A Beagle-bone Technology for Tongue Controlled Robot of the Physically Challenged

Saritha I G, Sowmyashree M S

1,2Department of Telecommunication Engineering, BMSIT&M

Abstract—Tongue Driven System (TDS) is a tongue operated wireless assistive technology which can provide effective computer access and environment control to the physically disabled. It interprets user intention into control commands by detecting and classifying tongue motion using small permanent magnetic sensors. The main aim of the project is to design and implement a Tongue Controlled Robot for the physically challenged to fulfill their basic needs and control the movement of wheel chair. The Tongue Controlled Robot is designed in such a way that the robot can move either forward/backward/lef/right by the movement of tongue. This project can be in turn extended to continuously monitor heartbeat rate whenever heart rate goes beyond set level. The project developed allows the user to control wheelchair using assistive technology by Tongue Controlled Robot which reduces the workload of manual aids so that the physically challenged can control the movement of their wheelchair as well as cater to their basic needs using this Tongue Controlled Robot. A smart wheelchair is any motorized platform with a chair designed to assist a user with a physical disability, where an artificial control system augments or replaces user control. [15] Its purpose is to reduce or eliminate the user’s task of driving a motorized wheelchair.

Key terms—Wheel chair, tongue driven systems, Beagle bone technology.

I. INTRODUCTION

The ability to move freely is highly valued by all people. However, it is sometimes difficult for a person with a physical disability. Some disabled people cannot drive an electric wheelchair manually, even with a joystick, because they lack the physical ability to control the movement. To enable a disabled person to drive a wheelchair safely and easily so that they can enjoy a higher quality of life, researchers have proposed several electric wheelchair systems. The use of voice commands to control an electric wheelchair is one research result. An electric wheelchair control with tongue technique has also been proposed.

In this case, the different commands for the wheelchair are derived from the capacitive touch screen signals of tongue movements. Many concepts of robotics are applied in helping a physically challenged. The need of equipment’s, which helps physically challenged has increased nowadays, to make them to be like a normal one. This project deals with the new embedded technology, which helps the physically challenged to control the robot using their tongue.

The Beagle bone black is the board which is used to make the transmitter part. This board has touch screen sensor on it. This can be control by tongue. The transmitter is fixed in the wheel chair and the movement can be controlled. The receiver is a robot. This robot is made up with pick and place option and trip the relay option for varous home appliances and for picking water, food and tub.

WHY WE USE TONGUE?

We use the tongue to operate the system because unlike the feet’s and hands, which are connected by brain through spinal cord, the tongue and brain has a direct connection through cranial nerve that generally escapes damage in severe spinal cord injuries or neuromuscular disease. Tongue movements are fast, accurate and do not required much thinking, concentration or effort.

We propose a robotic wheelchair that will help the paraplegic patients to move. It addition to mobility and independence this wheelchair also allows them to control the various devices in a room. This brings about in them confidence and a sense of self-reliance. Smart wheelchairs are designed for a variety of user types.

The use of powered wheelchairs with high navigational intelligence is one of the great steps towards the integration of severely physically disabled and mentally handicapped people. Driving a wheelchair in domestic operate a joystick unless they use the tongue, which is obviously a very tedious task. Simultaneously blind and paraplegic people deal with a very uneasy situation which couples two problems: locomotion and localization. The Rob Chair system is being developed to overcome the problems described above, allowing the end-user to just perform safe movements and accomplish some daily life important tasks. In addition, we can give more independence to the handicapped person by using the tongue movement to communicate with the devices in a room for example: a fan. This communication is done using a RF transmitter and receiver with the Beaglebone technology. Using this, the person can control various devices easily.
II. LITERATURE SURVEY

The implementation of a Tongue driven system [1], a new wireless assistive technology for the persons severely disabled due to spinal cord injuries, quadriplegia or repetitive strain injuries (RSIs). It is a tongue operated non-invasive or minimal invasive, unobtrusive and effective technology.

Designing and constructing a tongue controlled robot and devices operating wirelessly using RF technology [2], where the user can control the Robot directions with the simple tongue movement and he can also request the basic needs like water, food or medicine using voice module.

Voice Based method [7], which use user's voice as source input. Voice analysis is used to analyze user's voice and convert into digital data. The weakness of this system is vulnerable against noise. Other voices which come from surrounding user may affect the system.

Motion based method [8], utilizes other normal movement organs to operate computer input. Head, foot, and etc. can be used to control computer input.

III. SYSTEM ARCHITECTURE

The generalized block diagram of tongue driven wireless technology is shown in Fig. 1. The block diagram can be divided into two sections that is transmitter section and receiver section. Transmitter section consists of three Hall Effect sensor (HS1, HS2, and HS3), microcontroller unit, RF transmitter and power supply. While receiver section consists of RF receiver, microcontroller unit, dual full bridge driver, power supply and DC motor namely Left Motor (LM), Right Motor (RM).

![Fig. 1 Basic diagram of tongue driven wireless associative technology](image)

Tongue driven wireless assistive technology consists of an array of Hall Effect sensor and small permanent magnet. It translate user’s command into control commands by detecting and classifying their voluntary tongue motion by using small permanent magnet, held on the tongue using tissue adhesive or tongue piercing.

The microcontroller will compare the sensors output with the predefined threshold value and based on the programming in will check user has issued which command. Depending upon the command, microcontroller will send particular characters to the transmitter. Transmitter will transmit the encoded data wirelessly. Receiver will receive the transmitted data, decode it and feed it to microcontroller unit of receiver section. The microcontroller is the main controlling unit that will control the movement of wheelchair. The wheels of the wheelchair model will rotate with the help of DC motors. Based on the input, microcontroller will provide predefined logic to the dual full bridge driver, which is already loaded in microcontroller using Embedded C programming. Driver IC in turn will control the rotation of DC motor (clockwise and anticlockwise rotation) due to which wheelchair can move in left, right and forward direction. Tongue drive wireless assistive technology has five individual commands that are simultaneously available to the user three directional commands (LEFT, RIGHT and FORWARD) and two selection commands (Stand-by and Active Mode). When driving PWCs, FORWARD is used to move the wheelchair forward, while LEFT and RIGHT are used to turn left and right respectively.

To deactivate the system during eating and talking we can switch the TDS from active to stand-by mode, during which wheelchair will remain still.

Experimental Setup

Mouthpiece:

The mouthpiece uses the off-the-shelf commercially available components to evaluate the feasibility and performance of this approach in developing assistive devices. The prototype device uses three Hall Effect switch mounted on the hardhat in front of the mouth. The three magnet switches namely left, middle and right switch are linearly arranged. A small disk-shaped permanent magnet is used as the tracer. The main purpose of the prototype device was to move the wheelchair model based on the location of a permanent magnet relative to three Hall Effect magnetic switches.

The transmitting section and battery is placed on the backward side of hardhat. The transmitting section is operated with the help 9V battery. Subject can activate or deactivate the circuit with the help of switch. If the user wants to talk with someone or eat he can deactivate the transmitting section. The switch is held on the shoulder and the user who can move his neck can switch it on and off by pressing the button with the help on his chin.

Control Hardware and Wireless Link:

The Tongue driven wireless assistive technology uses three 3144 sensitive Hall Effect switches (Allegro) mounted linearly on hardhat. A small disk shaped permanent magnet is used as tracer. A high performance, low power Atmel AVR 8 bit microcontroller namely ATmega88 and ATmega32 has been used as the controlling unit in the transmitter section and receiver section respectively.

Software Used:

The main software used to program the microcontroller ATmega88 and ATmega32 was mikroC PRO for AVR. In EAGLE schematic diagram of the transmitter and
receiver section was made from which PCB layout was made. PROTEUS was used for simulating the whole design.

IV. SCOPE OF PRESENT WORK

A. Statement of project

Existing systems and technologies are so designed only to provide for either movement of wheelchair or provide physical assistance only. These systems rely on other abilities of the physically disabled like their hand, eye, feet, and voice movements. These movements could be easily misconstrued as control signals when the individual has involuntary physical movements. The tongue and mouth motions are the most suitable forms of signals since they are highly similar to the hand motions.

In order to provide greater independence to such severely disabled individuals in movement and their physical activities, a more specialized assistance is necessary which would be implemented by this project.

B. Specific objectives

- The main aim of the project is to design and implement a Tongue Controlled Robot for the physically challenged to fulfill their basic needs and control the movement of wheelchair.
- The Tongue Controlled Robot is designed in such a way that the robot can move either forward/ backward/ left/ right by the movement of tongue and also to pick the water, food and tub, utilizing Beagle bone black as the computer hardware.
- The project developed allows the user to control wheelchair using assistive technology by Tongue Controlled Robot which reduces the workload of manual aids so that the physically challenged can control the movement of their wheelchair as well as cater to their basic needs using this Tongue Controlled Robot.
- To provide independence and mobility to a handicapped.

V. PRESENT WORK

There have been much advancement in the field of assistive technologies for the industrial and transport sectors, by keeping in mind the shortcomings and hindrances of each disability. To overcome this and to cater to the same, a more efficient and beneficial assistive technology has to be developed. In order to provide greater independence to such severely disabled individuals in movement and their physical activities. A more specialized assistance is necessary which would be implemented by this project. Focusing on such aspects, where the less fortunate people are benefitted, is of prime importance in today’s scenario.

VI. PROPOSED METHODOLOGY

![Flowchart of proposed method](image)

**REQUIREMENTS:**

**TRANSMITTER:**

The transmitter part is the touch screen based beagle bone interface. This can move the wheelchair left, right, forward, backward and stop by touching the screen by tongue. The Beagle bone can speak loud for the physically handicapped. Beagle bone interfaced with speaker which can speak like few commands: Water, toilet and Hungry. The same command is transmitted to receiver for picking it and bringing. It can also switch on TV, Fan and Light.

![Block diagram of a transmitter](image)

**Fig 3. Block diagram of a transmitter**

**Fig 4. Components of the transmitter**

An **RF module** (radio frequency module) is a (usually)
small electronic device used to transmit and/or receive radio signals between two devices. The RF module, as the name suggests, operates at Radio Frequency. The corresponding frequency range varies between 30 kHz & 300 GHz. Transmission through RF is better than IR (infrared) because of many reasons. RF communication uses a specific frequency unlike IR signals which are affected by other IR emitting sources. This RF module comprises of an RF Transmitter and an RF Receiver. The transmitter/receiver (Tx/Rx) pair operates at a frequency of 434 MHz. An RF transmitter receives serial data and transmits it wirelessly through RF through its antenna connected at pin4. The transmission occurs at the rate of 1Kbps - 10Kbps. The transmitted data is received by an RF receiver operating at the same frequency as that of the transmitter.

![RF Transmitter and RF Receiver](image)

**Fig 5. Pin Description**

**RECEIVER:**
- The Chassis is made up of wheels and gear motors.
- This will carry the pick and place robot.
- The IR receives the signal from Wheel chairs and it will move and do the operations as commanded.

![Block diagram of a Receiver](image)

**Fig 7 Block diagram of a Receiver**

**Fig 8. Components of Receiver**

![Function Table](image)

**FUNCTION TABLE**

<table>
<thead>
<tr>
<th>INPUTS†</th>
<th>OUTPUTS</th>
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<tbody>
<tr>
<td>A</td>
<td>H</td>
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<tr>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>X</td>
<td>Z</td>
</tr>
</tbody>
</table>

H = high level, L = low level, X = irrelevant, Z = high impedance (off)
† In the thermal shutdown mode, the output is in the high-impedance state, regardless of the input levels.

**VII. HARDWARE & SOFTWARE REQUIREMENTS**

A. **KEIL Development Tool**

Keil software provides the ease of writing the code in either C or ASSEMBLY. U-VISION 2, the new IDE from Keil Software combines Project management, Source Code Editing and Program Debugging in one powerful environment. It acts as a CROSS-COMPILER.

B. **BEAGLEBONE TECHNOLOGY:**

Beaglebone Announced in the end of October 2011, the BeagleBone is a barebone development board with a Sitara ARM Cortex-A8 processor running at 720 MHz, 256 MB of RAM, two 46-pin expansion connectors, on-chip Ethernet, a microSD slot, and a USB host port and multipurpose device port which includes low-level serial control and JTAG hardware debug connections, so no JTAG emulator is required.

C. **Ethernet Port**

This is a standard RJ45 Ethernet port, which will come in handy for Internet-connected projects. We can connect it directly to a router, or to WiFi connection through Ethernet to the BeagleBone.

D. **MicroSD Card Slot:**

Unlike most computers, the BeagleBone doesn’t have a hard drive and instead uses a MicroSD card to store the operating system, programs, and our data.

E. **DC MOTORS**

DC motors consist of one set of coils, called armature winding, inside another set of coils or a set of permanent magnets, called the stator. Applying a voltage to the
coils produces a torque in the armature, resulting in motion.

VIII. RESULT

VIII. RESULT

Fig. 9: Rover arm in downward motion

Fig. 10: Rover arm in upward motion

Fig. 11: LCD display of the Beagle Bone remote

IX. APPLICATIONS, ADVANTAGE AND DISADVANTAGES

APPLICATIONS:
- Telecommunications systems
- Consumer electronics
- Mobile phones
- Videogame consoles
- Digital cameras
- DVD players
- GPS receivers
- Printers

Many household appliances, such as microwave ovens and dishwashers, Mp3 players

ADVANTAGES

1. User Friendly
2. Helpful for the paralysis stroke people who don’t have much stamina in the hands.
3. Reduces the human activity.
4. Reduces the physical strain.
5. Spontaneous output.
6. To promote personal mobility and enhance quality of life.

DISADVANTAGES

1. Expensive. Assistive technology on its own cannot provide human contact and personal care. Many older people experience loneliness and social isolation. Technology should only be provided as an addition to contact and care, not as a replacement.

X. CONCLUSION:

The project developed allows the user to control wheelchair using assistive technology by Tongue Controlled Robot which reduces the workload of manual aids so that the physically challenged can control the movement of their wheelchair as well as cater to their basic needs.

It provides independence and mobility to a handicapped. The design and coding of the various parameters and functionalities required of the robot by the physically challenged patient.

XI. SCOPE FOR FUTURE WORK:

Future assistive technologies may well become possible because of developments in human-machine interfaces that effectively create a direct connection between the human nervous system and machines.

We could use other devices like the Bluetooth, Zigbee to communicate with the various devices in the room. Stepper motors can be used instead of dc motors to control the wheel. There has been an explosion of technologies that build on the availability of Global Positioning Systems (GPS) technologies to provide way-finding assistance.

REFERENCES


