TONGUE DRIVE SYSTEM (TDS)

Project Presentation
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OVERVIEW

- Introduction
- Block Diagram
- Circuit Diagram
- Hardware component description
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INTRODUCTION

- The Tongue Drive System allows handicapped users
  - move around their wheelchairs,
  - control computers or other electronic devices, and
  - manage home appliances.

- The mouth is turned into a computer using a tiny magnetic system placed on the tongue.

- The tongue is the controller and with its movement the user tells the system what to do.

- A small magnet about the size of a rice grain is attached to the user’s tongue by implantation, piercing or tissue adhesive.
INTRODUCTION

- Movement of the magnetic tracer attached to the tongue is detected by an array of magnetic field sensors mounted on a headset outside the mouth.

- The sensor output signals are processed to determine the relative motion of the magnet.

- This information is then used to control the movement of a powered wheelchair.

- To operate the Tongue Drive system, users only need to be able to move their tongues.
The hall effect sensor generates analog signal proportional to magnetic field.

The ADC converts the analog values into digital.

The controller configures the PWM in accordance to the software (algorithm).

The PWM controls the speed of the motor

The H-Bridge driver drives the motor in both directions.
**BLOCK DIAGRAM**

- **Hall Effect Sensor 0** connects to **ADC-1**
- **Hall Effect Sensor 1** connects to **ADC-2**
- **Hall Effect Sensor 2** also connects to **ADC-2**
- **Hall Effect Sensor 3** connects to **ADC-3**

- **MSP 430G2252** processes inputs from ADC-1, ADC-2, ADC-3, and ADC-4

- **Driver IC SN754410** drives **Motor 1** and **Motor 2**
CIRCUIT DIAGRAM
HARDWARE COMPONENT DESCRIPTION

MSP430G2252

- 20-pin MSP430G2252.
- 4 ADC Channels for taking the output from the hall effect sensor.
- 5 pins as input to the H-bridge driver.
Two regulators LM 7805 and L1117 are used.

The hall effect sensors and the H-bridge driver require 5V.

MSP430 controller requires 3.3V.

The motors run on 5V.
HARDWARE COMPONENT DESCRIPTION

Hall Effect Sensor - A1321

- Hall-effect sensors provide a voltage output that is proportional to the applied magnetic field.

- A1321 is a linear Hall Effect Sensor which is sensitive and temperature stable.

- They are ideal for use in the harsh environments.

- It is connected to the ADC input channel of the MSP430G2252.
HARDWARE COMPONENT DESCRIPTION

H-Bridge Driver - SN754410

- SN754410 is a bidirectional driver and it can drive two motors at a time.
- Capable of driving high voltage motors
- It is controlled by the Pulse Width Modulated (PWM) signal. PWM is generated using timers on port 1.2.
HARDWARE COMPONENT DESCRIPTION

H-Bridge Driver - SN754410

- An H bridge is built with four switches.

- When the switches A and D are closed (and B and C are open) a positive voltage will be applied across the motor.

- By opening A and D switches and closing B and C switches, this voltage is reversed, allowing reverse operation of the motor.
$f_1 - S_1 > 750$ // forward
$f_2 - S_3 > 600$ // backward
$f_3 - S_3 > 700$ // speed increase
$f_4 - S_4 > 700$ // speed decrease
SOFTWARE DESCRIPTION

Analog to Digital Converter (ADC)

Magnetic field → Hall Effect Sensor → 0V to 5V Analog Output

A/D Converter → 0 to 1023 Digital output

<table>
<thead>
<tr>
<th>Analog Voltage from Sensor (V)</th>
<th>Corresponding Digital Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2.5</td>
<td>512</td>
</tr>
<tr>
<td>5</td>
<td>1023</td>
</tr>
</tbody>
</table>
SOFTWARE DESCRIPTION

Analog to Digital Converter (ADC)

- A 10-bit ADC is used to convert the analog output from the sensor to a digital value.
- 4 ADC channels: A3, A4, A5, A6 on pins P1.3- P1.6.

ADC Configuration:

- The conversion is initiated using the ADC10SC bit.
- A Single channel Single conversion mode is used.
- ADC10 oscillator is used as input clock to the ADC.
- The sampling time chosen is 16 times the ADC10 clock.
SOFTWARE DESCRIPTION

Pulse Width Modulator (PWM)

- A modulating technique which generates variable width pulses is used to vary the speed of the motor.
- The Duty cycle is varied based on the input values at P1.5 and P1.6 from sensors 3 & 4 respectively.
- The output is driven from P1.2 of controller to the 1,9 enable pins of H-bridge.

PWM approach:

- We set the corresponding modes
- Timer operating mode is UP mode (mode 1).
- Output mode is reset/set mode (mode 7).
SOFTWARE DESCRIPTION

Pulse Width Modulator (PWM)

- Of the 9 16bit registers, 2 CCR registers, TAR register the corresponding control registers are used.

- Initially, TACCR0 and TACCR1 are initialized to certain value. TACCR1 is incremented or decremented by a value based on the outputs from sensors 3 and 4 respectively.

- Thus as the Duty cycle is varied the output power is varied and the output is fed to enable pins of H-bridge to change the speed.
SOFTWARE DESCRIPTION

Duty Cycle = (TACCR1 / TACCR0) * 100
CHALLENGES

• Back E.M.F produced by motors.
• ADC value was read before completion of conversion.
• Exact Positioning of sensors.
• Turning the vehicle Left or Right.
CONCLUSION & FUTURE WORK

This device could revolutionize the field of assistive technologies by helping individuals with severe disabilities such as those with high-level spinal cord injuries return to rich, active, independent and productive lives.

Wireless communication. More sensor, Better navigation.
QUESTIONS?