Tongue driven wireless assistance technology for wheelchair movement

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Abstract: *Persons with severe disabilities as a result of spinal cord injuries and quadriplegia find it extremely difficult to carry out their daily work independently. These individuals completely depend on wheeled mobility for transportation in and out of their homes. The main principle behind the project is to help these people. It intends in the usage of unconstrained motion of tongue as its movements are fast and do not require much of thinking concentration or effort. Tongue being hidden inside mouth will give a high degree of privacy and is directly connected to brain. The key components of the project are three Hall-Effect sensors, a permanent magnet, microcontroller ATmega328, RF module, Encoder HT12E, Decoder HT12D, H-bridge driver, DC motor. A tiny permanent magnet is secured on the tongue and three Hall-Effect sensors are placed on the monkey cap, outside the mouth. Three Hall-Effect sensors are used for three directions of wheelchair motion i.e, left, right and forward. When a magnet is brought near any one of the sensor, the corresponding movement of wheelchair takes place. The sensor generates an analog signal which will be digitalized using ADC. Digitalized data is sent to encoder and then to RF transmitter. Transmitter section, which consists of encoder and RF transmitter, is placed on neck of the paralysed person. The signal is sent wirelessly, which is received by the RF receiver. Then it is decoded and sent to microcontroller. Microcontroller is programmed to drive a motor in a particular direction. Since the output of microcontroller is not enough to run the motor, H-bridge driver is used to drive the motor. Receiver section consisting of RF receiver, decoder, microcontroller and H-bridge driver is kept beneath the wheelchair. This device helps the individuals to become independent and lead productive lives.*

Keywords — *Hall effect Sensor, RFID module, wheelchair*

I. Introduction

Spinal cord injuries, traumatic brain injuries or a stroke will result in severe disabilities in humans due to which they find it difficult to carry out their day to day activities without others aid. Such victims are completely depend on wheel movement to accomplish their tasks, of which most of them use electrically powered wheelchair. Unfortunately, it is required to operate joystick to programme the powered wheelchairs, which eventually requires high level of physical movement ability, which may not be possible for people with severe disabilities. So there is need to develop a system which is simpler, easy to learn, small in size, require minimum effort and of low cost. This has led to the development of an efficient assistive technology called Tongue Driven System (TDS).

Tongue driven system is a wireless assistive technology which is an unobtrusive, can provide good access to the people with severe disabilities and effective environment control. Assistive technology refers to any item or piece of equipment or system that is commonly used to maintain or improve functional capabilities of individual with disabilities. Assistive technology encompasses enormous range of devices, including mobility aids, augmentative communication devices, prosthetic and orthotic devices and a myriad of adaptive computer equipment. Assistive technology can be "low-tech" or "high-tech". The high cost of assistive technology compounds the problem of finding an appropriate assistive technology device.

In this technology, user's requirement is translated into control signals by detecting, categorising the voluntary motion of the tongue using a small permanent magnet fixed on a tongue, and a row of magnetic sensors placed near the jaws. Interface circuitry has been designed and three control strategies to drive the wheelchair with the help of a prototype had been implemented. The magnetic sensors used here are Hall-Effect sensors. Hall-Effect sensor is a transducer, which changes its output voltage in accordance with the variations in the magnetic field. In simple terms, this sensor operates as an analogue transducer sending back a voltage value. The proposed design consists of microcontroller unit, wheelchair, RF module that is the encoder and decoder, three Hall-Effect sensors, DC motors and H-bridge driver to rotate the motor. The wheelchair used here operates with the help of high torque geared DC motors, the directions of the motor are changed according to the instructions provided through the Hall-Effect sensors and the action of these instructions are pre-loaded in the software section.

II. LITERATURE SURVEY

Sip-and-Puff (SNP) is assistive technology used to send signals to a device using air pressure by "sipping" or inhaling and "puffing" or exhaling on a wand. The system is used for a variety of purposes, ranging from basic wheelchair commands to sports, like hunting. People who do not have the use of their hands primarily use it. It is commonly used to control a motorized wheelchair by quadriplegics with a very high injury to their spinal cord [1]. The main problem with this system is, it is designed to respond to hard and soft puffs and sips, and for individuals that have problems controlling their breathing, achieving the hard puffs or sips with consistency can be difficult. Another alternative is powering the chair through speech or humming. The main problem with this method is that many people have difficulty with speech recognition software in general, because speech recognition varies due to many documented reasons including: accent, pronunciation, articulation, roughness, nasality, pitch, volume, and speed. Furthermore, a background noise, echoes, and electrical characteristics that cannot always be recognized and filtered out by the system [2] distort speech. The humming recognition attempts to compensate for the lack of accuracy in the speech recognition but limits the quantity of commands the system can be programmed for [3].

The Head or chin-controlled system is another assistive technology, which requires constant pressure to be applied to the sensor. The sensor is either a ball placed near the chin or a pad placed at the lower back of the head [4]. In head control devices, switches are mounted in the headrest and activated by head movements. Ideally the system has six commands: mode, power, and the four directional controls. By being in proximity to the switch in the centre pad, the patient moves the wheelchair forward. Activating the side pads moves the chair in the corresponding direction.

A reset switch toggles between the forward and reverse functions [5]. Some new head controllers can detect the position and movement of the head using ultrasonic transducers or RF, and translate those movements into proportional control of the wheelchair. This system is designed for a user with good head control [6]. A major problem with this mode of control is the need for constant pressure. Another problem with this system is the lack of stability. This system is not meant for people with decreased control of the neck or abdomen.

III. METHODOLOGY

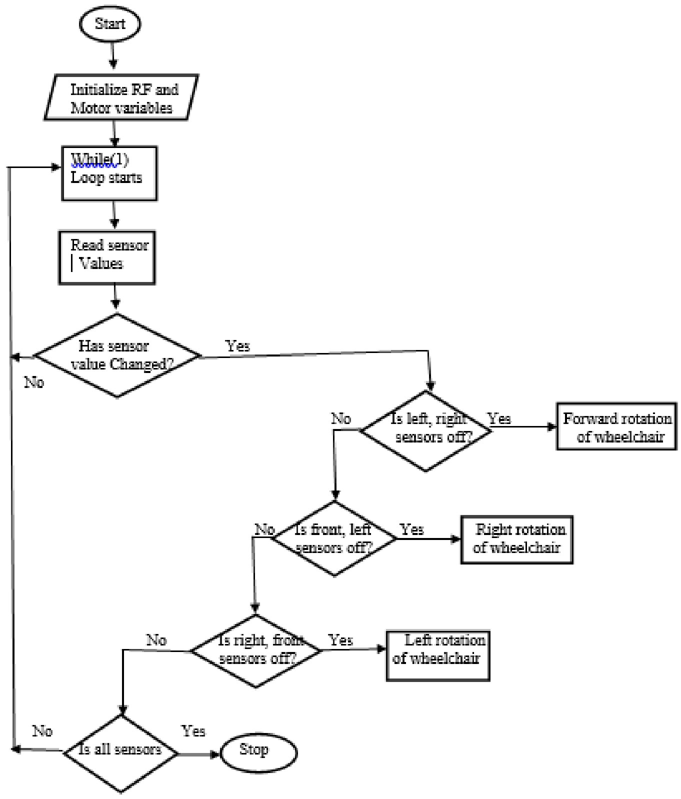

Fig.1: Flowchart of the proposed system

According to the algorithm when any two of the sensors left and right are off, the wheelchair moves in the forward direction. When left and front sensors are off, the wheelchair moves in the right direction. When the right and front sensors are off, the wheelchair moves in the left direction. When there is no magnet near the sensors in other words when all the sensors are off, there is no movement of the wheelchair. The flowchart of this system is shown in fig.1.

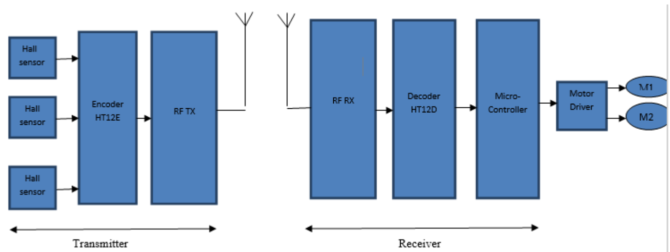

Fig.2: Block diagram

The block diagram is shown in fig.4.2. Transmitter section consists of three Hall-Effect sensors, Encoder HT12E, RF transmitter. Three Hall-Effect sensors will be placed on monkey cap. The board consisting of Encoder and RF transmitter along with voltage regulator will be placed on neck of the paralysed person. Receiver section consists of RF receiver, Decoder HT12D, Microcontroller, H-Bridge driver and dc motors. This whole section will be placed beneath the wheelchair.

The main objective of the system is to make the paralysed person independent for their wheelchair movement. In proposed system, wheelchair should move according to the tongue movement i,e, if tongue moves in left direction, the wheelchair should also move in left direction. Same principle applies for forward and right movement of wheelchair.

IV. RESULTS AND DISCUSSION

This project is developed for the people who are suffering from spinal cord injuries and quadriplegia since they are paralyzed. They must be able to carry out their day-to-day work independently. In this project, the designed wheelchair enables the paralysed person to move freely in and out of the homes. Out of three magnetic sensors, when a magnet is placed near one of the sensor, the corresponding movement of the wheelchair take place i.e, left, right and front.

Initially, when magnet is not placed near any of the sensor, wheelchair will not have any movement. Once the connection is established with the help of ARDUINO software and when the magnet is placed near any one of the sensor, out of three sensors the magnetic field is generated. The generated magnetic field is an analog signal and is converted in to digital signal and transmitted to the receiver. The microcontroller is used to drive the motor. When the motor rotates, the wheelchair starts moving to the required direction. Here movement of the wheelchair is controlled by using the magnet.

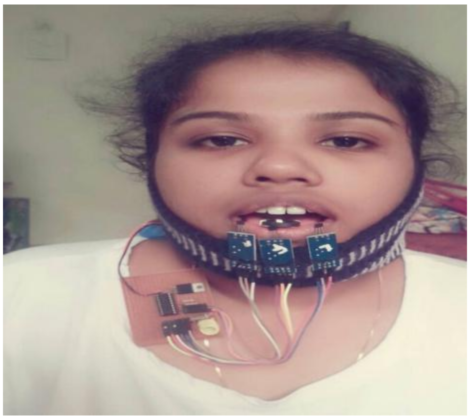

Fig.3:System setup of transmitter part

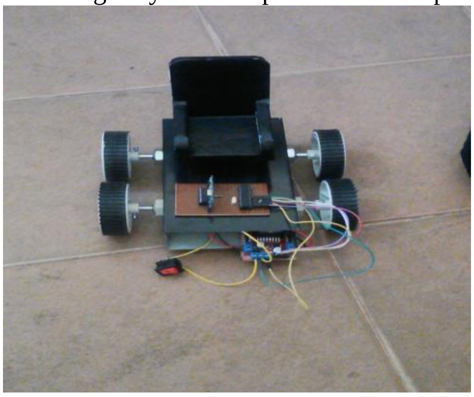

Fig 4: Wheel chair design

V. CONCLUSIONS

This system "Tongue Drive Assistive Technology for paralysed persons" is mainly intended to design a wheelchair which can be controlled by movement of tongue, which is very useful for handicapped and paralysed persons. This system consists of Hall Effect sensors and a wheelchair interfaced to microcontroller. This technology works by tracking the movements of a 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 to many existing assistive technologies. Other advantages of the Tongue Drive system are being unobtrusive, low cost, minimally invasive, flexible, and easy to operate. This device could revolutionize the field of assistive technologies by helping individuals with severe disabilities such as those with severe high level spinal cord injuries return to rich, active, independent and productive lives. Also this Hall Effect sensor can be used to control different devices based on the movement of the tongue. For example, home appliances like fan, TV can be controlled by paralysed person on his own. Thus this model helps severely paralysed person in reducing his/her dependency on others.

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