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RESEARCH ARTICLE

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A low cost EOG based design for wheelchair control

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ABSTRACT

A low cost and precise Electro-oculogram based device control is an active area of research and our present attempt is to design such a system to support severely disabled people to control the movement of wheel chair based on just eye movements. In present design we have successfully developed an EOG sensing circuit using off-the-shelf components as against standard procedures of using expensive instrumentation amplifier IC's and standard ECG/EMG cables. The instrumentation amplifier is designed using Rs.10/- Opamp IC TLO84. The cable used is cheap ordinary shielded 3 core cable. The results are quite satisfactory and system worthy of future development.

Key Words: Electro-oculogram, instrumentation amplifier, 0.1Hz HPF, 30Hz LPF, 50Hz NOTCH FILTER, PIC, DC motor

INTRODUCTION

Electro-oculogram based device control is mainstay of bio-medical field. Here the user can have facility of controlling devices using just movements of the eye. There exists a small potential difference across human eye in horizontal direction, in the range of 1 to 100uV whose magnitude and polarity depends on eye movement direction and angle of eye movement. Such small signals when properly amplified and filtered can be brought to use for signal processing and control signal generation for power devices using suitable microcontroller. Our present attempt is to use such a theme and design a system to control wheelchair based on just eye movements.

Of course such an attempt is not new and there are several examples of intelligent systems designed to assist disabled people in their movements with wheelchair. Where our system makes difference is in the design procedure employed. The entire system is designed using off-the-shelf components and therefore is very low cost. We have tried to go against the standards/favorite procedures of using expensive instrumentation amplifier IC and standard ECG/EMG cables used in bio-medical sensing.

Traditionally, amplification of uV level signals is done using precision instrumentation amplifier IC such as AD620/INA118 and in our case it is designed using Rs/-10 Opamp IC TLO84. The reason is low input bias current, high input impedance and low output impedance. The filter stages are designed using

LM324 which is again low cost. Thus a single channel EOG sensor consists of 2 Opamp IC's and few passive components. The cable used is the ordinary 3 core shielded wire available local electronic store and contacts with Ag-AgCl pads are done using small alligator clips.

EOG signal sensing and control signal generation for driving motors of wheelchair is done using PIC based general purpose microcontroller board.

The idea of wheelchair movement is demonstrated using two 12V DC motors. Differential drive mechanism is used to get left/right movement of wheelchair. And forward/reverse motion is as usual.

2. RELATED WORK

We got motivation from some of previous ideas implemented like..... Obviously the idea of DC motor speed control is not new. Particularly speaking, for the kind of motor we use in our project. We can find numerous authentic websites demonstrating speed control with help of PIC microcontroller[2] and L293D[3] which is a motor driver IC. In most cases potentiometer is used to demonstrate speed control using PWM capabilities of PIC microcontroller.

3. PROPOSED SYSTEM

Fig 1 shows the block level representation of system. The picture with Human face shows placement of Ag-AgCl disposable pads for horizontal position sensing. The three wires including ground on forehead carries the raw uVolts level EOG signal to the signal processing board. The signal processing circuit consists of two Opamp IC's and few passive components which makeup Instrumentation amplifier, 0.1Hz HPF, 20Hz LPF and 50Hz notch filter. The signal processing circuit amplifies filters and makes the signal suitable for microcontroller sensing. The PIC based microcontroller board senses the EOG signal and generates proper control signal for the motor drive circuit. The motor drive circuit is implemented using L293D driver IC. It is used to change speed and direction of motor. The H-bridge motor driver IC L293D requires a +5volt for operation and a separate 0-24volt external supply for motor. Thus a separate 12V power supply is used to drive the motors. And +5V is given from microcontroller board. Motor used is 12volt/10 RPM rated motor.

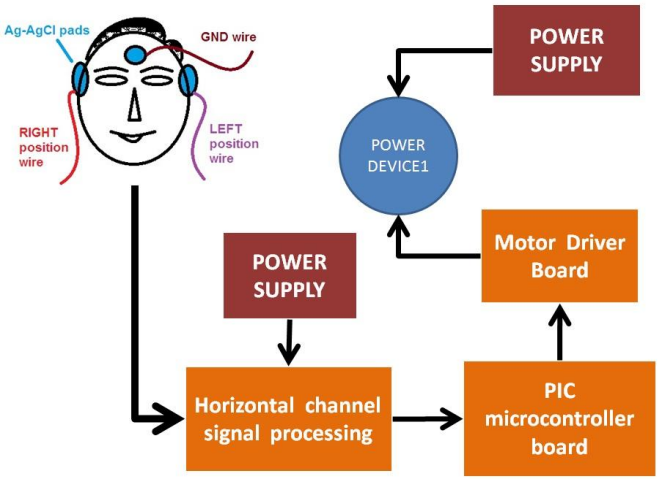

Fig -1: Proposed system

4. HARDWARE DESIGN

4.1 Signal Processing board

EOG signals caught from Ag-AgCl electrodes are in the range of 1 to 100uV and 0.1 to 30Hz. Also, they are severely corrupted by noise such as other bio signals originating on body, noise generated in circuit, and 50Hz mains noise. An extensive and well designed circuit is required to efficiently recover EOG signal from the raw signal. In our system the final goal of signal processing circuit is to bring raw EOG well enough to a level suitable for microcontroller sensing. That is to bring it to a level of 0 to 5volt variation. The resultant circuit is gives a signal well enough to be distinguished by microcontroller. Fig 2 shows block level representation of signal processing setup.

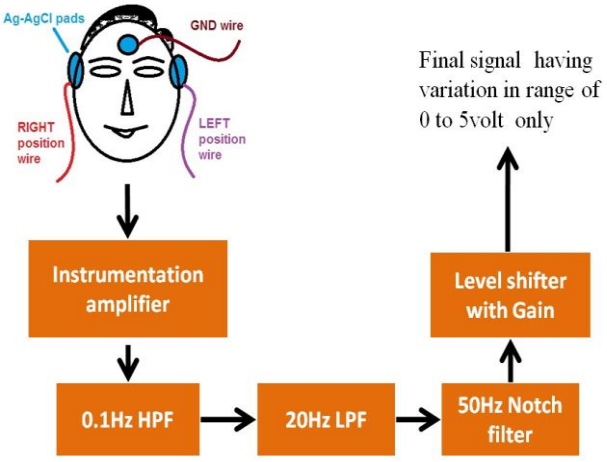

Fig -2: Signal processing circuit

4.2 Motor driver unit

Motor driver unit has IC L293D. The pin connections can be found in datasheet[3]. logic for changing direction of motor and controlling motion in Table 1. Table 1 indication the way pins must be configured for changing direction of rotation. Pins 2 and 7 of L293D are connected to PIC microcontroller pins4 and 5 respectively. These pins are used to control direction of rotation. Pin1 of L293D connected to PWM pin3 of PIC microcontroller. This pin is used to control speed of rotation. Values written in the range of 0-5 volt on this pin change the speed of motor from 0-max rated.

4.3 Power supply

External 0-24volt supply required for Motor. The supply is in actual connected between Pin8 of L293D and Ground. PIC microcontroller board itself receives power from separate +5volt power supply.

Table -1: LOGIC TABLE FOR H-BRIDGE IC L293D

EN	1A	2A	FUNCTION
HIGH	LOW	HIGH	Turn CW
HIGH	HIGH	LOW	Turn CCW
HIGH	LOW	LOW	Stop
HIGH	HIGH	HIGH	Stop
LOW	Ignored	Ignored	Stop

5. SOFTWARE DESIGN

5.1 PIC code

PIC microcontroller code is written in C using the MPLab IDE and HItech PIClite c compiler. Analog pins are used for sensing High and Low level of signal. Left and Right movement distinction is made based on High and Low level of signal. The flowchart corresponding to PIC microcontroller code is shown in fig 3.

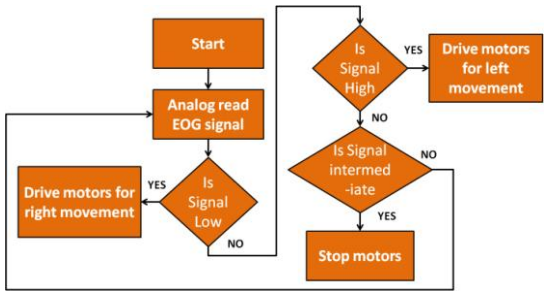

Fig -3: Flowchart for PIC microcontroller code

6. RESULT

Fig5-6 show the photographs of actual setup in running mode and fig7. shows PC based User interface. Fig8-9 give more closer look. In the user interface we can see RPM readings displayed in text window.

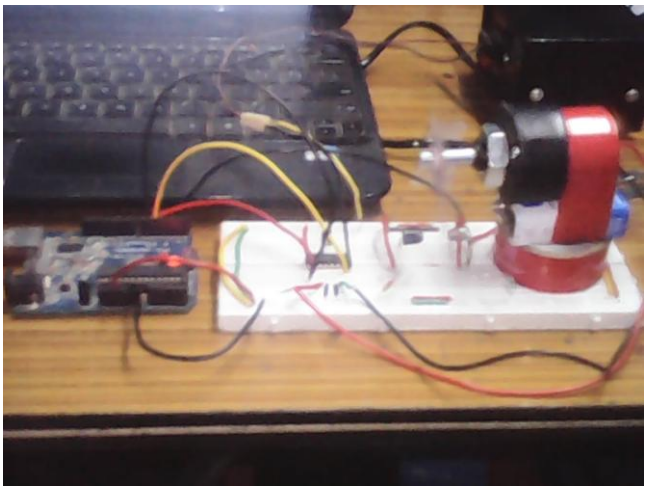

Fig -5: Running Demo

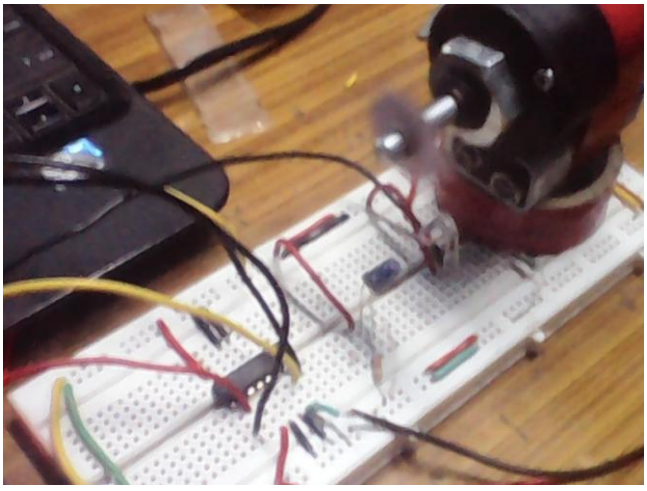

Fig -6: Running Demo (zoom)

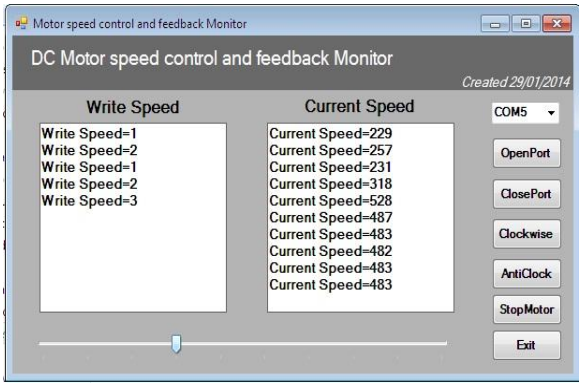

Fig -7: Running PC application

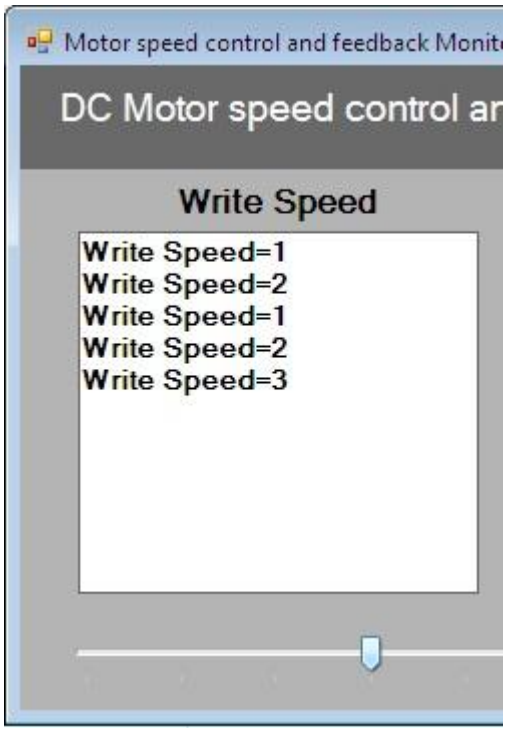

Fig -8: Running PC application (zoom)

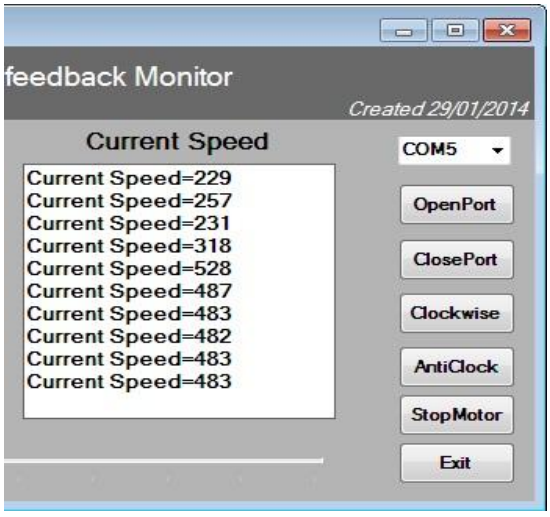

Fig -9: Running PC application (zoom)

CONCLUSIONS

Since the magnitude of signal for vertical channel is comparatively low, gain adjustment policies are to be considered separately for horizontal and vertical channel. System was tested for normal and disabled people and amount of training period required for proper use of system was studied and was found to be fairly low. Considering already existing research on EOG based wheelchair control, we are confident enough in proposing this low cost design. We hope that we can improvise on this in future.

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