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Robotic Wheelchair Using Eye Blink Sensors and Accelerometer Provided with Home Appliance Control

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ABSTRACT
According to a new report prepared jointly by the World Health Organization and the World Bank, 15 percent of the world's population is disabled. 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 is a tedious task for severely handicapped persons, unless they use the tongue to control the joystick. Simultaneously blind and paraplegic people deal with two problems, which creates uneasy situation for them, i.e locomotion and localization. Different systems are being developed to overcome the problems described above, allowing the end-user to perform safe movements and accomplish some daily life important tasks. Our Robotic wheelchair uses eye blink and head tilt movement to steer the wheelchair. In addition, we can give more independence to the disabled person by using the same head-tilt movement to communicate with the devices in a room for example: a fan. This communication is done using a RF transmitter and receiver. Using this, the person can control various devices easily.

Keywords **-** Accelerometer, Eye Blink Sensor, Handicapped, Microcontroller, Paraplegic

I. INTRODUCTION

Wheelchairs were designed with the idea to help handicapped people to move around and accomplish daily life tasks, but what use would it be if the person is severely handicapped? Many smart wheelchairs have been designed and with more and more advances in technologies newer and smarter wheelchairs are coming into the market to help the severely handicapped persons. Our wheelchair is also an attempt to make use of simple and easy movements of the eye and head to start, stop and move the wheelchair. In addition we also connect the various devise in a room to the wheelchair and communicate with it through a RF module.

In section 2 we are briefing out the literature survey of the work done on wheel chairs. In section 3 we have described the implementation of our model of the wheelchair, in section 4 has advantages and disadvantages of this design, section 5 gives the result of our project.

II. LITERATURE SURVEY

There were many pervious works carried out on Smart Wheelchairs. These are a few of them which helped us get ideas for our current prototype.

In [1] they present a model that in which the users can command the wheelchair based on their eye movements, eye blinks, head movements, by sip-and puff and through brain signals. It also is provided with an easy to use and flexible graphical user interface on board a personal digital assistant, which is used to allow users to choose commands to be sent to the robotic wheelchair. Several experiments were carried out with people with disabilities, and the results validate the developed system as an assistive tool for people with distinct levels of disability.

In [2] they propose a new algorithm, the coherence algorithm, for eye movement tracking. Researchers continue to restore some functions lost by handicapped people using some powered electrical and robotic wheelchairs. This paper presents an application of eye tracking method to such wheelchairs. The coherence algorithm tracks the movement of eye towards left or right. The eye blinking feature is also used by the algorithm to control the starting and stopping of wheelchair.

Drawback: Eye blink is an involuntary action and if we try controlling the start and stop motion of the wheelchair through it will be difficult. Eye motion is difficult to control at times and becomes difficult to give directions to the wheelchair.

In [3] they present an interface that uses two different sensing techniques and combines both results through a fusion process to obtain the minimum-variance estimator of the orientation of the user's head. Sensing techniques of the interface are based on an inertial sensor and artificial vision. The orientation of the user's head is used to steer the navigation of a robotic wheelchair. Also, a control algorithm for assistive technology system is

presented. The system is evaluated by four individuals with severe motors disability and a quantitative index was developed, in order to objectively evaluate the performance. The results obtained are promising since most users could perform the proposed tasks with the robotic wheelchair.

In [4] they paper describes a wheelchair for physically disabled people developed within the UMIDAM I Project. A dependent-user recognition voice system and ultrasonic and infrared sensor systems has been integrated in this wheelchair. In this way we have obtained a wheelchair which can be driven with using voice commands and with the possibility of avoiding obstacles and downstairs or hole detection. The wheelchair has also been developed to allow autonomous driving (for example, following walls).

In [5] they describe a comprehensive system for remote control of closely localized electric appliances. Our system enhances the interaction possibilities of people with reduced mobility in a twofold fashion: firstly, it enables the interaction with dumb appliances, for instance any standard electrical appliance; secondly, it supports two different interaction modalities suitable for people with movement impairments.

Using the ideas listed in the survey we developed a wheel chair for tetraplegia patients with the following objectives

1. To provide independence and mobility to a handicapped.
2. Eye blink sensors are used to provide mobility to the wheelchair.
3. Head tilting movement is used to give directions to the wheelchair.
4. RF remote control is used to connect various devices in the room to the wheelchair.

III. IMPLEMENTATION

A) Motors and Motor Driver

The prototype chair is implemented with a small chair and we use 60rpm motors to move the chair. 12V rechargeable battery is used to run the motors.

The truth table of the motors and the wheels are shown below

Input One	Input Two	Output
0	1	Forward
1	0	Backward
1	1	Stop
0	0	Stop

Table1: Truth Table Representing the Working of the Motor

We have connected 2 wheels together and each is controlled simultaneously, the truth table becomes as shown in table2

Motor 1		Motor 2		Direction
Input 1	Input 2	Input 1	Input 2	
0	1	0	1	Forward
1	0	1	0	Reverse
0	1	0	1	Right
1	0	0	1	Left

Table2: Truth Table for Controlling Two Wheels Simultaneously

B) Microcontroller

A microcontroller is an ‘all in one' processor, the processor, RAM, ROM, IO all on the one chip. Microcontroller is specific purpose device. P89v51RD2BN - is the microcontroller being used. It has an 8051 CPU and belongs to the same series. It is an 8-bit processor and has 40 pins. Microcontroller is used to control the device. The rest of the modules as shown in the block diagram are controlled by the microcontroller.

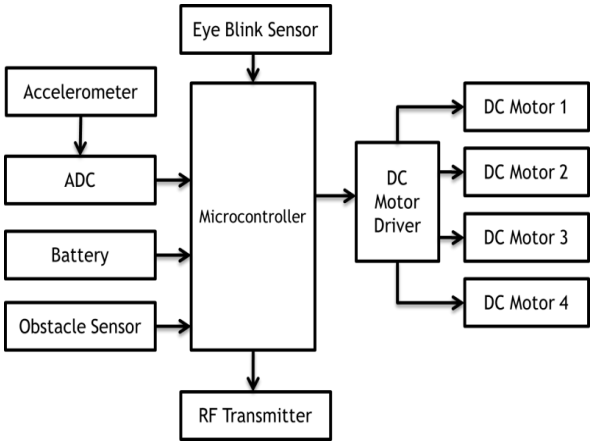

Fig1: General Block Diagram of Wheelchair Control

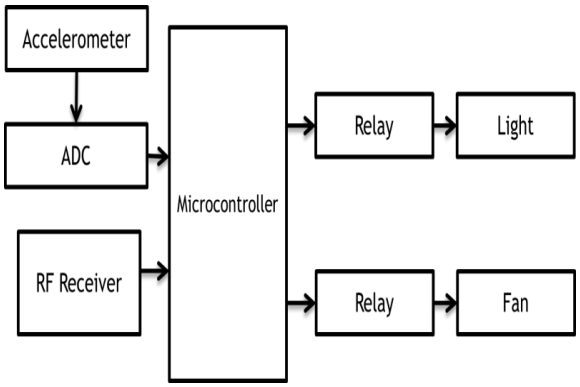

Fig2: General Block Diagram for Home Appliance Control

The wheelchair can be operated in two modes:

- Wheelchair control mode
- Home appliance control mode

The switching between the two modes is done using a toggle switch provided at the back of the head.

The eye blink sensor and accelerometer are programmed to control the movement of the wheelchair in wheelchair control mode and home appliances in home appliance control mode.

C) Eye blink Sensor

The wheel chair can be started and stopped by the eye blink movements. Eye blink sensor senses whether eye is open or closed. The eye-blink sensor works by illuminating the eye and/or eyelid area with infrared light and then monitoring the changes in the reflected light using a phototransistor and differentiator circuit.

5V (High) → LED ON When Eye is close.

0V (Low) → LED OFF when Eye is open.

We program the number of blinks required to start and stop the wheelchair.

For demo purposes in our prototype model we use IR002 sensor which is essentially an IR sensor.

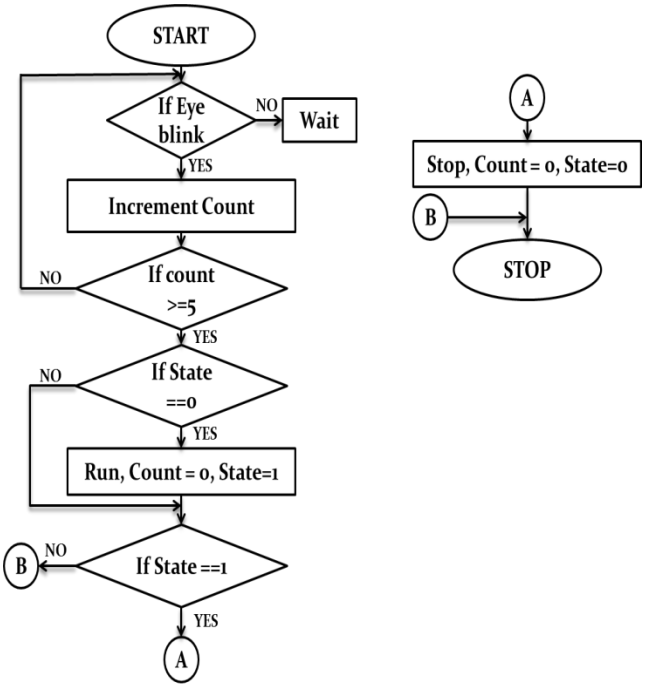

Fig3: Flowchart Representing the Working of the Eye Blink Sensor

There are 2 states for the wheelchair State 1(Run) and State 2(Stop), if the wheelchair is in State 0 and the eye is blinked 5 times or more it starts and moves to State 1. Similarly if the wheelchair is in State 1 and the eye is blinked 5 times or more it moves to State 0 and stops.

D) Accelerometer and ADC

The wheelchair is being directionally controlled through the head tilt activating a programmed accelerometer type head switch. [6]Accelerometers are devices that measure acceleration, which is the rate of change of the velocity of an object. They measure in meters per second squared (m/s^2) or in G-forces (g). A single G-force for us here on planet Earth is equivalent to 9.8 m/s^2, but this does vary slightly with elevation (and will be a different value on different planets due to variations in gravitational pull). Accelerometers are useful for sensing vibrations in systems or for orientation applications. The output of an Accelerometer IC is in terms of variable voltage linear to the acceleration or the tilt angle. The output of the accelerometer is in analog mode and the microcontroller uses digital signals and hence we need to use an ADC.it our system we use a

multichannel ADC since we use 2 axes if the accelerometer.

3 Axis Acceleration Sensor Board used is ADXL3XX from Analog devices and the ADC used is the ADC0809

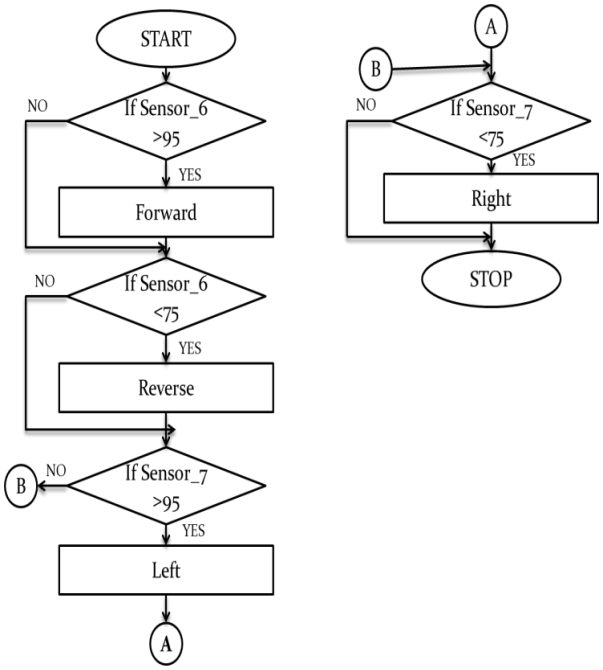

Fig4: Flowchart Representing the Working of the Accelerometer

We make use of any 2 sensors out of the 8 sensors available. If the values of the accelerometer reading exceeds a certain limits it performs the assigned functions as shown in the flowchart.

E) Home Appliance Control

In addition, we are trying to give more independence to the handicapped person by using the same head-tilt movements to control home appliances. This communication is done using a RF Transmitter/Receiver. Using this disabled person can control various devices easily.

i. Relay and RF Module:

A relay is a simple electromechanical switch made up of an electromagnet and a set of contacts. Relays are used where it is necessary to control a circuit by a low-power signal (with complete electrical isolation between control and controlled circuits), or where several circuits must be controlled by one signal. In our wheelchair we use a single pole 12V relay (VRS4H-S-DC12V-C). It has 2 wires connected to its ends, one is given directly to supply and the other if high switches on the device and if low turns off the device.

RF module comprises of a transmitter and a receiver. It operates at a frequency of 434MHz. RF transmitter receives serial data and transmits it wirelessly through RF through its antenna. The transmission occurs at the rate of 1Kbps - 10Kbps. The RF module is often used along with a pair of encoder/decoder. The encoder is used for encoding parallel data for transmission feed while reception is decoded by a decoder.

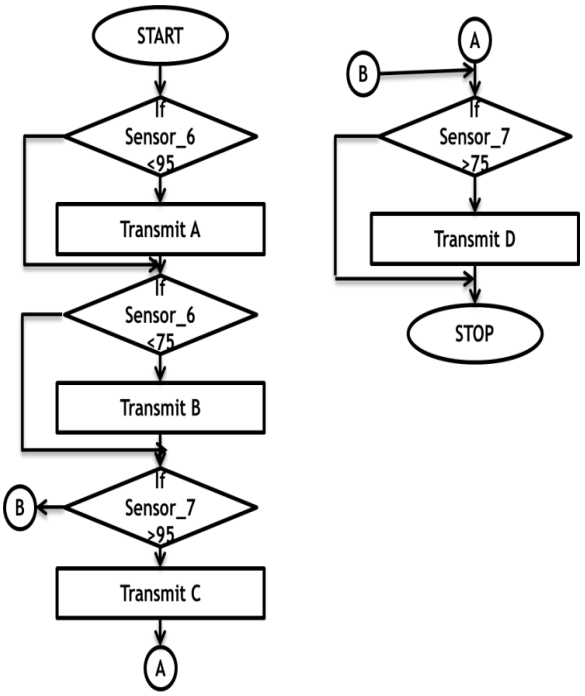

Fig 5: Flowchart at the Transmitter

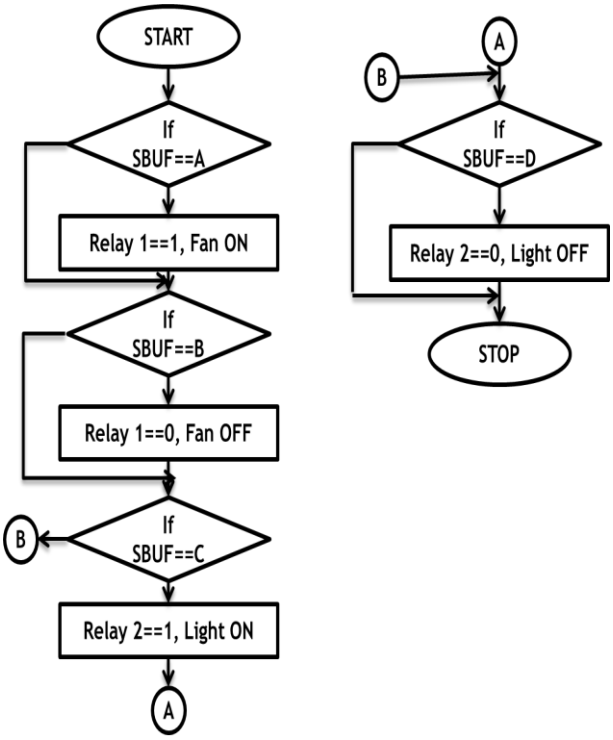

Fig 6: Flowchart at the Receiver

F) Obstacle Sensor

The obstacle sensor is placed at the bottom of the wheelchair. It is used to stop the wheelchair in case there is an obstacle and the eye blink sensor fails. The obstacle sensor stops the wheelchair completely and it must be reset to operate again. IR 002 sensor is used for this purpose.

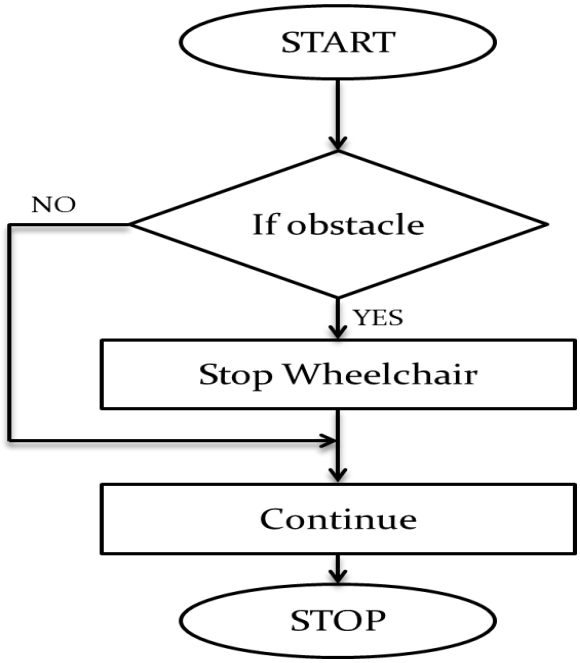

Fig 7: Flowchart Representing the Working of the Obstacle Sensor

G) Keil C Compiler and Flash Magic Burner

We are using the Keil C Complier software to program the microcontroller in Embedded C codes.[7] The Keil C51 C Compiler for the 8051 microcontroller is the most popular 8051 C compiler in the world. It provides more features than any other 8051 C compiler available today. The C51 Compiler allows you to write 8051 microcontroller applications in C that, once compiled, have the efficiency and speed of assembly language. Language extensions in the C51 Compiler give you full access to all resources of the 8051.

Flash Magic Burner is an application for programming microcontrollers. The program will automatically verify the chip after the Hex file is loaded to it.

IV. ADVANTAGES AND DISADVANTAGES

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.

DISADVANTAGES

1. Expensive

V. RESULTS

The wheelchair that is controlled by Eye Blink Sensor and the Accelerometer is successfully designed. We are also able to control the various devices in the room from the wheelchair itself using the Accelerometer.

Fig 8: Steering of the wheelchair using the accelerometer

Fig 9: Working of the devices attached to the wheelchair

VI. CONCLUSION

This paper presents the model of a wheelchair that is controlled using eye blink sensors and accelerometer. Eye blink sensor is used to control the start and stop motion of the wheelchair. The

accelerometer is controlled by the head tilt motion and is used to steer the wheelchair. Along with making the movement and control of the wheelchair easy for a handicapped person we also try to give more independence to these people by provided a way to communicate with the various devices in the room again using head tilt motion and through a RF transmitter receiver.

We have only made use of eye blink and head tilt movements, various other activities of the face like sip and puff can also be used to command the wheelchair. We could use other devices like the Bluetooth, Zigbee to communicate with the various devices in the room.

VII. ACKNOWLEDGEMENT

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