TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING

Kathmandu Engineering College
Department of Electronics and Communication Engineering

Minor Project Report

On

SMART WHEEL CHAIR

By

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Kathmandu, Nepal

2070

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SMART WHEEL CHAIR

PROJECT REPORT SUBMITTED TO
THE DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING
IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR
THE BACHELOR OF ENGINEERING

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CERTIFICATE

This certify that they have read and recommended to the Department of Electronics and Computer Engineering, a minor project work entitled "Smart Wheel Chair" submitted by Rohit Singh , Ramu Raut ,Sabin Adhikari in partial fulfillment of the requirements for the degree of Bachelor of Engineering.

Suman Sharma
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Abstract

Smart Wheel Chair is mechanically controlled devices designed to have self-mobility with the help of the user command. This reduces the user's human effort and force to drive the wheels for wheelchair .Furthermore it also provides an opportunity for visually or physically impaired persons to move from one place to another. The wheelchair is also provided with obstacle detection system which reduces the chance of collision while on the journey.

Smart wheelchair has gained a lot of interests in the recent times. These devices are useful especially in transportation from one place to another. The machines can also be used in old age homes where the old age persons have difficulty in their movements. The devices serve as a boon for those who have lost their mobility.

Different types of smart wheelchair have been developed in the past but the new generations of wheelchairs are being developed and used which features the use of artificial intelligence and hence leaves a little to tinker about to the user who uses the wheel chair. The project also aims to build a similar wheel chair which would have a sort of intelligence and hence helps the user on his/her movement.

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1. Introduction

1.1. Background

Though the recent developments of science and technology has drastically changed the way a normal person lives his life , there are certain groups of people who have not been able to be benefit from this development. On particular handicapped people with have limited mobility are still living a miserable life.

A smart wheel chair aims to provide aid to those handicapped and physically challenged persons by providing them with some sort of mobility which would greatly help them. Smart wheel chair consists of a major controller unit which allows the user to provide the input in the form of joystick or accelerometer or a voice command. The controller unit then synthesizes the command and takes required action so as to move the wheelchair to the particular position.

1.2 Team Members

For this project three of us have worked together. Followings are the names and College roll number of ours.

1. Ramu Raut(67084) BEX
2. Rohit Singh(67088) BEX
3. Sabin Adhikari(67091) BEX

1.3 Project Management

This project constituted mechanical design as its major part as well as embedded system design. So the work had to be divided accordingly.

Mechanical Design:

Designed Part/Component	Member/Members	Remarks
Computer adaptive design of smart wheel chair	All group members	Discussion were made in group regarding the dimension and structure
Body placement	All group members	
Base Structure	All group members	
Gear arrangement	All group members	
Motor placement	All group members	This part needed a lot of calculation and trials for exact fit.

Table 1.1 Work divisions for mechanical design

Embedded system design

Designed Part/Component	Member/Members	Remarks
MEMS Gyroscope, Ultrasonic, MEMS Accelerometer	Rohit Singh	
Speech Synthesis Interfacing	Ramu Raut	
Joystick Interfacing	Sabin Adhikari	
Connection and Power system design	All group members	

Table 1.2 Work division

Schedule

Week 1	Initiation of Project

	Base Structure Design and assembly
Week 2	
	Coding and sensor adjustment
Week 3	
	Calibration and final assembly

Table 1. 3 Work scheduling

1.4 Literature Review

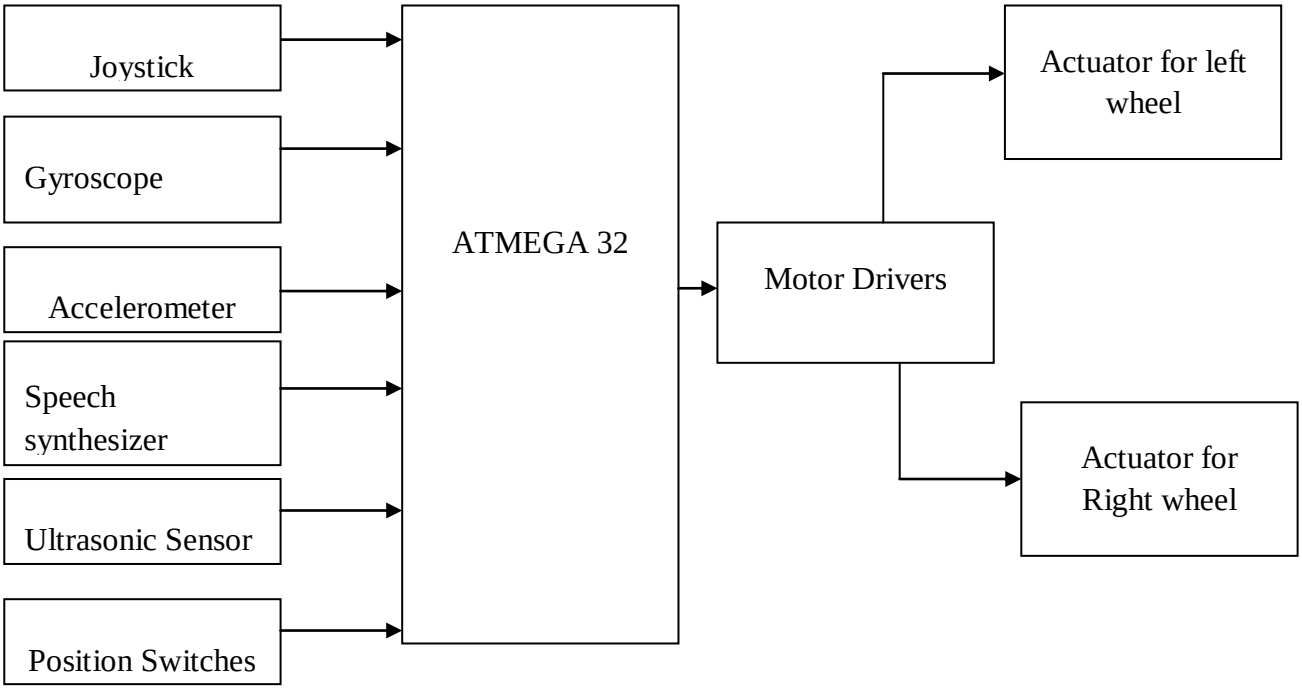
Before making the final decision regarding the choice of the minor project, a brief research was conducted to find out the projects done previously on the related topic. There were only few previous projects that dealt with speech synthesis processing we could find out.

After our project proposal was accepted much effort was made to find the necessary resources on the gyroscope, speech synthesizer. We had to search the topics on numerous website and books. The resources that prove to be most important and we used as our reference are given below:

The MIT Intelligent Wheelchair Project

MEMS motion sensor (L3G4200D Datasheet)

1.5 Block Diagram



Block Diagram Description

1.5.1 Accelerometers

Accelerometer is one of the main inputs for this project. The accelerometer sensors are mounted on headphone and they transducer change in acceleration of head movement to voltage signal which is sent to ADC input of microcontroller.

1.5.2 Joystick

Joystick is one of the main inputs for this project. The outputs of the two variable resistor of the joystick are connected with the two channels of ADC.

1.5.3 Speech Synthesizer

Speech synthesizer is one of the main inputs for this project. Speech synthesizer module works by giving user input voice command and send signal to actuators.

1.5.4 Ultrasonic Ranging Module

It is used to detect the obstacle. It is use to halt the wheel chair.

1.5.5 Gyroscope (L3G4200D)

Gyroscope compares input demand from a joystick, accelerometer source with the direction that the wheelchair is tracking. When the system detects that the wheelchair is deviating from the intended course of direction it automatically corrects the path of travel.

1.5.6 Position Switches

These switches are attached at chair, to switch the input control unit as Speech or Joystick or Accelerometer.

1.5.7 Microcontroller

It is the main computational and processing part of the Smart Wheel Chair that takes input from the sensor, processes it and gives output. It operates at high frequency of 12 MHz and acts as control center for the robot.

1.5.8 Relay Switch

A relay is an electrically operated switch. Many relays use an electromagnet to operate a switching mechanism mechanically. It is used to switch on or off electrical circuits operating at high voltage using a low DC control voltage.

Relays are used to provide high voltage to motors. The switching of relays is performed using l293D motor driver.

1.5.9 Motor Drivers

Motor Drivers amplifies the TTL output of the microcontroller such that it can drive the respective actuators. L293D IC is used for the switching the relay driver. It is dual H-Bridge IC.

1.5.10 LCD

LCD is the visual display unit of the project. It is used to display the values of different interfacing inputs. A 16 x 2 alphanumeric LCD is used for this purpose.

1.5.11 Actuators

Actuators are the motors that drive Smart Chair. They actually change the electric signals of the microcontroller into the rotational motion and provide desired functionality.

We have used Wiper Motors. The minimum required current for the motor is 1.6 amps at 70 rpm, maximum at 4 amps to run it at 106 rpm (without load).

1.6 Working Principle

1.6.1 Input Sensing

The input sensor for the smart wheel chair is an Accelerometer, Joystick, Ultrasonic Sensor, speech synthesizer and gyroscope.

1.6.1.1 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.

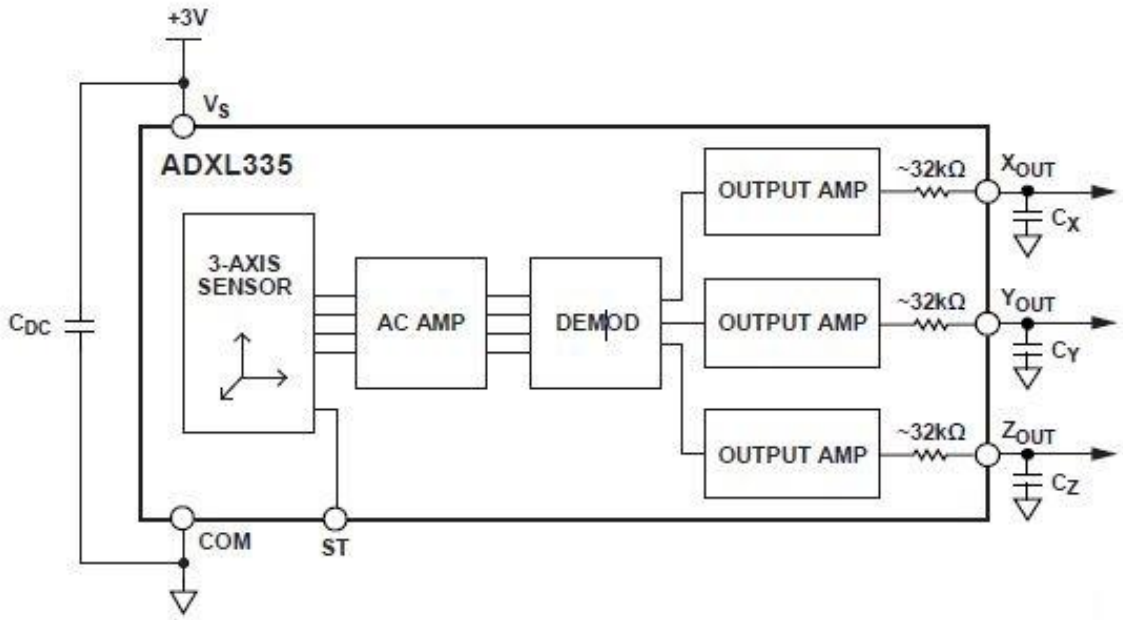


Figure : Block Diagram of ADXL335

1.6.1.2 Joystick

Analog joystick has two variable resistors for two axes. Each variable resistor has three pins; two extreme pins are connected to Vcc (5v in our case) and ground. The center pin is the output pin. The output voltage is between Vcc and GND depending on the position of stick. By measuring the voltage output of two variable resister from which the joystick is built, we can determine the position of stick in x and y axis.

1.6.1.3 Gyroscope (L3G4200D)

The L3G4200D is a low-power three-axis angular rate sensor able to provide unprecedented stability of zero rate level and sensitivity over temperature and time. It includes a sensing element and an IC interface capable of providing the measured angular rate to the external world through a digital interface (I2C/SPI).

The L3G4200D has a full scale of ±250/±500/±2000 dps and is capable of measuring rates with a user-selectable bandwidth.

1.6.1.4 Ultrasonic Ranging Module

Ultrasonic ranging module HC - SR04 provides 2cm - 400cm non-contact measurement function, the ranging accuracy can reach to 3mm. The modules includes ultrasonic transmitters, receiver and control circuit.

The basic principle of work:

-Using IO trigger for at least 10us high level signal

- The Module automatically sends eight 40 kHz and detect whether there is a pulse signal back.

- If the signal back, through high level , time of high output IO duration is the time from sending ultrasonic to returning.

Test distance = (high level time×velocity of sound (340M/S) / 2

1.6.1.5 Speech Synthesizer

Speech Synthesizer module EasyVR is the second generation version of the successful VRbot Module. It is a multi-purpose speech recognition module designed to easily add versatile, robust and cost effective speech recognition capabilities to virtually any application.
The EasyVR module can be used with any host with an UART interface powered at 3.3V – 5V, such as PIC and Arduino boards.

EasyVR features:

- Supports up to 32 user-defined Speaker Dependent (SD) triggers or commands as well as Voice Passwords. SD custom commands can be spoken in ANY language.
- Easy-to-use and simple Graphical User Interface to program Voice Commands and audio.
- Module can be used with any host with an UART interface (powered at 3.3V - 5V)
- 3 GPIO lines (IO1, IO2, IO3) that can be controlled by new protocol commands.

- PWM audio output that supports 8 ohm speakers.
- Sound playback feature.

Working principle of EasyVr:

The voice command of user is send to sample and hold circuit and it is sampled by obeying Nyquist criterion. After that it is send to ADC which convert the value in digital form. The voice command which we give through module is saved to internal flash memory and we program it through host microcontroller and it compares pre stored command and real time command and perform the specified task.

1.6.2 Actuating

After taking input and processing the input at the speed of 12 MIPS (Million Instructions per Second) process selects the corresponding motor driver and sends the signal which then drives the required part.

There are two wipers motors for the movement of the smart wheel chair. The output of the motor driver is fed to the relay switch, the output of relay switches are connected to motors.

1.7 Hardware Description

1.7.1 Microcontroller (ATmega32)

ATmega32 is a High-performance, Low-power Atmel 8-bit Microcontroller designed with Advanced RISC Architecture which has 131 Powerful Instructions among which most are single-clock Cycle Execution. Some features of this microcontroller are as follows.

– 32 × 8 General Purpose Working Registers
– Up to 16 MIPS Throughput at 16MHz
– On-chip 2-cycle Multiplier

• Peripheral Features

– Two 8-bit Timer/Counters with Separate Pre-scalers and Compare Modes
– One 16-bit Timer/Counter with Separate Pre-scaler, Compare Mode, and Capture Mode
– Real Time Counter with Separate Oscillator
– Four PWM Channels
– 8-channel, 10-bit ADC
– Byte-oriented Two-wire Serial Interface
– Programmable Serial USART
– Master/Slave SPI Serial Interface
– Programmable Watchdog Timer with Separate On-chip Oscillator
– On-chip Analog Comparator

• High Endurance Non-volatile Memory segments

– 32Kbytes of In-System Self-programmable Flash program memory
– 1024Bytes EEPROM
– 2Kbytes Internal SRAM
– Write/Erase Cycles: 10,000 Flash/100,000 EEPROM
– Data retention: 20 years at 85°C/100 years at 25°C

• Special Microcontroller Features

– Power-on Reset and Programmable Brown-out Detection
– Internal Calibrated RC Oscillator
– External and Internal Interrupt Sources

– Six Sleep Modes: Idle, ADC Noise Reduction, Power-save, Power-down, Standby and Extended Standby

• Operating Voltages

– 2.7V - 5.5V for ATmega32L

– 4.5V - 5.5V for ATmega32

• Power Consumption at 1MHz, 3V, 25°C

– Active: 1.1mA

– Idle Mode: 0.35mA

– Power-down Mode: < 1µA

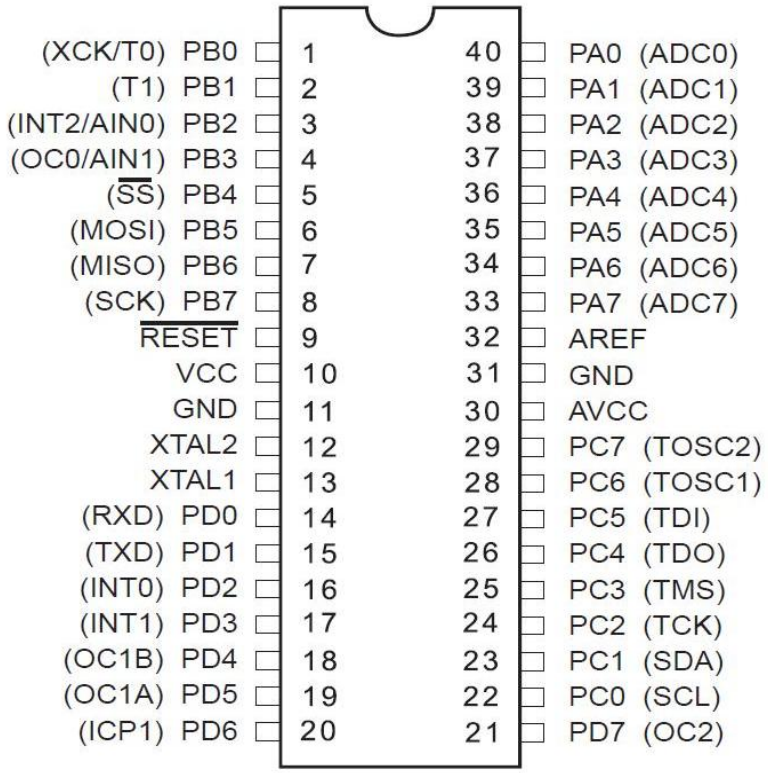


Figure 1.2 Pin Configuration of ATmega32

1.8 Mechanical Design:

This part includes the mechanical design of the smart Wheel Chair. Following considerations are taken to design it:

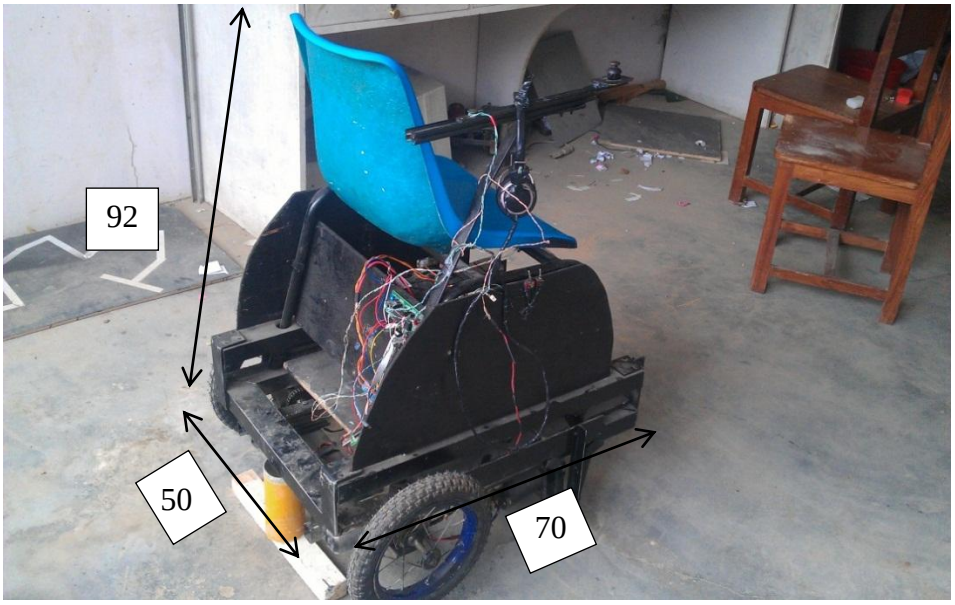


Figure: 1.4 Body Dimension of Smart Wheel Chair

Height of the chair: 92cm

Breath of the chair: 50cm

Length of the chair: 70cm

2. Software Description

The software controls the operation of the system and hence it is imperative that the software is developed in a flawless manner so as to attain the desired result.
In our project, all but one desired coding is stored in the microcontroller. It is the software that controls the overall functioning of the system. The stored program in a microcontroller controls all the basic functionalities of the function and the operation of the devices used in the system. The inputs are taken from sensors and output of the program decides action to be taken by the system. Software, being a crucial part of our project, is going to be discussed in detail in this section**.**

2.1 Software Development Process

It is important to go through a series of predictable steps to build a product or a system. Software process helps to get a series of steps. Software process is automated process that simplifies project management and, what is most important, enhances visibility of the project. It provides stability, control of the project. Software process requires a systematic and consistent approach to the project.
Software engineer or a team of engineers must incorporate a development strategy that encompasses the process for solving the problem. This strategy is often referred to a process model. The development of robotic application systems is usually realized on the basic of iterative process models of which there are many different variants. The selection of an appropriate process is a crucial issue for the success of every system development project, particularly for systems in a highly volatile environment such as mobile application systems. There are different types of process models in the software engineering. These are: - Linear sequential model, prototyping model, Evolutionary process model, incremental models, Spiral model. In our project we have followed these steps , i.e. project identification and selection, project initiation and planning ,analysis, design, Implementation, maintenance on the basics of these models.

2.2 Software language

The software or any program used for the operation of any system can be written in any language considering various factors. The choice is made on the basis of following decisive factors.

- Memory available
- Required execution speed
- Accurate control of peripheral devices
- Programming experience of team members
- Time available

Assembly language is considered to be the best for projects that need minimum memory, the highest execution speed, and precise control of peripheral devices but since writing in this language is a tedious task with more knowledge in C programming, we choose to write our source code in the C language. Not only that C programming is used knowing us the more about it but it has also several advantages over assembly language.

2.2.1 Choosing C++ language

C++ is a powerful, flexible language that provides fast program execution and imposes few constraints on the programmer. It allows low level access to information and commands while still retaining the portability and syntax of a high level language. These qualities make it a useful language for both system programming and general purpose programs. Its flexibility comes from the many ways the programmer has to accomplish the same tasks. C++ includes bitwise operators along with powerful pointer manipulation capabilities. C++ imposes few constraints on the programmer. The main area this shows up is in C's lack of type checking. This can be a powerful advantage to an experienced programmer but a dangerous disadvantage to a novice.

Another strong point of C++ is its use of modularity. Section of code can be stored in libraries for re-use in future programs. This concept of modularity also helps with ‘c++’ portability and execution speed. The core C++ language leaves out many features included in the core of other languages. These functions are instead stored in the C++ standard Library where they can be called on when needed. An example of this concept would be C’s lack of built in I/O capabilities. I/O functions tend to slow down program execution and also be machine independent when running optimally. For these reasons, they are stored in a library separately from the C language and only included when necessary.

3. Cost Estimation

S. No.	Component	Quantity	Availability	Price($)
1	ATMEGA32	2	Available locally	10
2	Speech synthesizing module	1	Scarcely Available	57
3	Battery 12V,22Ah	1	Available	56
4	Joystick	1	Available locally	5
5	Motor Driver	2	Available locally	5
6	Accelerometer (ADXL335)	3	Scarcely available	28
7	Ultrasonic Sensor Module	1	Scarcely Available	28
8	Resistors	50	Available locally	1
9	Capacitors	5	Available locally	1
10	Relay	5	Available locally	2
12	Mechanical component		Available locally	25
13	Arduino board	1	Available locally	27
14	Gyroscope	1	Scarcely available	30
15	Oscillator (12 MHZ)	1	Available locally	2
	Total			277

Table 2 Cost Estimation

4. Scope and Application

Smart Wheel Chair has a wide range of application and scope in following areas:

- **Physically Challenged People**

  Physically Disabled People can use it as per their purposes. People who are able to use their hand can use Joystick; People suffering from certain paralysis can use either voice or head movement as per requirement.

- **Patients in the Hospitals**

  People suffering from certain paralysis can use either voice or head movement as per requirement.

- **Old Age Homes**

  People at old age homes can use this chair as per their requirement.

5. Limitations:

- Problem faced during mechanical design.
- Problem faced during designing of high power motor driver.
- Due to problem of gear, higher weight cannot be supported.
- Speech Synthesizer cannot be performed at noisy environment.

6. Further Enhancements:

- **Alternate power source**

  Solar panel roof can be used as alternative power source and also it can be a protective layer from rain and sun.

- **Artificial intelligence and image processing.**

  Artificial intelligence (AI) is technology and a branch of computer science that studies and develops intelligent machines and software. Major AI researchers and textbooks define the field as "the study and design of intelligent agents",where an intelligent agent is a system that perceives its environment and takes actions that maximize its chances of success.

- **GPS navigation.**

  Navigating the actual position of wheel chair.

- **Mind control:**

  Controlling wheelchair by electric signal coming from brain. As our brain contains thousands of neuron, there is certain potential difference between each neuron. When we think something neuron emits 0 to 50 HZ electric signal. By interpreting the signal by modulation/demodulation, we can control the chair.

7. Conclusion

This project work was carried on to fulfill the requirement of minor project of Bachelor in Electronics and Communication Engineering. Smart Wheel Chair was chosen to be done as it incorporated designing an embedded system that was real time and also due to the sensor that was to be used in it. Most modern day technologies use sensors such as accelerometer, gyroscope, to take interactive input and in this project we also have tried to make the robot interactive and close to human. Also we wanted to know about the accelerometer, Gyroscope, Joystick, Ultrasonic Sensor and its working in detail and also wanted to develop a fast and real time project that can help others people. These conditions made Smart Wheel Chair a suitable project for us.

Completion of this project needed sheer determination as there were many things that could go wrong. As the mechanical design meant a lot in this project, creating a mechanical structure proved to be a difficult task being electronics student.

Though some difficulties aroused and many remodeling was needed and the chair had some limitations which we learned while building it, at last the Smart Wheel Chair created very close to the adapted design philosophy.

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