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DRIVING SYSTEM FOR DISABLED

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ABSTRACT

The need to help the persons with disabilities has led to the development of assistive technology. In this paper, a technology is presented with the use of which a person with disability can control his or her surroundings effectively. They can move their wheelchair; operate electronic appliances, computer as well as phones. Persons who have different degrees of disabilities can operate their surroundings in different manners. The people who are having a minimal amount of upper limb movement only and no lower limb movement can control the system using a magnet on their tongue. Whereas those people who cannot move their lower limb but have access over their upper body can control their vehicle using their hands. The tongue can be used in the project because there is a degree of freedom with the tongue and moreover it is connected to the brain by the hypoglossal nerve, which generally escapes severe damage even in high level spinal cord injuries. Non-invasive access to the tongue is readily available. The paper additionally presents the practical use of encoder–decoder module and the LMX Bluetooth module for transferring data as a wireless transmission. The results show that the system is efficient and highly practical.

KEYWORDS: Assistive Technology, LMX Bluetooth Module, Magnetic Tracer Tongue, Wireless Transmission

INTRODUCTION

The Driving Systems for Disabled (DSD) proves to be a boon for the disabled persons because it provides a practical use of the electromagnetic theories and wireless technologies in the Bio-Medical science. DSD serves its different users by using various key components. In general, system consists of the 4 key components: a small magnetic tracer fixed on the tongue with tissue adhesives or piercing, a headset with an array of 3-axial magnetic hall effect sensors to detect the changes in the magnetic field generated by the tracer, a wireless link established between a control unit on the headset and a receiver on a driving vehicle or smart phone to transfer the magnetic sensor data, and a sensing and driving algorithm to carry out the processes, a switch to control the wireless transmission through an encoder-decoder module or a Bluetooth module. The paper presents a driving system for those persons who are disabled because of accidents, strokes, some sort of injury or trauma and can have a driving system by using their tongue. It is an efficient system using wireless transmission of data. The paper also presents the technology for those people who are having some sort of hand movement but movement of legs in their case is very difficult. The Section 2 includes the solution proposed to the above problems.

SOLUTION PROPOSED

The paper presents the solution to a majority of problems faced by those persons who are suffered from strokes, trauma or accident and have minimal amount of upper and lower body movements. In the solution the driving system is designed in such a way that the use of rare-earth super magnet provides a degree of higher efficiency. The magnetic sensors used are Ratiometric Linear Bipolar "hall effect sensors A1321EUA-T". Further the paper also presents the

technology for those persons who are suffering from lymphedema, joint dysfunction or paralysis of legs. The Bluetooth technology combined with android technology can be an aid for those who can control the vehicle through hand movements. The paper presents use of LMX9839 Bluetooth IC combined with the Bluetooth of the android mobile to drive out vehicle and the Bluetooth IC can be used to control various devices as well.

SYSTEM OVERALL ARCHITECTURE AND DESIGN

Overall proposed solution consists of both the hardware as well as the software part.

Hardware System Design

The proposed system hardware includes the following blocks:

- Headset Module,

- Encoder Circuit,

- Microcontroller MSP430G2553,

- Decoder Circuit,

- Driving Circuit,

- LMX9838 Bluetooth.

Headset Module

In this module a small magnet is placed on the tongue which can be permanently pierced or it can be placed temporarily by using adhesives. This magnet is surrounded by an array of Ratiometric Linear Bipolar "hall effect sensors A1321EUA-T". These sensors are mounted on the headphones outside the mouth and kept near to the cheeks. These magnetic sensors will respond to the magnetic field generated by the motion of the tongue. This prototype has a set of directional commands based on the change in values of the magnetic field respective to the tracer magnet. The detailed description of the circuit containing an array of Hall Effect sensors is given in Figure 1.
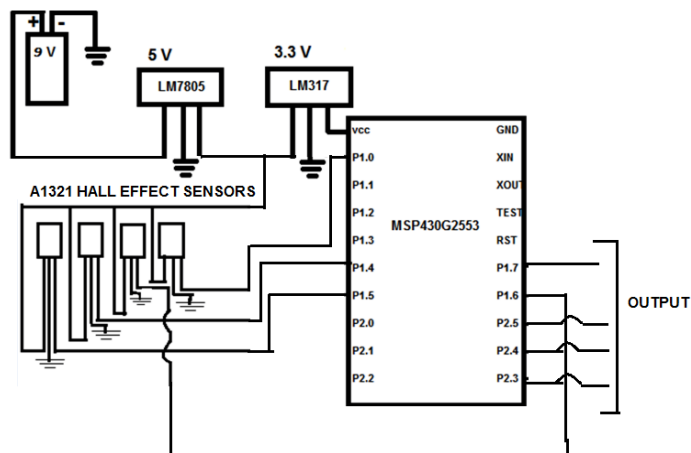
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Figure 1: Circuit Diagram of Array Using Hall Effect Sensors

The circuit shows an array of Ratiometric Bipolar Linear Hall Effect magnetic sensors A1321EUA-T. These sensors measure the magnetic field generated by a small tracer magnet. There are also voltage regulators. The data from these linear bipolar sensors is converted to digital form through the inbuilt 10-Bit analog to digital converter that is present in MSP430G2553 which is the microcontroller used here. The conversion is initiated using the ADC10SC bit. ADC10 oscillator is used as input clock to the ADC. The processed output of the microcontroller is then sent to the encoder circuit. This whole circuitry is assembled over the headset. The complete headset is shown in the Figure 2.

Figure 2: Picture of Headset Used by the Person

ENCODER CIRCUIT

The encoder circuit consists of an encoder IC, the 4 pin encoder device R403A and LM7805 and TLV2217 as the voltage regulators. The encoder IC used in the project is HT12E. This encoder IC is designed by Holtex which has low noise and high immunity CMOS technology. The encoder and decoder module used is operating at the frequencies of 315MHz and 434 MHz [see Figure 3].
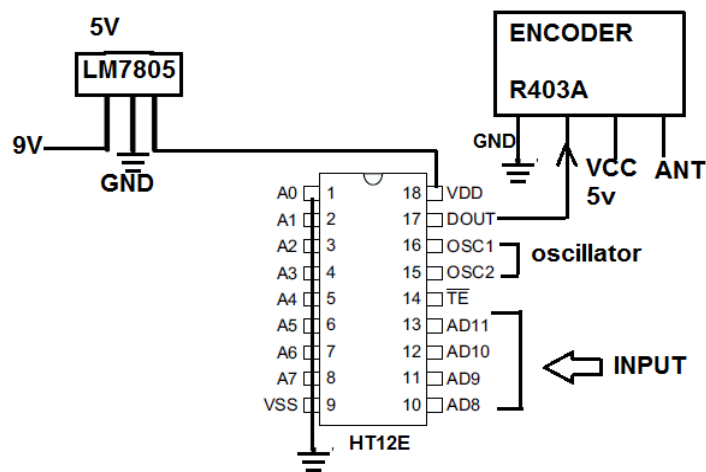

Figure 3: Circuit Diagram of Encoder Circuit Using HT12E

Microcontroller MSP430G2553

MSP430G2x53 series are ultra-low-power mixed signal microcontrollers with low voltage supply ranging from 1.8 volts to 3.6 volts built-in 16-bit timers, up to 24 I/O touch-sense-enabled pins, a versatile analog comparator, and built-in communication capability using the universal serial communication interface. The device features a powerful 16-bit RISC CPU, 16-bit registers, the package consists of PDIP with 20 pins and there are constant generators.

Decoder Circuit

The transmitted data is received wirelessly through the decoder IC at the receiver side. At the receiver side decoder IC employed is HT12D for reception of the data which is actually the output of linear Hall Effect sensors placed near the person's mouth. The decoder IC is an 8 pin device which works on the frequencies of 315MHz and 425MHz.The received data goes from decoder to the microcontroller MSP430G2553 at the receiving section. The motor driving circuit consists of L293d IC. L293d are quadruple high-current half-H drivers. There are controlling the DC geared motors in the project. In this paper we present the working of Driving System for Disabled on a small driving vehicle which included 4 DC geared motors and a driving circuitry whereas on at a comprehensive approach it can be implemented on a Powered wheelchair. The wheelchair is robust, 125cc and gives maximum power of 8 bhp@ 7500 RPM. The detailed description of the circuit is given in Figure 4.

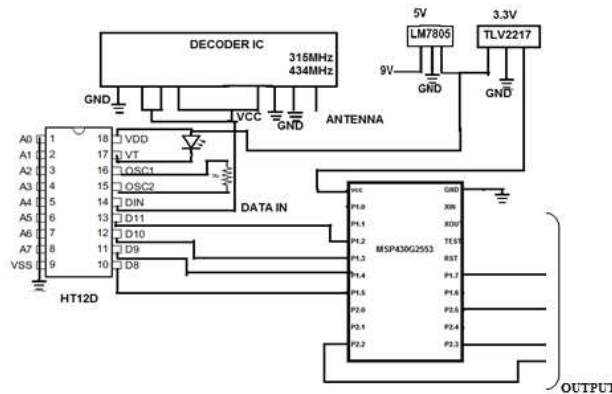**Driving System for Disabled**

Figure 4: Circuit Diagram of Decoder Circuit Using HT12D

The project also includes the concept of pulse width modulation. 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 input ports from sensors. For the PWM approach we have selected the UP mode of the microcontroller MSP430G2553. Since the output is taken from port 2 of the controller the corresponding timer of controller used is Timer A1. Of the nine 16bit registers we have used 2 Capture/Compare registers (CCR registers) and one Timer A control register (TACTL registers). At the initial stages of the project some experiments are performed. In the first experiment the Timer A Capture/Compare registers (TACCR0 and TACCR1) are initialized to a certain value. TACCR1 is incremented or decremented by a value based on the outputs from sensors. As the duty cycle is varied the changes in power output are given to the pins of   H-bridge and the speed is varied correspondingly.

Driving Circuit

The driving circuit consists of L293d IC. The L293d are quadruple high-current H-Bridge drivers. The L293d is designed to provide bidirectional drive currents of up to 1 A at voltages from 4.5 V to 36 V. The driving vehicle is shown in Figure 6 and using powered wheelchair Figure 7.
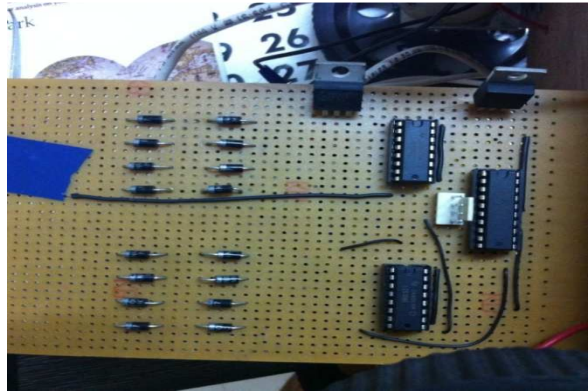

Figure 5: Picture of the Driver Circuit

Figure 6: Implementing the Circuit on Powered Wheelchair

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LMX9838 Bluetooth IC

LMX9838 Serial port is designed by the Texas Instrument which serves as a fully integrated Bluetooth 2.0 baseband controller, 2.4 GHz radio, crystal, antenna, LDO and discreet; combined to form small form factor (10 mm x 17 mm x 2.0 mm). The connections of the module are shown in the figure below.
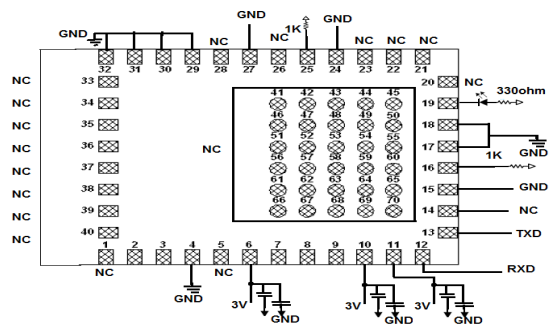

Figure 7: Circuit Diagram of LMX9838 Bluetooth Module

Firmware Design

The system firmware includes programming in embedded c and the software used is Code Composer 5. AIDE integrated development environment (IDE) is for Android. AIDE supports building Apps with Java/Xml, Android SDK, Eclipse project. The Bluetooth device is recognised as serial port device when the link between Bluetooth of the phone and the module is established. The pulse width modulation technique is also included since it controls the speed of the vehicle. In the app the two sliders control the two motors and the speed as well. The code is written for a period value of 3472 and 31 step resolution. The first five bits describe the throttle duty cycle. The next bit provides the choice of motor and further bit gives the direction of the motors. In this prototype both timers Timer A0 and Timer A1 serves the purpose. The timers control duty cycles which is given by (1).

Software Implementation

The MSP430 is used in the UP mode with timer register at Outmode 7i.e Reset/Set mode.
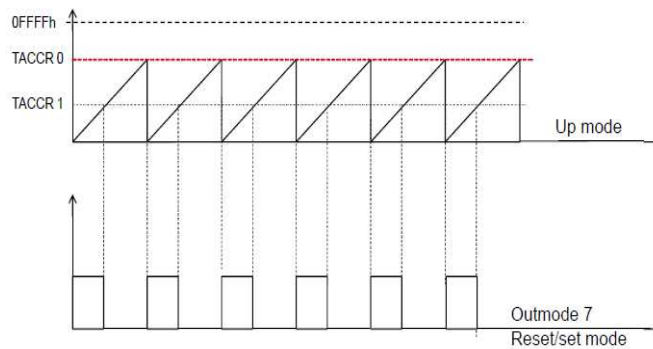

Figure 8: The Software Description of DSD UP Mode

The Duty Cycle is given by the formula-

Duty Cycle = (TACCR1/TACCR0)*100 (1)

EXPERIMENTAL RESULTS

In this section we include the series of experiments done while working on this project.

EXPERIMENT 1

In the first experiment a series of readings of sensor values are taken. This experiment was designed to provide a quantitative measure of the DSD performance by measuring the exact values of sensors at different positions and this experiment helped further in deciding the exact positioning of the sensors.

EXPERIMENT 2

In this experiment the sensor values are input to the MSP430. The ADC10 of the microcontroller is enabled for conversion here. It is recorded that the following values appear in digital form according to the input sensor values. The recorded values are shown in Table 1.

TABLE 1

The recorded analog values from sensors and their corresponding calculated digital values are given in the table below.

Table 1: Recorded Analog Value from Sensor

Analog Values from Sensor (V)	Digital Values
0	0
2.5	512
5	1023

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EXPERIMENT 3

This experiment was done to have a complete understanding of the basics of PWM. In this experiment the values of the timer registers is changed to obtain various duty cycles and understand different modes of operation and generating PWM.

DESCRIPTION TABLE

Table 2: Specifications of the Components Used in the Project

Microcontroller Used	MSP430G2553
Dimensions	12.5 x 18 x16 mm^3
Operating voltage	3.3volts
Clock Frequency	1Mhz
Wireless Transmission source	R403A Encoder – Decoder; LMX9838
Operating Voltages	5volts; 3.3 volts
Magnetic Sensors	Linear Bipolar Hall effect Sensors
Operating voltage	5 volts
Tracer source	Rare Earth Super magnet

CONCLUSIONS

The project presents a revolutionized work in the field of assistive technology by helping individuals with severe disabilities such as those with high level spinal cord injuries return to rich, active, independent and productive lives. The android application is designed to transfer the data using the Bluetooth module LMX9838. This comprehensive technology provides an aid to the disabled persons. The output values of Hall Effect sensors are presented in this report. In the future scope, the Bluetooth module can also be used to control appliances.

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