Tongue Driven System

Shankar Menon, Akhil Nambiar, Anjali Pariyarathu, Krishnamoorthy.M.

***Abstract*— The "tongue drive system" is a tongue-operated assistive technology developed for people with severe disability to control their environment. The tongue is considered an excellent appendage in severely disabled people for operating an assistive device. Tongue Drive consists of an array of Hall-effect magnetic sensors to measure the magnetic field generated by a small permanent magnet secured on the tongue. The sensor signals are transmitted across a wireless link and processed to control the movements of a cursor on a computer screen or to operate a powered wheelchair, a phone, or other equipments. The principal advantage of this technology is the possibility of capturing a large variety of tongue movements by processing a combination of sensor outputs. This would provide the user with a smooth proportional control as opposed to a switch based on/off control that is the basis of most existing technologies.**

***Index Terms*—Tongue drive system, Wheel chair and Hall Effect sensor**

I. INTRODUCTION

Tongue Drive system (TDS) is a tongue-operated unobtrusive assistive technology, which can potentially provide people with severe disabilities with effective access and environment control. It translates user's intentions in to control commands by detecting and classifying their voluntary tongue motion utilizing a small permanent magnet, secured on the tongue, and an array of magnetic sensors mounted on a headset outside the mouth or an orthodontic brace inside. Persons with severe disabilities as a result of causes ranging from traumatic brain and spinal cord injuries to amyotrophic lateral sclerosis and stroke generally find it extremely difficult to carry out daily tasks without receiving continuous help. These individuals are completely dependent on wheeled mobility for transportation inside and out of their homes. Many of them use electrically powered wheelchairs (PWC) that are the most helpful tools allowing individuals to complete daily tasks with greater independence, and to access school, work, and community environments. Unfortunately, the default method for controlling PWCs is by operating a joystick, which requires a certain level of physical movement ability, which may not exist in people with severe disabilities.

The Tongue Drive Assistive technology for paralyzed persons using MSP430 Microcontrollers is an exclusive project that can move the wheel chair according to the instructions given by the above said microcontroller. This Project consists of a Microcontroller Units, Wheel chair and Hall Effect sensor. Wheel chair is made up of High torque Geared DC Motors, the Motors Directions can be changed through the set of instructions given from the Hall Effect sensor and the action of these Instructions is already loaded into the Microcontroller using Embedded C programming.[1]&[2]

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Shankar Menon,BE Student,Department of Electronic and Telecommunication, SIES Graduate School of Technology,Nerul, Navi Mumbai 400706, India.
Akhil Nambiar,BE Student,Department of Electronic and Telecommunication,SIES Graduate School of Technology,Nerul, Navi Mumbai 400706, India.
Anjali Pariyarathu,BE Student,Department of Electronic and Telecommunication,SIES Graduate School of Technology,Nerul, Navi Mumbai 400706, India.
Kishnamurthy.M., BE Student,Department of Electronic and Telecommunication,SIES Graduate School of Technology,Nerul, Navi Mumbai 400706, India.

II. NEED AND SCOPE OF THE PROJECT

A. EXISTING POWERED WHEEL CHAIRED TECHNOLOGY

In the market the types of wheel chair available are Joystick controlled, head pad controlled, sip and puff. Speech recognition controlled wheelchair is also available. Each of this wheel chair is driven by different driving factors and each of them has a disadvantage in itself.

FIG.1. SIP AND PUFF TECHNOLOGY

FIG. 2. JOYSTICK CONTROLLED WHEELCHAIR

In the sip and puff controlled wheel chair, to drive the motorized wheelchair, the person on the wheel chair must make a sucking sound or exhale quickly. His "sip-and-puff" chair responds to four commands he delivers with his breath. But the commands aren't intuitive, and the straw that relays his orders needs regular cleaning and sits in front of his mouth. The speech recognition controlled wheelchair recognises the speech of the person but it has a disadvantage it can hinder with the speech of the person in the day to day activities. It also proves to be a disadvantage to those who have speech related problems. Joy stick controlled wheelchair proves to be useless to those who can't even move their hands or fingers. Head pad controlled wheelchair has many advantages as compared to other wheelchair technologies except for the fact that it is stressful for a spine-related injured person to move his head back and forth for directing the wheelchair. Thus a wheelchair technology needs to be developed that is simple, easy to command and flexible compared to other technology. The tongue-directed wheelchair is easier to manipulate and allows for faster driving than the sip-and-puff version. A headset interprets the movements of a magnet embedded in his tongue (like the tongue piercings some people get) and relays them to a program on his cell phone, which drives the wheelchair forward or back, right or left. A noticeable advantage of tongue drive system is it that it can be used to interface many other devices. If someone who uses a sip-and-puff system wants to control a computer mouse from bed, they can't use the one on their wheelchair, but they could with this new system.The other key advantage of the tongue system is that it's all but invisible. This had shrunk the technology down so it now will fit inside a dental retainer that the patient can wear inside his or her mouth. Tongue Drive System is another step toward bringing power wheelchairs into the next century.

B. WHY TONGUE ?

Tongue and mouth occupy that part of the sensory and motor cortex of the brain which is different from that of hands and fingers. Tongue is connected to the brain by hypoglossal nerve, which is not affected by the spinal cord injuries. The big advantage that tongue has over other body parts is flexibility and freedom, which enables it to move faster and also, can attain different position as our tongue can touch every single tooth in our mouth. Thus this makes tongue a unique solution to all the wheelchair controlling problems. Henceforth tongue drive system can be considered as a solution to all those problems faced by the people, who had suffered severe spinal cord injuries, thus helping them to cope up with day to day activities.[7]&[8]

#The project has been implemented on a LEVEL 1 BOT

III. WORKING AND IMPLMENTATION.

A. PRINCIPLE OF THE PROJECT.

The main principle behind the working of this project is Hall Effect. The Hall Effect is the production of a voltage difference (the Hall Voltage) across an electrical conductor, transverse to an electric current in the conductor and a magnetic field perpendicular to the current. In this project we make use of Hall Effect sensors which is a transducer that varies its output voltage in response to the change in the magnetic field. Depending on the change in the position of the magnet affixed on the tongue there is a voltage change in the output of sensor values, which determines the motion of the tongue and also varied directional control can be achieved by means of increased no of sensors, thus achieving maximum directionality and control over the wheelchair[5].

B. BLOCK DIAGRAM

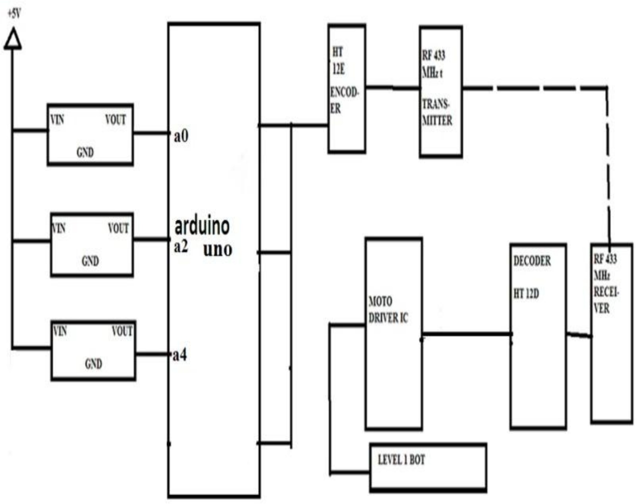

FIG.3. BASIC CONNECTIONS

The block diagram consists of 4 Hall Effect sensors that are placed outside the mouth, 4 ADC channels of arduino mega are used to convert the analog signals from sensor to digital values for processing. The arduino mega microcontroller is the main processing unit and based on the processing information microcontroller drives the driver IC which in turn drives the DC powered wheel chair.[6]

C. POWER SUPPLY

The power supply is the integral part of any project. Lack of supply of the board would damage all the components or may not work properly. We are using a 12mv battery with 700mA of current for power supply to the motherboard. As different devices work at different voltages we have used some regulator IC and filters for regulating the power supply to each component.LM78M05 is used to regulate the power supply to 5V for all sensors and L1117 is used to regulate a power supply of 3.3 volt supplied to msp430 microcontroller.[5]&[6]

D. SENSORS

The sensors used in the project are A1321 Linear Hall Effect sensors. The Sensors can detect the North Pole and South Pole of the magnet. The output of the sensor is an analog voltage that ranges from 0-5volts; it is read and converted into a digital value by ADC of the arduino microcontroller. The sensor value gives an output of Vcc/2 when no magnetic field is in the range of sensors, i.e. the sensors that requires 5 volt will give an initial sensor value output of 2.5 volt. Now the North Pole and south pole of the magnet have an effect on the sensor output as the North Pole approaches the sensor there is an increase in the sensor output, it rises from 2.5 to 5 volt and it decreases to 0 volt as the South Pole approaches. The pole directions are not important as the magnetic field is required in one direction only

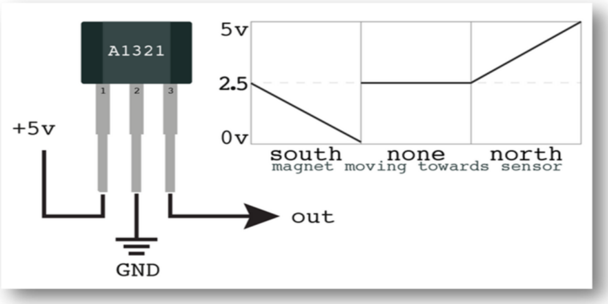

Fig.4. Sensors output and configuration

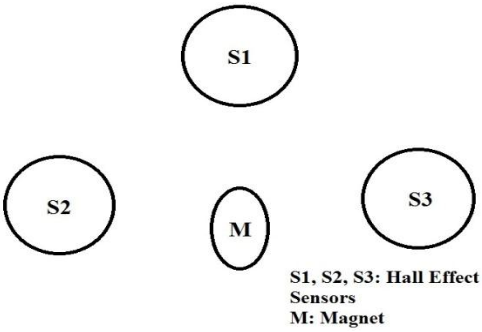

Fig.5. Position of Magnet and Sensor

We have kept the threshold value of the sensors at 600 Tesla, that is when a magnetic field at a particular sensor is maximum and it crosses the threshold value of 600 then following analog values of all sensors are converted into digital value by the arduino mega microcontroller, this corresponding digital value is encoded using an encoder and wirelessly transmitted over the transmitter thus controlling the motion of the wheelchair. Different values at the corresponding sensors target to a code that is used to dictate motion in a particular direction.

When the value of the sensors is greater than the threshold value, then arduino generates the digital code for the corresponding analog value. .[5]&[6]

S1	S2	S3	o/p digital code of arduino	
1	0	0	1010	S1 > 600
0	1	0	1001	S2 > 600
0	0	1	0110	S3 > 600

E. ARDUINO MEGA 2560 MICROCONTROLLER

FIG.6.ARDUINO 2560 MICROCONTROLLER

The Arduino Mega 2560 is a microcontroller board based on the ATmega2560 (datasheet). It has 54 digital input/output pins (of which 15 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button.

The main function of the arduino Mega 2560 microcontroller is to convert the analog output of the sensors to a digital code which is used to control the movements of the wheelchair. The Arduino Mega 2560 can be programmed using arduino software, which uses Java or C++. The programming used in the project is basically to measure the analog value of sensors, and to correspondingly provide the digital code. The programming code used to determine the sensor value at which the proximity of tongue is closest is given as[4]

```
tongue_driven_system

int threshold_fwd=600 ;
int threshold_left=600 ;
int threshold_right=600 ;

int val1=0;
int val2=0;
int val3=0;
int flag1=0;
int flag2=0;
int flag3=0;

/*

pin5 pin4 pin3 pin2
 1    0    1    0   forward
 1    0    0    1   left
 0    1    1    0   right
 0    0    0    0   do nothing

tongue_driven_system
void setup()
{

pinMode(5,OUTPUT);
pinMode(4,OUTPUT);
pinMode(3,OUTPUT);
pinMode(2,OUTPUT);

}

void loop()
{

 val1=analogRead(0);  //forward
 val2=analogRead(2);  //left
 val3=analogRead(4);  //right

if(val1>threshold_fwd)
flag1=1;
else
flag1=0;

tongue_driven_system
if(val2>threshold_left)
flag2=1;
else
flag2=0;

if(val3>threshold_right)
flag3=1;
else
flag3=0;

if((flag1==1)&&(flag2==0)&&(flag3==0))
{
digitalWrite(5,1);
digitalWrite(4,0);
digitalWrite(3,1);
digitalWrite(2,0);

}

if((flag1==0)&&(flag2==1)&&(flag3==0))
{
digitalWrite(5,1);

tongue_driven_system §
digitalWrite(4,0);
digitalWrite(3,0);
digitalWrite(2,1);

}

if((flag1==0)&&(flag2==0)&&(flag3==1))
{
digitalWrite(5,0);
digitalWrite(4,1);
digitalWrite(3,1);
digitalWrite(2,0);
}

if((flag1==0)&&(flag2==0)&&(flag3==0))

{
digitalWrite(5,0);
digitalWrite(4,0);
digitalWrite(3,0);
digitalWrite(2,0);
}
}
```

FIG.7.ARDUINO PROGRAM CODE FOR MEASURING AND COMPARING THE SENSOR VALUE.

The coding for arduino, requires the use of already in built functions. They make movement of the bot easier and better. They make use of embedded C programming which is simpler and is easy to use.[4]

F. ENCODER AND DECODER PAIR.

The Encoder and Decoder pair used here is HT12E and HT12D, the 12 in the address lines means use of 8 address lines and 4 data lines. It requires a 5 volt supply, the data that needs to be encoded are provided at the data pins D0 to D3.

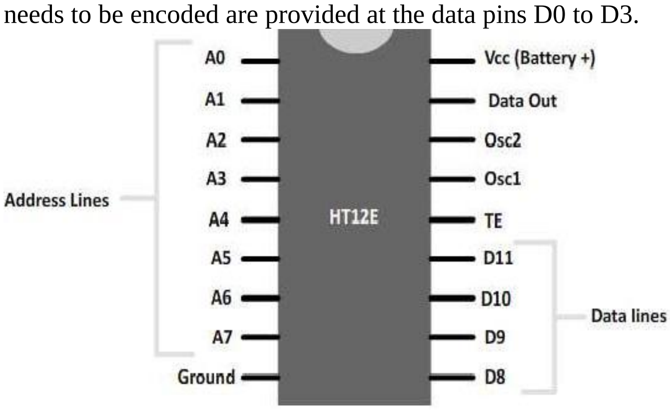

FIG.8. HT12E ENCODER

The input given to data pin is in parallel form which is being transmitted from output data pin in serial form as shown below

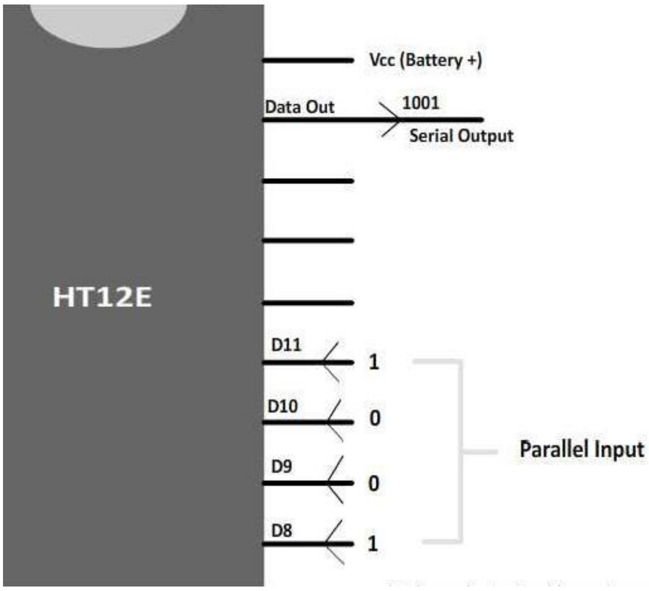

FIG.9.ENCODING OF DATA

Thus the sensor values are digitally encoded and transmitted over the media; the media could be anything it could be wire or wireless. We are using wireless transmission and the data is wirelessly transmitted and received by the receiver, and the decoder HT12D is used to retrieve the original data of the sensors. While decoding the data is serially fed into the data pin of the decoder, which decode the data and provide the output at the four pins in the same order how the data was fed into encoder.

When there is no input at the data in pin, the output pins i.e. data lines remains high. There is also a resistor which is connected between the two oscillator pins at the encoder which is of Re, 1 mega ohms. At the decoder section the resistor connected between the two oscillator pin is of Re/20=50k.

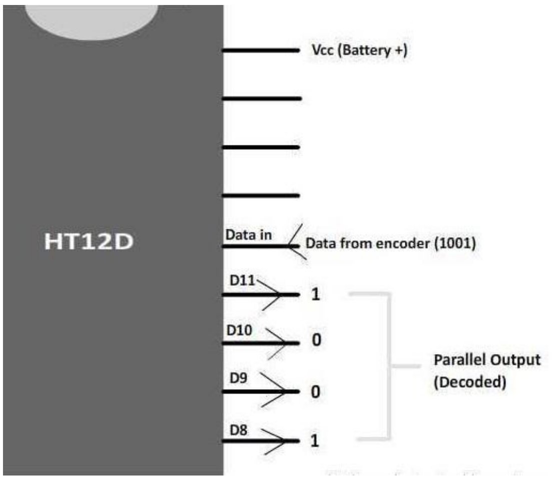

FIG.10.HT12D DECODER

When using a single pair of encoder-decoder IC, we generally leave the address pins as it is i.e. we do not connect them to either ground or VCC. [3],[5]&[6]

A. TRANSMITTER AND RECEIVER

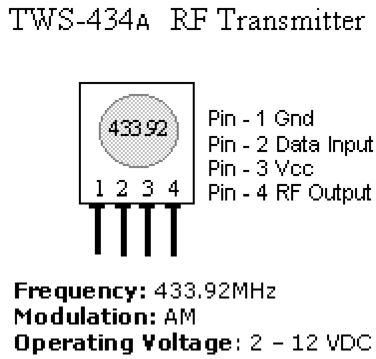

Fig.11.RF TRANSMITTER

The digital code that is encoded by the Encoder is given to the RF transmitter, to wirelessly transmit it. The 434 in the name of the transmitter is the operating frequency at which the transmitter and receiver works.

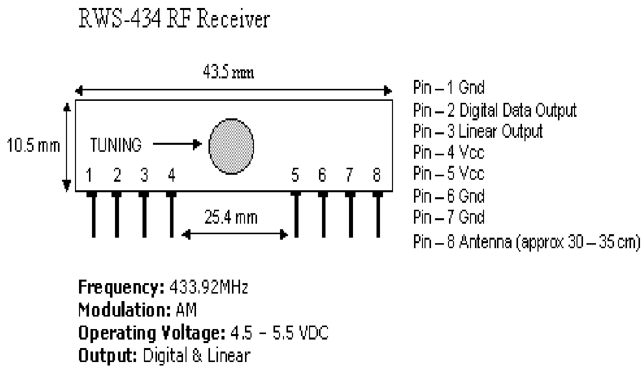

FIG.12. RF RECEIVER

G. L293D

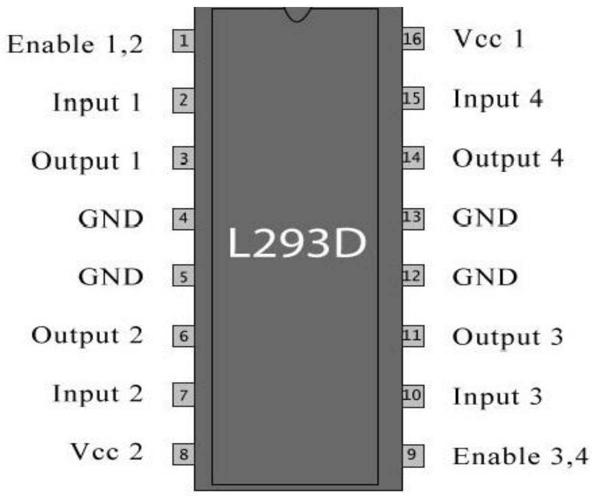

Fig 13:L239D

L293D is a dual H-Bridge motor driver integrated circuit (IC) that act as current amplifiers since they take a low-current control signal and provide a higher-current signal. This higher current signal is used to drive the motors. L293D contains two inbuilt H-bridge driver circuits. In its common mode of operation, two DC motors can be driven simultaneously, both in forward and reverse direction. The motor operations of two motors can be controlled by input logic at pins 2 & 7 and 10 & 15. Input logic 00 or 11 will stop the corresponding motor. Logic 01 and 10 will rotate it in clockwise and anticlockwise directions, respectively. Enable pins 1 and 9 which correspond to the two motors, must be high for motors to start operating. When an enable input is high, the associated driver gets enabled. As a result, the outputs become active and work in phase with their inputs. Similarly, when the enable input is low, that driver is disabled, and their outputs are off and in the high-impedance state.

Thus when we give the input as 1010, then the input to each motor of the robot will be 10; hence it will move it in the forward direction.[5]&[6]

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OUTPUT

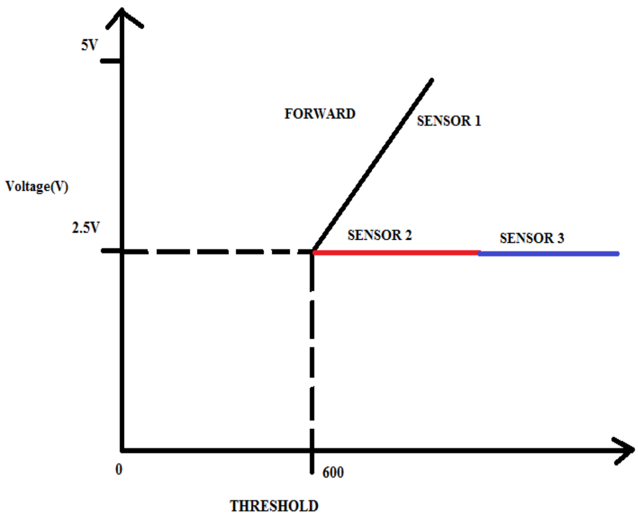

FIG 14 :VARIATION OF SENSORS WITH MAGNETIC FIELD

Hall effect sensors A123D sensors are bipolar sensors. The sensor value gives an output of Vcc/2 when no magnetic field is in the range of sensors, i.e. the sensors that requires 5 volt will give an initial sensor value output of 2.5 volt. So as a result initially when we begin with our execution the sensors are at a predetermined value of 2.5 volts. When the magnet placed in the tongue approaches any one the sensors the threshold of that particular sensor to which it has approached increases which is again at a predetermined value of 600.While the other two values remain at 600.The sensor whole threshold has risen feeds the output to an encoder. The encoder is a 4:1 parallel t serial data converter. So the output obtained is 1 bit. This bit of data is transmitted wirelessly from transmitter section to receiver section using wireless transmitter and receiver. The transmitter and receiver each have a 1 bit data pin which can transmit 1 bit of data. This bit of data is fed to the decoder which is a 1:4 serial to parallel converter which reverts the four bit data back to its original form. The output of the decoder is fed to the motor driver integrated circuit (IC) that act as current amplifiers since they take a low-current control signal and provide a higher-current signal. This higher current signal is used to drive the motors. Input logic 00 or 11 will stop the corresponding motor. Logic 01 and 10 will rotate it in clockwise and anticlockwise directions, respectively. Enable pins 1 and 9 which correspond to the two motors, must be high for motors to start operating. When an enable input is high, the associated driver gets enabled. So in this way we have achieved an easy way to move the bot in the requisite direction. [3],[6]&[5]

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Shankar Menon,BE Student,Department of Electronic and Telecommunication, SIES Graduate School of Technology,Nerul, Navi Mumbai 400706, India.
Akhil Nambiar,BE Student,Department of Electronic and Telecommunication,SIES Graduate School of Technology,Nerul, Navi Mumbai 400706, India.
Anjali Pariyarathu,BE Student,Department of Electronic and Telecommunication,SIES Graduate School of Technology,Nerul, Navi Mumbai 400706, India.
Kishnamurthy.M., BE Student,Department of Electronic and Telecommunication,SIES Graduate School of Technology,Nerul, Navi Mumbai 400706, India.