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AUTOMATIC WHEELCHAIR WITH DEPTH CONTROL FEATURE

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ABSTRACT:

"Speech" and "gestures" are the expressions, which are mostly used in communication between human beings and for Human Computer Interaction (HCI). Recent development promises a wide scope in developing smart control systems. We present an integrated approach to real time detection, gesture based data glove approach which controls the wheelchair using hand movements. The paper proposed a microcontroller based system to control the wheelchair using low-cost and small 3-axis wireless accelerometers. The system is divided into four main components: Gesture recognition module with Micro electromechanical systems (MEMS) sensor wheelchair control, alcohol detection, depth sensing and auto-guided feature. In the gesture recognition module the heart of the system is microcontroller. The MEMS sensor which is connected to hand, is a 3-axis accelerometer with digital output that senses the angle of the hand, i.e. according to the tilt of hand it gives voltages to microcontroller. The wheelchair control unit is controlled using ATmega89S52 controller. The four proposed movements that achieved: are stop, forward, left and right. Finally, the results of some tests performed with the controlled system are presented and discussed.

Keywords: ***Hand gesture recognition, posture, MEMS Sensor, Microcontroller, GRS and Human Robot Interface.***

INTRODUCTION:

The need for automatic Wheelchair is especially present in care of the immovable people (people with persistent vegetative state, paraplegia, stroke and spinal cord injuries), where the care requires a lot of time and manpower. This report is the result of a design and development of an automated multifunctional Wheelchair that would perform all functions present in today's Wheelchair (Wheelchair

with adjustable portion and also remote control with which we can provide all necessary movement) as well as new functions of appropriate Wheelchair sections. It is expected that this new automatic Wheelchair would enable people's better medical care, and would greatly reduce time and manpower to the old-age home staff. The present wheelchairs do not have integration of technologies for their working. It either requires constant monitoring by the helper or hence lot of effort. Handicapped people face many problems in their life for surviving. To overcome this problem we are going to make a wheelchair which is hand gesture controlled or controlled by the hand movement (when hand tilted forward wheelchair move in forward direction, when hand tilted backward wheelchair move in backward direction, when hand tilted in right side it will move in right direction and when hand tilted in left side it will move in left direction).Different modules of this wheelchair are as follows:

- **Anti-accident feature:** In this proposed work, a simple, cheap, friendly user, virtual eye will be designed and implemented to improve the mobility of both blind and visually impaired people in a specific area. The proposed work includes an auto guided mode in which the wheel chair moves automatically without interruption and if found any it will move in the safe direction where the space is available. In addition to this there is also a depth sensor which detect the depth and stops the wheelchair if found any.

- **Alcohol Detection System:** This system is basically an Embedded System which is combination of both software and hardware which can perform some specific functions using Microcontroller AT89S52. The Alcohol sensor on detecting the alcohol concentration will give the analog resistive output to the microcontroller then further alcohol detection message will be displayed on LCD. Microcontroller controls the H-bridge driver circuit which is responsible for working of the DC motor. Thus wheelchair will be stopped on detecting alcohol concentration and related information will go to nearby location through GSM.

- **Obstacle Avoidance System:** This can detect obstacles from its three sides- front, left and right side. The robot changes its direction of movement, whenever it detects any obstacle in its path from any side. Here, we will use three analog IR sensors to detect obstacles from the three sides of the robot. The three sensors will be placed in the front side, left side and right side of the robot pointing towards their respective side.

The objective of this project is to analyze and prototype a motorized wheelchair based on extensive fact findings and research on existing models, technology used, market scenario and customer

requirements. The course of our work begins with the planning phase involving initial research, literature review and background study. It is followed by concept generation phase that includes evaluating customer requirements, outlining specifications and generating concept designs. Next come the system level design in which product architecture is defined. The fourth phase is detailed design phase where we focus on design for assembly and manufacturing and simulation in virtual environment. In the final phase, we progress towards prototyping and testing a feasible model.

Need and importance of this works are listed as:

- Give the comfort to the senior adults and physically handicapped persons.
- Bedsore prevention for support.
- Improve balance and postural stability of Old-Age people.
- Convert Sleeping Position from sitting position easily.
- Prevention of incapable of surviving serious injuries.
- Easy movement from one place to another place.
- Specific service to the human in a safe and comfortable manner.
- Focusing on mobility assistance for bedridden persons.
- Power mobility allows people to move within their home and community
- It can also help maximize independence for those with limited mobility.

LITERATURE REVIEWS:

Adaptive Navigation of Mobile Robots with Obstacle Avoidance

Robot navigation problems can be generally classified as global or local, depending upon the environment surrounding the robot. In global navigation, the environment surrounding the robot is known and a path which avoids the obstacles is selected. In one example of the global navigation techniques, graphical maps which contain information about the obstacles are used to determine a desirable path. In local navigation, the environment surrounding the robot is unknown, or only partially known, and sensors have to be used to detect the obstacles and a collision avoidance system must be incorporated into the robot to avoid the obstacles. The artificial potential field approach is one of the well-known techniques which has been developed for this purpose. Krogh, for example, used a generalized potential field approach to obstacle avoidance. Kilm and Khosla used instead harmonic potential functions for obstacle avoidance. On the other hand, Krogh and Fang used the dynamic generation of sub goals using local feedback information.

Potential Field Methods and Their Inherent Limitations for Mobile Robot

During the past few years, potential field methods (PFM) for obstacle avoidance have gained increased popularity among researchers in the field of robots and mobile robots. The idea of imaginary forces acting on a robot has been suggested by Andrews and Hogan and Khatib.

In these approaches obstacles exert repulsive forces onto the robot, while the target applies an attractive force to the robot. The sum of all forces, the resultant force R, determines the subsequent direction and speed of travel. One of the reasons for the popularity of this method is its simplicity and elegance.

Histogramic in-motion mapping for mobile robot obstacle avoidance

This paper introduces histogram in-motion mapping (HIMM), a new method for real-time map building with a mobile robot in motion. HIMM represents data in a two-dimensional array, called a histogram grid that is updated through rapid in-motion sampling of onboard range sensors. Rapid in-motion sampling results in a map representation that is well-suited to modeling inaccurate and noisy range-sensor data, such as that produced by ultrasonic sensors, and requires minimal computational overhead. Fast map-building allows the robot to immediately use the mapped information in real-time obstacle-avoidance algorithms. The benefits of this integrated approach are twofold: (1) quick, accurate mapping; and (2) safe navigation of the robot toward a given target.

Real-time Obstacle Avoidance for Fast Mobile Robots

Real-time obstacle avoidance is one of the key issues to successful application of mobile robot systems. All mobile robots feature some kind of collision avoidance, ranging from primitive algorithms that detect an obstacle and stop the robot short of it in order to avoid a collision, through sophisticate algorithms, that enable the robot to detour obstacle. The later algorithms are much more complex, since they involve not only the detection of an obstacle, but also some kind of quantitative measurements concerning the obstacle's dimensions.

In our system the ultrasonic sensor are continuously sampled while the robot is moving. If an obstacle produces an echo, the corresponding cell contents are incremented. A solid, motionless obstacle eventually causes a high count in the corresponding cells. Misreading, on the other hand, occur randomly, and do not cause high count in any particular cell. These methods yield a more reliable obstacle representation in spite of the ultrasonic sensor's inaccuracies.

Obstacle Avoidance Robotic Vehicle Using Ultrasonic Sensor, Android and Bluetooth for Obstacle Detection

Now day's many industries are using robots due to their high level of performance and reliability and which is a great help for human beings. The obstacle avoidance robotics is used for detecting obstacle and avoiding the collision. This is an autonomous robot. The design of obstacle avoidance robot requires the integration of many sensors according to their task. The obstacle detection is primary requirement of this autonomous robot. The robot gets the information from surrounding area through mounted sensors on the robot. Some sensing devices used for obstacle detection like bump sensor, infrared sensor, ultrasonic sensor etc. Ultrasonic sensor is most suitable for obstacle detection and it is of low cost and has high ranging capability. Arduino robot that can be controlled by an android mobile or tablet, with the help of an android app that can be downloaded from Google Play store. The android application gets connected to the Bluetooth module and sends desired commands. This app controlled robot is capable to move in any direction. Though there are lots of similar apps out there, we have programmed this project to be used with ANDROID app.

Obstacle Avoidance Wheelchair System

We present a collision avoidance system for powered wheelchairs used by people with cognitive disabilities. Such systems increase mobility and feelings of independence, thereby enabling reversal of some symptoms of depression and cognitive impairment and improvement of quality of life. We use a novel 3D sensor developed by Canesta Inc. that allows the wheelchair to "see" obstacles, avoid collisions, and suggest alternatives to users. The Canesta sensors are ideal, as they combine accuracy with efficiency in the distance range necessary for collision avoidance.

High quality of life is of the utmost importance and mobility is a key component of a positive quality of life. Unfortunately, many older adults face various impairments and disabilities that result in their mobility being compromised. Furthermore, many of these people require a powered wheelchair because they lack the strength to manually propel themselves. However, powered wheelchairs are not appropriate for older adults with a cognitive impairment, such as Alzheimer's disease, as they do not have the cognitive capacity required to effectively and safely manoeuvre the wheelchair. In addition, their sometimes aggressive and unpredictable behavior makes wheelchair use unsafe for both themselves and others.

Currently there are an estimated 15 to 18 million people worldwide who have been diagnosed with dementia with this number expected to reach 34 million by 2025 [1]. If we can provide these users with some level of independence, irrespective of ability, without placing the person or others at unreasonable risk, then it may be possible to reverse some symptoms of depression and cognitive impairment and improve quality of life. The goal of this project is the application of a novel 3D sensor system to adapt a powered wheelchair, specifically, the Nimble Rocket TM so that it can be driven safely by users with cognitive and other complex impairments. Figure 1 shows an artist's rendition of the Canesta sensor mounted on the wheelchair. There have been numerous prototypes for automated wheelchairs in the literature. Perhaps the most well known are the stereo-vision guided Wellesley, and the sonar guided NavChair. Further investigations into shared control were presented in, and ultrasound was studies as a failsafe collision avoidance system in. Our work is distinguished for these in that we use audio prompts as our method of communication with the user: the system itself has no control over the motors other than simply stopping the wheelchair. This type of interaction fits into our broader goals for assistive technologies.

Alcohol Detection and Vehicle Controlling

This system is aimed at making vehicle driving safer than before. This is implemented using Arduino. We have derived the driver's condition in real time environment and we propose the detection of alcohol using alcohol detector connected to Arduino such that when the level of alcohol crosses a permissible limit, the vehicle ignition system will turn off and the GPS module will capture the present location of the vehicle. Also the GSM module will automatically send distress message to police or family members.

India had earned the dubious distinction of having more number of fatalities due to road accidents in the world. Road safety is emerging as a major social concern around the world especially in India. Drinking and driving is already a serious public health problem, which is likely to emerge as one of the most significant problems in the near future. The system implemented by us aims at reducing the road accidents in the near future due to drunken driving. The system detects the presence of alcohol in the vehicle and immediately locks the engine of the vehicle. At the same time an SMS along with the location of the vehicle is send to three pre-selected contacts. Hence the system reduces the quantum of road accidents and fatalities due to drunk driving in future.

Obstacle Avoidance Robot

The project is design to build an obstacle avoidance robotic vehicle using ultrasonic sensors

for its movement. A micro-controller (AT mega 8) is used to achieve the desired operation. A robot is a machine that can perform task automatically or with guidance. Robotics is a combination of computational intelligence and physical machines (motors). Computational intelligence involves the programmed instructions.

The project proposes robotic vehicle that has an intelligence built in it such that it directs itself whenever an obstacle comes in its path. This robotic vehicle is built, using a micro-controller of AT mega 8 family. An ultrasonic sensor is used to detect any obstacle ahead of it and sends a command to the micro-controller. Depending on the input signal received, the micro-controller redirects the robot to move in an alternate direction by actuating the motors which are interfaced to it through a motor driver.

Obstacle avoidance is a primary requirement of any autonomous mobile robot. Obstacle avoidance Robot is design to allow robot to navigate in unknown environment by avoiding collisions. Obstacle avoiding robot senses obstacles in the path, avoid it and resumes its running.

There are some very famous methods for robot navigation like wall-following, edge detection, line following. One of the commercial systems uses wall-following method on a floor cleaning robot for long hallways. A more general and commonly employed method for obstacle avoidance is based on edge detection. A disadvantage with obstacle avoidance based on edge detecting is the need of the robot to stop in front of an obstacle in order to provide a more accurate measurement. All mobile robots feature some kind of collision avoidance, ranging from primitive algorithms that detect an obstacle and stop the robot in order to avoid a collision, using some sophisticated algorithms that enable the robot to detour obstacles. The latter algorithms are more complex, since they involve detection of an obstacle as well as some kind of quantitative measurements concerning the obstacle's dimensions. Once these have been determined, the obstacle avoidance algorithm needs to steer the robot around the obstacle and resume motion toward the original target.

In this paper the steering algorithm ensures that the robot does not have to stop in front of an obstacle during its navigation. Hence the robots may overcome some of the problems during navigation, which are discussed above and it can navigate smoothly during its operation avoiding the collisions. We have presented a basic algorithm and design which can be further improved depending upon the required applications.

PROBLEM IDENTIFICATION:

In this era of fast growing technology and healthcare, there are still considerable amounts of physically challenged and elderly who find it difficult to move around in their house. Their primary option will be to use a wheelchair. But often quadriplegics and tetraplegia people will find it uncomfortable to manually control the wheelchair and will go in search of an external aid. Thus there is a need for an improved method of navigation to be devised. One such method proposed here is the gesture based navigation in which simple hand gestures forms the input to the system which is processed, recognized and used for navigating the wheelchair. By this method, the user with disability will find it comfortable for indoor navigation and does not need an external aid.

The objective of this project is to use the concept of gesture recognition to control a wheelchair (robot). By the use of latest emerging technology Gesture recognition the movement of the wheel chair will be controlled. The primary emphasis laid on the mechanism of GR Technology which is achieved by the help of accelerometer and its proposed mechanism. The four proposed movements that will be tried to achieve are backward, forward, stop, left and right.

DESIGN AND IMPLEMENTATION:

Working

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, we measure the value of 3Axis accelerometer (ADXL335) based on the hand movement and converted into digital with the help of ADC 0809. 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 C 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 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 IR (infrared) sensors for obstacle detection and hole, steps identification. For that we have written a C 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 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 this way we can identify any obstacle or steps, holes in the way of wheelchair.

Block Diagram

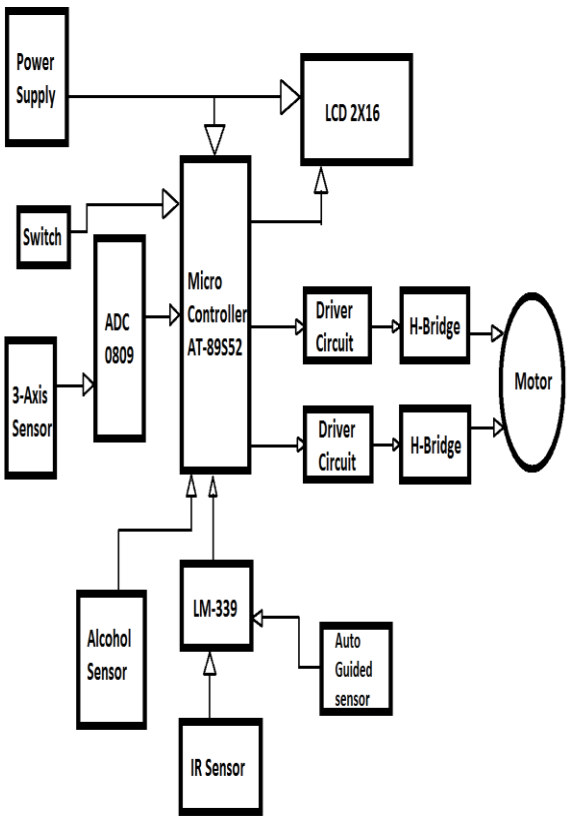

Fig. A: Block Diagram of Automatic Wheelchair.

According to different types of tilt code in peril security region. This wheelchair have innovative and applicable conceptual feature such as:

[1] Gesture control: According to hand movement thus wheelchair moves in different direction and place.

[2] Alcohol detection: This wheelchair senses the alcohol quantity and display in LCD with beeping of buzzer.

[3] Anti-accident feature: The wheelchair senses the obstacle and stop automatically with the help of IR sensors.

[4] Depth protection: The wheelchair senses the depth on road/floor and it indicates on LCD and stop or changes the wheelchair direction.

Simulation platform

ISIS Proteus

The micro-controller simulation in Proteus works by applying either a hex file or a debug file to the microcontroller part on the schematic. It is then co-simulated along with any analog and digital electronics connected to it. This enables it's used in a broad spectrum of project prototyping in areas such as motor control, temperature control and user interface design. It also finds use in the general hobbyist community and, since no hardware is required, is convenient to use as a training or teaching tool. Support is available for co-simulation of:

- Microchip Technologies PIC10, PIC12, PIC16, PIC18, PIC24, dsPIC33 Microcontrollers.
- Atmel AVR and Arduino, 8051 and ARM Cortex-M3 Microcontrollers.
- NXP 8051, ARM7, ARM Cortex-M0 and ARM Cortex-M3 Microcontrollers.
- Texas Instruments MSP430, PICCOLO DSP and ARM Cortex-M3 Microcontrollers.
- Parallax Basic Stamp, Freescale HC11, 8086 Microcontrollers.

Keil Software

The Keil **Real View Microcontroller Development Kit**is the complete software development environment for all ARM7, ARM9, Cortex-M1, and Cortex-M3 processor-based devices. It combines the industry leading Real View compilation tools (by ARM®) with the µVision IDE/Debugger, providing developers with an easy to use, feature-rich environment optimized for ARM Powered devices.

The RealView Microcontroller Development Kit (MDK) provides an easy-to-use development interface, with many unique features designed to help you to develop your project quickly and easily. The Device Database allows you to automatically configure device and project parameters. You can verify your code using the integrated Device Simulator, which accurately models more than 260 ARM Powered devices including the ARM instruction set and on-chip peripherals.

The Keil **RealView Microcontroller Development Kit (MDK)** package includes:

- µVision Integrated Development Environment and Debugger
- ARM RealView **C/C++ Compilation Tools**, including Assembler and Linker

- **MicroLib** highly optimized run-time Library
- **Simulator** with complete device support, including Peripheral Simulation
- **Device Databas**e supporting more than 260 ARM-core devices
- Deterministic and Preemptive **RTX** RTOS Kernel, royalty-free
- Support for ULINK-ME, ULINK2 and SWV hardware debug interfaces
- Code **examples** and **templates**

MDK is available in two variants:

- **MDK** Standard, with unlimited code size and support for RL-ARM; or
- **MDK-Basic**, limited to 256KB code size (no support for RL-ARM).

RESULT AND DISCUSSIONS:

Simulation Circuit

The figure bellow shows the simulated circuit of "Hand Gesture Controlled Accelerometer based Automatic Wheelchair".

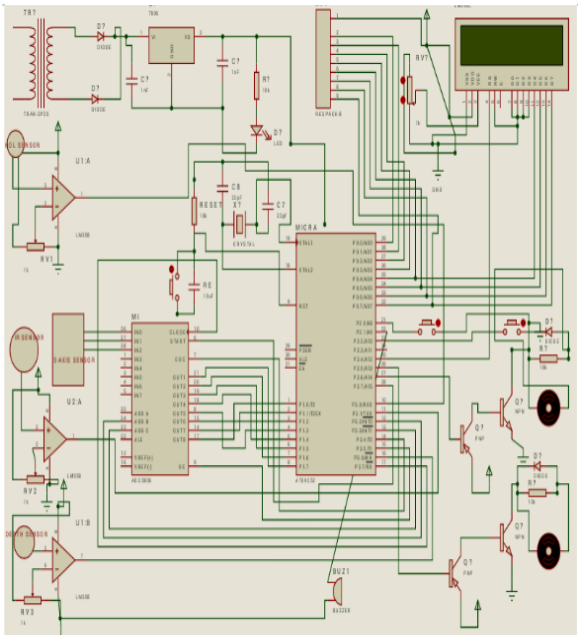

Fig. B: Simulated Circuit.

Simulation Results

The receiver module controls the movement of wheelchair in four direction i.e. forward, backward, left direction and right direction. And if any obstacle present in the path of wheel-chair then the wheel-chair automatically stops.

Acceleration sensor which we used to drive a motor in four Directions. The circuit has an alcohol sensor. This sensor measures the content of alcohol from the breath of drunken people. The sensor delivers a current with linear relationship to the alcohol molecules from zero to very high concentrations. Output of the sensor is directly proportional to the alcohol content. When the alcohol molecules in the air meet the electrode that is between alumina and tin dioxide in the sensor, ethanol burns into acetic acid then more current is produced. So the more alcohol molecules more will be the current produced. Because of this current change, we get the different values from the sensor. Output of the sensor is then fed to the microcontroller for comparison. The output of the sensor is in the analog nature which should be converted into digital format. This is done by the analog to digital converter of the microcontroller unit. The microcontroller controls the entire circuit. When the measured value reaches the threshold (here it is 255) the microcontroller switches the ignition ON. Then relay cuts off automatically and buzzer produces sound. The LCD displays the message that sent from the microcontroller unit. The working conditions and various constraints

FUNCTION	ANGLE
Forward	Forward 45°
Backward	Back 45°
Left	Left 45°
Right	Right 45°
Stop	0°

were properly studied before carrying out further steps. The components were purchased and the circuit was initially set on the breadboard. The PCB was fabricated as per the requirement and was soldered with components, taking proper care to avoid shorting between various connections. The output was verified on the PCB. The circuit worked successfully.

The wheelchair approaches a large obstacle. The top row shows a view of the scene from a different camera, while the second row shows the depth image output by the depth image manager, and the bottom shows the occupancy grid constructed. When cells too close to the chair become occupied, the chair

stops and a prompt is issued to suggest a possible direction to the user. The wheelchair approaches a cane. This example demonstrates one of the strengths of the Canesta sensor: the ability to pick out small obstacles rapidly. Clearly, however, a laser range finder would also perform well in this situation.

Real time Results

Fig. C: Working Ciruit on wheelchair.

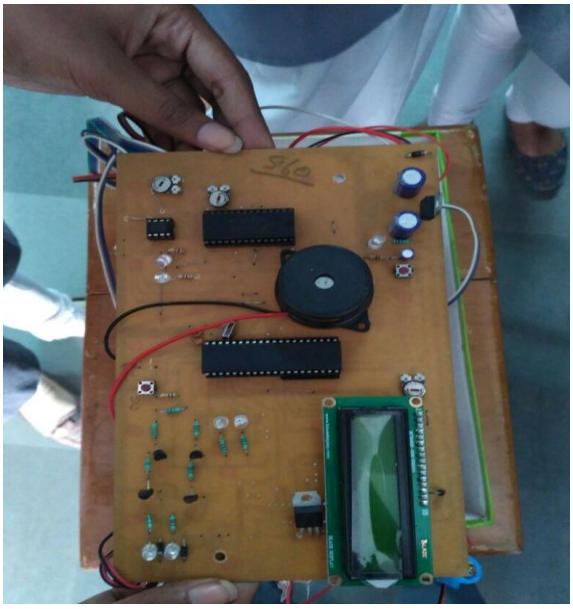

Fig. D: Hardware of wheelchair

CONCLUSION

We conclude that, on the basis of our hospital, old-age home and market survey, we made a best design of wheelchair and for old age home people. We also provide the up and down motion of back and leg portion and also we automate (means remote control) forward, backward motion. Depending on the needs and specifications required by the user, any of the above mentioned methods can be used to design the wheelchair making sure that it guarantees safe and comfortable experience to the user. The newly proposed methods are ideal for application in developing countries as there is high need for low cost navigation system for people with health issues affecting walking. 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.

FUTURE SCOPE

There are plenty of scopes to upgrade this accelerometer based hand Gesture controlled wheelchair by adding different features which provides ease of operation in the system that will be more user friendly. Heart beat monitor which can detect the heart beat rate of the user as well as the sign of heart attack; GPS tracker to find out users exact location; and many more optional features can be added according to user's need.

- In future the proposed system will be designed to identify more number of gestures and command
- Range of communication will also be increased to 100m with the powerful wireless devices

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