individual commands used in tongue drive wireless assistive technology that are simultaneously available to the user three directional command (LEFT,RIGHT,FRONT) and two selection command(Stand by and Active command).The left sensor is used to move the chair to the left and right sensor is used to move the chair to the right and front sensor is used to move the chair to the forward. To deactivate the system during eating and talking can switch the TDS from active to stand-by mode ,during which wheelchair remain still.

b) Wireless Control of Power Wheelchair

A] Human subjects:

For experiment six able bodies human subjects are participates. All this subjects are from Government College of Engineering Amravti, comprising of six male with ages from 20-26 years. The subjects are familiar with English subjects are willing to perform the task. These subjects had no former experience with other assistive technologies.

B] Experimental Procedure:

According to the prepared instructions during trials they are provided to the subjects and then strictly followed to ensure that each subject followed the same procedure. A permanent magnetic tracer was washed with detergent and tap water and dried and attached to the subject tongue, about 0.5cm from the tip, using denture adhesive. Adhesive means attaching the magnet for temporary purpose, if user wants to permanently attach it should pierce the magnet on the tongue. Subjects were allowed to familiarize themselves with the TDS technology and magnetic tracer on their tongue for approximately 10minites

C] Tongue drives system training:

Subject gives information about the tongue position in their mouth for each command. For achieve the best command definition the subjects were told to repeat this step three times once the subjects in familiar with command related to the tongue position, it is ready for training session every subjects has given 10 minutes for training and they have used all the commands controlled the wheel chair.

D] Task Related Operation:

During wheel chair trials subjects are required to drive the wheel chair with their tongue through the track. Approximates dimensions of the track with its start and stop point it includes total eight turns in the path. For perform various navigation tasks such as making a u-turn, move left or right, and forward in a limited space track was designed. The subjects were asked to navigate wheel chair from start point to stop point as fast as they can.

E] Experimental Result:

System performance successfully completed the given task. For analyzed the performance of the system completion time and navigation error are considered.

F] Completion Time:

During five sessions of experiment, the average completion time decreased from 52.33seconds in first session to 40.83seconds in fifth sessions. The improvement was faster from the first to the second session and however, while it slowed down from the second session to the last session. The statistic shows that as the subjects get familiarized with the system and response time of the subject decreases at the time of turns that makes navigate the wheel chair model faster.

G] Navigation error:

When subjects were not able to correctly issue to the command that they had intended, it had to issue another command to correct the previous one called as navigation error. The important point leading to navigation error was the timing of the command. For example, for performing a 90 right turn, subject could drive the PWC to a proper position and issue a turn right command at the right time to make a single sharp turn followed by forward when the rotation was closer to 90.

Now a day's many services accidents and injuries end with various motorics disabilities which results in a limited control of muscles of various disabilities. Here they can make the research to concentrate on the development of natural and effective associative HCI interface for mobility device for a paralyzed people. They are combined traditional input with speech and video recognition technologies on multimodal control package .The government support programs of him for providing independent life to the handicapped person. Due to limited capability of paralyzed people standard mobility devices such as typical manual and electrical wheelchairs naturally do not fit our targeted audience multimodal approach can overcome this problem. Depending upon level of paralysis the person can be able to move a finger he can able to speak, or in worst case he is able to move his eyes. The certain of multimodal control the interface which combine various input and output modalities looks like a responsible choice .When these interfaces combined with mobile technologies can have tremendous applications on usability, accessibility for people with wider variety of impairments.

State of art:

The integration of traditional input with speech and video recognition into one assistive control this project as speech is the most natural form of human many solutions are being developed based on speech recognition ranging from integral microchips to the appliance of fuzzy logic in case of unclear speech. But the speech recognition is not up to the human speech interpretation standards and work poorely.So the combination with other control modalities such as video recognition technique is most important factor in multimodal system design.fig lip contour extraction is another or second useful technique for obtaining a multishape in an image.

Multimodal Wheelchair Control Algorithm For Handicapped Or Paralyzed Person.

Now the many researches are developing the interfaces for semi-disabled people while we target the fully and practically paralyzed which integrates various types of inputs and output into one modular control package where all the modalities are enabled /disabled based on person's needs. At the current stage they are concentrating on the main three control modalities.

1] A speech recognizing predefined list of Lithuanian voice commands.

2] An eye tracking system which is capable of tracking the movement of eye pupil.

3] A special"cursor"centric touch recognition system which is capable of detecting the finger direction and tongue movement on the surface of sensor.

They can develop the simple algorithm for controlling the wheelchair. At beginning a user inputs some control commands. Depending upon his abilities a user can use more than one input modality. In this case primary input is chosen based on present. Then it is sent to the appropriate processing block. If traditional input is present they can introduce security solution as a safety feature. A person has to lift his tongue after each swipe. If he does not lift his tongue, the command is rejected and he is asked to repeal. To enable or disable additional modalities an easy option is also offered to user. By touching left or upward sides of the input pad a user may enable speech recognition or eye tracking. For safety purpose they can disable the additional modalities.

In case of speech recognition and eye tracking, the confidence measures of altered voice command .If the gaze recognition is compared to a model and it is high then system issues a command to a wheel chair motor. If the accuracy of recognition is low the user is asked to repeat the input.

Implementation:-

For the technical implementation of mobility device they have choose a modulator architecture .Wheelchair itself is a standard issued wheelchair in which consist of added gears, dual motor cone for each wheel, automation controller block and set of I/O modules. At a current stage all type of processing operations are done on a network PC.

Here they can choose the touch input for traditional input and this principle is compatible with most touch input device like smartphone, computer touchpad,touchscreen which is capable of detecting the direction of pointer (tongue or finger).For safety purpose the system does not react to a user input if tongue is kept touched down continuously. This type of software allows us for enabling the other two modalities. Modalities if it is able to use them.

The voice command recognizer which is capable of recognizing simple phroses for example direction commands, such as "(vaziuok) plrmyo, (vaziuok) atgal (the words in brackets are optimal) was implemented to control the wheelchair.

The video recognition was realized under the ANN based software for enabling the device to turn left or right, move forwarded backward based on movement of eye pupil.

Conclusion and future work:-

The traditional input which was combined with voice recognition capabilities and eye tracking into one associative interface. Then this is aimed at control of mobility device for fully and partly paralyzed people which creates very intuitive HCI interface.

The solution for this problem is not universal-every disabled person is very different: some might be unable to stick to a predefined control scheme, some might be psyctdogical fear of techmtoy,future experiment can be done, trying to determines and overcome different issues for performing the device in various environmental conditions.

[3]Wireless tongue-operated assistive technology

A] Design and Implementation:

1) SOC Design

The TDS system consist of 3 axis magnetometers(HMC 1043,Honeywell,Golden valley,MN,USA) for measuring the magnetic field generated by the magnetic tracer on the tongue and FPGA generating digital control signal and a system-on-a-chip (SOC) that amplifies, filters ,digitizes ,and wireless easily transmits the sensor data. In that TOU-UI receives the row magnetic sensor data from the input Tongue driven system which processes the data and classifies it into user-defined commands which delivered into target devices, such as a computer or a powered wheelchair. Another current-feedback instrumentation amplifier (CFIA) is followed by pesduo RC low pass filter and a differential amplifier. But current-feedback instrumentation amplifier (CFIA) is equipped with offset can solutij, an auto-zeroing scheme and correlation current that is applied accordingly to balance the current –feedback instrumentation amplifier (CFIA) up to the next readout. In that 21MHz off-chip ceramic is generated by an internal oscillator circuit that has a 27MHz off-chip ceramic crystal and the 423MHz is generated by nine voltage-controlled delay cells in a dual loop DLL that has a 48MHz off-chip ceramic crystal mainly the class-c power amplifier generates on-off–keying(ook) outputs at 27MHz,while the edge combiner operates as a nonlinear amplifier to generate ook or FSK outputs at 432MHz.power management consist of voltage regulator, data telementry,and battery charging circuits. The data telemetry block has advantage like bidirectional capability, forward data telemetry consist of data and clock recovery circuits, while back telemetry consist of a load-shift-keying (LSK) mechanism built in the MCU, on-chip 13 bit SAR ADC and it employs noise shaping and foreground digital calibration schemes to decrease the digitization noise by pushing it out into a higher frequency band and to minimize the effect of capacitor mismatch, respectively. The SR-RX was added to reduce the limitation of the one directional communication and to improve the system robutnem.Here SR-RX incorporates a digitally-assigned self-quenching architecture, which reduces the power consumption by turning off the oscillation following each bit. The biggest advantage of the digitally-assigned self-quenching architecture is the reduced quench period which can increase the maximum data rate.

[4] Multimodal wheelchair control for paralyzed person

A] RELATED WORK:

The magnet which is placed on tongue create magnetic field and motion of tongue is traced by an array of magnetic sensors. The size of magnet is small just like grain of rice which embedded in a biocompatible material such as titanium and attached to the tongue through piercing, implementation or adhesion .the magnetic sensor mounted on teeth with the help of clips(internal TDS)or on headset(external TDS)positioned near the cheeks. It is noticed that majority of paralytic people are able to move their tongue. Sensor outputs are amplified, multiplexed, digitized and transmitted wirelessly to an external controller unit. Signals received by the external controller unit are processed to indicate the motion of the permanent magnet and consequently the tongue position within the oral cavity. Persons who severely disabled as a result of causing ranging from traumatic brain and spinal cord injuries find it extremely difficult to carry out everyday tasks without continuous help. The system purpose is to assign a certain control function to each particular tongue movement in software and customize the system for each individual user.

B] Proposed system:

The tongue drive systems mainly consist of encoder circuit and decoder circuit. Encoder circuit placed in the transmitter section and decoder circuit placed in receiver section of circuit. To place the magnet on tongue of the patient this method called ZIP surgery can be used or simply an elastic adhesive can be used .here four reed relays are used. Each reed relays carry one message as per programmed. At first reed relays are inactive .they will perform their work or get active when patient will move his tongue towards a particular reed relay. Ferromagnetic blades of reed relay will get connected because of magnet which is placed on tongue and thus signal will be transferred to encoder IC .then encoder signal is send to receiver section and decode signal and given to output object that chair. This system will provide great social impact as this project will reduce the stress of family members of paralytic person as well as it will reduce the time to be spent with such a person.

[5]Tongue motion control wheelchair

The magnet output is given to the Hall Effect sensor module. The Hall Effect sensor converts the magnetic field into electrical energy. Hall Effect sensor does not affect due to any external environment conditions. It does not suffer from a contact bounce, there is isolation between magnet and Hall Effect sensor it consisting of a material such as gallium arsenide, indium arsenide. The Hall Effect sensor has four bit output. As tongue is move to the left sensor it goes from high to low. At that time right sensor and front sensor output remains high. This code is transmitted to the encoder. The output of a Hall Effect sensor connected to the encoder. Encoders convert the parallel data into serial. It is from CMOS LSI series. It also receives 8 bit address from DIP pin output of this connected to RF transmitter.RF transmitter has a frequency of 434MHz.Operating range 0f RF transmitter is 100m in open area and 30m in built up area.

RF receiver receives the data from transmitter output of this is given to the decoder. Decoder 8 bit address is checked with local address and if it is matched then it converts the serial to parallel. The output of decoder is given to the microcontroller 89C51.Microcontroller outputs are given to the buzzer motor and motor driver

III. Conclusion

A tongue operated magnetic sensor based wireless assistive technology has been developed for people with severe disabilities to lead a self -supportive independent life by enabling them to control their environment using their tongue. The sensor outputs are a function of the position-dependent magnetic field generated by the Hall Effect sensor.

References

[1] Christopher and Dana Reeve Foundation [Internet]. Short Hills (NJ): The Association; c2008. Areas of research; [about 5 screens]. Available from: http://www.christopherreeve. org/site/c.geIMLPOpGjF/b.1034087/k.A619/Areas_of_ Research.htm

[2] National Spinal Cord Injury Statistical Center [Internet]. Birmingham (AL): University of Alabama at Birmingham Department of Physical Medicine and Rehabilitation; c2008. Facts and figures at a glance, January 2008; [about 6 screens]. Available from: http://www.spinalcord.uab.edu/show.asp?durki=116979 &site=1021&return=19775

[3] National Institute of Neurological Disorders and Stroke [Internet]. Bethesda (MD): National Institutes of Health; c2008 [updated 2008 Jul 24]. Spinal cord injury: Hope through research; [about 38 screens]. Available from: http:// www.ninds.nih.gov/disorders/sci/detail_sci.htm

[4] Bilmes JA Malkin J, Li X, Harada S, Kilanski K, Kirchhoff K, Wright R, Subramanya A, Landay JA, Dowden P, Chizeck H. The vocal joystick. In: Proceedings of the IEEE International Conference on Acoustics, Speech, and Signal Processing; 2006; Toulouse, France. New York (NY): IEEE. p. 625–28.

[5] Chen YL, Tang FT, Chang WH, Wong MK, Shih YY, Kuo TS. The new design of an infrared-controlled human-computer interface for the disabled. IEEE Trans Rehabil Eng. 1999; 7(4):474–81. [PMID: 10609635]

[6] Hutchinson T, White KP Jr, Martin WN, Reichert KC, Frey LA. Human-computer interaction using eye-gaze input. IEEE Trans Syst Man Cybern. 1989; 19(6):1527–34.

[7] Law CK, Leung MY, Xu Y, Tso SK. A cap as interface for wheelchair control. In: Proceedings of the 2002 IEEE/RSJ International Conference on Intelligent Robots and Systems; 2002 Oct; Laussanne, Switzerland. New York (NY): IEEE. p. 1439–44.

[8] Barea R, Boquete L, Mazo M, Lopez E. System for assisted mobility using eye movements based on electrooculography. IEEE Trans Neural Syst Rehabil Eng. 2002;10(4):209–18. [PMID: 12611358]

[9] 9] Moore MM. Real-world applications for brain-computer

[10] interface technology. IEEE Trans Neural Syst Rehabil Eng.

[11] 2003;11(2):162–65. [PMID: 12899263]

[12] 10] Cook AM, Hussey SM. Assistive technologies: Principles and practice. 2nd ed. St. Louis (MO): Mosby; 2002.

[13] 11] Wolpaw JR, Birbaumer N, McFarland DJ, Pfurtscheller G,Vaughan TM. Brain-computer interfaces for communication and control. Clin Neurophysiol. 2002;113(6):767–91.[PMID: 12048038]

[14] 12] Kennedy P, Andreasen D, Ehirim P, King B, Kirby T, MaoH, Moore M. Using human extra-cortical local field potentials to control a switch. J Neural Eng. 2004;1(2):72–77.[PMID: 15876625]

[15] 13] Kennedy PR, Kirby MT, Moore MM, King B, Mallory A. Computer control using human intracortical local field

[16] potentials. IEEE Trans Neural Syst Rehabil Eng. 2004;12(3): 339–44. [PMID: 15473196]

[17] 14] Hochberg LR, Serruya MD, Friehs GM, Mukand JA, Saleh M, Caplan AH, Branner A, Chen D, Penn RD, Donoghue JP. Neuronal ensemble control of prosthetic devices by a human with tetraplegia. Nature. 2006;442(7099):164–71. [PMID: 16838014]

[18] 15] Hochberg LR, Donoghue JP. Sensors for brain-computer interfaces. IEEE Eng Med Biol Mag. 2006;25(5):32–38. [PMID: 17020197]

[19] 16] Kandel ER, Schwartz JH, Jessell TM. Principles of neural science. 4th ed. New York (NY): McGraw-Hill; 2000.

[20] 17] Lau C, O'Leary S. Comparison of computer interface

[21] devices for persons with severe physical disabilities. Am J

[22] Occup Ther. 1993;47(11):1022–30. [PMID: 8279497]

[23] 18] Salem C, Zhai S. An isometric tongue pointing device. In: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems; 1997 Mar 22–27; Atlanta, Georgia. New York (NY): Association for Computing Machinery; 1997. p. 22–27.

[24] 19] Anderson KD. Targeting recovery: Priorities of the spinalcord-injured population. J Neurotrauma. 2004;21(10):1371–83. [PMID: 15672628]

[25] 20] Huo X, Wang J, Ghovanloo M. A magnetic wireless tonguecomputer Interface. In: Proceedings of the 3rd International IEEE/EMBS Conference on Neural Engineering; 2007 May 2–5; Kohala Coast, Hawaii. New York (NY): IEEE; 2007. p. 322–26.

[26] 21] Krishnamurthy G, Ghovanloo M. Tongue drive: A tongue operated magnetic sensor based wireless assistive technology for people with severe disabilities. In: Proceedings of the 2006 IEEE International Symposium on Circuits and Systems; 2006 May 21–24; Kos, Greece. New York (NY): IEEE; 2006. p. 5551–54.Huo X, Wang J, Ghovanloo M. Use of tongue movements as a substitute for arm and hand functions in people with severe disabilities. In: Proceedings of the RESNA 2007 Annual Conference; 2007 Jun 16–19; Phoenix, Arizona. Arlington (VA): RESNA; 2007.

[27] 22] Cohen A. Biomedical signal processing. Vol. 2. Boca

[28] Raton (FL): CRC Press; 1988. p. 63–75.

[29] 23] Duda RO, Hart PE, Stork DG. Pattern classification. 2nd ed. New York (NY): Wiley; 2001. p. 174–87.

[30] 24] Struijk LN. An inductive tongue computer interface for control of computers and assistive devices. IEEE Trans