Flex based Locomotion System

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***Abstract*—In the past couple of years nerve system related diseases like - Parkinson's disease , Paralysis etc have been increased dramatically which have severely limited person's ability to do physical movement or work. If we can channel their limited movement ability to control various aspects of their life it will ease their daily life and will also reduce their dependency on other people. This paper aims at designing a system which will take reading from two finger movement and translate them to control a locomotor which can further be extended into controlling a wheelchair or a car or control any electrical object. This system is a versatile system, which uses normal truth table based logic which leaves the opportunity for more inputs from various fingers to execute even more commands.**

***Index Terms*—Gesture Control, Motion Control, Remote System, Microcontroller, PICF4550**

I. Introduction

Degenerative nerve diseases affect many of peoples' physical activities, such as balance, movement, talking, breathing, and heart function. Many of these diseases are genetic. Sometimes the cause is a medical condition such as alcoholism, a tumor, or a stroke. Other causes may include toxins, chemicals, and viruses.

These diseases severely limit their ability to perform daily chore . Constant supervision is needed to perform day to day task. If we can further connect and expand their limited movement to an automated controller system which can decode and translate their limited movement to perform their day to day task, it will make their life a lot easier.

Several projects have been done regarding to microcontroller and motion sensor or gesture sensor based systems. One such project detect motion from fingers and translate them into Piano nodes[1] . They have created a pair of gloves that were capable of playing a synthesized grand piano sound when it was played like a real piano. A flex sensor was attached to each finger on the glove and connected to a Schmitt trigger so that when the finger was bent, the appropriate note was played over a speaker connected to a 12-bit DAC. This enabled the user of the gloves to play the natural (non sharp or flat) notes between C3 and E4. Because many basic songs utilize the C major scale, these gloves are perfect for children or beginning musicians. These gloves provide a convenient way to practice when a piano isnt available.

Another project[2] was built to control a toy helicopter using flex sensors attached to a glove. The flex sensors are intended to replace the remote control that is generally used to fly the helicopter. Additionally they have also created another mode which will allow them to use an accelerometer to control the forward and backward, and left and right movements, while using a flex sensor to control the throttle of the helicopter. They have two gloves each with three flex sensors attached to it. One of the gloves has an accelerometer attached to it.

II. Design Methodology

In this project a sensor capable of reading the movement or bending of a finger is required . To reading the input and creating the logic for the output a capable microprocessor is also required. To run the wheelchair two motors are needed for moving towards any direction. To drive the motors with the required logic, a capable motor driver is also needed .

III. System Overview

This system contains a PIC18 Microcontroller with F4550 variation , two normal DC motors , a H Bridge Motor driver , two Flex sensor along with required wires, resistors.

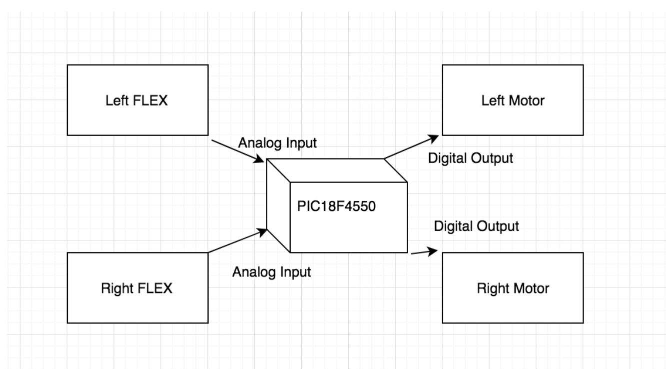

Fig. 1. System Block Diagram

A. PIC18F4550 Microcontroller

PIC18F4550 is ideal for low power (nanoWatt) and connectivity applications that benefit from the availability of three serial ports: FS-USB(12Mbit/s), IC and SPI (up to 10 Mbit/s) and an asynchronous (LIN capable) serial port (EUSART). Large amounts of RAM memory for buffering and Enhanced Flash program memory make it ideal for embedded control and monitoring applications that require periodic connection with a (legacy free) personal computer via USB for data upload/download and/or firmware updates. For reading the analog input from the FLEX sensors, converting them to digital data , doing necessary calculation and performing logic to ouput necessary digital outputs this microprocessor is ideal for its robustness , small form factor and necessary stack size and reasonable calculation speed.

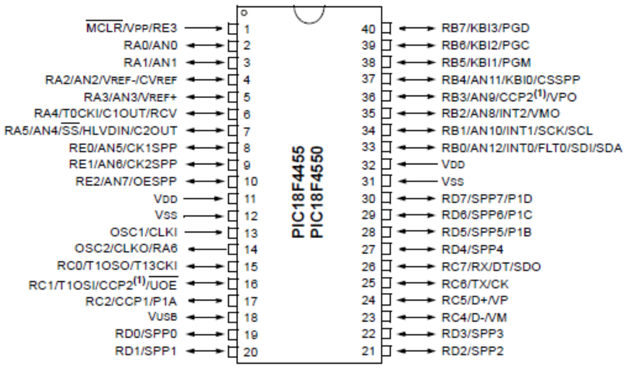

Fig. 2. PIC18F4550 Pin Diagram

It has a 40- pin configuration. It has 32 KB Program memory and 2 KB RAM. It has a 10-bit ADC with 13 input channels, so it can detect 210 levels. It needs 5V for operation. The ADC module five registers, of which three are control registers and two result registers. The output registers contain high and low bits. When the microcontroller gets value from FLEX sensors, the results are stored in those registers.

Parameter Name	Value
Program Memory Type	Flash
Program Memory (KB)	32
CPU Speed (MIPS)	12
RAM Bytes	2,048
Data EEPROM (bytes)	256
Digital Communication Peripherals	1-UART, 1-SPI, 1-I2C1-MSSP(SPI/I2C)
Capture/Compare/PWM Peripherals	1 CCP, 1 ECCP
Timers	1 x 8-bit, 3 x 16-bit
ADC	13 ch, 10-bit
Comparators	2
USB (ch, speed, compliance)	1, FS Device
Temperature Range (C)	-40 to 85
Operating Voltage Range (V)	2 to 5.5
Pin Count	40

Fig. 3. PIC18F4550 Specification

B. FLEX Sensor

A flex sensor or bend sensor is a sensor that measures the amount of deflection or bending. Usually the sensor is stuck to the surface, and resistance of sensor element is varied by bending the surface. Since the resistance is directly proportional to amount of bend it is used as goniometer, and often called flexible potentiometer. To measure the bending of fingers in terms of analog input this sensor is used.

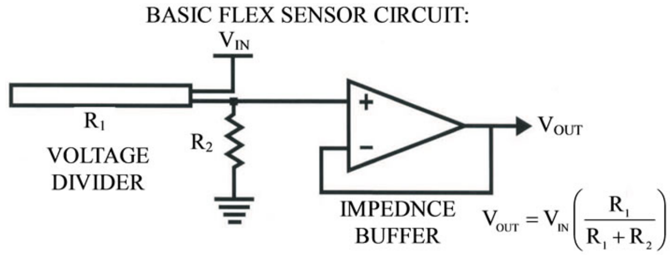

Fig. 4. Flex Sensor Circuit Diagram

When a person moves his finger the flex sensor attached to it can accurately measure this bending. This data is later used to control the motors for the locomotor.

C. L293D Dual DC Motor Controller

To control the dual motor simuntaniously and separately a L293D Dual DC Motor Controller has been used here.

The L293D devices are quadruple high-current half-H drivers. The L293D is designed to provide bidirectional drive currents of up to 600-mA at voltages from 4.5 V to 36 V. Both devices are designed to drive inductive loads such as relays, solenoids, DC and bipolar stepping motors, as well as other high-current/high-voltage loads in positive supply applications.

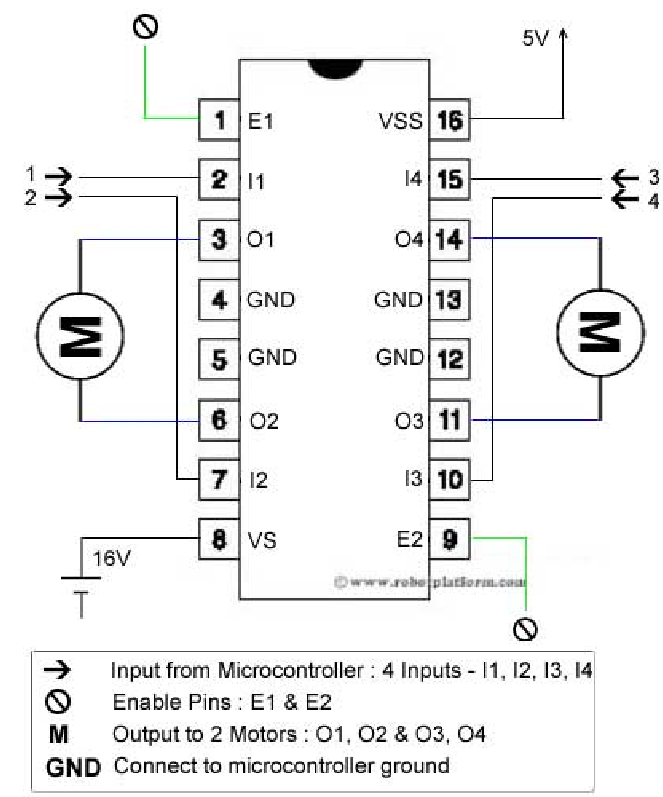

Fig. 5. L293D Pin Configuration

Each output is a complete totem-pole drive circuit with a Darlington transistor sink and a pseudo Darlington source. Drivers are enabled in pairs, with drivers 1 and 2 enabled by 1,2EN and drivers 3 and 4 enabled by 3,4EN. The L293 and L293D are characterized for operation from 0C to 70C.

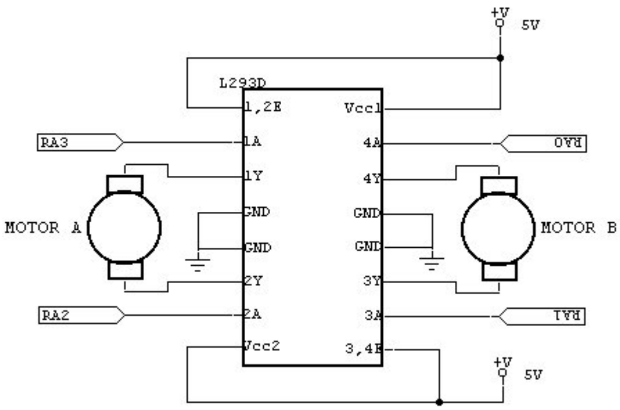

Fig. 6. H Bridge Connection

IV. Experimental Setup

PIC18F4550 is the core of this whole system. The input from the FLEX sensors have been fed into RA0 and RA1 pin as analog pin input . This whole input sequence was taken sequentially in a loop. These two analog signals are converted to numeric value stored in ADRESH register. If it cross a certain threshold it is considered as triggered and consider the FLEX is in ON state. The two flex state can create 4 truth table state - STOP , MOVE FORWARD , MOVE RIGHT , MOVE LEFT.

A program is written to execute this four states by outputting required bit for the L293D drive . Stop code - 00 00 , Move Forward - 01 01 , Move Right - 01 00 , Move Left - 00 01 . This output bits are fed through Digital pin ranging from RB0 to RB3 .

The motor driver takes output from PIC as input and drive the motors accordingly.

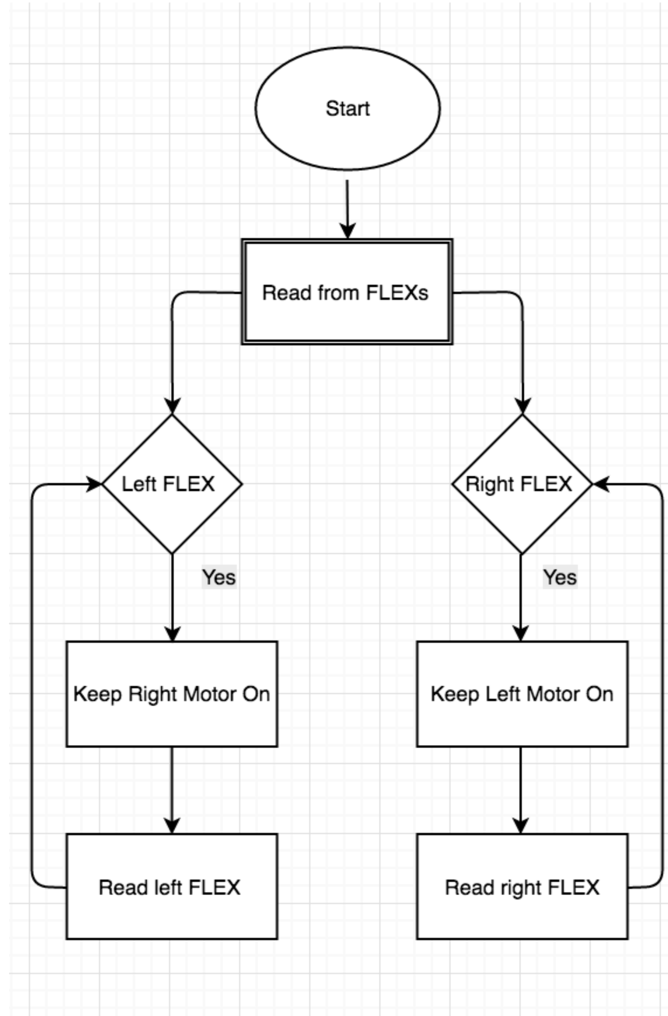

Fig. 7. Flow Chart of Algorithm

V. Result

For testing the system, flex sensors are bent to see if the system outputs desired result. When the left flex was bent the right motor started moving resulting in moving the locomotor to the left , when the right flex was bent the left motor started rolling resulting in moving the locomotor to the right , when both sensors was bent both motor started rolling resulted in going straight forward.

So the system was working as expected. It performed necessary tasks as per the input given by two flex sensors.

VI. Conclusion

This system sets a path to control any motorized digital system with bare minimum physical movement. This system paves the way to control every possible electronics with the movement of fingers. It was observed while testing that though theoretically PIC18 can provide 5V to its output PIN which is enough for operating most of the electrical devices practically this is not always true. Due to internal resistance voltage drop occurs so it is better to use necessary amplifiers while building this with industry grade quality.

Otherwise this system really works as described and really easy for any handicapped person with neuro dysfunction diseases causing motor movement limitation.

VII. Future Work

This project can be improved by including wireless technology between input and output terminal. In this way this system will be mobile and pave the way for more functionality. IOT can be included so that the health and other status of intended target user mostly handicapped patient can be observed remotely by the doctors and relatives. As PIC is not ideal solution for these kind of wireless serial communication. More updated Microcontroller technology can be used here for better performance and functionality.

References

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[2] DesPortes K., Kumar J., Dzegede Z. Flexicopter. ECE 4760: Final Project Cornell University Available online at- https://goo.gl/CxmfXZ