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"Automatic wheelchair for physically disabled persons"

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Abstract - This project is on automatic wheelchair for physically disabled people. 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 automatic wheelchair which can be driven using voice commands and with the possibility of avoiding obstacles by using infrared sensors and down stairs or hole detection by using ultrasonic sensors. The wheelchair has also been developed to work on movement of accelerometer which will help for the person whose limbs are not working. Accelerometer can be attached to any part of body of physically disabled person which he can easily move like head , hand etc. It has also provision of joystick for disabled person who can easily move his/her hand. Electronic system configuration, a sensor system, a mechanical model, voice recognition control, accelerometer control and joystick control are considered.

Index Terms **—accelerometer, infrared sensor ,joystick, robotics,ultrasonic, voice recognition**
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I. INTRODUCTION

Robotics Wheelchairs extend the capabilities of traditional powered devices by introducing control and navigational intelligence. These devices can ease the lives of many disabled people, particularly those with severe impairments by increasing their range of mobility.

For handicapped people human found a wheel chair which can be moved by using hands for those who don't have legs. But the peoples who don't have legs as well as hands cannot move their wheel chair self. They need some other person to move their wheel chair. But sometimes such person faces so many problems if they didn't get any person to move their wheel chair.

Fig1. model of wheelchair

This project "Auto Wheel Chair" aims to resolve the above mentioned issue. In this project we are going to make a wheel chair which can be controlled automatically as well as manually. This wheel chair controlled manually through head of the person sitting on it. He/ she just need to move his/her hand into the direction it wants to move by using accelerometer. In automatic control user just need to press keys for saved destination. Then the wheel chair will automatically move into the direction of saved destination by

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using encoder wheels. This chair also provide the another feature i.e. it can be operated by speech. The proposed Speech Recognition Based Wheelchair Operation allows physically isabled person to control the wheelchair easily without the need to use hands. The movement of the powered wheelchair depends on the motor control and drive system which consists of microcontroller and motor driving. Once the voice recognition system recognizes the voice commands in comparison to the stored memory, the respective coded digital signals would be sent to the microcontroller which then controls the wheelchair accordingly.

II Block diagram

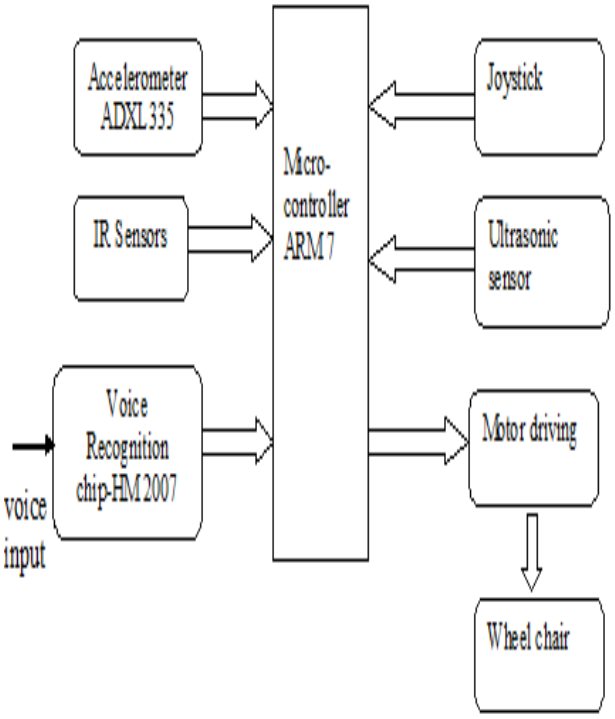

Fig 2. Block diagram

The block diagram can be described as follows:

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1) The speech is recognized by the HM2007 IC and processed thus giving commands to the microcontroller accordingly and hence to the robot.
2) When accelerometer moves or tilt his position thus gives analog signal to microcontroller and convert it in appropriate digital level so as to move the motors of wheelchair.
3) Infrared sensors is used detect the obstacle .If any obstacle is detect then it gives signal to arm7 and it will stop the motor s.
4) Ultrasonic sensors is used detect the down stair .If any hole or down stair is detect then it gives signal to arm7 and it will stop the motors.
5) Microcontroller controls the movements of the robot.

1] Voice Recognition Module

The speech recognition module basically consists of:

I)Voice Recognition Chip

It is the heart of the entire system. HM2007 is a voice recognition chip with on-chip analog front end, voice analysis, recognition process and system control functions. The input voice command is analyzed, processed, recognized and then obtained at one of its output port which is then decoded , amplified and given to motors of robot. The chip provides the options of recognizing either forty 0 .96 second words or twenty 1.92 second words. This circuit allows the user to choose either the 0.96 second word length (40 word vocabulary) or the 1.92 second word length (20 word vocabulary). For memory the circuit uses an *8K X 8 static RAM*. The chip has two operational modes; *manual mode and CPU mode*. The CPU mode is designed to allow the chip to work under a host computer. This is an attractive approach to speech recognition for computers because the speech recognition chip operates as a co-processor to the main CPU. The jobs of listening and recognition don't occupy any of the computer's CPU time. When the HM2007 recognizes a command it can signal an interrupt to the host CPU and then relay the command code. The HM2007 chip can be cascaded to provide a larger word recognition library. The circuit we are building operates in the *manual mode*. The manual mode allows one to build a standalone speech recognition board that doesn't require a host computer and may be integrated into other devices to utilize speech control. The major components of this design are: a speech recognition chip, memory, keypad, and LED 7-segment display. The chip is designed for speaker dependent (one user) applications, but can be manipulated to perform speaker independent (multiple users) applications. The keypad and LED 7-segment display will be used to program and test the voice recognition circuit. The HM2007 is a single-chip complementary metal-oxide semiconductor (CMOS) voice recognition large-scale integration (LSI) circuit. The chip contains an analog front end voice analysis, recognition, and system control functions. The chip may be used in a stand-alone or connected CPU.

Features

1. Single-chip voice-recognition CMOS LSI.
2. Speaker-dependent
3. External RAM support
4. Maximum of 40-word recognition
5. Maximum word length of 1.92 s
6. Microphone support
7. Manual and CPU modes available
8. Response time less than 300 milliseconds (ms)
9. 5 volt (5V) power supply

II) Microphone: It takes the analog voice commands and sends it to voice recognition chip (HM 2007) in the form of electrical signal. The human ear has an auditory range from 10 to 15,000 Hz. Sound can be picked up easily using a microphone and amplifier.
Microphones are transducers which detect sound signals and produce a voltage or a current which is proportional to the sound signal. The most common microphones for musical use

are dynamic, ribbon, or condenser microphones. Besides the variety of basic mechanisms, microphones can be designed with different directional patterns and different impedances

III) Keypad: It is used for training/programming the chip. It also allocates definite memory locations to voice commands. The keypad is made up of 12 switches.

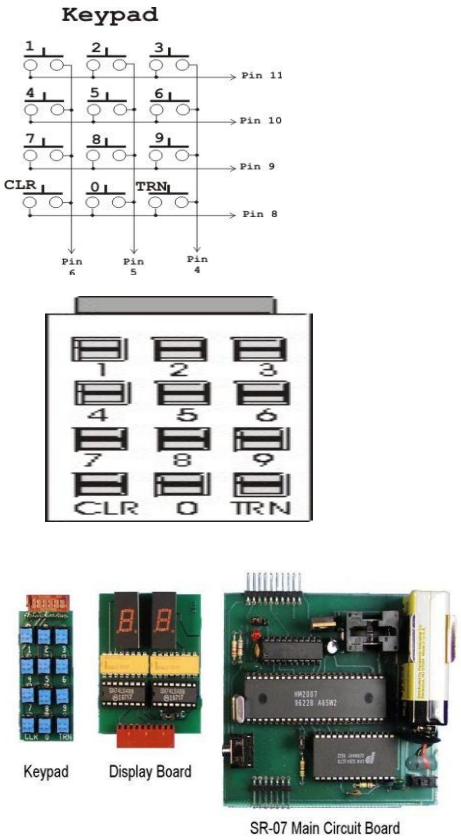


Fig3. HM2007 kit

When the circuit is turned on, the HM2007 checks the static RAM. If everything checks out the board displays "00" on the digital display and lights the red LED (READY). It is in the "Ready" waiting for a command.

IV) 7-segment Display: It is used to test the voice recognition circuit. The 7 segment display is used as a numerical indicator on many types of test equipment. It is an assembly of light emitting diodes which can be powered individually. They most commonly emit red light. Powering all the segments will display the number 8.
Powering a,b,c d and g will display the number 3. Numbers 0 to 9 can be displayed. The d.p represents a decimal point.

V) Applications and Drivers: A numeral to be displayed on a seven segment display is usually encoded in BCD form, and a logic circuit driver ON or OFF the proper segments of the display. This logic is also called decoder. Various decoders are available to drive common anode and common cathode displays. One of the easily available decoder is 7447 AND 7448 TTL decoders. They are open collector TTL that are designed to pull down common anode (7447 type) and common cathode (7448 type) through external current limiting resistors. We used **7448** decoder chip driving a common cathode seven segment display. 8k x 8 RAM: It stores decoded voice commands by the chip at the assigned locations.

VI) Output of Voice recognition module: The 8-bit output is taken from the output of the 74LS373 data octal latch. The output is not a standard 8-bit byte, but it is broken into two 4-bit binary coded decimal (BCD) nibbles. BCD code is related to standard binary numbers as Table below illustrates

Table 1. Binary and BCD numbers

Decimal	Binary	BCD
0	0000	0000
1	0001	0001
2	0010	0010
3	0011	0011
4	0100	0100
5	0101	0101
6	0110	0110
7	0111	0111
8	1000	1000
9	1001	1001
10	1010	0001 0000
11	1011	0001 0001
12	1100	0001 0010
13	1101	0001 0011
14	1110	0001 0100
15	1111	0001 0101
16	0001 0000	0001 0110
17	0001 0001	0001 0111
18	0001 0010	0001 1000
19	0001 0011	0001 1001
20	0001 0100	0010 0000

As you can see, the binary and BCD numbers remain the same until reaching decimal 10. At decimal 10, BCD jumps to the upper nibble and the lower nibble resets to zero. The binary numbers continue to decimal 15, and then jump to the upper nibble at 16 where the lower nibble resets. If a computer is expecting to read an 8-bit binary number and BCD is provided, this will be the cause of errors. Further since the module outputs nos.55, 66 and 77 as default value for errors and we want these outputs not to be used, we use microcontroller.

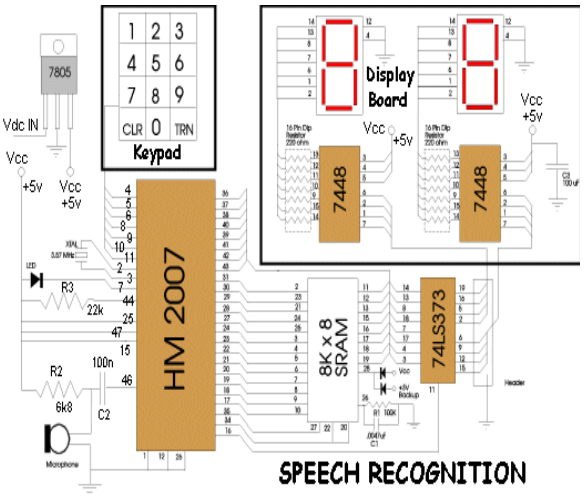


Fig4. Internal circuitary of speech recognition IC

VII) TRAINING AND RECOGNITION: To record or train a command, the chip stores the analog signal pattern and amplitude and saves it in the 8kx8 SRAM. In recognition mode, the chip compares the user- inputted analog signal from the microphone with those stored in the SRAM and if it recognizes a command, an output of the command identifier will be sent to the microprocessor through the D0 to D7 ports of the chip. For training, testing (if recognized properly) and clearing the memory, keypad and 7-segment display is used.

a) To Train: To train the circuit begin by pressing the word number you want to train on the keypad. Use any numbers between 1 and 40. For example press the number "1" to train word number 1. When you press the number(s) on the keypad the red led will turn off. The number is displayed on the digital display. Next press the "#" key for train. When the "#" key is pressed it signals the chip to listen for a training word and the red led turns back on. Now speak the word you want the circuit to recognize into the microphone clearly.The LED should blink off momentarily, this is a signal that the word has been accepted. Continue training new words in the circuit using the procedure outlined above. Press the "2" key then "#" key to train the second word and so on. The circuit will accept up to forty words. You do not have to enter 40 words into memory to use the circuit. If you want you can use as many word spaces as you want..

b) Recognition: The circuit is continually listening. Repeat a trained word into the microphone. The number of the word should be displayed on the digital display. For instance if the word "directory" was trained as word number 25. Saying the word "directory" into the microphone will cause the number 25 to be displayed.

c) Error Codes:

The chip provides the following error codes:
55 = word too long
66 = word too short
77= word no match

2] Robot assembly:

L293D is a dual H-Bridge motor driver, so with one IC we can interface two DC motors which can be controlled in both clockwise and counter clockwise direction and if you have motor with fix direction of motion then you can make use of all the four I/Os to connect up to four DC motors. L293D has output current of 600mA and peak output current of 1.2A per channel. Moreover for protection of circuit from back EMF output diodes are included within the IC. The output supply (VCC2) has a wide range from 4.5V to 36V, which has made L293D a best choice for DC motor driver.

A simple schematic for interfacing a DC motor using L293D is shown below.

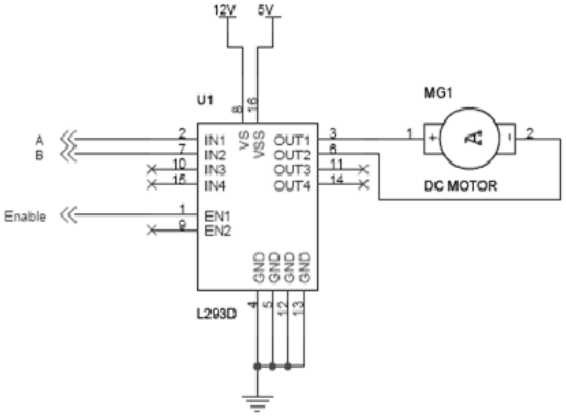


Fig5: motor driver IC.

As you can see in the circuit, three pins are needed for interfacing a DC motor (A, B, Enable). If you want the o/p to be enabled completely then you can connect Enable to VCC and only 2 pins needed from controller to make the motor work.

Table 2. Action of the motor wheels.

A	B	Description
0	0	Motor stops/breaks
0	1	Motor runs anticlockwise
1	0	Motor runs clockwise
1	1	Motor stops/breaks

As per the truth mentioned in the image above its fairly simple to program the microcontroller. It's also clear from the truth table of BJT circuit and L293D the programming will be same for both of them, just keeping in mind the allowed combinations of A and B. We will discuss about programming in C as well as assembly for running motor with the help of a microcontroller.

3] ACCELEROMETER:

Fig6. Accelerometer:

The ADXL335 is a small, thin, low power, complete 3-axis accelerometer with signal conditioned voltage outputs. The product measures acceleration with a minimum full-scale range of ±3 *g*. It can measure the static acceleration of gravity in tilt-sensing applications, as well as dynamic acceleration resulting from motion, shock, or vibration.

The user selects the bandwidth of the accelerometer using the CX, CY, and CZ capacitors at the XOUT, YOUT, and ZOUT pins. Bandwidths can be selected to suit the application, with a range of 0.5 Hz to 1600 Hz for the X and Y axes, and a range of 0.5 Hz to 550 Hz for the Z axis.

The ADXL335 is available in a small, low profile, 4 mm × 4 mm × 1.45 mm, 16-lead, plastic lead frame chip scale package (LFCSP_LQ).

Functional block of accelerometer

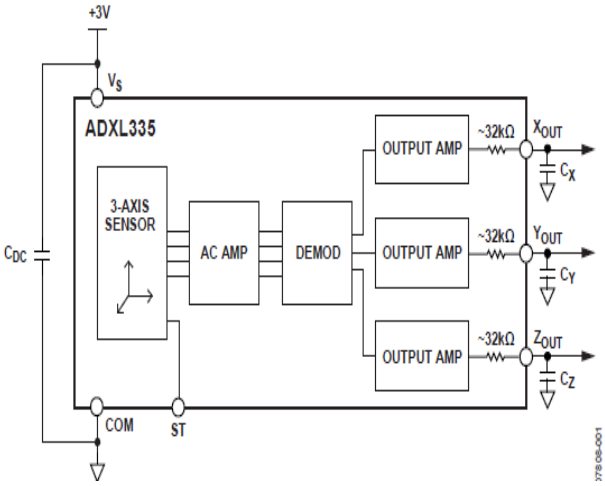


Fig 7. Block diagram of accelerometer

Operation

The ADXL335 is a complete 3-axis acceleration measurement system. The ADXL335 has a measurement range of ±3 *g* mini-mum. It contains a polysilicon surface-micromachined sensor and signal conditioning circuitry to implement an open-loop acceleration measurement architecture. The output signals are analog voltages that are proportional to acceleration. The accelerometer can measure the static acceleration of gravity in tilt-sensing applications as well as dynamic acceleration resulting from motion, shock, or vibration.

The sensor is a polysilicon surface-micro machined structure built on top of a silicon wafer. Polysilicon springs suspend the structure over the surface of the wafer and provide a resistance against acceleration forces. Deflection of the structure is measured using a differential capacitor that consists of independent fixed plates and plates attached to the moving mass. The fixed plates are driven by 180° out-of-phase square waves. Acceleration deflects the moving mass and unbalances the differential capacitor resulting in a sensor output whose amplitude is proportional to acceleration. Phase-sensitive demodulation techniques are then used to determine the magnitude and direction of the acceleration.

The demodulator output is amplified and brought off-chip through a 32 kΩ resistor. The user then sets the signal bandwidth of the device by adding a capacitor. This filtering improves measurement resolution and helps prevent aliasing.

Mechanical sensor

The ADXL335 uses a single structure for sensing the X, Y, and Z axes. As a result, the three axes' sense directions are highly orthogonal and have little cross-axis sensitivity. Mechanical misalignment of the sensor die to the package is the chief source of cross-axis sensitivity. Mechanical misalignment can, of course, be calibrated out at the system level.

Performance

Rather than using additional temperature compensation circuitry, innovative design techniques ensure that high performance is built in to the ADXL335. As a result, there is no quantization error or nonmonotonic behavior, and temperature hysteresis is very low (typically less than 3 m*g* over the −25°C to +70°C temperature range).

4] ULTRASONIC SENSOR :

The HC-SR04 ultrasonic sensor uses sonar to determine distance to an object like bats or dolphins do. It offers excellent range accuracy and stable readings in an easy-to-use package. It operation is not affected by sunlight or black material like Sharp rangefinders are (although acoustically soft materials like cloth can be difficult to detect). Similar in performance to the SRF005 but with the low-price of a Sharp infrared sensor.

A short ultrasonic pulse is transmitted at the time 0, reflected by an object. The senor receives this signal and converts it to an electric signal. The next pulse can be transmitted when the echo is faded away. This time period is called cycle period. The recommend cycle period should be no less than 50ms. If a 10μs width trigger pulse is sent to the signal pin, the Ultrasonic module will output eight 40kHz ultrasonic signal and detect the echo back. The measured distance is proportional to the echo pulse width and can be calculated by the formula above. If no obstacle is detected, the output pin will give a 38ms high level signal.

Fig 8. ultrasonic sensor

5] MODULE WISE PROJECT SPECIFICATION:

a) MAX232

1. Low-Voltage, Integrated ESD Applications
2. Operating voltage: +3.0V to +5.5V.
3. Low-Power consumption.
4. Input current is 5 to 40 uA

b) HM2007

1. 48-pin single chip CMOS voice recognition LSI circuit
2. On- chip analog front end, voice analysis, recognition process and system control
3. Functions.
4. Input current 6 to 15mA.
5.

C) ARM7:

As it has following advantages:

1. Inbuilt ADC and Clock is present.
2. Speed is more as compared to other controller or processors.
3. Single operating cycle is required for execution of 1 instruction.
4. RISC architecture is used.

d) L293D

1. H-bridge motor driver integrated circuit (IC).
2. Motor drivers act as current amplifiers.
3. L293D has output current of 600mA and peak output current of 1.2A per channel.
4. The output supply (VCC2) has a wide range from 4.5V to 36V.

e) Accelerometer adxl 335:

1. 3 Axis Sensing.
2. Small, Low, Profile Package.
3. Low Power: 350uA.
4. Single supply Operation: 1.8 to 3.6V.
5. 10,000 g shock survival.

f) Ultrasonic sensor: HC-SR04

1. Power Supply :+5V DC
2. Quiescent Current : <2mA
3. Working Currnt: 15mA
4. Effectual Angle: <15°
5. Ranging Distance : 2cm – 400 cm/1" - 13ft
6. Resolution : 0.3 cm
7. Measuring Angle: 30 degree
8. Trigger Input Pulse width: 10uS
9. Dimension: 45mm x 20mm x 15mm

6] SOFTWARE-

Required software are mentioned as follows:

a). KEILuVision4

b). Eagle

a) KEIL µVision4*:*

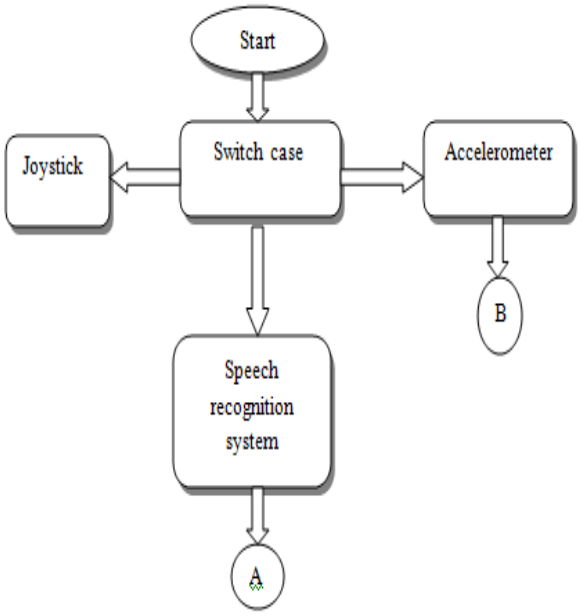
The new Keil µVision4 IDE has been designed to enhance developer's productivity, enabling faster, more efficient program development. µVision4 introduces a flexible window management system, enabling you to drag and drop individual windows anywhere on the visual surface including support for Multiple Monitors.The µVision IDE from Keil combines project management, make facilities, source code editing, program debugging, and complete simulation in one powerful environment. The µVision development platform is easy to use and helping you quickly creates embedded programs that work. The µVision editor and debugger are integrated in a single application that provides a seamless embedded project development environment.

b) Eagle:

EAGLE (Easily Applicable Graphical Layout Edito r) by Cadsoft is a flexible and expandable EDA schematic capture, PCB layout, autorouter and CAM program widely used since 1988. EAGLE is popular among hobbyists because of its freeware license and rich availability of component libraries on the web.

EAGLE contains a schematic editor, for designing circuit diagrams. Parts can be placed on many sheets and connected together through ports.

7) FLOWCHART OF PROJECT:



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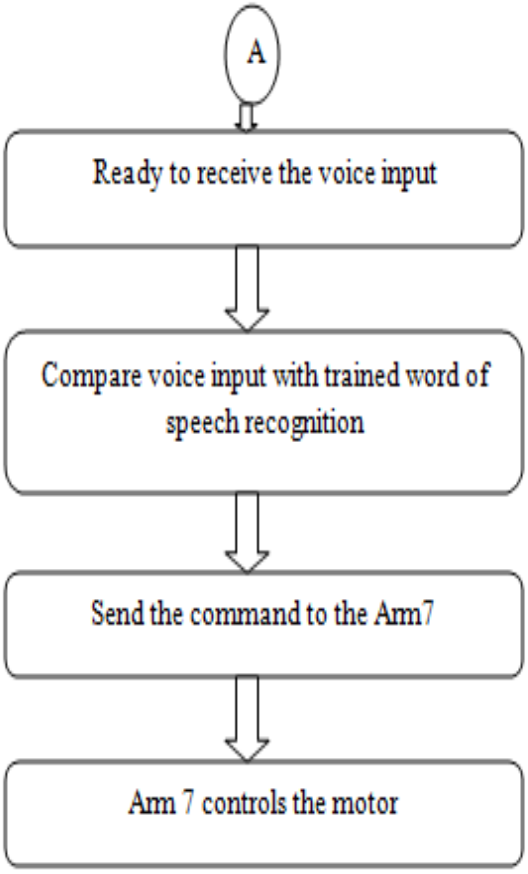
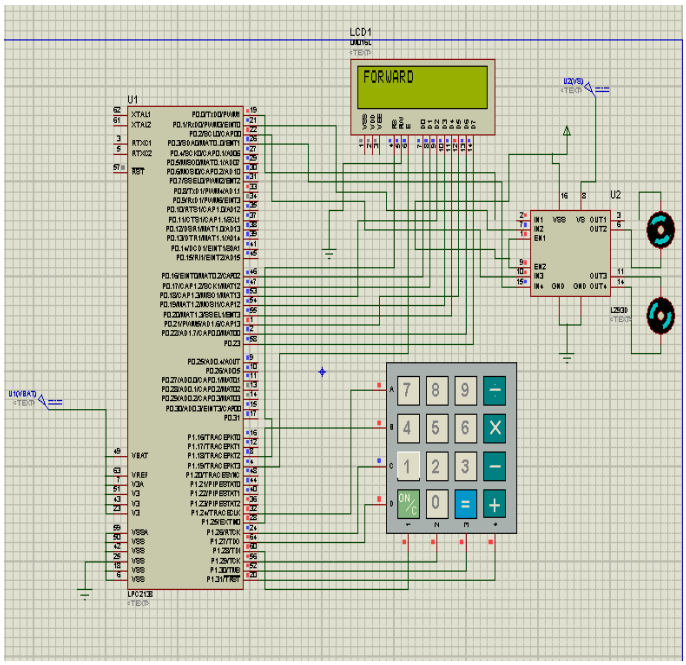
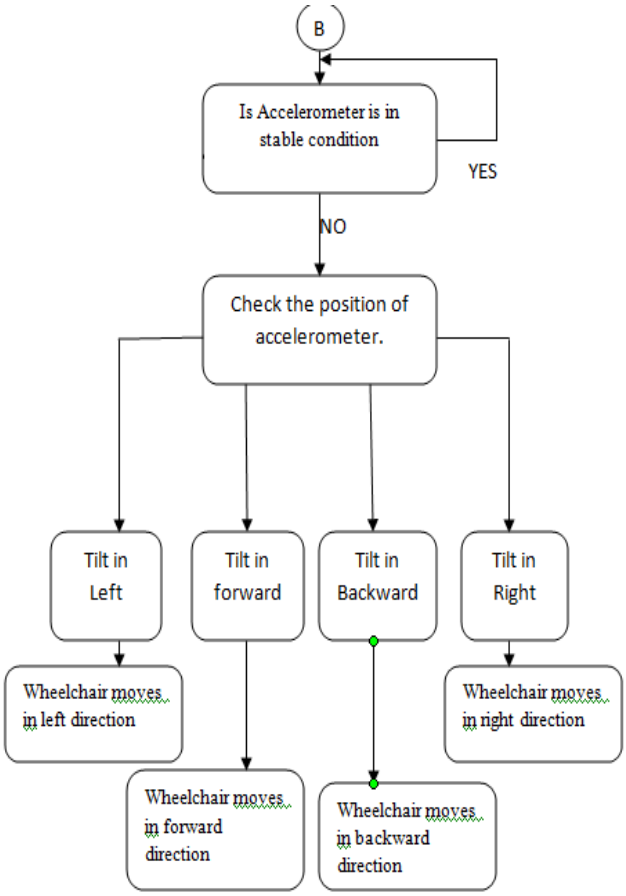


8) **RESULT:**

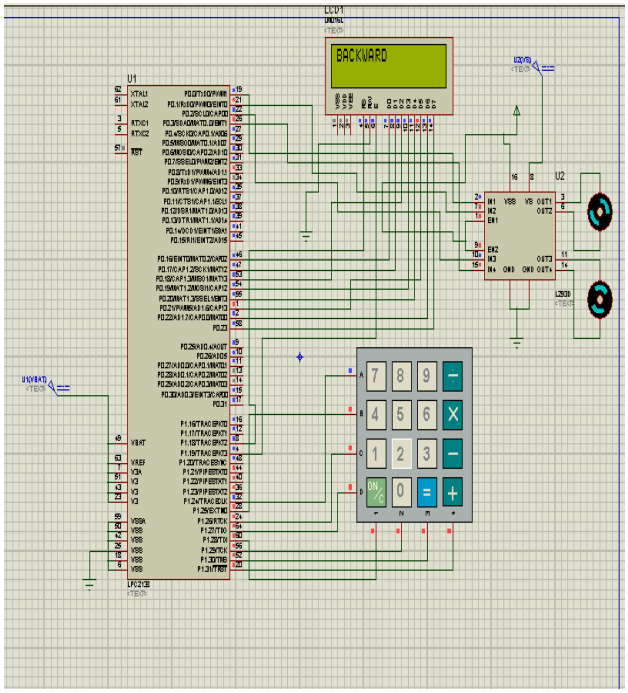
A) Motor Driver Simulation:

1. Wheel Chair in forward direction:

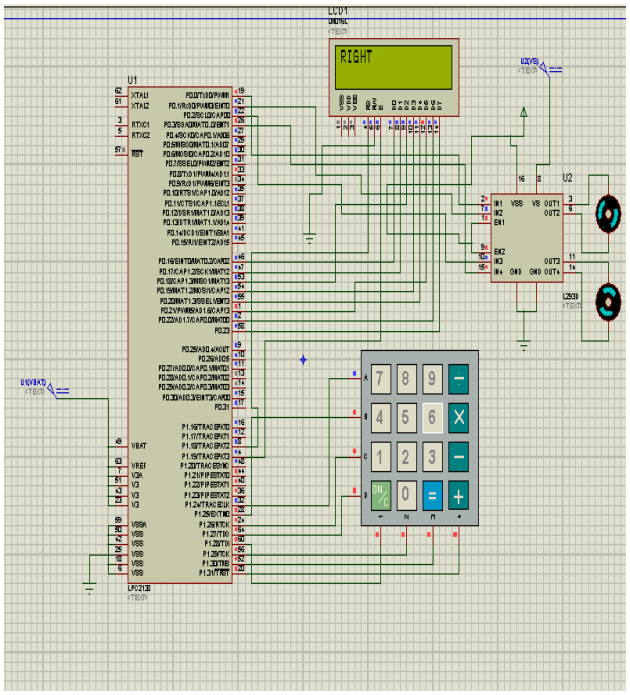


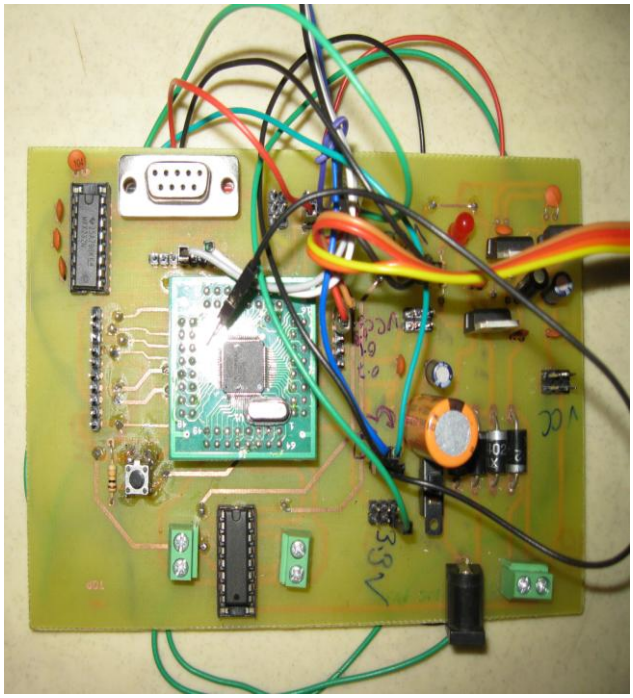


2.Wheel chair in backward direction



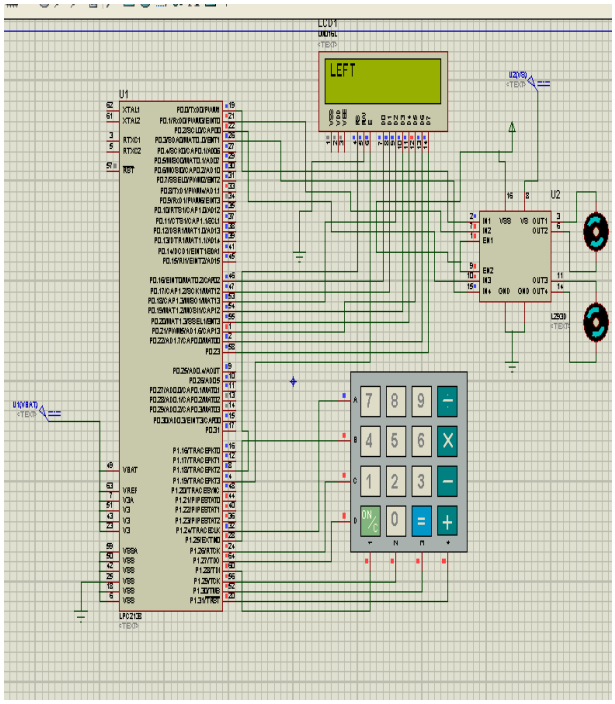
3.Wheel chair turns Right:

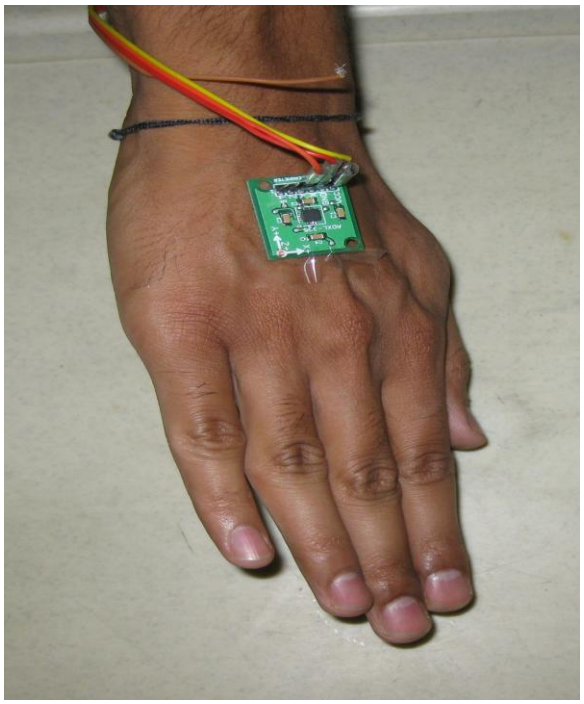




4.Wheel chair turns left:

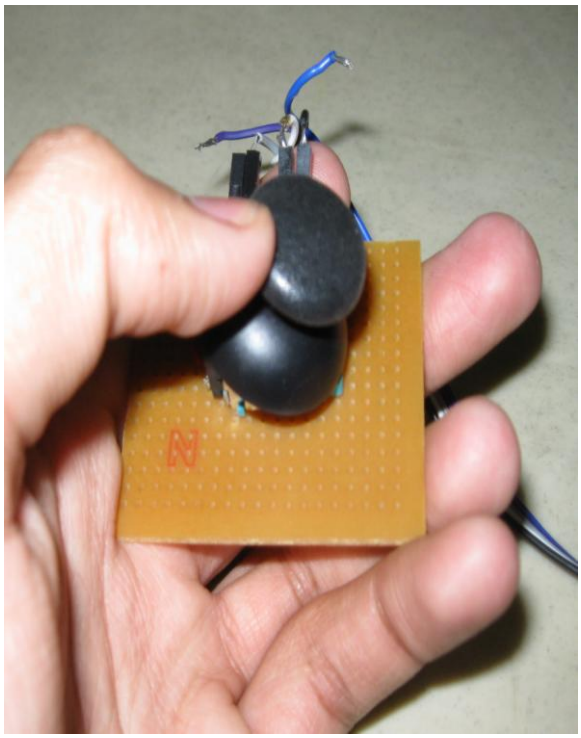
Accelerometer





B) Project images

Joystick



Wheelchair demo model

III.CONCLUSION

We are implementing automatic wheelchair which has various advantages. It is operating in three different modes i.e. joystick mode, accelerometer mode and voice recognition mode. Also there two types of sensors which increases accuracy of wheelchair. This Wheelchair will be economical and can affordable to common people. We can also add new technology in this wheelchair. A system for reliable recognition of speech and face has been designed and developed. This system can be made highly efficient and effective if stringent environmental conditions are maintained. The setup for maintaining these environmental conditions will be a onetime investment for any real life application . The running cost of this system is much lower as compare to other systems used for the same purpose

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