DESIGN AND DEVELOPMENT OF A SMART WHEELCHAIR PROTOTYPE FOR PHYSICALLY DISABLED PEOPLE

by

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A project
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CERTIFICATE OF APPROVAL

The project entitled as "**Design and development of a smart wheel chair prototype for physically disabled people**" submitted by **Md. Salman Khan,** bearing matric ID **ET131017** and **Md. Shakhawat Hossain**, bearing matric ID **ET131052** of session **Spring 2013**, to the Department of Electrical and Electronic Engineering, International Islamic University Chittagong, has been accepted as satisfactory for the partial fulfilment of the requirements for the degree of Bachelor of Science in Engineering and approved for the examination held on **14 December, 2017.**

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DECLARATION

It is hereby declared that this work has been done by us and no portion of the work contained in this thesis/project has been submitted elsewhere for the award of any degree or diploma.

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We would also like to thank our parents who gave inspirations all the times for completing the project.

Authors

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ABSTRACT

Bangladesh is a developing country with a large number of people. Every year, a large number of people become lame due to road accident and unable to walk normally. Wheel chair is the best assistive device used by elder and differently abled people who cannot walked normally. The driving and controlling of traditional manual wheel chair are much harder task. So our aim is to build a powerful wheel chair which helps the handicapped (lower half of the body is paralyzed) people to travel without depending others. The bone for physically challenged people is a wheel chair. The wheel chair is developing day by day. The modern wheel chairs come equipped with a self-motor to help run the wheel chair by a joystick. The joystick controlled wheel chair is a bit difficult for certain people to operate. Mainly for old and weak people. Again, the voice controlled wheel chair is not suitable at all situation because of noisy environment and sound. It is also difficult to give command for old or weak people. Moreover this wheelchair is costly. So our proposal is to make such a cost effective electronic gesture based wheel chair which will be easy to operate rather than the joystick input. In our proposal, we will show to control a wheel chair using in build gesture function of a smartphone and touch sensor. A special feature of our wheel chair is that, obstacles in front of the way of wheel chair can be detected which can avoid the collision between chair with that detected obstacle. Another feature of this chair is to use an IP camera that gives visual and acoustic information to the guardian of the riding people. The aim of this developed electric wheelchair is to provide easy and comfortable life for the handicapped people whose lower half of the body is paralyzed.

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CHAPTER 1
INTRODUCTION

1.1 Introduction

The goal of this project is to make a wheel chair for physically challenged people for automatically moving forward, backward, left and right. We have designed this prototype for those physically challenged people whose lower part of the body is paralyzed and have a little bit sense of control their hand. This is an electric wheelchair fitted with acceleration sensors of smartphone,4 channel capacitive touch module, obstacle sensor and IP camera. Since we have designed this control system using in build acceleration sensor of smart phone, so anyone can easily control this chair by acceleration of his hand. By just moving his smartphone into a slopping position, wheelchair can be moved in four directions. Again using Capacitive Touch Sensor, one can control in four directions by using his fingers. Obstacle in the way can be determined by wheelchair and wheelchair will stop automatically.Taking advantage of technological evolution, we added an external IP camera to observe the movement of the riderin the wheel chair.

1.2 Motivation

Over 100 million people worldwide, with physical disabilities require the assistance of a wheelchair but only a small percentage of them actually own or have the liberty of buying one. Although manual wheelchairs have proven to be beneficial for the disabled but it has only served the purpose of people with minor disabilities [1].

In recent times there have been a wide range of assistive and guidance systems available in Wheelchair to make their life less complicated. In recent times there have been various control systems developing specialized for people with various disorders and disabilities. The systems that are developed are highly competitive in replacing the old traditional systems [2].

There are many assistive systems to control the wheelchair like Joystick, voice control and much more. Most of the users feel comfortable with joystick controller to control electric wheelchair.Users who suffer from upper limb disability cannot manipulate the joystick with their chair [3].

In voice control system, there are problems in noisy environment. The accelerometer sensor which is used for gesture recognition or movement control is a micro electromechanical sensor which is highly sensitive sensor and capable of detecting the tilt very fast. This sensor find the tilt and makes use of accelerometer sensor to change the direction of wheel chair which is control with the movements of hand using this sensor.The capacitive touch control system allows the rider to control the chair by his finger. When the rider fails to control the chair, there need a safety system to avoid unwanted collision.

The obstacle sensor can help the rider control the wheelchair by talking over some of the responsibility for steering and avoiding objects until the user is able to handle the job [4].

So by considering all the factors, we have motivated to design a wheel chair with duel control system using in build gesture function of a smartphone and a capacitive touch sensor. We have also decided to add an obstacle sensor for avoiding unwanted collision if the rider lost the control.

1.3 Problem Statement

In developing country like Bangladesh, every year, most of the people become paralyzed by road accident. In 2015, the number was 47,437 and in 2014, the number was 46, 558 [5].

Most of them are poor. So to provide them a modern wheel chair at a limited cost to allow them freely movement, we have proposed a smart wheel chair with duel control system.The duel control systems are gestured control and touch sensor control. To detect the obstacles in front of the chair, we have to add an obstacle detector. An IP camera is to put the riderunder surveillance by his guardian.

In build gesture function of smart phone or Capacitive Touch Sensorallows the rider to control the chair easily and the obstacle detector helps to control the wheelchair by taking responsibility for avoiding objects.

As the paralyzed person has no freedom to do anything like a normal human being, so at emergency case to take help, we have used an IP camera with the chair, which allows a continuous communication with the rider and his guardian.

1.4 Objectives

- To develop a wheel chair for physically challenged people.
- To control the wheel chair bysmartphone.
- To control the wheel chair by finger touch.
- To detect the obstacles in front of the chair and emergency response.
- To make a continuous communication between the rider and other.

1.5 Chapter overview

Following this chapter, the dissertation is organized as follows:

Chapter 1: This chapter containsthe "Introduction" including introductory discussion about motivation, problem statement and objectives.

Chapter 2:This chapter contains "Literature review."Previous work which is related on this project has been discussed in this chapter.

Chapter 3:This chapter contains "Methodology"including the methodology of the project, block diagram, hardware development, component list, circuit diagram and the circuit operation.

Chapter 4: This chapter contains "Result and discussion" where the result of our project has been discussed.

Chapter 5:This chapter contains "Conclusion" where conclusion and future work has been discussed.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

In this chapter we will demonstrate the previous work which is related to this project. We will discuss about the background of modern wheel chair and about their controlling system.

2.2 Summary of the previous work

A handicapped person with locomotive disabilities needs a wheelchair to perform functions that require him or her to move around. He can do so manually by pushing the wheelchair with his hands. However many individuals have weak upper limbs or find the manual mode of operating too tiring. Hence it is desirable to provide them with a motorized wheelchair that can be easily controlled. Many research works have been published related on this topic. In this section we will discuss some of them related to the working principle of our topic.

2.2.1 Automatic Wheelchair using Gesture Recognition by Rakhi A. Kalantri and D. K. Chitre:

Rakhi A. Kalantri and D. K. Chitre published a research proposal on Automatic Wheelchair using Gesture Recognition in International Journal of Engineering and Innovative Technology (IJEIT) on 9,March 2013 [6]. They proposed a wheelchair by just tilting acceleration sensor wheelchair can be moved in four directions. The obstacle sensor can help the rider control the wheelchair by taking over some of the responsibility for steering and avoiding objects until he or she is able to handle the job. Obstacle in the way can be determined by wheelchair and wheel chair will stop automatically. Fig. 2.1 shows theBlock diagramof this automated wheelchair.

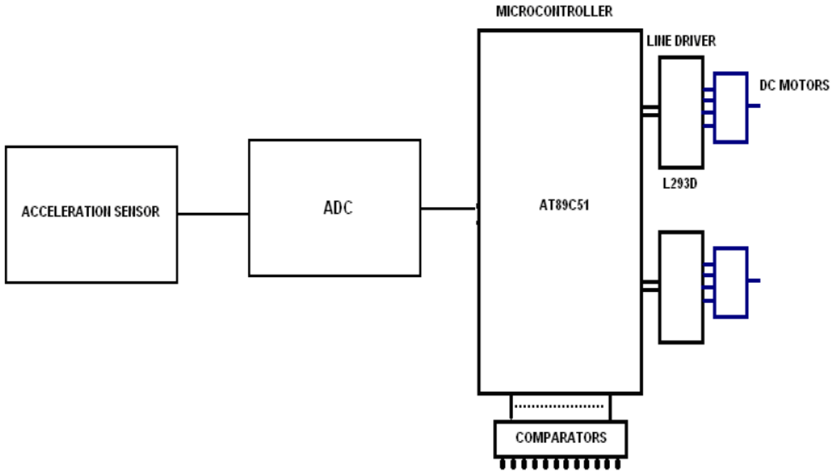


Fig. 2.1: Block diagram of automated wheelchair [6].

This handicap wheelchair basically works on the principle of acceleration. An acceleration sensor provides two axes whose output is analogs. The analog output varies according to acceleration applied to it. By applying simple formula, they calculated the amount of tilt and output of tilt will decide to move in which direction. They installed four sensors for detection of wall or obstacle in the forward, backward, left and right direction.

Advantages:

- This chair can be easily controlled using hand gesture.
- The additional feature which is obstacle sensor can stop the chair if any obstacle remain in front of the chair.

Limitation:

- Seriously weak and old people does not able to control acceleration controlled chair.

2.2.2 Hand Gesture Based Wheelchair Movement Control for Disabled Person Using MEMS by Prof. Vishal V. Pande, Nikita S. Ubale, Darshana P. Masurkar, Nikita R. Ingole, Pragati P. Mane:In the research article by Prof. Vishal V. Pande at al Int. Journal of Engineering Research and Applications ISSN:2248-9622, Vol.4, Issue 4(Version 4) on April 2014,he wrote a paper on to develop a wheel chair control which is useful to the physically disabled person with his hand movement or his hand gesture recognition using Acceleration technology. They employs a sensor ADXL202, which controls the wheelchair hand gestures made by the user and interprets the motion intended by user and moves accordingly. When anyone change the direction, the sensor registers value are changed and that value are given to microcontroller. Depending on the direction of the Acceleration, microcontroller controls the wheel chair direction like Left, Right, Front and Back [7].

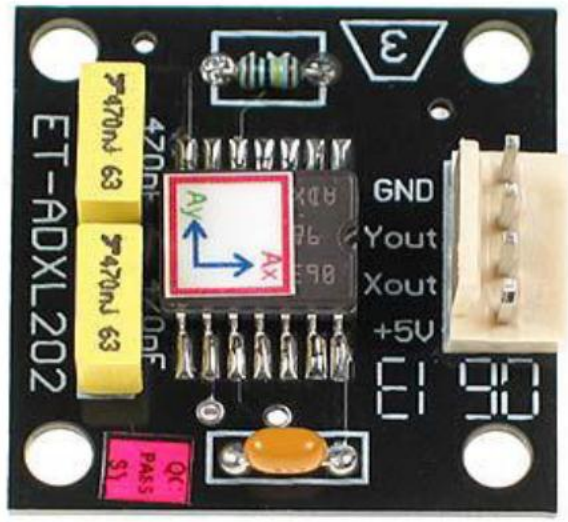


Fig. 2.2: ADXL 202 sensor [7].

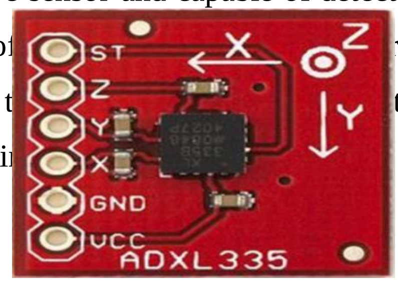
Advantages:

- This chair can be easily controlled using hand gesture.

Limitation:

- Seriously weak and old people does not able to control acceleration controlled chair.
- Acceleration sensor is costly.

2.2.3 Hand Gesture Recognition Based Wheel Chair Direction Control Using AVR Microcontroller by Gaurav Kumar Soni, VidhataPoddar, YogitaSahu, PratimaSuryawanshi: On 3 March,2016, Gaurav Kumar Soni, VidhataPoddar, YogitaSahu, PratimaSuryawanshi published a paper on Hand Gesture Recognition Based Wheel Chair Direction Control Using AVR Microcontroller at International Journal of Advanced Research in Computer and Communication Engineering [8]. They designed and developed a hand gestured based wheelchair that can be easily controlled by the help of gesture recognition system. They designed this wheel chair for handicapped or elder people by hand movements only. Accelerometer module which is used in this project is one of the most important part of our project. They designed their wheelchair with the help of MEMS accelerometer sensor, AVR microcontroller, motor driver IC and RF module. The MEMS accelerometer sensor which was used for movement control is a micro electromechanical sensor which is highly sensitive sensor and capable of detecting the tilt very fast. This sensor find the tilt and makes use of ... to change the direction of wheel chair which is control with t... the sensor. They used ADXL 335 in their proposed wheelchai...



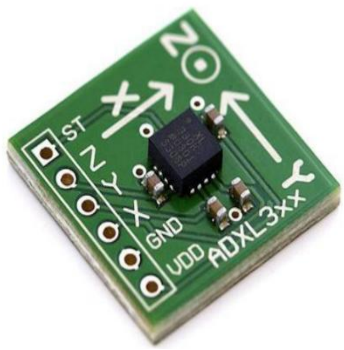


Fig. 2.3: An Accelerometer Sensor ADXL3XX [8].

Table 2.1: Pin configuration of accelerometer Sensor ADXL3XX [8]

Pin No.	Use of pin
1- VDD	On this pin we will give the +5volt supply.
2- GND	We connect its pin no. 2 to the ground for biasing.
3- X	This pin is used receive the analog data for x direction movement.
4- Y	This pin is used to receive the analog data for y direction movement.
5- Z	This pin is used to receive the analog data for z direction movement.
6- ST	This pin is used to set the sensitivity of accelerometer 1.5g/2g/3g/4g.

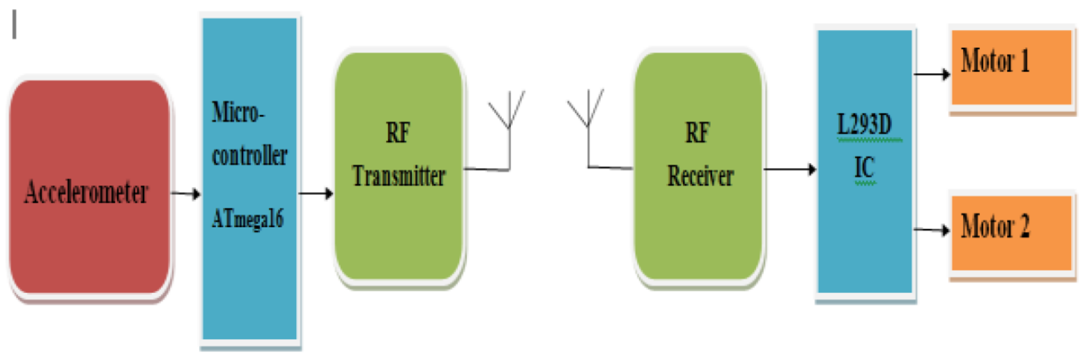


Fig. 2.4: Basic block diagram of hand gestured based wheel chair direction control [8].

Advantages:

- This chair can be easily controlled using hand gesture.
- RF transmission is comfortable for wireless data transmit.

Limitation:

- Sometimes accelerometer cannot control the chair smoothly.
- This control system is costly.

2.2.4 Design and Development of a Hand-glove Controlled Wheel Chair by RiniAkmeliawati, Faez S. Ba tis and Umar J. Wani: RiniAkmeliawati, Faez S. Ba tis and Umar J. Wani proposed a wheelchair in their research paper titled Design and Development of a Hand-glove Controlled Wheel Chair in 4th International Conference on Mechatronics (ICOM), 17-19 May,2011, Kuala Lampur, Malaysia [1]. According to their paper, common experience shows that a joystick requires a relatively large force which is more than the threshold for severely disabled people. Considering the force and the whopping cost of wheelchairs available in the market, the described their paper on how to design of a cost-effective and easier to control wheelchair. They proposed a prototype which will be communication wirelessly between the controller and the plant and it will also replace the traditional joystick by the implementation of user hand glove control.

Fig. 2.5: Instrumented glove with Flex Sensor with transmitter and the prototype [1].

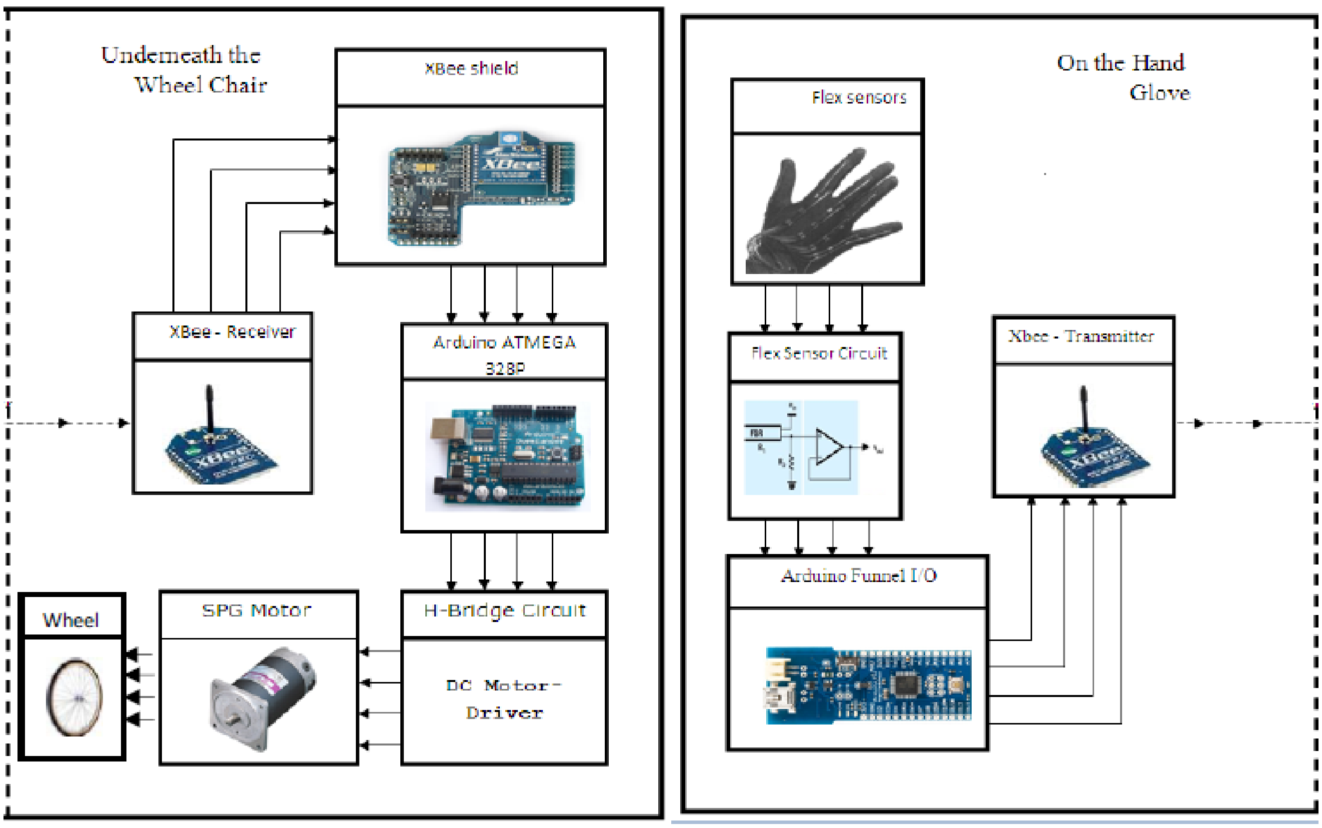


Fig. 2.6: Block diagram of Hand Glove and Wheelchair [1].

Advantages:

- This chair can be easily controlled using hand gesture.
- RF transmission is comfortable for wireless data transmit.

Limitation:

- No additional control system.
- System is costly.
- Sometimes accelerometer cannot control the chair smoothly.

2.2.5 Android phone controlled Voice, Gesture and Touch screen operated Smart Wheelchair by ShraddhaUddhavkhadilkar&NarendraWagdarikar: At International Conference on Pervasive Computing (ICPC), SharaddhaUddhaykhadilkar and NarendraWagdarikar proposed a wheel chair which can control by android phone using build in functions. The control system using voice, Gesture and Touch screen [9].

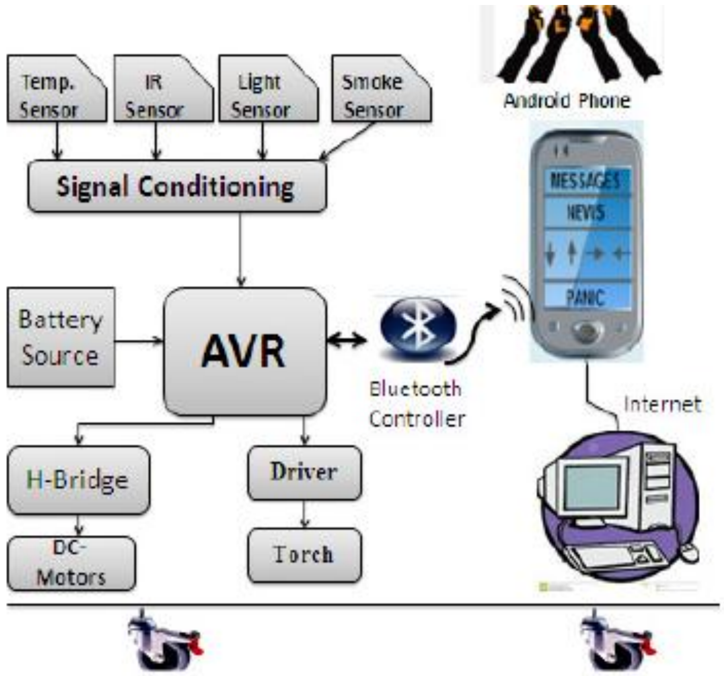


Fig. 2.7: Block diagram of smart wheel chair [9].

Position of Smart Phone	Description
	Go Forward
	Go Backward
	Go Right
	Go Left

Fig. 2.8: The tilt of mobile corresponding angle and output [9].

Advantages:

- This chair can be easily controlled using hand gesture, voice and touch.
- Multi control system.

Limitation:

- Very costly for one more control system.
- No obstacle detection system.

2.3 Summary

We have discussed about some works related to this topic. The authors proposed and described their model with figure. The next chapter will discuss about the methodology of this project which includes the block diagram of the project and its description, component list and its description, circuit diagram with its operation and finally the next chapter will discuss about the algorithm development of this project.

CHAPTER 3

METHODOLOGY

3.1 Introduction

We have developed an electrical wheelchair to assist handicapped and old people whose lower part of the body is paralyzed. In this chapter we will discuss about methodology of the project including the blockdiagram of the project, component list and their description, circuit diagram with its operation. Finally we will discuss about the algorithm development of the project.

3.2 Functional Block Diagram

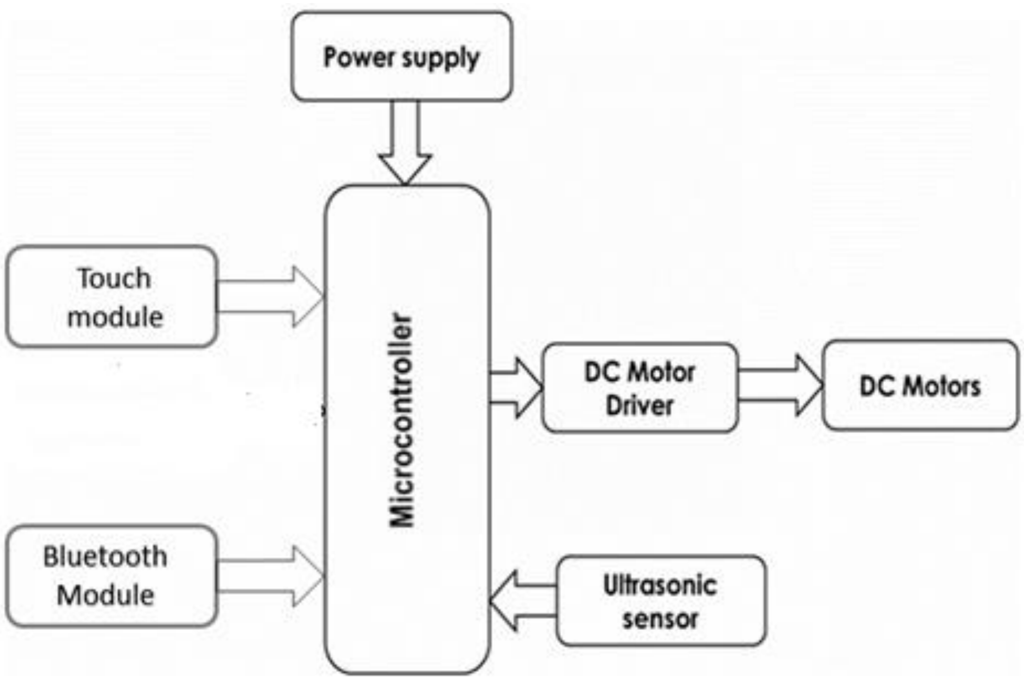


Fig. 3.1: Functional Block Diagram of Control System.

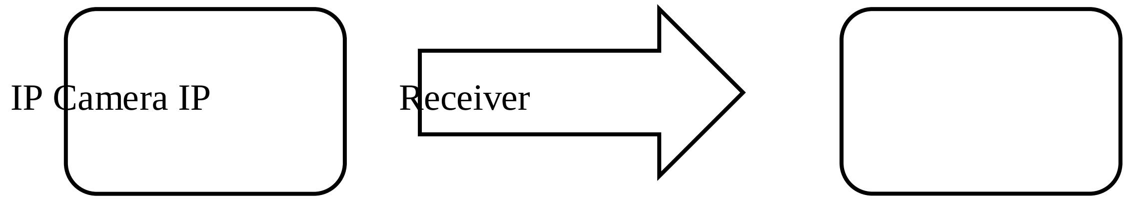


Fig. 3.2: Functional Block Diagram of IP camera broadcasting

Figure 3.1 shows the functional block diagram of proposed system. The working function of this wheelchair can be represented by this block diagram. The mobile phone of the rider connected through Bluetooth with microcontroller. In build gesture function of the mobile phone gives signal according to its tilting position and the microcontroller gives output to the motor driver. This is the first control system.

In the second control system, a 4 channel capacitive touch module is connected with the microcontroller. By touching per channel, we can give four unique input to microcontroller. Microcontroller gives output to motor driver.

By the rotation of the two motors, we can easily control the four direction movement of the wheelchair. The ultrasonic sensor will detect the obstacles in front of the chair and stop the motors to avoid the collision to save the wheelchair. Here power supply from a 12 volt dc battery.

Figure 3.2 shows the functional block diagram of IP camera system. The IP camera connected with a fixed IP and helps to observe by the guardian of the rider continuously and response for emergency help and security purpose.

3.3 Hardware description

This section contains different types of hardware and their description with figure whose are required in this project.

3.3.1 Hardware components

- Arduino board (UNO R3 ATMEGA328)
- L298N motor driver
- DC gear motor
- Ultrasonic Sensor
- TTP224 Capacitive Touch Sensor Module (4 channels)
- Bluetooth Module HC-05
- Battery (12V)
- Connectors and wire.
- IP Camera

3.3.2 Arduino board (UNO R3 ATMEGA328)

We have used Arduino UNO microcontroller. The Uno is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller, simply connect it to a computer with a USB cable or power it with an AC to DC adapter or battery to get started. The pictures were taken from the manufacturer’s website [10].The reason for selecting this device is its reliability and availability. It is easy to program and burn. Easy to use and to observe the operation which helps us to correct the program.. This allows for faster transfer rates and more memory.

Fig. 3.3: Arduino board (UNO R3 ATMEGA328). [10]

Fig. 3.3 shows the Arduino board (UNO R3 ATMEGA328) And Fig. 3.4 shows Pin diagram of Arduino board (UNO R3 ATMEGA 328). It contains digital input/output pins, analog inputs,16 MHz quartz crystal, one USB connection port, one power jack, one ICSP header and a reset button and one microcontroller model no:ATMEGA328

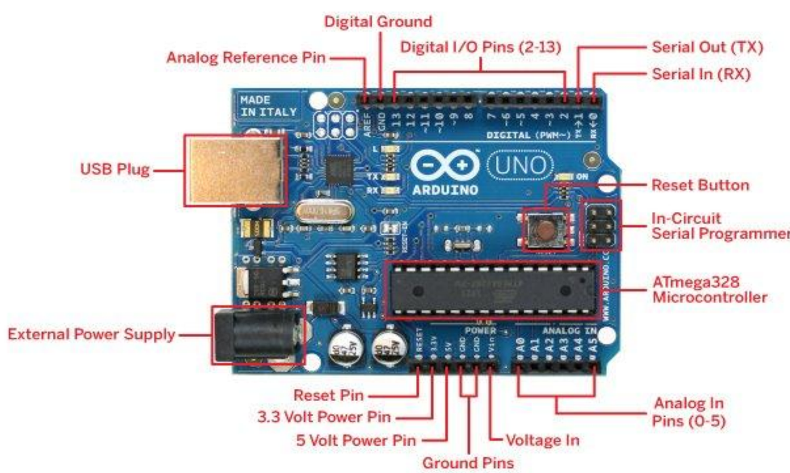


Fig. 3.4: Pin diagram of Arduino board (UNO R3 ATMEGA 328). [11]

Fig. 3.5 shows the Pin diagram of ATMEGA328 Microcontroller. It has 16MHz clock speed with 32KB flash Memory.It also has SRAM with capacity 2KB and EEPROM with capacity 1KB.Its operation voltage is 5 volts. Other specification shown in Table 3.1 below.

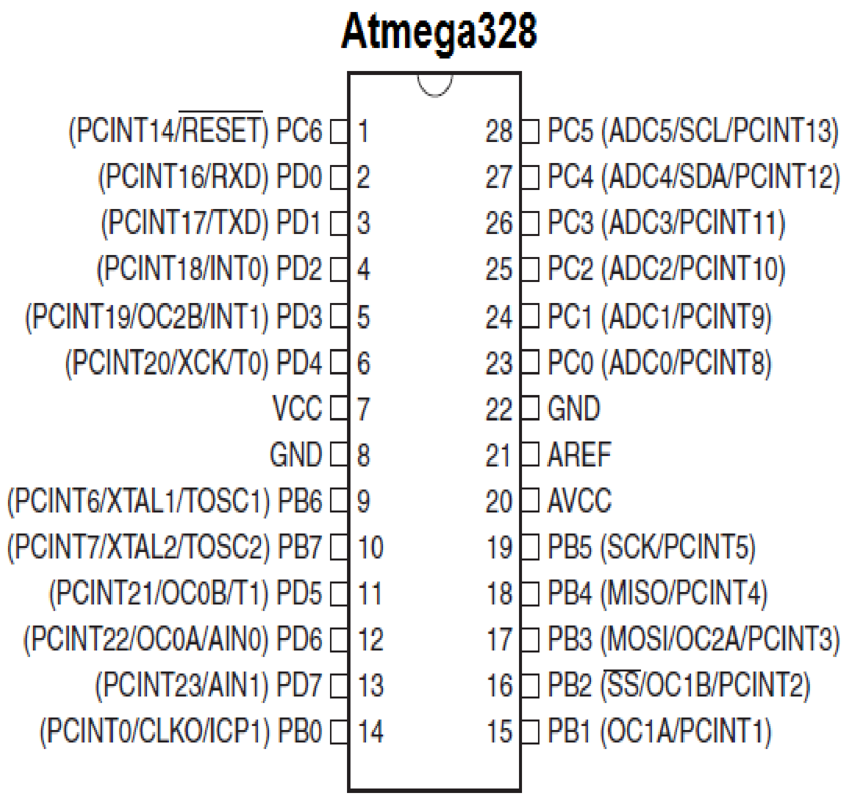


Fig. 3.5: Pin diagram of ATMEGA328 Microcontroller [12].

Table 3.1: Features of Arduino Uno [13].

Microcontroller	ATmega328
Operation voltage	5 volt
Input Voltage (recommended)	7-12V
Input Voltage (limits)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
Analog Input Pins	6
DC Current per I/O Pin	40 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB of which 0.5 KB used by boot loader
SRAM	2 KB
EEPROM	1 KB
Clock Speed	16 MHz

3.3.3 DC gear motor

Geared DC motors can be defined as an extension of DC motor which already had its insight details demystified here. A geared DC Motor has a gear assembly attached to the motor. The speed of motor is counted in terms of rotations of the shaft per minute and is termed as RPM [13].

The gear assembly helps in increasing the torque and reducing the speed. Using the correct combination of gears in a gear motor, its speed can be reduced to any desirable figure. This concept where gears reduce the speed of the vehicle but increase its torque is known as gear reduction. Gear motors are commonly used in commercial application where a piece of equipment needs to be able to exert a high amount of force in order to move a very heavy object.

The relationship between torque vs. speed and current is linear as shown left as the load on a motor increases, speed will decrease. The graph pictured here represents the characteristics of a typical motor. As long as the motor is used in the area of high efficiency (as represented by the shaded area) long life and good performance can be expected.

However, using the motor outside this range will result in high temperature rises and deterioration of motor parts. If voltage in continuous applied to a motor in a locked rotor condition, the motor will heat up and fail in a relatively short time. Therefore it is important that there is some form of protection against high temperature rises. A motor's basic rating point is slightly lower than its maximum efficiency point. Load torque can be determined by measuring the current drawn when the motor is attached to a machine whose actual load value is known.

Fig. 3.6: DC gear motor [14]

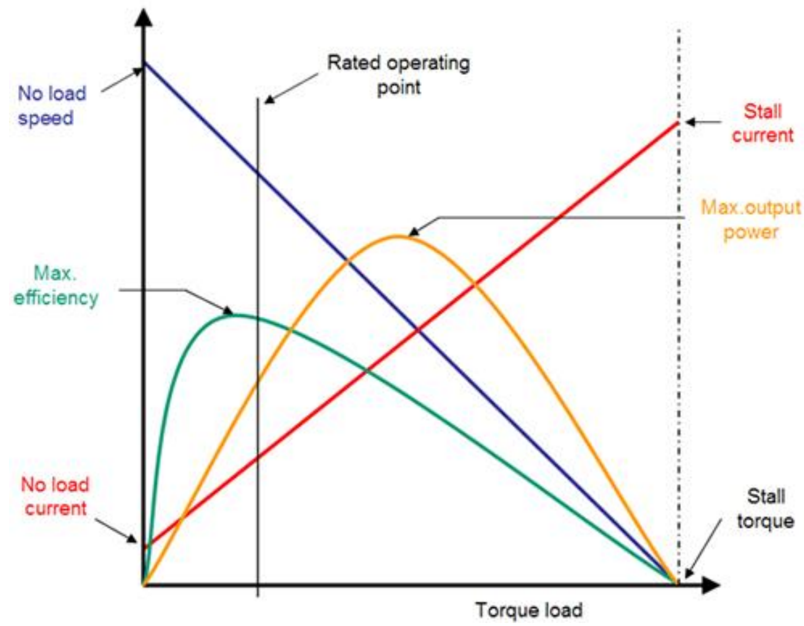


Fig. 3.7: Speed and Load characteristics [14].

3.3.4: Ultrasonic Sensor

This is the HC-SR04 ultrasonic ranging sensor. This economical sensor provides 2cm to 400cm of non-contact measurement functionality with a ranging accuracy that can reach up to 3mm. Each HC-SR04 module includes an ultrasonic transmitter, a receiver and a control circuit. We used HC-SR04 ultrasonic sensor which has 4 pin containing ground pin, VCC pin, trigger pin and echo pin where trigger pin sends sonar wave and echo pin receive the reflected wave [15]. Fig. 3.8 shows Ultrasonic Sonar Sensor (HC-SR04) And Fig. 3.9 shows the working principle of ultrasonic sensor which sends sonar wave via trigger pin

And receive this reflecting wave from obstacle via echo pin.

Fig. 3.8: Ultrasonic Sonar Sensor (HC-SR04). [15]

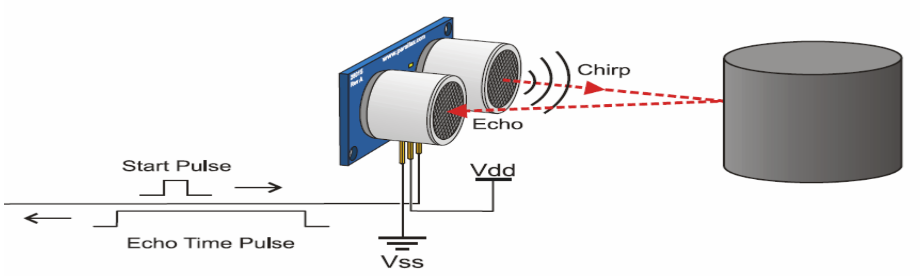


Fig. 3.9: The working principle of ultrasonic sensor which sends sonar wave via trigger pin And receive this reflecting wave from obstacle via echo pin [15].

Table 3.2: Features of Ultrasonic Sensor.

Power Supply	+5 Volt DC
Quiescent Current	<2mA
Working Current	15mA
Effectual Angle	<15°
Ranging Distance	2cm – 400 cm/1″ – 13ft
Resolution	0.3 cm
Measuring Angle	30 degree
Trigger Input Pulse width	10uS
Dimension	45mm x 20mm x 15mm

3.3.5: TTP224 Capacitive Touch Sensor Module (4 channels)

The TTP224 capacitive touch sensor module is perfect for adding 4 capacitive touch inputs to our system. The capacitive touch sensor module uses the TTP224 integrated circuit, making it easy to add capacitive touch input. It features 4 sensitive touch pads that make an ideal replacement for the old fashioned switches. There are on-board 4-key TTP224 capacitive touch sensor IC, 4 status indicator LEDs. Its working voltage range: 2.4 V to 5.5 V. [16]Fig. 3.10 shows Capacitive Touch Sensor model no: TTP224

Fig. 3.10: TTP224 Capacitive Touch Sensor. [16]

3.3.6: IP Camera

Internet protocol camera, or IP camera, is a type of digital video camera commonly employed for surveillance, and which, unlike analog closed circuit television (CCTV) cameras, can send and receive data via a computer network and the Internet. Although most cameras that do this are webcams, the term "IP camera" is usually applied only to those used for surveillance.An IP camera is typically either centralized (requiring a central network video recorder (NVR) to handle the recording, video and alarm management) or decentralized (no NVR needed, as camera can record to any local or remove storage media). [17]

For cost minimization, we proposed a normal android smart phone. Using android application, the camera of the phone can be installed as an IP camera. Network can be provided by own phone network. So external modem or internet connection does not need. So, we think it is batter to use a smart phone instant of an IP camera for cost minimization. Fig. 3.12 shows front view of wheel chair using IP Camera.

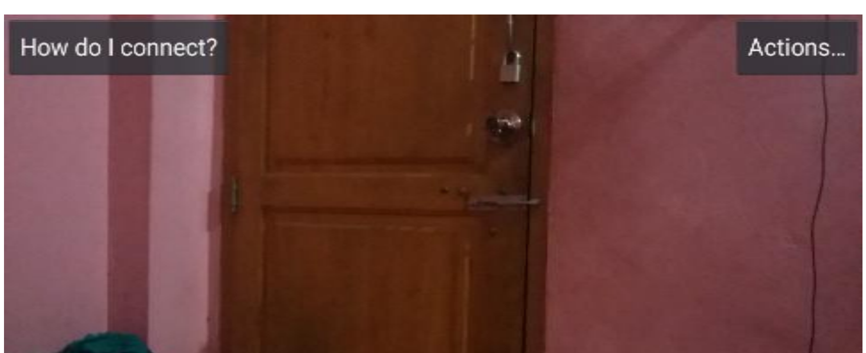


Fig. 3.12: IP Camera.

3.3.7: Bluetooth Module HC-05

The Bluetooth module shows in Fig. 3.13 model no: HC-05 is a MASTER/SLAVE module.By default the factory setting is SLAVE.The Role of the module (Master or Slave) can be configured only by AT COMMANDS.The slave modules cannot initiate a connection to another Bluetooth device, but can accept connections.Master module can initiate a connection to other devices.The user can use it simply for a serial port replacement to establish connection between MCU and GPS, PC to your embedded projectetc. [18]

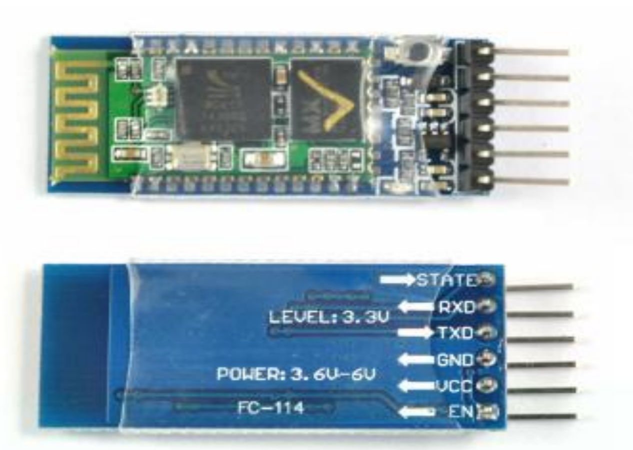


Fig. 3.13: Bluetooth HC-05. [18]

Table no 3.3: Pin description of HC-05

Pin Name	Functions
Enable	When enable is pulled LOW, the module is disabled which means the module will not turn on and it fails to communicate.When enable is left open or connected to 3.3V, the module is enabled i.e. the module remains onand communication also takes place.
Vcc	Supply Voltage 3.3V to 5V.
GND	Ground pin.
TXD & RXD	These two pins acts as an UART interface for communication.
STATE	It acts as a status indicator.When the module is not connected to / paired with any other bluetoothdevice, signal goes Low.At this low state,the led flashes continuously which denotes that the module is not paired with other device.When this module is connected to/paired with any other bluetooth device,the signal goes High.At this high state,the led blinks with a constant delay say for example 2s delay which indicates that the module is paired.

HC-05 module is an easy to use Bluetooth SPP (Serial Port Protocol) module, designed for transparent wireless serial connection setup. Data moves here bit by bit or in a series of bits what defines the term serial communication comes from. It is a standardized protocol for sending and receiving data via a 2.4 GHz wireless link. It is a secure protocol and it’s perfect for short-range, low power, low cost wireless transmissions between electronic devices. Every single Bluetooth device has a unique 48 bit address.

3.3.8: L298N motor driver

Motor Driver IC is a bipolar module which allows DC motor to drive on either direction. Here L298N H-bridge Dual Motor Controller Module is used. [19]Fig. 3.14 shows Motor driver L298N IC which have following Specifications:

- Maximum operation voltage: 46V
- Peak output current per channel: 2A
- Minimum logic voltage: 4.5 V
- Maximum logic voltage: 7V

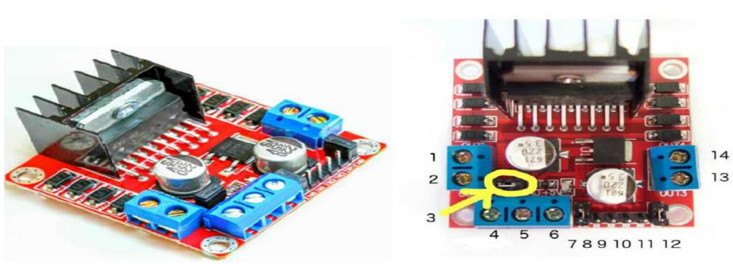


Fig. 3.14: Motor driver L298N. [19]

3.4 Hardware implementation

This section complete implementation of the project will be shown. Step by step with proper demonstration. Complete circuit will be shown for understanding the circuit description and its operation.

3.4.1 Circuit Design

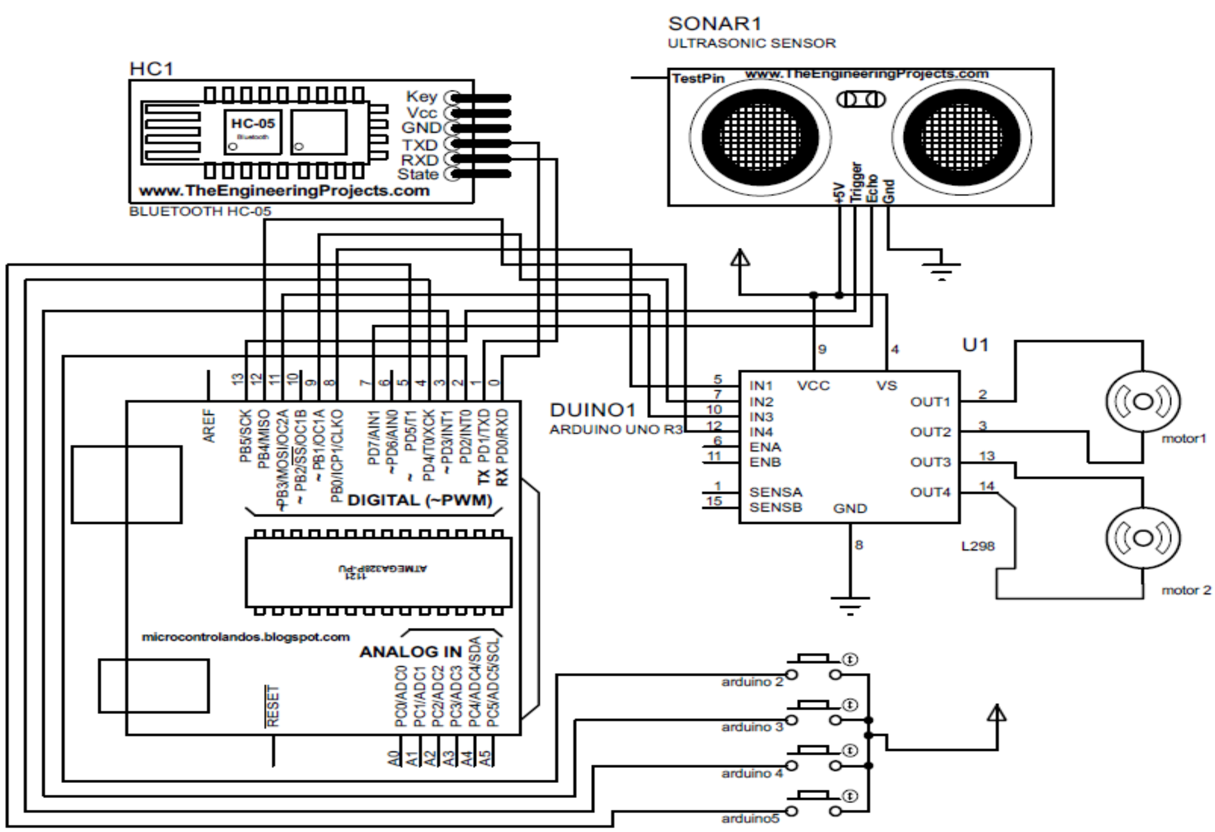


Fig. 3.15: Circuit Diagram of control system.

3.4.2 Circuit Connection

- 8, 9, 11 and 12 no pin of Arduino are connected with input 1, 2, 3 & 4 of motor driver respectively.
- Rx and Tx pin of Arduino are connected with Tx and Rx of HC-05 respectively.
- 2, 3, 4 and 5 no pin of Arduino are connected with 4 output pins of capacitive touch sensor respectively.
- 13 and 7 no pin of Arduino are connected with Trig and Echo pin of Ultrasonic Sensor respectively.
- Left motor is connected with output 1 and output 2 of motor driver.
- Right motor is connected with output 3 and output 4 of motor driver.
- A 12 volt battery is connected to provide power.

3.4.3: Circuit Operation

The rider can control the chair by his smart phone or the touch pad. During the touch pad operation, there are four channel in the capacitive touch module. 1 is for forward, 2 is for backward, 3 is for left and 4 is for right. The rider just touch his finger on particular channel to move the chair. To control the chair using in build gesture function of smart phone, the phone have to connect through Bluetooth using “BT robot controller” software. After connecting, he will able to control the chair just tilting his smartphone. Capacitive touch pad or Smartphone gives signal to the microcontroller. According to the program, it gives output to the motor driver to control the rotation of two motors. The logic to control the motor are given in table 3.2.

Table no 3.4: Condition for movement of the wheelchair

Tilt position	Pin no 8	Pin no 9	Pin no 11	Pin no 12	Wheel Chair Direction
Normal	0	0	0	0	STOP
Forward	1	0	1	0	FORWARD
Backward	0	1	0	1	BACK
Left	0	1	1	0	LEFT

Right	1	0	0	1	RIGHT

The ultrasonic sensor will detect obstacles in front of the chair and it will stop the motors as well as the wheelchair.

3.4.4: Algorithm Development

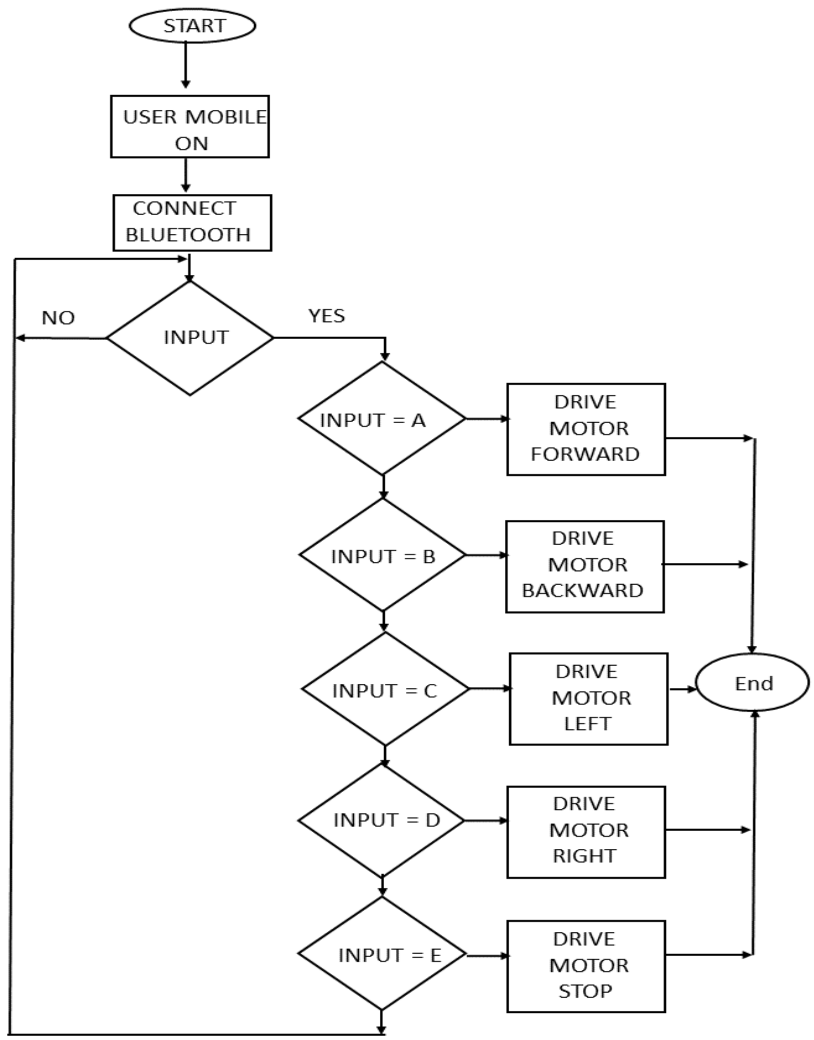


Fig. 3.16: Flow chart of gesture control system via Bluetooth.

In figure 3.16, we have shown the flow chart of gesture control system via Bluetooth. To give signal using accelerometer sensor of the mobile phone, first of all we have to connect the mobile via Bluetooth. Using android application, depending on tilting position of hand, the smart phone will give signal to microcontroller via Bluetooth and according to the program microcontroller will give output to move forward, backward, left or right.

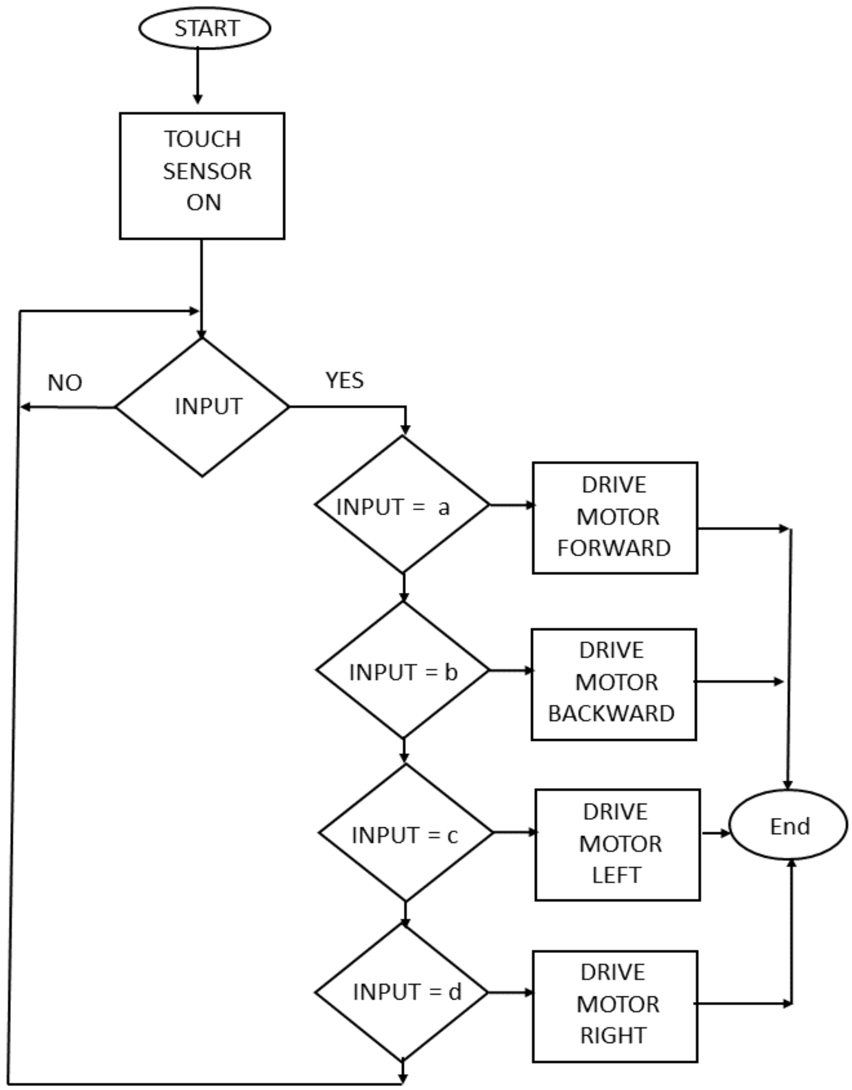


Fig. 3.17: Flow chart of control system using Touch sensor

In figure 3.17, we have shown the flow chart to control the chair using capacitive touch sensor. We will use a four channel capacitive touch sensor which will be directly connected with the microcontroller. If any one touch the 1st channel, it will be high and according to the program, microcontroller will give output to motor driver to move forward. Similarly the rest three channel will work similarly.

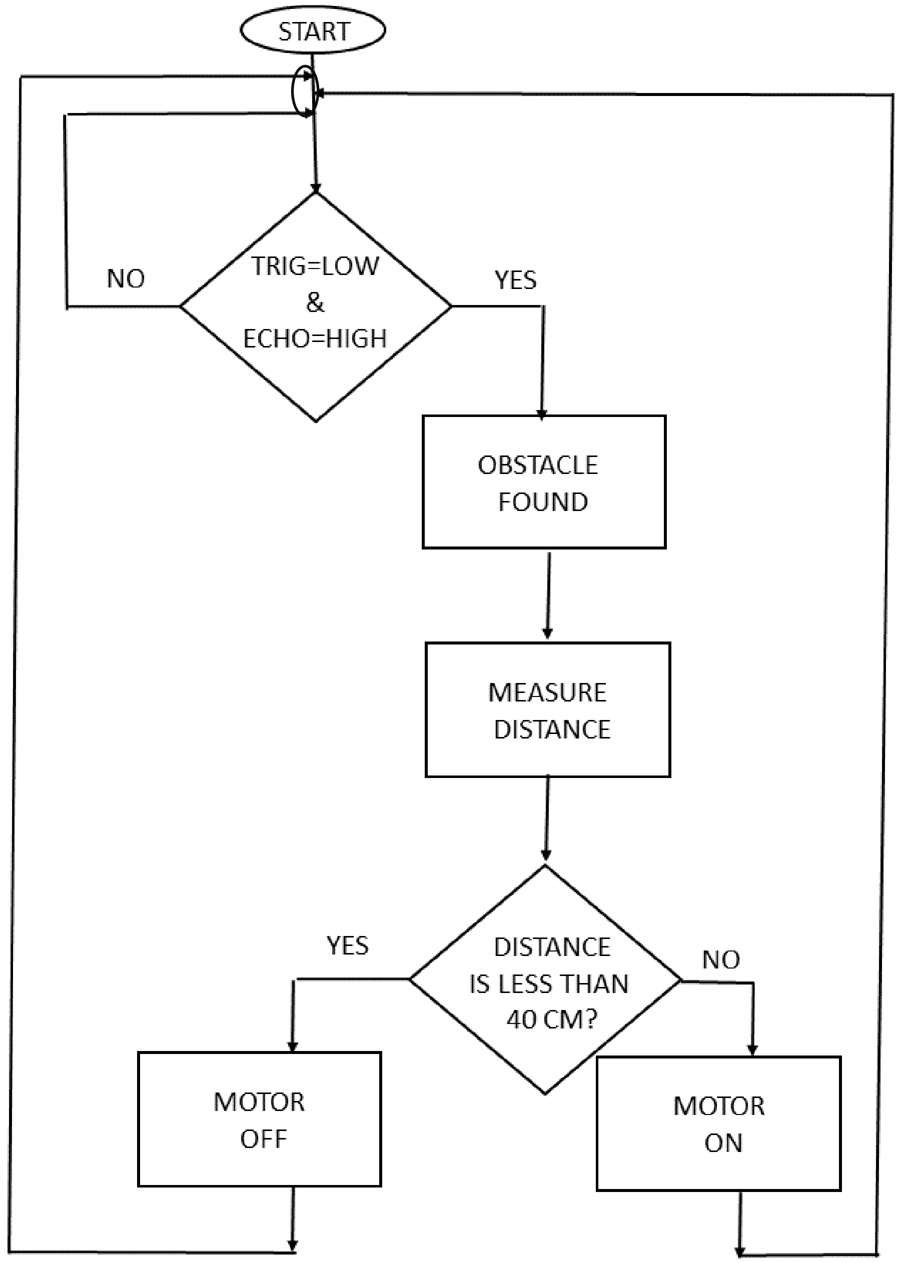


Fig. 3.18: Flow chart of obstacle detection system using ultrasonic sensor.

In figure 3.18, we have shown the algorithm of obstacle detection system using ultrasonic sensor. According to the working principle of ultrasonic sensor, the trigger pin will give an ultrasonic wave and if any obstacle in front of the chair, the wave will reflect which make the echo pin high and according to the formula of motion, it will calculate the distance. If the distance is less than 40 cm, the chair will stop.

3.5 Summary

In this chapter methodology of the project has been discussed which include block diagram of the project, component list and the description of major components. Also include the circuit diagram with its operation and description. Finally this chapter discussed about the algorithm development of the project.

The next chapter will discuss about the result and discussion of this project which include the overall result of the project output.

CHAPTER 4

RESULT AND DISCUSSION

4.1 Introduction

This section introduces with the individual hardware implementation pictures and other processes. The operations and achievement through the project work defines via the attached picture of the particular findings indeed.

4.2 Hardware Prototype- Smart Wheelchair

Fig. 4.1: Prototype development of Smart Wheel Chair (Front and side view)

In fig. 4.1, we have shown the prototype which we have tried to develop. The system is placed under the chair. To save it from dust, it can be covered using light hard board. The obstacle sensor is placed in front of the chair. The capacitive touch sensor is placed on the right hand of the chair.

4.3 Hardware Connections

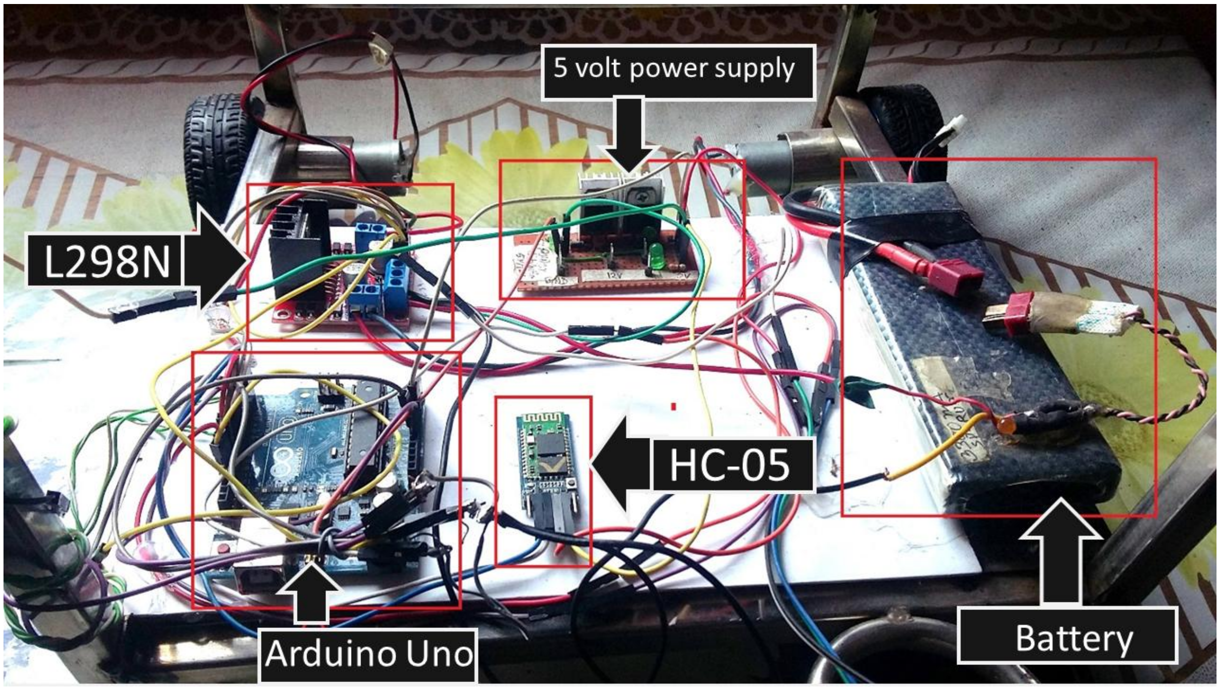


Fig. 4.2: Main Hardware connection

Fig. 4.3: Ultrasonic Sensor in front of the chair to detect obstacles.

Fig. 4.2 shows the overview of the hardware of the project. Here the different components which are used in the project have been indication by arrow symbol.

Fig. 4.3 shows the ultrasonic sensor which is in front of the chair. This is for detecting obstacles in front of the chair.

4.4 Power Calculation:

4.4.1 Ratings of Battery:

Battery type: Lipo Battery (3 cells)

Operating volt: 12 volt

Capacity: 3.3 Ah.

4.4.2 Ratings of motor:

Motor type: DC gear motor

Operating Voltage: 12 volt.

Speed: 120 rpm

Free running current: 50 mA,

Stall torque: 1.4 A,

Weight: 180 gr.

We have used two DC motors. So maximum current at full load is 2.8 A, The motor driver IC L298N gives output maximum 4A, so it is suitable. The ratting of the battery is 3.3 A which is enough to give supply at full load.

4.5 Controlling Unit

We have developed two control unit. They are described below.

4.5.1 By Smart Phone Control mode

We are using in build gesture function of smart phone to control the chair movement.

Fig. 4.4: Android Application (BT Robot Controller)

This android application is available in Google Play Store. The accelerometer of Smartphone is used to detect the tilt movement angle of Smartphone, just tilt your mobile forward, backward, left and right to control the direction of the chair. The application is connected by HC-05 Bluetooth module with microcontroller.

Bluetooth is able to send and receive data via a 2.4 GHz wireless link. According to the tilting position of the hand, the build in accelerometer of the smartphone give signal to the android application which generates 4 unique ASCII (American Standard Code for Information Interchange) code. Using Bluetooth, the smart phone send the code and the Bluetooth module HC-05 receives the code and gives to the microcontroller.

Table 4.1: Data send by Bluetooth and output.

Tilting position	ASCII code	Character	Motor 1	Motor 2
Forward	001	A	Forward	Forward
Backward	002	B	Backward	Backward
Left	003	C	Backward	Forward
Right	004	D	Forward	Backward
Stop	005	E	Stop	Stop

Fig. 4.5: Tilt movement angle of Smartphone

This wireless system can transmit data with approximately 10 meters.

4.5.2 By Capacitive Touch Pad

If the rider is unable to move his hand, then he will be able to control the chair using Capacitive Touch Pad. Here we use a four channel capacitive touch module. By touching each channel, the chair can be moved in four direction.

Touch pad works like momentary switch. If anyone touches the pad, it will be high and give an output voltage to microcontroller. The 4 channels of the touch sensor are connected with four pins (2, 3, 4, and 5) of the arduino.

Table no 4.2: Capacitive touch module output direction.

Channel No	Connected with pin	Direction of Motor 1	Direction of Motor 2
Channel No 1	2	Forward	Forward
Channel No 2	3	Backward	Backward
Channel No 3	4	Backward	Forward
Channel No 4	5	Forward	Backward

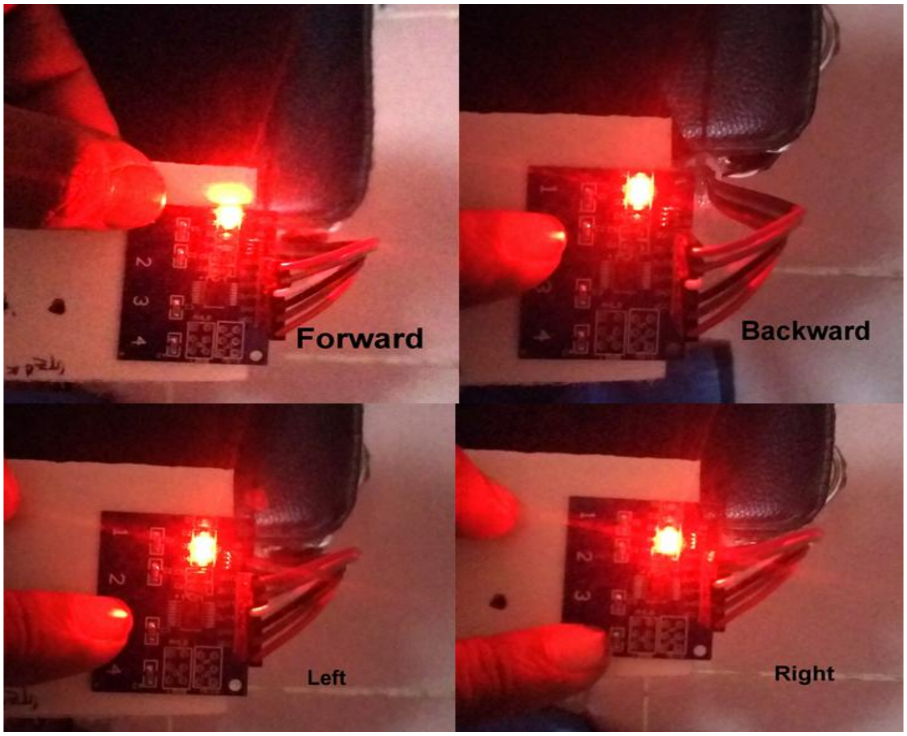


Fig. 4.6: Four channel capacitive touch module output And the moment of operation 4 channel touching by finger.

4.6 Movement of Wheelchair

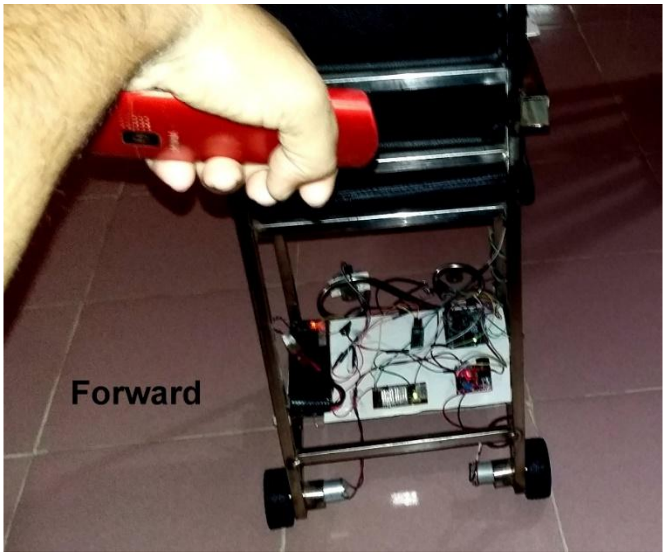


Fig. 4.7: Wheel Chair Moving to Forward.

Figure 4.7 shows that, the chair is moving to forward controlled by smartphone tilt movement.Mobile phone transmits code “A” to microcontroller via Bluetooth and microcontroller gives output to the motor driver IC according to the program to move forward.

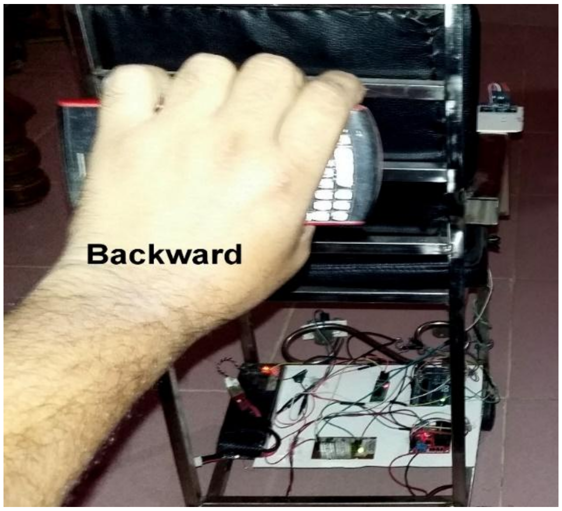


Fig. 4.8: Wheel Chair Moving Backward.

Figure 4.8 shows that, the chair is moving to backward controlled by smartphone tilt movement. Mobile phone transmits code “B” to microcontroller via Bluetooth and microcontroller gives output to the motor driver IC according to the program to move backward.

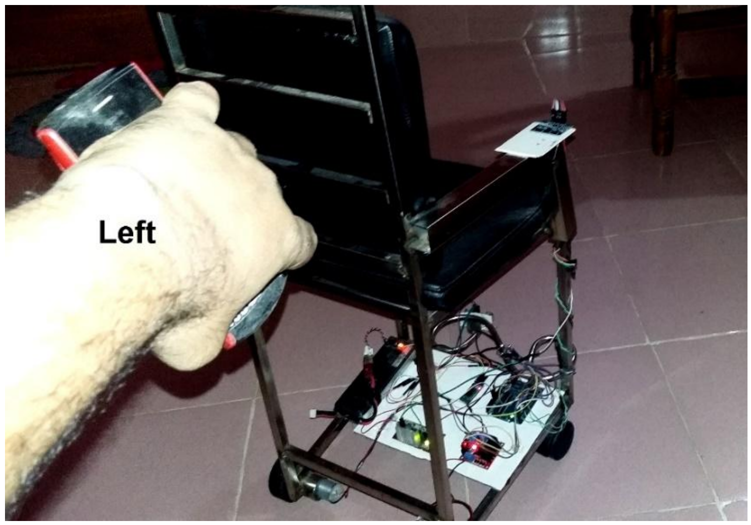


Fig. 4.9: Wheel Chair Moving to Left

Figure 4.9 shows that, the chair is moving to left controlled by smartphone tilt movement.Mobile phone transmits code “C” to microcontroller via Bluetooth and microcontroller gives output to the motor driver IC according to the program to move left.

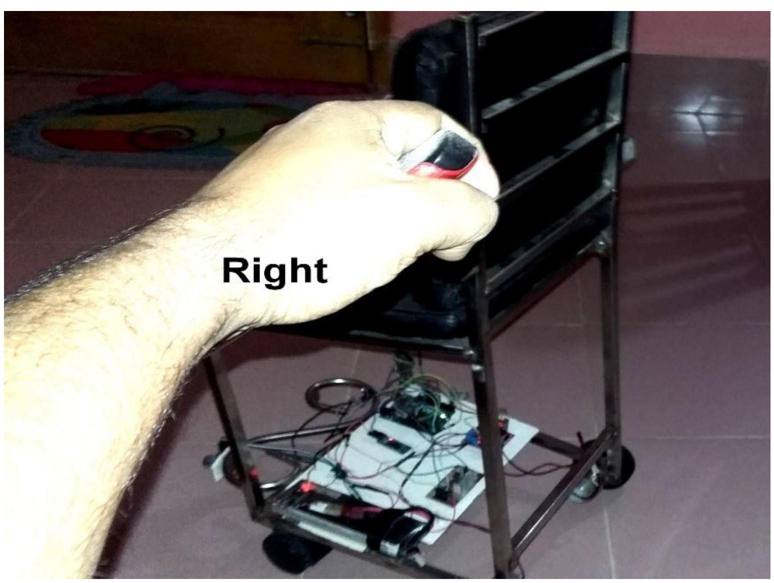


Fig. 4.10: Wheel Chair Moving to Right.

Figure 4.10 shows that, the chair is moving to right controlled by smartphone tilt movement. Mobile phone transmits code “D” to microcontroller via Bluetooth and microcontroller gives output to the motor driver IC according to the program to move right.

At normal position of the hand or mobile phone, it transmits code “E” to microcontroller via Bluetooth and microcontroller gives output to the motor driver IC according to the program to stop the two motors.

4.7 Detection of Obstacle

Fig. 4.11: Wheel Chair is detecting obstacles and stop.

If the chair detect any obstacles within 40 cm, it will be stopped. Figure 4.11 shows the obstacle detection of the chair.

“Trigger” pin which is connected to the 13 no pin of arduino, continuously gives an ultrasonic wave. If any obstacle in front of the sensor, the wave will be reflected. The “Echo” pin receives the reflected wave and become high. The time between sending and receiving wave is calculated.

According to the formula, $2d = v \times t$

or, $d = \frac{v \times t}{2}$

or, $d = \frac{t}{2} \times 29.1$ (speed of sound is 29.1 cm/μs)

so, $d = \frac{t}{2} \div 29.1$

So, just measuring the time between sending and receiving wave, the distance is calculated by the microcontroller. If the distance is less than 40 cm, it will stop the chair.

4.8 Camera Performance

Fig. 4.12: Position of IP camera on the wheel chair.

To minimize the cost, we have proposed a smart phone to use it as an ip camera. IP camera android application is available in Google play store. By this application, one can easily use his smartphone camera as an IP camera. Figure 4.12 shows the position of camera on the chair. It is just behind of the rider.

Fig. 4.13: IP camera is capturing picture.

Figure 4.13 shows the picture captured by the camera. It can easily transmitted to cloud streaming by mobile internet. So that, the cost for internet connection and other arrangement to set up an IP camera in the chair will be minimized.

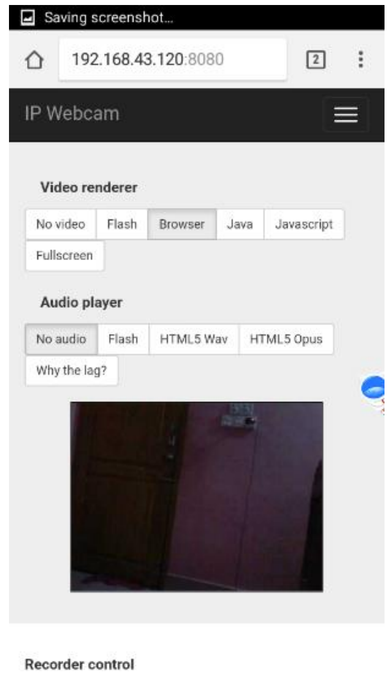


Fig. 4.14: The camera captured picture observing from anywhere.

Figure 4.14 shows that the picture captured by the IP camera can be observed from anywhere. It ensures the location and condition of the wheel chair rider to his guardian. Moreover, the rider will be able to ask for any help to his guardian since, this camera is able to transmit audio sound as well as.

It is an addition external feature. No relation with the main circuit of the control system.

4.9 Real time implementation

We have developed the control circuit which can be used in real time implement of this type of wheel chair. In real time implementation, we have to increase the load carrying capacity of the wheel chair. For this, we have to use high torque (10.0Nm) dc gear motor. In this case, motor drive IC L298N is not able to supply more than 2 A current. So, instant of this is, we have to use 5 volt relay to operate the motor.

Besides motor, we have to add strong wheel with the motor using coupler.

By calculation full load current, we have to determine the current ratings of the battery.

4.10 Discussion

So finally we have developed the wheel chair for physically challenged people especially for lower limb disable people with several paralysis. We hope that, a physically challenged people will be able to control this chair very easily. We also hope that we will provide this chair at a low cost which will bring a great benefit for the lower class people of our country.

CHAPTER 5
CONCLUSION

5.1 Conclusion

The project shows the real implementation of a smartphone and touch control wheelchair. The main objective of this study is developing a useable, low cost assistive robotic wheelchair to help physically disabled persons to make their life independent. In this project we developed a robotic wheelchair with an in-built programmed Arduino based on ATmega32 microcontroller. By controlling wheelchair, we also add some additional feature like obstacle sensing sensors to shut-down the entire system in case of imminent collision, security camera. However, there are still many improvements to be made. In the future more safety features like speed control of the wheel chair and also bring an improvement to the obstacle sensing Ultrasonic sensor algorithm. The entire processes of different methodology are accumulated. The codes are mentioned in the Appendix part.

5.2 Limitation

- When obstacle detecting sensor send signal to microcontroller then the forward movement of the system will stop, it cannot be started again until the obstacle will be removed. But by the using of an external switch without using obstacle sensor system will run.
- It is not suitable for upper limb disable people.
- System is not developed with any programming for controlling its speed.
- System is not able to move through irregular surface.

5.3 Future Work

We are hopeful to make some future works that can be done with it to modify it with its best outcomes. Some suggestions of the possibilities of future works are given below:

- For handicapped people who are not able to move their hand, this chair can be developed with the tongue motion driver for the movement of wheelchair.

- For diabetic handicapped people, an artificial injection of insulin machine can be set up,it will be helpful for user when they will stay far from home..
- Solar charging system can be added to charge the battery and run the system in daylight time. .

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APPENDIX

Program Code

```
#define trigPin 13

#define echoPin 7

int a = 2;

int b = 3;

int c = 4;

int d = 5;

int input1 = 8;

int input2 = 9;

int input3 = 11;

int input4 = 12;

int state;

int flag=0;        //makes sure that the serial only prints once the state

intstateStop=0;

void setup() {

  // sets the pins as outputs:

pinMode(input1, OUTPUT);

pinMode(input2, OUTPUT);

pinMode(input3, OUTPUT);

pinMode(input4, OUTPUT);


pinMode(a, INPUT);

pinMode(b, INPUT);
```

```
pinMode(c, INPUT);
pinMode(d, INPUT);
pinMode(trigPin, OUTPUT);
pinMode(echoPin, INPUT);
  // initialize serial communication at 9600 bits per second:
Serial.begin(9600);
}


void loop() {
  //if some date is sent, reads it and saves in state
if(Serial.available() > 0){
state = Serial.read();
flag=0;
  }
long duration, distance;
digitalWrite(trigPin, LOW);  // Added this line
delayMicroseconds(2); // Added this line
digitalWrite(trigPin, HIGH);
//  delayMicroseconds(1000); - Removed this line
delayMicroseconds(10); // Added this line
digitalWrite(trigPin, LOW);
duration = pulseIn(echoPin, HIGH);
distance = (duration/2) / 29.1;
  // if the state is 'A' the DC motor will go forward
```

```
if (distance < 40)   // if distance is less than 40 cm
    {
digitalWrite(input1, LOW);
digitalWrite(input2, LOW);
digitalWrite(input3, LOW);
digitalWrite(input4, LOW);
Serial.println("stop");
delay(200);
}
else if (state == 'A') {
digitalWrite(input1, HIGH);
digitalWrite(input2, LOW);
digitalWrite(input3, HIGH);
digitalWrite(input4, LOW);
if(flag == 0){
Serial.println("Go Forward!");
flag=1;
      }
   }

   // if the state is 'C' the motor will turn left
else if (state == 'C') {
digitalWrite(input1, LOW);
digitalWrite(input2, HIGH);
```

```
digitalWrite(input3, HIGH);
digitalWrite(input4, LOW);
if(flag == 0){
Serial.println("Turn LEFT");
flag=1;
      }
delay(100);
state=3;
stateStop=1;
   }
   // if the state is 'E' the motor will Stop
else if (state == 'E' || stateStop == 1) {
digitalWrite(input1, LOW);
digitalWrite(input2, LOW);
digitalWrite(input3, LOW);
digitalWrite(input4, LOW);
if(flag == 0){
Serial.println("STOP!");
flag=1;
      }
stateStop=0;
   }
   // if the state is 'D' the motor will turn right
else if (state == 'D') {
```

```
digitalWrite(input1, HIGH);

digitalWrite(input2, LOW);

digitalWrite(input3, LOW);

digitalWrite(input4, HIGH);

if(flag == 0){

Serial.println("Turn RIGHT");

flag=1;

        }

delay(100);

state=3;

stateStop=1;

    }

    // if the state is 'B' the motor will Reverse

else if (state == 'B') {

digitalWrite(input1, LOW);

digitalWrite(input2, HIGH);

digitalWrite(input3, LOW);

digitalWrite(input4, HIGH);

if(flag == 0){

Serial.println("Reverse!");

flag=1;

        }

    }

while (digitalRead(a) == HIGH)   //forward
```

```
  {digitalWrite(input1, HIGH);
digitalWrite(input2, LOW);
digitalWrite(input3, HIGH);
digitalWrite(input4, LOW);
  }


while (digitalRead(b) == HIGH)   //backward
  {
digitalWrite(input1, LOW);
digitalWrite(input2, HIGH);
digitalWrite(input3, LOW);
digitalWrite(input4, HIGH);
  }
while (digitalRead(c) == HIGH)   //left
  {
digitalWrite(input1, LOW);
digitalWrite(input2, HIGH);
digitalWrite(input3, HIGH);
digitalWrite(input4, LOW);
}
while (digitalRead(d)== HIGH)     // right
{
digitalWrite(input1, HIGH);
digitalWrite(input2, LOW);
```

```
digitalWrite(input3, LOW);

digitalWrite(input4, HIGH);

}


}
```