ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 5, May 2015

Design and Development of Smart Wheelchair using Voice Recognition and Head Gesture Control System

Srishti[1], Prateeksha Jain[2], Shalu[3], Swati Singh[4]

Student, Department of ECE, Meerut Institute of Technology, Meerut, India[1,2, 3].

Assistant Professor, Department of ECE, Meerut Institute of Technology, Meerut, India [4]

ABSTRACT: After several studies and survey it have shown that both children and adults benefit substantially from access to a means of independent mobility. Though many disabled people can satisfied with traditional manual or powered wheelchairs, there is a segment of disabled community find it difficult or impossible to use wheelchairs independently. Many researchers have used several technologies to make a wheelchair accessible to use for this population.Several wheelchairs have been developed with several control devices. The brain signal interfaces, vision based, head gesture based and many more controlled wheelchairs have been developed. The proposed work is to design and develop a smart wheelchair using a voice recognition and head gesture control system. It can be used efficiently with less effort by the users so that they can use it independently and easily.

KEYWORDS: Accelerometer, AVR microcontroller Atmega328, Arduino compiler, Motor Driver IC L293D, Smart Wheelchair, Gesture Control, Voice Recognition Module V2, Microphone.

I. INTRODUCTION

More than 1 billion persons in the world have some form of disability. This corresponds to about 15% of the world's population. The aim of this project is to design and develop a smart wheelchair which can be controlled by the head gesture as well as with the help of voice commands. This project will facilitate the movement of people who are disabled or handicapped. The result of this project will help such people to live a life with less dependence on others. A wheelchair is an electric wheelchair fitted with acceleration sensors, ultrasonic sensor and voice recognition module. By tilting the acceleration sensor, wheelchair can be moved in the four directions. Using the voice recognition module, the user can control the movement of chair by sending the voice commands such as Forward, Backward, and Left & Right. The ultrasonic sensor is the device used to sense the obstacle back to the wheelchair.

II. VOICE RECOGNITION AND HEAD GESTURE CONTROL

Voice Recognition Module

Nowadays speech recognition modules are used in voice based systemsinstead of using whole computer systems to reduce complexity and size of the total system. For a successful ASR (automatic speech recognition) system, accuracy, speed and extraordinary flexibility to handle large variance in speech patterns are essential characteristics. A Voice Recognition Module V2 is used in this hardware as shown in Fig.1.

The voice recognition module can recognize the commands through mice. It receives configuration commands or response through serial port interface.

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 5, May 2015

Fig.1 Voice Recognition Module V2

Fig.2 ADXL 335 Accelerometer

Voice module works in 2 modes: Training & Recognition. It can support 80 commands but maximum 7 commands can work at a time. User needs to train the module first before let it recognizing the voice commands.

Gesture Control

Gesture means a motion of the limbs or the body part to express your thought. This gesture is used here for controlling of the wheelchair. To recognize this gesture an Accelerometer is used.

The surface-micro machined integrated-circuit accelerometer ADXL 335 is an electromechanical device that measures the acceleration forces which is shown in Fig.2. This can be used for gesture detection. This is 3-axes accelerometer which produces three voltages in three directions based on the tilt of the accelerometer.This comprises of a very capacitive sensing cell (g-cell) and a signal conditioning ASIC (Application Specific Integrated Circuit) incorporated in a single package. The head movement of the user is detected by accelerometer and is used for the movement of wheelchair according to the head movement of the user.

III. HARDWARE COMPONENTS USED IN CIRCUIT

i. Arduino Compiler

Arduino is a tool for making devices that can sense and control more of the physical world than desktop computers. It is a microcontroller development board for writing software for the hardware circuitry. It consists of an ATmega2560 microcontroller. The Atmel Atmega2560 is a low-power CMOS 8-bit microcontroller based on AVR enhanced RISC architecture. By executing powerful instructions in a single clock cycle, the Atmega2560 achieves throughputs approaching 1 MIPS per MHz allowing the system designed to optimize power consumption versus processing speed. Fig.3 shows the complete Arduino Board that is used in the proposed hardware.

Fig.3 Arduino compiler

ii. Voice Recognition Module

The module V2 that has been described earlier in this paper can recognize voice commands. With this module, the car or other electrical devices can be controlled by voice.This module can store up to 15 pieces of voice instruction. Those 15 pieces are divided into 3 groups, with 5 in each group. First the module is trained with voice instruction. After training of the module user can give voice command to voice module through microphone. The module is speaker independent. The output of voice module is fed to the Atmega2560 microcontroller. The microcontroller generates control signal to drive motors of wheelchair. DC Geared motors are used for controlling the 2 wheels of the chair independently.

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 5, May 2015

iii. Motor driver L293D IC

The most common method to drive DC Motors in 2 directions under control of computer is with an H-Bridge motor driver which can be seen in the figure shown below. The L293D is an integrated circuit motor driver that can be used for simultaneous, bi-directional control of 2 small motors. It is used to drive two DC motors simultaneously, both in forward and reverse direction. The motor operations can be controlled by input logic at pins 2 & 7 and 10 & 15.

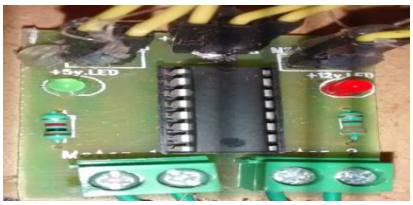

Fig.4 Motor Driver IC L293D

Fig.5 Ultrasonic Sensors

iv. Ultrasonic Sensor

They are commonly used for a wide variety of distance measuring applications, non-contact presence, and proximity. These devices typically transmit a short burst of ultrasonic sound toward a target, which reflects the sound back to the sensor. The system then measures the time for the echo to return to the sensor and, computes the distance to the target using the speed of sound in the medium. Ultrasonic sensors work on a principle similar to Radar or Sonar, which evaluate attributes of a target by interpreting the echoes from radios or sound waves respectively. It is used as the obstacle detector in the hardware in reverse direction.

v. ADXL 335 Accelerometer

The ADXL 335 accelerometer as illustrated above, is a low power, low profile capacitive micro machined accelerometer featuring signal conditioning, a 1-pole low pass filter, temperature compensation, self-test, g-detect which detects linear free-fall, and g-select which allows for the selection between 2 sensitivities. Zero-g offset and sensitivity are factory set and require no external device. It is used to detect the gesture of the user in this hardware.

vi. DC Geared Motors

It is a simple motor which uses electricity and a magnetic field to produce or which turns the motor. It comprises of 2 magnets of opposite polarity & an electric coil, which acts as an electromagnet.The repellent and attractive electromagnetic forces of the magnets provide the torque that causes the DC motor to turn. They are used them for the wheels of wheelchair.

PROPOSED SMART WHEELCHAIR USING VOICE AND HEAD GESTURE CONTROL USING ACCELEROMETER

The design of Smart Wheelchair using Voice and Gesture Control system consists of two main parts namely, Hardware & Software. The hardware circuit is used to recognize, digitize and transmit control signal to wheelchair motor driver. The hardware consists of various components which are described below. Here a control unit named as Arduino ATmega2560microcontroller is used.

Software Implementation

i. **Voice Control**

The microcontroller ATMEGA328 is programmed using C language. Programming is done on computer system. Further Arduino In system Programming platform is used to upload the code in form of Hex File to the microcontroller. Various steps of the programming for the voice control are performed which are illustrated below with the help of flowchart in Fig.6.

Firstly, Voice module is trained with 4 commands. After that the voice command is send by the user. The microcontroller is used to check the signal associated with this command and compare it with the stored commands and performs the task related to this command.

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 5, May 2015

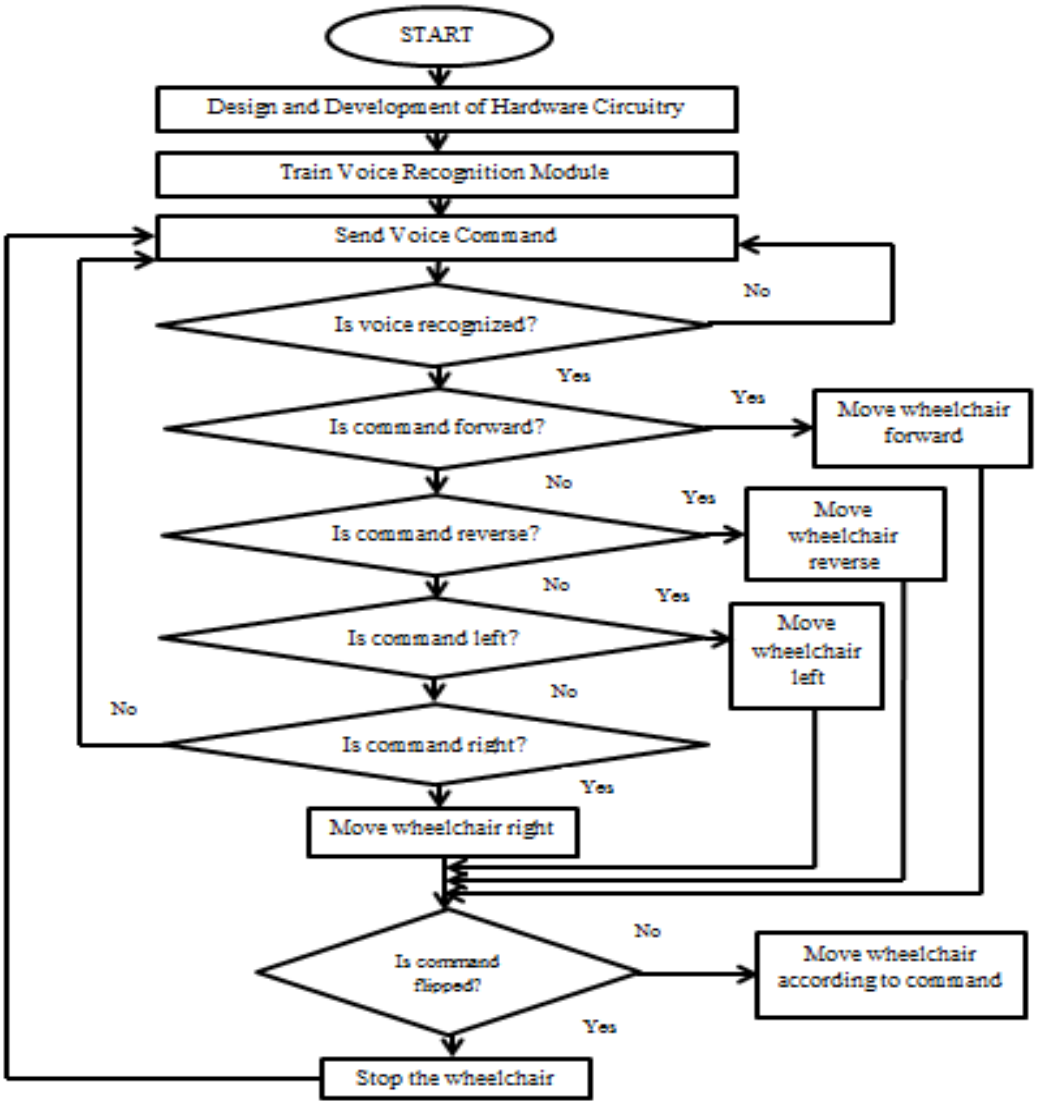

Fig.6 Flowchart for Voice Control

ii. **Gesture Control**

Similarly, the microcontroller ATMEGA2560 is programmed using C language for the controlling of wheelchair using gesture control.

Firstly, we designed and developed a hardware circuitry which willbe explained below in hardware implementation. After that DC supply is provided to the hardware to perform the task. According to the program, the ranges of X and Y axis for accelerometer are used to set the direction of motion of wheelchair according to the gesture. When the accelerometer is tilted to face the forward direction the wheelchair starts to move forward. The verification of the direction of motion is taken form the monitor screen which is shown in the Fig.7. It shows that the wheelchair moves in forward direction when values of X and Y lie in the predefined range and stops to move the X and Y lie in the range for stable condition (left side).

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 5, May 2015

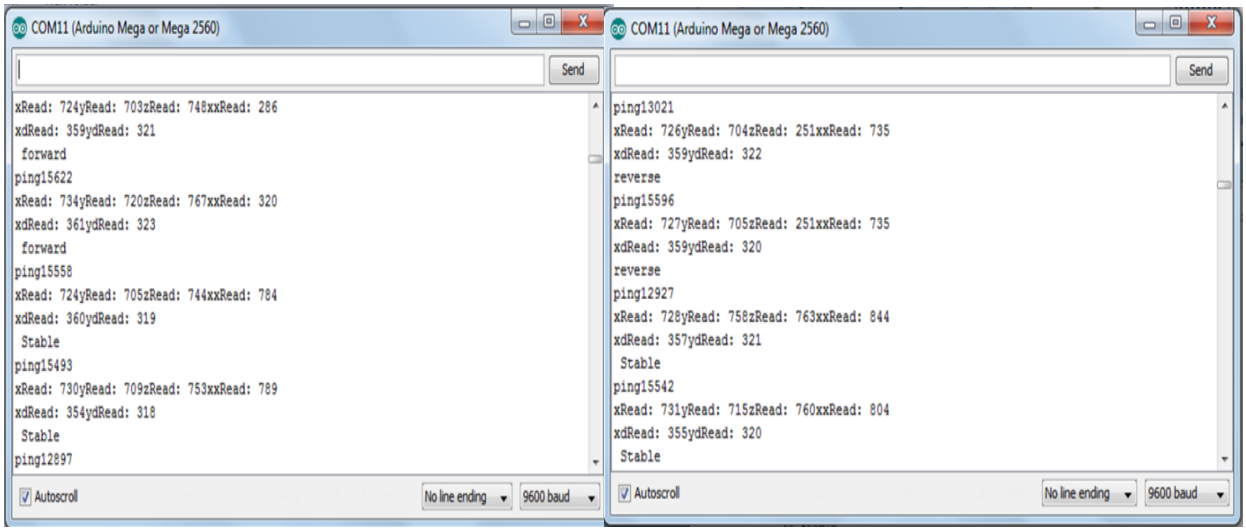

Fig.7 Screen Shot for Movement in Forward Direction and Reverse Direction

Fig.7 (right side) also shows that the movement of the wheelchair is in the reverse direction when the values of X and Y lie in the range for facing the accelerometer in the reverse direction. After that the accelerometer is moved in stable condition range.

Similarly, the wheelchair is moved in left direction by the accelerometer facing it in left direction. The left side wheel of the wheelchair moves in reverse direction and right side wheel moves in forward so that the wheelchair moves in left direction.The process for the movement in right direction is same as that in left direction. There are two main differences in both. Firstly the accelerometer should face the right direction then right side wheel moves in reverse direction and other in forward direction.

The ultrasonic sensor is attached behind the wheelchair approaching the reverse direction. It is used to detect the obstacle in the reverse movement of the wheelchair. If any obstacle occurs within 2m to 3m wheelchair automatically will stop to move.

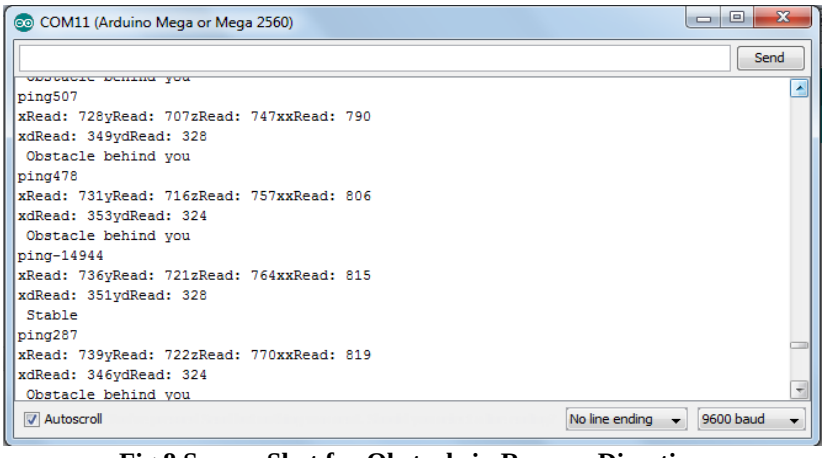

Fig.8 Screen Shot for Obstacle in Reverse Direction

The software implementation for the wheelchair with gesture control can also understand with the help of flowchart. It shows the movement of wheelchair according to the ranges which are determined for the different directions. According to these ranges the programming is done for the wheelchair controlling by using gesture control. Fig.9 shows the flowchart for the gesture control software implementation. The values of X and Y are checked then compare with the given conditions. When these values match with any condition then that particular task has been performed by the wheelchair. If no condition is match then values are again checked and the cycle repeats itself again and again.

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 5, May 2015

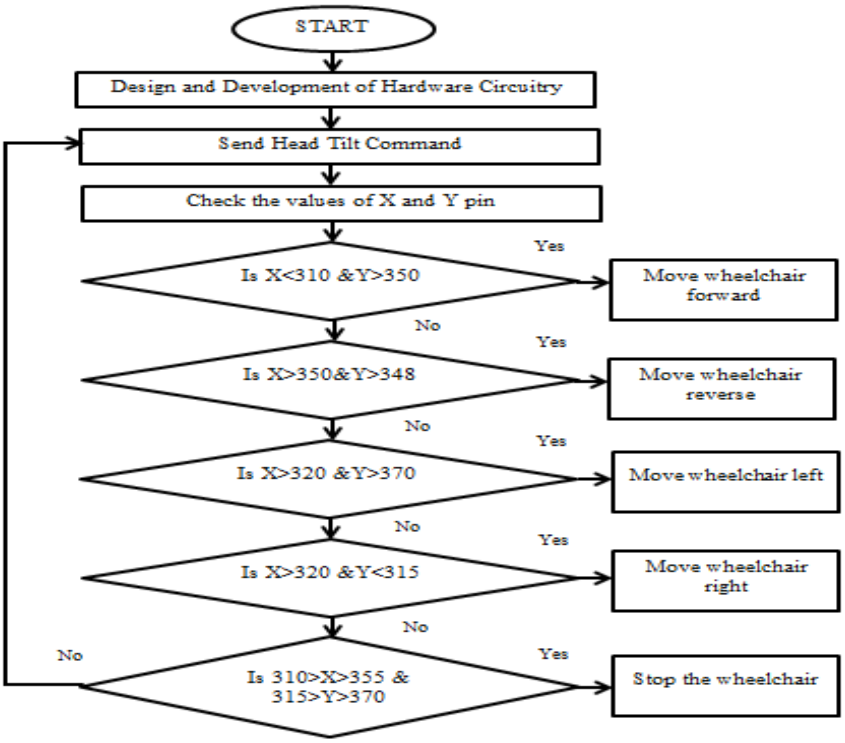

Fig.9Flowchart for Voice Control

Hardware Implementation

The paper work is to design and develop a smart wheelchair using voice and head gesture. Now the prepared coding is uploading on the Arduino board and interfacing of wheels of the prototype, Motor Driver IC, Voice Recognition Module V2 and accelerometer is done with the Arduino board. The Circuitry Diagram is shown in the Fig.10.

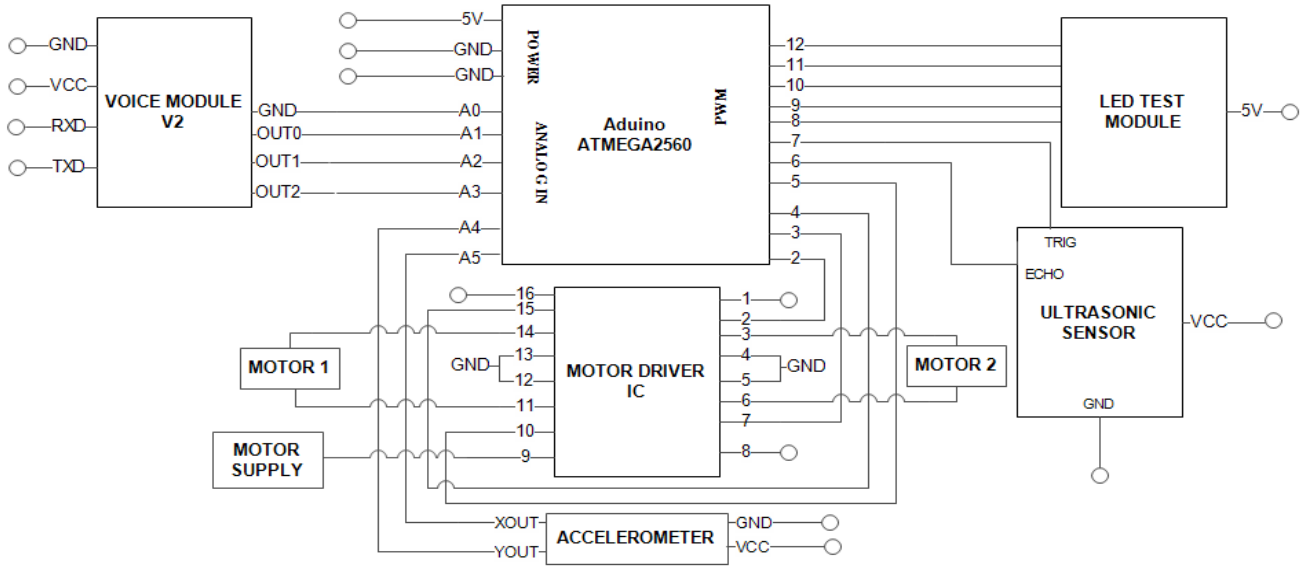

Fig.10 Circuit Diagram

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 5, May 2015

After that the prototype is tested whether it works according to the program. The accelerometeris adjusted on the head on the user and a microphone is also provided with it. The prototype worked according to the voice commands and head gesture of the patient. There is given the prototype wheelchair in the Fig.11.

Fig.11 Prototype Wheelchair

IV. RESULTS AND DESCUSSION

The proper interfacing of all components according to the circuit diagram gives us hardware circuitry for prototype wheelchair with voice and gesture control. The prototype wheelchair runs perfectly for head gesture and voice command as a Smart Wheelchair. The hardware and software implementation is done properly. Now,in this section all the steps of this work is discussed and their results are also specified.

The implemented software is uploaded on the Arduino board then the prototype is checked using gesture and voice module. The head tilt commands are given. When the prototype worked properly according to the head tilt commands then voice module is test by sending the voice command through the mike. The head gesture should be in stable condition at the time of voice module working. The prototype worked successfully by using gesture and voice module.

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 5, May 2015

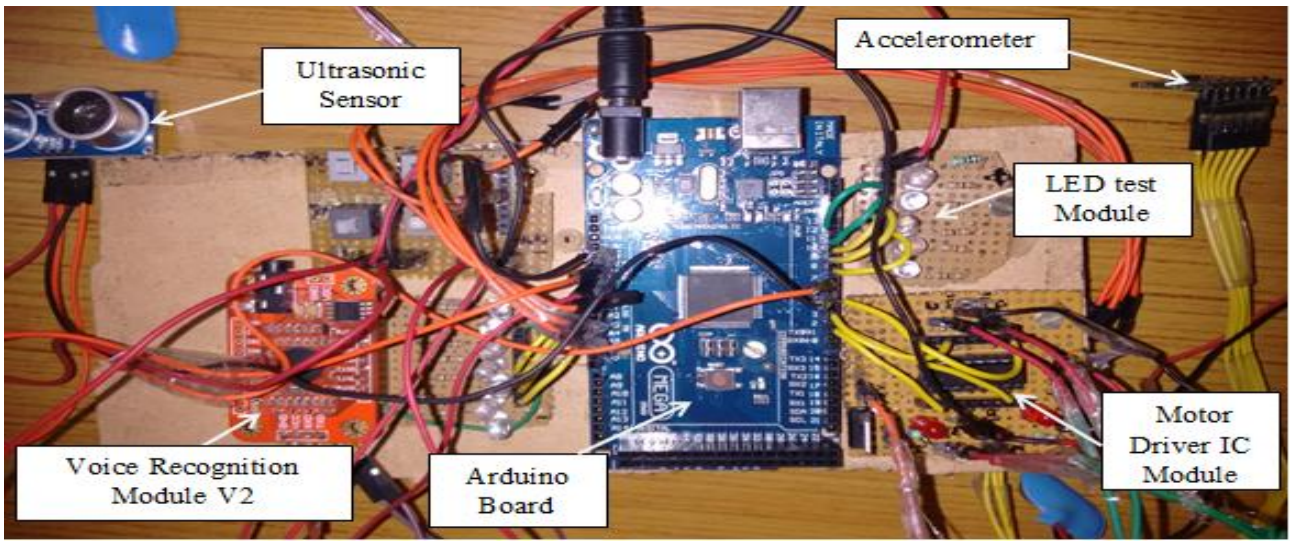

Fig.12 Hardware Circuitry

The prototype wheelchair is controlled by the hardware circuitry which is given above in Fig.12.

V. CONCLUSION

This paper is to design and develop a smart wheelchair using voice and head gesture control is completed. The developed wheelchair is very user friendly and does not contain any computer system with wheelchair for controlling. So it is easy to understand and process. It contains two modules to control the movement of the wheelchair according to user commands. If any patient is unable to move head then voice commands can be used for the navigation of the wheelchair independently. The accelerometer can be mounted on the head by using any band to recognize the head gesture. A headphone with attached microphone can be used to give voice commands.This system provides independent mobility as well as many intelligent facilities to the rising disabled population.

REFERENCES

[1] Srishti, Shalu, Prateeksha Jain, "The Smart Wheelchair Using Head Gesture Control", International Journal of Advanced Engineering Science and Technological Research, vol.3, Issue 1 March 2015,ISSI 2321-1202.

[2] JavajjiVeeraiah., P.V.N AravindSyam,.N.NagaDurga., K.RaviKanth., G.Vasudha, "Accelerometer Based Gesture Recognisation for Wheel Chair Direction Control Using ZIGBEE Protocol", International Journal of Technological Exploration and Learning (IJTEL), Vol. 2, No.2, pp.104-108, April 2013.

[3] ShreedeepGangopadhy., SomsubraMukherjee, Soumya Chatterjee, "Intelligent Gesture Controlled Wireless Wheelchair For The Physically Handicapped", Proceedings of Fifth IRAJ International Conference, Pune, India,Vol.1,No.7,pp.47-52, 15 September 2013.

[4] MoniruzzamanBhuiyan, Rich Picking, "A Gesture Controlled User Interface For Inclusive Design And Evaluation Study Of Its Usability", Journal of Software Engineering and Applications,Vol.4,No.9,pp.513-521,September 2011.

[5] Aleksandra Pajkanovic, BrankoDokic, "Wheelchair Control by Head Motion", Serbian Journal of Electrical Engineering, Vol.10, No.1, pp.135-151, February 2013.

[6] P. Jia, Huosheng H. Hu.,Tao Lu., Kui Yuan., "Head gesture recognition for hands-free control of an intelligent wheelchair", An International Journal on Industrial Robot, Vol.34, No.1, pp.60-68, 2007.

[7] Rakhi A. Kalantri., D.K. Chitre.," Automatic Wheelchair using Gesture Recognition", International Journal of Engineering and Innovative Technology (IJEIT), Vol 2,No.9, pp.216- 218, March 2013.

[8] H H. Seki, S. Kobayashi, Y. Kamiya, M. Hikizu, H. Nomura, "Autonomous/Semi-Autonomous Navigational System of Wheelchair by Active Ultrasonic Beacons," IEEE International Conference on Robotics and Automation, April 2000.

[9] Dan Ding., BambangParmantu., Hasan A. Karimi., DuangduenRoongpiboonsopit., GediPramana., Thomas Conahan., PiyawanKasemsuppakorn., " Design Considerations For A Personalized Wheelchair Navigation System", Proceedings Of The 29th Annual International Conference Of The IEEE EMBS Cite International , Lyon, France, Vol.3, pp.4790-4793,23-26 August 2007.

[10] I.Iturrate., j.antelis., J.Minguez., " synochronous EEG Brain –actuated wheelchairwith automated navigation", Proceeding of IEEE International Conference on Robotics and Automation Kobi International conference Centre Kobe, JAPAN, 12-17 May,2009.

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 5, May 2015

[11] Vasundhara G. POsugade., Komal K.shedge., Chaitali S. Tikhe., "Touch-Screen Based Wheelchair System",International Journal of Engineering Research and Applications(IJERA) Vol.2,No.2, pp.1245-1248, March –April 2012.

[12] Andres Ubeda ., Eduardo Lanez., and Jose M. Azor., "Wireless and portable EOg Based Interface For Assisting Disabled people". IEEE/ASME Transactions on Mechatronics, Vol.16, No.5,pp.870-873, October 2011.

[13] Matt Bailey., Andrew Chanler., Bruce Maxwell., Mark Micire., Katherine Tsui., Holly Yanco., "Development of Vision-Based Navigation for a Robotic Wheelchair", IEEE 10th International Conference on Rehabilitation Robotics,Noordwijk,pp.951-957,June 2007.