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Hand movements based control of an intelligent wheelchair Using Accelerometer, obstacle avoidance Using Ultrasonic and IR sensors

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Abstract:- The number of Physically Challenged people, who wants to move around with the help of some artificial means, whether through illness or an accident, is continuously increasing. Driving a wheelchair in domestic environments is a difficult task for a normal person and becomes even more difficult for people with arms or hands impairments. In this project we used Accelerometer, ultrasonic and infrared sensor systems has been integrated in this wheelchair. We have a Pre fabricated Wheel Chair which can be driven with using Accelerometer and with the possibility of avoiding obstacles using IR sensor and downstairs or hole detection using Ultrasonic Sensor. Intended users control the system by wearing a glove fitted with accelerometer for controlling the movement and direction of the wheelchair. The MEMS sensor senses the angle of the hand, i.e. according to the tilt of hand it gives voltages to microcontroller. The main advantage of this wheelchair is low cost, low power consumption, easy to control.

Keywords:- Wheelchair, ADXL335 Accelerometer, GSAS 51E Microcontroller Board, GSAS ADC0816, IR Sensor, DC Motor Driver, Battery, DC Motors, Physically Handicapped.

I. INTRODUCTION

In today's time, an estimated 1% of the world's population needs a wheelchair. An increased percentage of elderly and disabled people who want to enhance their personal mobility, for them wheelchair is the best assistive device. A disabled or an invalid individual (usually the disability of the lower part of the body) can find it convenient to move around and maneuver using the help of a chair constructed on wheels which can either be pushed by another individual or propelled either by physical force or electronically. Such a chair is called as a Wheelchair.

Traditional wheelchairs have some limitations in context to flexibility, bulkiness and limited functions [1]. Some existing wheelchairs are fitted with pc for the gesture recognition [2]. But making use of the pc along with the chair makes it bulkier and increases complexity. This complexity is reduced by making use of the MEMS accelerometer [3-4], the size of which is very compact and can be placed on the fingertip.

They used eyebrow muscle activity to obtain required signal. By using the signal the wheelchair movement has been controlled as the movement of the eyebrow was not easier so it had some difficulties. [5] Used head and finger movement for wheelchair locomotion. In finger movement they use flex sensor, placed on the finger. It is analog resistors usually in the form of strip long vary resistance. Due to the bending of finger the resistance varies which controls the locomotion of the wheelchair. Bending the sensor at one point more than 90 may permanently damage the sensor which is a main drawback.

The NavChair Assistive Wheelchair Navigation System, The NavChair shares vehicle control decisions with the wheelchair operator regarding obstacle avoidance, safe object approach, maintenance of a straight path, and other navigational issues, to reduce the motor and cognitive requirements for operating a power wheelchair.[6]

Touch Screen Based Direction and Speed Control of Wheel Chair for Physically Challenged, when we want to change the direction, the touch screen sensor is modeled to direct the user to required destination using direction keys on the screen and that values are given to micro-controller. Depending on the direction selected on the touch screen, micro-controller controls the wheel chair directions. [7]

In [2] this proposal is of a concept of the wheelchair which consists of 3axis accelerometer, LCD display, DC motors, Relays, IR sensor, Ultrasonic sensor and an AT89C51 Microcontroller. To avoid accident we have added IR sensor for obstacle detection and Ultrasonic sensor for hole or satires detection.

This paper proposes a system that can assist the disabled people to control the motion of their wheelchair by the hand movements wirelessly. The system proposed can be mounted on primary functioning body part to control the wheelchair movement i.e. hand, head. In accordance with these tilt readings microcontroller issues control signals which are transmitted relays of DC Motors. The Relays controls the DC

motors of the wheelchair on the basis of control signals received from accelerometer. Furthermore the operator can also control the speed of the wheelchair as we are using concept of PWM(Pulse Width Modulation) speed of wheel chair is controlled with amount of tilt of transmitter as the tilt increases speed of wheel chair is increasing and vice versa.

II. EXPERIMENTAL RESULTS AND DISCUSSIONS

Block diagram

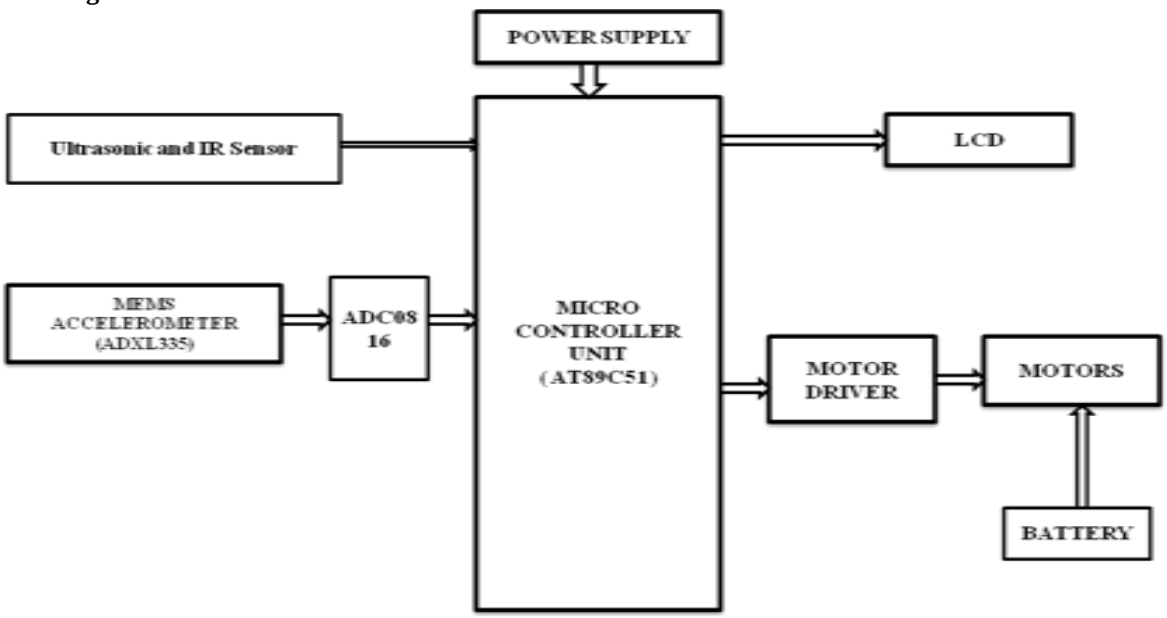


Fig1. Block Diagram

Accelerometer:

An accelerometer is an electromechanical device that will measure acceleration forces. These forces may be static, like the constant force of gravity pulling at your feet, or they could be dynamic - caused by moving or vibrating the accelerometer. An Accelerometer is a kind of sensor which gives an analog data while moving in X, Y,Z direction. In this project we have used ADXLL335 accelerometer. The ADXL335 is a complete 3-axis acceleration measurement system. It is having six pins those are Vcc, GND, ST (self Test). 3 axis sensing small, low profile package ,4mm x 4mm x 1.45mm LFCSP low power:350uA (typical) Single, operation: 1.8v to 3.6v 10,000g shock survival.

ADC0816:

This interface provides 16 Channel, 8-bit ADC (Analog to Digital Converter), based on ADC 0816 – 16 channel 8bit data acquisition device. Provision is made for on-board reference voltage generation using precision voltage regular LM 723. The interface has 20 pin terminal strip to feed in the analog voltages, the input signal voltage range is 0-5V. Outputs meet TTL voltage level specifications, No zero or full-scale adjust required, Standard hermetic or molded 40-pin DIP package, Temperature range −40°C to +85°C or −55°C to +125°C, Latched TRI-STATE output.

Ultrasonic Sensor

The sensor provides precise and stable noncontact distance measurements from about 2 cm to 5 meters with very high accuracy. You only need to supply a short 10uS pulse to the trigger input to start the ranging. Power supply: 5V DC, Quiescent current: <2mA, Effectual angle: <15°.The sensor will send out an 8 cycle burst of ultrasound at 40 kHz and raise its echo line high. It then listens for an echo, and as soon as it detects one it lowers the echo line again. The echo line is therefore a pulse whose width is proportional to the distance to the object.

IR (Infrared) Sensor

Obstacle Detecting Sensor is used to detect objects and obstacles in front of sensor in a narrow angle useful in robotics applications. Sensor keeps transmitting modulated infrared light and when any object comes near, it is detected by the sensor by monitoring the reflected light from the object. The range of IR sensor is Up to 10cm range for white object. Can differentiate between dark and light colors.

GSAS 51E Board:

8051 family of micro-controllers and its derivatives are increasingly becoming popular for instrumentation and control applications due to its speed and powerful instruction set which are essential for real-time applications. This has created the need for a good trainer and development tools.

GSAS 51E (an economically priced microcontroller trainer) provides a complete solution for this requirement. It can be used as a flexible instructional aid in academic institutions and as a powerful development kit in R&D Labs.

The system firmware provides stand-alone monitor, serial monitor, one-line assembler, dis assembler, driver for EPROM programmer and Parallel printer interfaces. GSAS 51E is supplied with comprehensive and user-friendly documentation as well as windows based communication software with online-help. The GSAS 51E trainer communicates with host PC through its onboard USB or RS-232C in serial mode.

The main **features** of this GSAS 51E are:

- GSAS 51E operates on single +5V power supply either stand – alone mode or with host PC through its USB or RS-232C interface in serial mode.
- Stand-alone and serial monitor, support the entry of user programs, editing and debugging facilities like single stepping and full speed execution of user programs.
- On-board memory is 128K bytes of which 88 Kbytes RAM has battery backup provision.
- Total on-board memory is 128K bytes of which 88K bytes RAM has battery backup provision.
- 48 I/O lines and four programmable interval timers.
- 9 Port lines of MCU brought out to the right angle ribbon cable connector including INT1.
- Buffered Bus Signals are available through flat ribbon cable connector for easy system expansion.
- Driver Software for file upload/download to/from host PC.

Motor Driver

One popular type of motor drive circuits is the H-Bridge (sometimes called: the Full Bridge). It has been named that because it looks like the letter H when viewed on the discrete schematic. An H-Bridge is an electronic circuit that allows the voltage to be applied on the load in either direction. It is used to allow DC motors to operate in two opposite directions i.e. forward and Backward. The direction of rotation of a series motor can be changed by changing the polarity of either the armature or field winding.

Motors

In this project two 24V Series DC motors were used. The direction of rotation of a series motor can be changed by changing the polarity of either the armature or field winding, 24 Volt,12 Nm Torque,1 & 2 speed heavy duty rocker switched available, Adjust wiper angles from 40˚ to 130˚ Coast to park motor, Left or right hand side park,1, 2 or 3 inch shafts, Pantograph & radial wiper arms, Flex blades.

Battery

We have used chloride safe power sealed acid battery. Having 12v,7Ah. These batteries are rechargeable. We have used four batteries for 24v motors driving purpose.

LCD

Used for displaying output 4x16 line LCD is used. Number of Characters: 16 characters x 4 Lines. Character Table: English-European (RS in Datasheet). Duty: 1/16 ,View direction: Wide viewing angle .Backlight Type: yellow/green LED.Operating Temperature: -20°C to + 70°C

III. METHODOLOGY

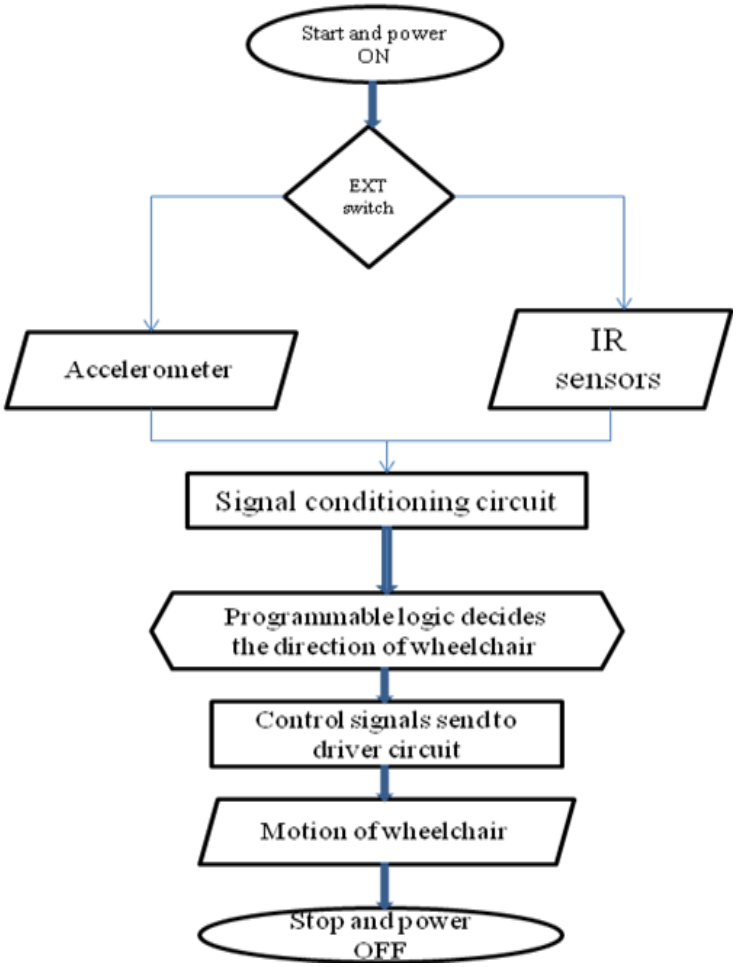


Fig2. Flow chart

IV. FLOW CHART OF ACCELEROMETER OPERATION

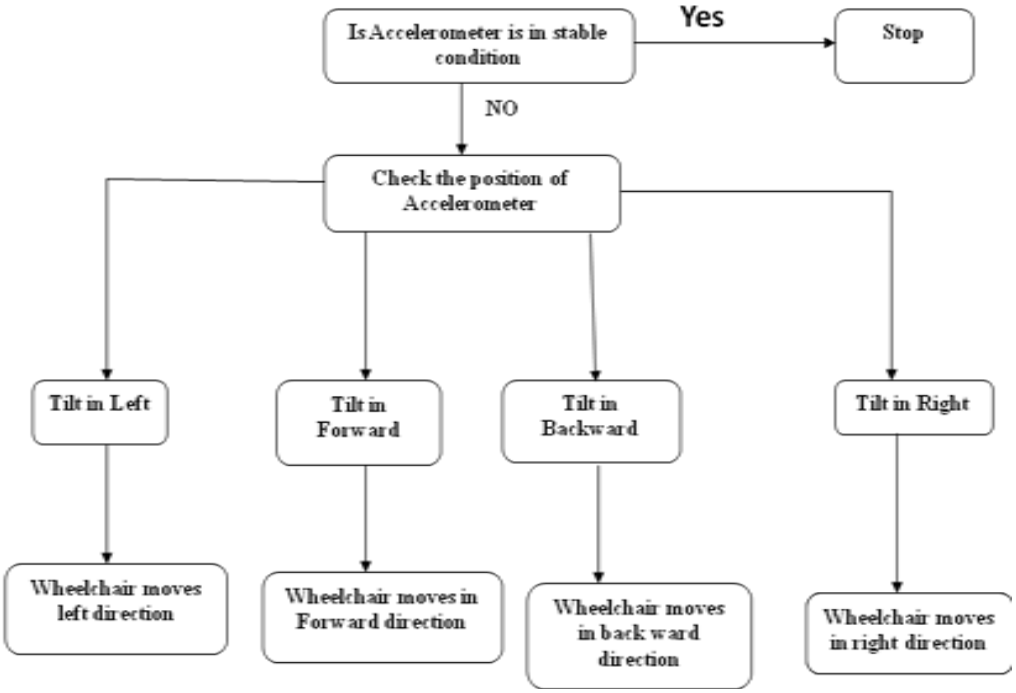


Fig3. Accelerometer controlling flow chart

The wheelchair is going to be controlled two modes. One is Accelerometer and other on is IR sensors mode. Initially we have to decide which mode we what to control wheelchair. Based on the given condition it is going to be operated.

In the transmitter circuit, as shown in fig.1, we measure the value of 3Axis accelerometer (ADXL335)based on the hand movement and converted into digital with the help of ADC 0816. ADC converts the data from sensor and proceeds to the microcontroller for further conversion. Microcontroller gets the hex data from the accelerometer. LCD display the corresponding directions Messages i.e. Left for –X direction, Right for +X direction, Forward for +Y direction, Back for –Y direction and Remaining any condition it will stop. At the same time microcontroller gets the data and compare inside with pre-defined values. As we change the position of hand, values are change automatically and corresponding messages are shown on the LCD.

In accelerometer we are getting 1.40v maximum for Positive X, Y directions, then 0.95v minimum voltage for negative X, Y directions, for stable condition we are getting 1.14v. so by using these values we have given conditions to microcontroller board to control wheelchair. Accelerometer giving analog values but the microcontroller will takes only hexadecimal values. For that we have used 16 channel ADC0816 board. Here we are taking ch1,ch2,ch3 for Xout, Yout, Zout respectively. The reference voltage we set for ADC0816 board is 3v. In this project we have used the programming language as assembly language program. So we have written the code for analog to digital conversion of Accelerometer output analog data. When we get the analog data for accelerometer it is converted in to digital and stored in the memory location of microcontroller is 8190,8191,8192 locations of X,Y, Z respectively. Then after we have written the comparison program by using these values and predefined values in the program. If the values we get from accelerometer is matched with the predefined values, then corresponding direction message is going to displayed in the LCD display of GSAS 51E board and corresponding DC motors relays are going to be ON/OFF. We have written assembly language program for corresponding relays ON/OFF.

In this project we are using Ultrasonic and IR (infrared) sensors for obstacle detection and hole, steps identification. For that we have written an assembly language code we are using the Interrupts. In the code we have written that when accelerometer is in active mode if we get any IR or Ultrasonic sensors are active all the current processes are going to be stop i.e. if any direction we are getting from accelerometer are could not execute. So in these way we can identify any obstacle or steps, holes in the way of wheelchair.

The below table shows that accelerometer corresponding axis directions.

DIRECTION	ACCELEROMETER ORIENTATION
FORWARD	+Y
BACKWARD	-Y
RIGHT	+X
LEFT	-X
STOP	REST

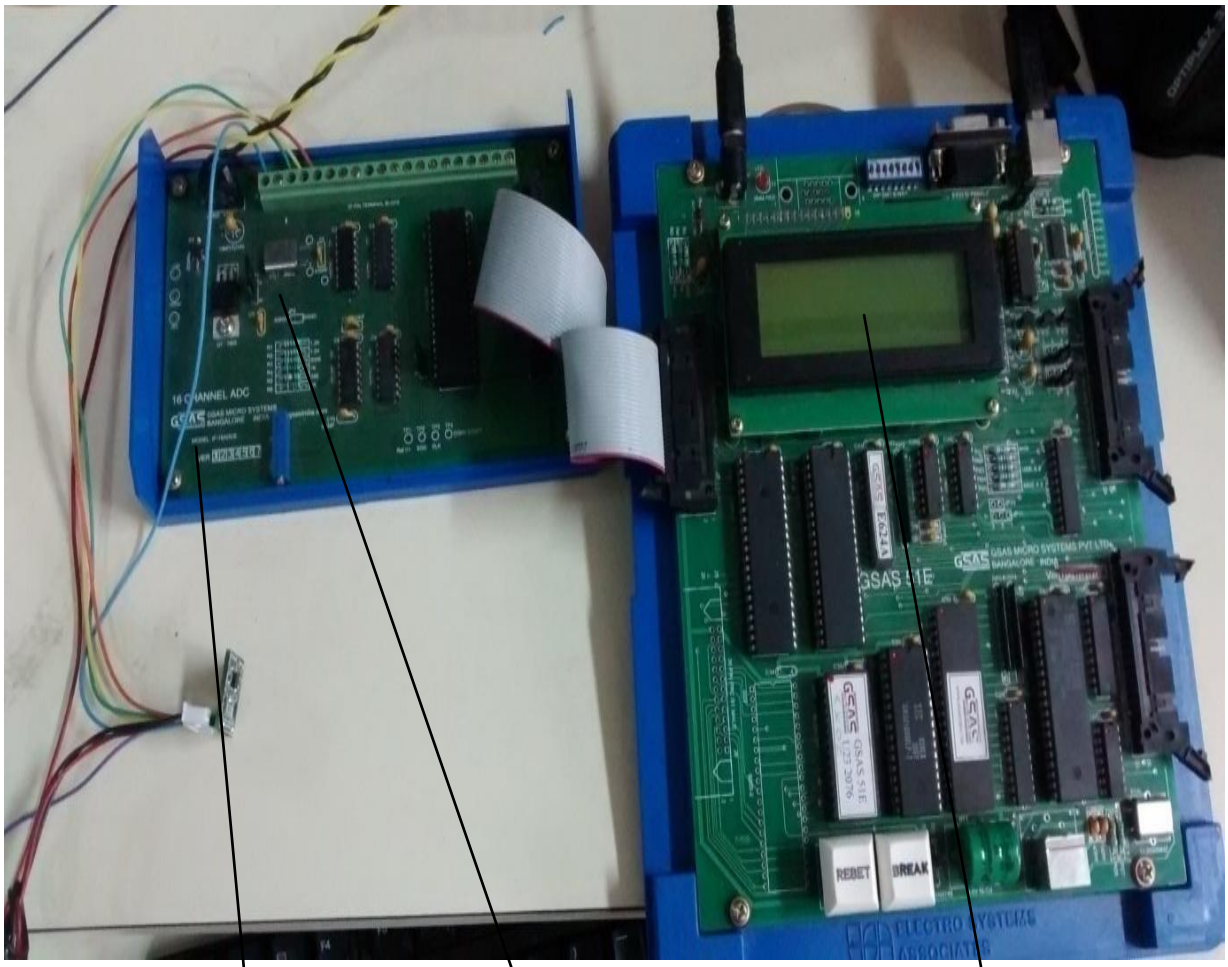
Table1. Directions indication of Accelerometer

The below table show s that corresponding relays transistor ON/OFF values. Based on these values the wheelchair is going to changing its direction and corresponding DC motors are going to be ON/OFF.

Direction	Left motor		Right motor	
	Transistor 1	Transistor 2	Transistor 3	Transistor 4
Non	0	0	0	0
Forward	1	1	1	1
Reverse	0	1	0	1
Right	0	0	1	1
Left	1	1	0	0

Table2: Relays ON/OFF conditions

Below diagram shows the interfacing of ADXL335, GSAS ADC0816 and GSAS 51E Microcontroller board.



ADXL335 (Accelerometer) ADC0816 Board GSAS 51E Microcontroller Board

Fig4. Accelerometer, ADC0816 and GSAS51E Board interfacing

Fig5. Complete wiring of Batteries with board.

Fig6. Interfacing of motors with wheels

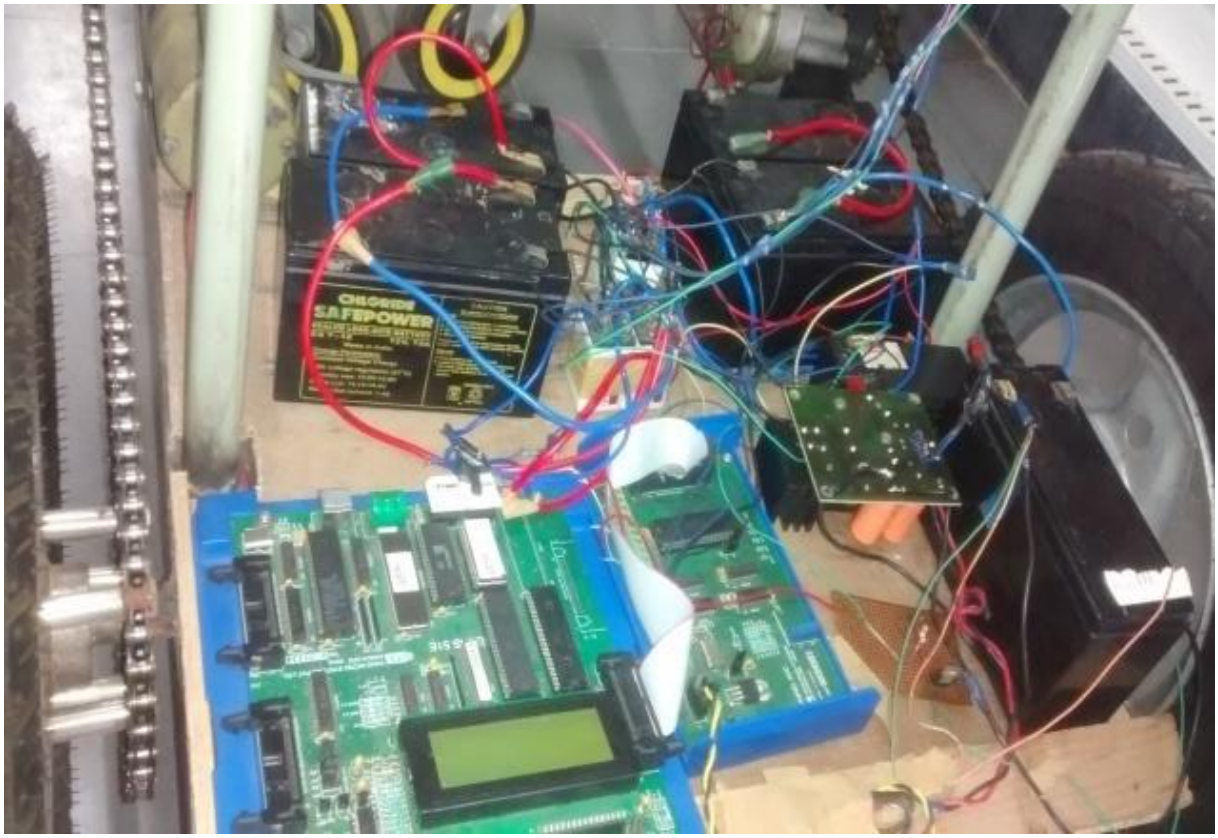


Fig7. Complete wiring connections with batteries, Motors and Wheels of wheelchair

Fig8. Complete Accelerometer controlled wheelchair with a man operating

V. CONCLUSION

We are implementing automatic wheelchair which has various advantages. It is operating in two different modes i.e. accelerometer mode and IR sensor mode. Also there two types of sensors (Ultrasonic, IR (Infrared sensor)) used for obstacle and steps, hole detection. This Wheelchair will be economical and can affordable to common people.. This system can be made highly efficient and effective if stringent environmental conditions are maintained. The running cost of this system is much lower as compare to other systems used for the same purpose. Our work is to control Wheelchair by accelerometer where the wheelchair is programmed to reacts according to the motion of accelerometer (forward, reverse, stop, left and right). The movement is recognized by ADXL335 is used to control the motion of the Wheelchair. Also the accelerometer sensor is calibrated such that it produces particular analog voltage for a corresponding tilt.

VI. FUTURE WORK

This system can be extended by including GSM which sends an SMS during emergency by assigning particular gesture command. By including GPS, position of the wheelchair can also be known.
Work is at present being carried out on the incorporation of a new interface so that the user can give orders on guiding based on eye movement.

Wheel chair can be fitted with direct mind reader. For example, if a person is paralyzed and cannot move his body parts, in that case it can be used.

Improvements can be made by using various body gestures such as eye gaze, leg movement or head movement accordingly.

Generally the pulse rate of an ordinary person is 72 bits/min. If the pulse rate increases or decreases nearby 72 bits/min then the signal will make the wheelchair to halt immediately at current position and it will activate the alarm system. This will tend others to know about the situation and position of the patient.

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