AUTOMATIC STAIR CLIMBING WHEELCHAIR WITH BED

MAIN PROJECT REPORT

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ABSTRACT

In this project we are aimed at making an automatic stair climbing wheelchair with bed. A concept for a stair climbing wheelchair capable of moving in structured and unstructured environments, climbing over obstacles and going up and down stairs and also converted into bed. The mechanisms involved in this system are rack and pinion mechanism and the worm and gear mechanism. All these mechanisms are operated by using the dc motors, controlled by the wireless remote controller and the micro controller.In this design of the wheelchair consisting of a frame and a seat. When the wheelchair faces an obstacle such as a step or a stair, it can be operated to overcome that.

CHAPTER 1

INTRODUCTION

In simple words a wheelchair can be described as a structure having a set of wheels attached to a chair. Wheelchair is a device which can empower and enable a person with a disability to live a normal and independent life. The invention of wheelchair is one of the contributions for such physically challenged people. It is a boon for them. Since from the day wheelchair was invented, it has been continuously improving to raise its comfort level and with as many features as possible. We have come across many types of wheelchairs with different shapes, sizes, mechanisms, sources, materials etc. For many people, an appropriate, well-designed and well-fitted wheelchair can be the first step towards inclusion and participation in society. Though the wheelchair is helping the physically challenged & disabled people for their mobility, it is not equivalent to the motion by normal people. They can't run, jump reach all places where ever they wish to go. These suppress the mental level of those people and they start feeling themselves as burden to others. To overcome this psychological depression, the comfort level should be raised up to the peak, where they can do all those things that a normal man can do. So this is our small step or attempt to reach that peak. We wish that this work will become a contribution for the society helping large number of disabled. Keeping all the above things in mind, focusing the possible improvements in wheelchairs we got an idea of a stair climbing wheelchair with Bed.

1.1. AIM OF THE PROJECT

Over the years wheelchairs have evolved rapidly from the manual wheelchairs to the powered wheelchairs. But still these wheelchairs have not been able to satisfy the needs of the disabled people. It is therefore critical that the problems of disabled be understood and accordingly wheelchairs are developed fulfilling their needs. So we have designed a multipurpose wheelchair that can work as wheelchair as well as a Stretcher. Its construction is so easy and can be operated and maintained easily. We have used simple mechanical linkages along with rack and pinion and worm and wheel mechanism to achieve the required motion. This project is the result of a design and development of a multi functional Wheelchair that would perform all the required functions.

1.2. OBJECTIVE OF THE PROJECT

The objectives of the project are:

- Decrease the cost by using new mechanism.
- Works reliably under different operating conditions.
- Multipurpose such as stair climbing and stretcher.
- To save space and precluding exertion of the disable person.

CHAPTER 2

LITERATURE REVIEW

2.1. INTRODUCTION

Modern wheelchairs are very different from the ancient counterparts. According to Rory A. Cooper in Wheelchair Selection and Configuration, the earliest use of a wheelchair can be traced back to the sixth century AD. However, it was during the Renaissance that a movable, "rolling chair" came into existence and during the 16th century, King Philip II of Spain who suffered from gout had one made for him with luxurious upholstery and adjustable leg rests and back rests. Louis XIV also used a wheelchair or roulette to move around after an operation that restricted his movements. The roulette gained popularity, and according to Cooper, in 1700 the Palace of Versailles had nearly 20 of these historical wheelchairs.

The wheelchair as we know it today was developed only in the 18th century and had two large wooden wheels in the front and a caster wheel at the rear. These wheelchairs were decorative, heavy and difficult to operate without a lot of assistance. The amputees of the Civil War and World War I received lighter wheelchairs than these but even then, the chairs weighed nearly 50-pounds and didn't enable mobility and independence.

The modern wheelchair, light and practical, was developed by a paraplegic, Herbert Everest and his engineer friend, Harry Jennings. This wheelchair was foldable and made of aircraft-steel which made it durable and usable. The two formed the E&J Company which still makes wheelchairs. It was their company that supplied WWII veterans with chrome wheelchairs. However, even then, the wheelchairs were not customized to the user and didn't facilitate a great deal of mobility. It was only when wheelchair users began using their chairs to participate in sports, thanks to the efforts of Sir Ludwig Guttmann and others, that manufacturers began creating chairs that were comfortable, durable, aesthetically pleasing and most importantly, practical.

The wheelchair with its many modern avatars makes mobility convenient and easy for its users. Inventions, like the wheelchair bicycle and stair climbing wheelchair, enable users to enjoy life to the fullest and go just about anywhere their heart desires. Using a wheelchair no longer means being confined to a single room or house. These modern inventions surely make life easier and better for all wheelchair users.

2.2. MODERN WHEELCHAIR INVENTIONS

Life in a wheelchair can be challenging and tough. There are areas that one can't go to and things that one may not be able to do. However, with advances in science, technology and engineering, several modern inventions have made using and living in a wheelchair more convenient and comfortable. For instance, a wheelchair that can help one climb the stairs will make visiting areas with no ramps possible and easy. Similarly, a bicycle wheelchair will help enjoy the pleasures of cycling. Here is more information about useful modern inventions that make life more comfortable for wheelchair users.

2.2.1. Top Chair

The Top Chair is an electric wheel chair with an incorporated stair climbing mechanism. The chair has four wheels used for flat terrain, and for all normal purposes it performs the function of a normal motorised wheel chair.

Fig.2.1. Top Chair

When the chair approaches some steps, the owner can switch to "step mode". This directs the power to the tracks. (The chair must approach the steps backwards) The front wheels then retract placing the rubber tracks on the ground. The owner continues to drive backwards and as the chair approaches the first step the rear wheels are raised into the wheelchair placing the track onto the first step. This happens automatically as

the chair is fitted with Infra-red detectors. Through the controls the owner can begin the ascent. Once the chair detects the top step, the rear wheels and then the front wheels are moved back down.

In descending the steps the owner approaches the steps forwards and positions the chair on the first step. He switches to "step mode" again. As before the front wheels are moved up and the owner drives forward. When the chair detects that the centre of gravity has surpassed the first step nosing, the motion stops and the rear wheels are retracted. As the chair detects the bottom of the steps, it moves down the rear wheels. By choosing the "road switch" the front wheels reappear and the owner can drive away as normal. Top Chair owners boost its unmatched ability to "go up or down a 20 cm high step", with single battery charge enough to conquer around 300 steps.

Throughout this whole process ("several times per second") the wheelchair seat is kept at a horizontal position by chassis and seat sensors. This undoubtedly makes the Top Chair the most effortless and stable stair climbing wheelchair machine available. Although it is beyond the requirements of our group to match the Top Chair, the simplicity of its design is definitely any element which group one would try to incorporate.

2.2.2. I-Bot

Fig.2.2. I-Bot

This American design is praised as one of the most technologically advanced stair climbing wheelchairs available, and it is not hard to see why. The main focus of the chair is to bring the owner to the eye level of his/her peers and is promoted as a must have accessory. The I-Bot is pitched to everyone from ambitious corporate workers, to building surveyors to high school students who want to have a fun time at

their "prom" parties. This is a credit to its design. It is capable of tackling most terrains, rotating 360 degrees at almost a zero radius, reaching the jar on the top shelf of a cupboard, and most importantly climbing up and down stairs.

The chair is able to climb stairs because of its four rotating wheels. Each set of clusters rotates about and above the axes of the next. As each cluster lands on the next step, the robot can leap frog up the flight of stairs. This motion is lengthy and requires great strength and balance from the user.

2.2.3. Stair-max

The stair-max is designed by a German company called Lehner Lifttechnik. The company specialise in mobility for wheelchair users. This device unlike the others attaches to regular wheel chairs and enables them to climb up and down stairs. It is an effective design.

Fig.2.3. Stair-max

Like the TopChair, motorised caterpillar tracks are used to transport the wheelchair and user up and down stairs. The tracks need to be fitted before the user can tackle any stairs, and the tracks can be brought down or raised – allowing the user to move to the stairs from the point of installation. The user approaches the stairs backwards and lowers the stair-max. The wheelchair is then raised. The advantage here over the Top Chair, is that the tracks do not need to be mounted directly onto the first step. This is because the stair-max is designed with a tilted tracked front. This means that the mechanism can approach the first step, and through the caterpillar track grip on and pull the rest of its body forward and upwards. The tracks then continue up the stairs.

The motion up the stairs is controlled by the user through a control at the front of the mechanism (or behind the user as they are climbing up the stairs). Although the user and wheelchair enter the mechanism at an angle, during the ascent, the wheelchair seat is returned to a horizontal position. The motion down the stairs is similar to the Top Chair. The tracks comfortably take the user and wheelchair down the stair case. This is partly due to the length of the mechanism. It is over two hypotenuses of the steps. This ensures that the journey up and down the stairs is smooth and continuous.

2.2.4. S-Max

It may not be the bulkiest looking mechanism, but it is operationally practical. The s-Max has an effective load capacity of 160kg. Spiral stair cases are not a problem for this robot which producers (AAT – the stair climbing people) call the "ideal partner for life". AAT specialise in transport for people with physical disabilities. This is mainly focused at overcoming obstacles that wheelchair users may otherwise struggle to tackle, such as stairs, but also includes motorising regular wheelchairs.

The device appears at first to be a simple system, balanced on two rotating wheels and two connected handles, extended to an assistant's waist level with two rods. Once the system approaches a step however the cool stuff can begin. The system uses single climbing step technology to project the wheelchair and user over the step. It does this in three stages. Firstly the device is attached to the commercial wheelchair. The assistant is then required to approach the step backwards.

Then, through electronic controls (included in the handle of the system) the assistant can release a robotic limb, which travels behind the set of wheels and lifts the wheelchair above and over step onto the second step (extending and folding mechanism). Finally, the limb retracts back into the device and the assistant can proceed to the third step. This process is repeated until the wheelchair is at the top of the stairs.

Fig.2.4. S-max

In descending the stairs, the assistant must approach the steps forwards, this time with the centre of the set of wheels slightly beyond the nosing top step. The extending limb will then land on the next top step. A controlled descent can now occur as the device lowers the wheelchair and folder up underneath it. The assistant then proceeds to the end of this step and the process repeats itself until the wheelchair is at the bottom of the stairs. Clever and original, even with such a simple design; its main selling point is its compact and easy to use. The s-max does make the user dependent on others and it may require some strength. Also, it may take a bit of getting used to. It is not quite clear at first how one should operate the system. The folding mechanism is very impressive, but perhaps not quite the design the group was hoping to investigate.

2.2.5. Stairbot

This robotic design was particularly interesting. The stairbot is a stair climbing robot with a new and exciting design. Visually complicated, its designer boosts simplicity as compared to other known stair robots: It was one of the objectives for the design to use as few actuators and sensors as possible and although there are several well known robots out there the clear distinction with stairbot is its use of wheels as opposed to tracks or legs.

The stairbot is 500 mm long controlled by four microcontrollers and is limited to a 37.6 degree stair slope. The controllers are programmed in TEA with four sensors feeding back information to the driver. These sensors are located at various places on the robot, aimed at aiding different functions. The robot has an evenly distributed mass of 6kg (20% batteries) and this is in order to keep this great structure well balanced. The front wheels of the stairbot make up over half of the robot's length with a large 255mm diameter and aided with a circular support the robot can reach the highest step without risk of toppling over or sliding backwards.

The stairbot is well constructed and its clever design can be attributed to its creator and owner Gunter Wendel (2004) who owns the rights to the robot design. The robot tackles steps in the following way. The system approaches the step and sensors detect the stairs. The wheel then rests drives to the first step and the brakes are applied. The "linear guide" travels forward beyond the first step and the brakes are released. The wheel climbs up the first step using the guide as a support. (It travels up the guide) When the wheels are on the first step, the brakes are applied again and the guide is drawn up into the wheel pulling up the "Omni wheels" as it does. The wheel then proceeds to the next step and the process repeats itself until the wheels, guide and Omni wheels are on the top step. The robot can then drive away.

On taking the descent, the robot sensors detect the stairs once again. The robot then rotates 180 degrees in order to tackle the stairs backwards. The guide is first lowered with the omni-wheels onto the

next highest step (whilst the robot wheels are stationary). The wheels then roll towards the step and roll down the guide onto the second step. This is basically the same process as before (when climbing up the stairs), but in a reverse order. Again this method is repeated. Once the wheels clear the last step, the robot rotates back to its original position with the wheels pointing in the direction of travel (and away from the steps) and rolls away. Although it is a futuristic concept, I do not feel that this design is ideal for our project. We do not require any form of sensors and the group is against using wheels to scale the portico steps. Furthermore, it is hard to see how this design would support a wheelchair and its user.

2.2.6. Tri-Wheel Robot

This design was an early favourite. It was practical and effective as proven by the fact that it is used in the movement of heavy goods items. The rectangular shaped robot has four sets of tri-wheels on each of its corners. The robot's driving motor and servo motors are placed in the middle of the structure to ensure the robot's stability specially when climbing up stairs. Each tri-wheel has the ability to rotate around its centre axis. This way the wheel is able to grip and mount the step sending the second wheel forward over the step. The third wheel then rotates over the second wheel driving the robot forward. This process is repeated for each step.
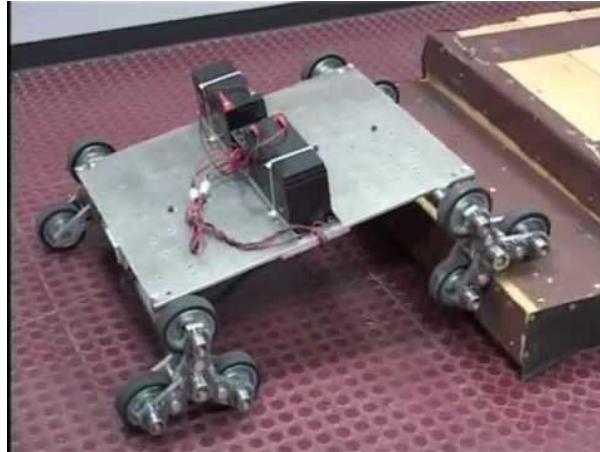

Fig.2.5. Tri- wheeled robot

Despite its simplicity and ease of operation this robot carries a flaw. Its ability to scale any set of stairs is limited to the size of its wheels and wheel rotary system. The robot has to be practically custom made for the stairs in question and this is a clear disadvantage.

2.2.7. Three Legged Robot

A group of final year university students in India looks closely at human mechanisms before constructing this next robot. Although the robot failed to meet its objectives it is nevertheless an interesting model to study. The three legged robot differs from other stair climbers as it uses legs to ascend and descend steps (as the name suggests). The system relies heavily of a complex system of "On" and "Off" switches.
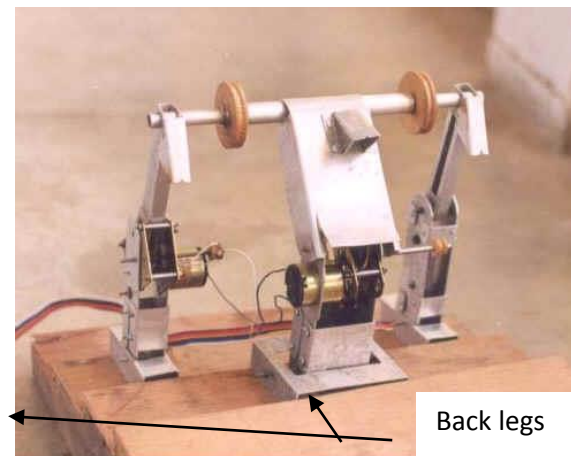

Back legs

Fig.2.6. Three legged robot

Synchronised motors work to move the back two legs simultaneously whilst moving the front leg moves independently of the other two. At each command the motor will hold the front leg in a set position whilst the other motor rotates the back legs above and onto the next step. The motor then sets the two back wheels (now in front) in position and the motor controlling the front wheel is supposed to "instantly" move the front limb forward. This leap frog system – identical to how humans would ascend stairs – repeats.

The movement down stairs would perhaps be the same with the robot now facing the bottom of the steps. This would work as the limbs do extend.

2.3. CONCLUSION

All of the above stairs climbing wheelchairs are very expensive and not affordable for the ordinary peoples. So we aimed to make a wheel chair with stair climbing ability and also used as a stretcher. It can be useful for the disable persons with the low cost.

CHAPTER 3

COMPONENTS AND DESCRIPTION

The working stair climbing wheel chair model consists of the following components to full fill the requirements of complete operation of the machine.

1. Rack and Pinion arrangement

2. Worm and worm wheel arrangement

3. Dc Motor (High Torque)

4. Frame

5. Bearing

6.Wheel

7. Battery

8. Electronics Control unit

3.1. RACK AND PINION ARRANGEMENT

Rack and Pinion is a type of linear actuator that comprises a pair of gears which convert rotational motion into linear motion. A circular gear is called pinion engages teeth on a linear gear bar called the rack. Rotational motion applied to the pinion causes the rack to move relative to the pinion, thereby translating the rotational motion of the pinion into linear motion. The rack is a portion of the gear having an infinite pitch diameter and the line of action is tangent to the pinion. The rack and pinion is mostly used for the timing and the reverse mode of operation of the system.

Fig.3.1. Rack and Pinion

In this wheel chair model, rack and pinion mechanism is used to provide the linear motion of the legs and the sliding motion of the seat. The pinion is usually attached to the dc motor, which is provided to get mesh with rack to convert rotary motion to linear motion.

3.2. WORM AND WORM WHEEL ARRANGEMENT

Worm gears are used for transmitting power between two non-parallel, non-intersecting shafts. A worm is a gear with one or more cylindrical, screw-like threads and a face width that is usually greater than its diameter. A worm has a centre hole (bore) for mounting the worm on a shaft. Worm Wheel (gears), like worms, also is cylindrical and bored for mounting on a shaft. However, unlike a worm, a worm gear's diameter is usually much larger than the width of its face. In order to transmit motion and power at various speeds and speed ratios, worms and worm gears work in sets, rotating on shafts at right angles to one another. The worm usually drives the worm gear. Accordingly, the worm gear is usually the driven member.

In worms and worm gear sets, both the worm and worm gear are of the same hand. Right-hand sets are considered standard. As a result, right-hand sets will always be furnished unless otherwise specified.

Fig.3.2. Worm and Worm Wheel

In this wheel chair model, worm and worm wheel arrangement is used to convert the wheel chair into stretcher. The worm arrangement is the integral part of the selected high torque dc motor.

3.3. DC MOTOR

The DC Gear motor, consisting of a DC electric motor and a gearbox, is at the heart of several electrical and electronic applications. Precision Micro drives have been designing and developing such high quality mini DC gear motors in an easy-to-mount package for a range of products and equipment. Our miniature gear motor work smoothly and efficiently, supporting these electrical and electronic applications.

These geared motors have reduction gear trains capable of providing high torque at relatively low shaft speed or revolutions per minute (RPM).Precision Micro drives DC geared motors reduce the complexity and cost   of designing and constructing applications such as industrial equipment, actuators, medical tools, and robotics. Precision Micro drives have engineered a range of planetary and spur gear motors (also known as mini-geared motors and micro-geared motors) suitable for many future and existing applications.

The main characteristics of these gear motors are miniature form factors, offering significant strength, torque, and other technical capabilities that these applications require. Their linear performance characteristics make them suitable for many applications requiring a controlled performance. Whether you are looking for automotive, medical, or domestic applications, DC Gear motors from Precision Micro drives not only offer the variable speed and torque control required in each of these applications.

They also possess quality characteristics of reliability, ruggedness, and compactness. The operations performed by Precision Micro drives geared motors appear simple and effortless. However, they are highly sophisticated devices, and some units are encapsulated in housings to prevent exposure to moisture and dust. A precision Micro drive is the leading supplier of sub Ø60 mm DC Gear motors in the industry.

Fig.3.3. DC Gear motor

High efficiency, high quality low cost DC motor with gearbox for robotics applications. It is very easy to use and available in standard size. Nut and threads on shaft to easily connect and internal threaded shaft for easily connecting it to wheel

In our wheelchair, High Torque encoded dc motors are used. It is commonly used for the car window lifting system. The motors have a worm gear that gives them a very high torque and stops them from rotating if any mechanical force is applied to them. They only rotate if current is flowing through the coils of the motor.

Specification

- 45 RPM at 12V DC motors with Gearbox, RPM can vary when operating from 3 to 15V

- 5kgcm torque

- 6mm shaft diameter with internal hole

- 125gm weight

- Same size motor available in various rpm

- No-load current = 60 mA (Max), Load current = 300 mA (Max)

3.4. FRAME

Frame is the integral part of the wheel chair. All the components are fitted to the frame and also act as a supporting member. The frame consisting of

1.Front Legs

2.Back Legs

3.Supporting Legs

4.Seat Frame

5.Foot rest

3.4.1. Front Legs

Front legs are attached to the main frame. The legs are provided with a linear motion, such that the leg can move in forward and reverse direction. The linear motion provided by the rack and pinion arrangement fitted to the leg frame. Two wheels provided at the ends of legs for moving through the floor as well as through the stair. Front legs are made up of hollow mild steel rod.

3.4.2. Back Legs

Back legs are also attached to the main frame. The legs are provided with a linear motion by the rack and pinion arrangement, such that the leg can move in forward and reverse direction. The rack and pinion arrangement fitted to the leg frame. Two wheels provided at the ends of legs for moving through the floor as well as through the stair. Front legs are made up of hollow mild steel rod.

3.4.3. Supporting legs

Supporting legs are provided to the wheel chair for the proper balancing while climbing up and down the stair. Supporting legs are fitted to the back side of the main frame. It also gives forward and reverse motion. Comparatively large wheels are provided to the supporting legs. It also made up of hollow mild steel rod.

Fig.3.4. Supporting legs

3.4.4. Seat Frame

The Seat frame consisting of the back rest, seating portion and the foot rest. The three parts are separately made in rectangle shape and joined together by hinges. The seat frame can be converted into straight (to convert seat into stretcher). Worm and worm wheel mechanism is used for convert the seat in to bed.
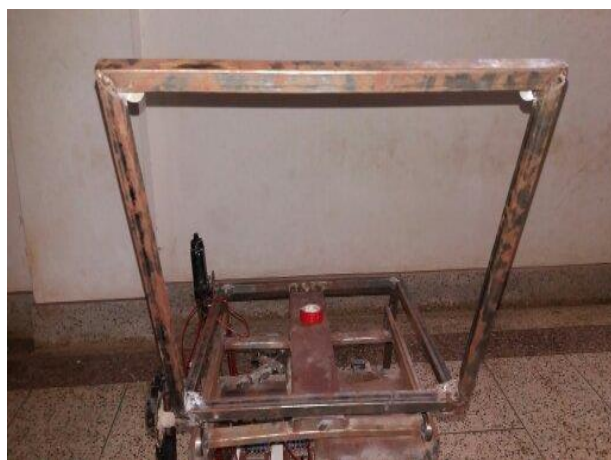
Fig.3.5. Seat Frame

3.4.5. Foot Rest

Foot rest is used to support the foot of the disabled person. It is also provides the forward and backward motion, which helps to climb up and down through the stair. Small wheels are provided for mobility.

Fig.3.6. Foot rest

3.5. BEARING

A bearing is a machine element which supports another moving machine element (known as journal). It permits a relative motion between the contact surfaces of the members, while carrying the load. A little consideration will show that due to the relative motion between the contact surfaces, a certain amount of power is wasted in overcoming frictional resistance and if the rubbing surfaces are in direct contact, there will be rapid wear. In order to reduce frictional resistance and wear and in some cases to carry away the heat generated, a layer of fluid (known as lubricant) may be provided. The lubricant used to separate the journal and bearing is usually a mineral oil refined from petroleum, but vegetable oils, silicon oils, greases etc., may be used.

A ball bearing is a type of rolling element bearing that uses balls to maintain the separation between the bearing races. The purpose of a ball bearing is to reduce rotational friction and support radial and axial loads. It achieves this by using at least two races to contain the balls and transmit the loads through the balls. In most applications, one race is stationary and the other is attached to the rotating assembly (e.g., a hub or shaft). As one of the bearing races rotates it causes the balls to rotate as well. Because the balls are rolling they have a much lower coefficient of friction than if two flat surfaces were sliding against each other. Ball bearings tend to have lower load capacity for their size than other kinds of rolling-element bearings due to the smaller contact area between the balls and races. However, they can tolerate some misalignment of the inner and outer races.

Fig.3.7. Ball Bearing

Ball bearings are fixed at the end of the legs to hold the wheel shafts. It provides the smooth running of shaft under load.

3.6. WHEEL

A wheel greatly reduces friction by facilitating motion by rolling together with the use of axles. In order for wheels to rotate, a moment needs to be applied to the wheel about its axis, either by way of gravity, or by application of another external force. Wheels are attached at the end of the legs to provide the mobility to the wheel chair. The supporting wheels are larger than the leg wheels.

Fig.3.8. Wheels

3.7. BATTERY

In our project we are using secondary type battery. It is rechargeable Type. A battery is one or more electrochemical cells, which store chemical energy and make it available as electric current. There are two

types of batteries, primary (disposable) and secondary (rechargeable), both of which convert chemical energy to electrical energy. Primary batteries can only be used once because they use up their chemicals in an irreversible reaction. Secondary batteries can be recharged because the chemical reactions they use are reversible; they are recharged by running a charging current through the battery, but in the opposite direction of the discharge current. Secondary, also called rechargeable batteries can be charged and discharged many times before wearing out. After wearing out some batteries can be recycled.

Here we can use the sealed maintenance free valve regulated lead acid battery. Also known as SLA, VRLA (valve-regulated lead-acid battery), sealed lead acid batteries have many uses in today's world. From modern motorcycles, ATVs, home alarm systems, toys, backup systems, workout equipment, generators and the list goes on. These batteries come in all shapes, voltages, amperages and sizes. All SLA batteries self-discharge. If the battery is not recharged periodically, its full capacity may not be recoverable.

Typically, SLA batteries self-discharge 3% every month. We recommend you check and recharge every three months. SLA batteries should never be stored longer than six months without being recharged. Store the battery in a dry, cool place. Ideal storage temperature is 65-70 degrees Fahrenheit. 30 volt supply is provided with the battery connection to the wheel chair circuit. It can be achieved by connecting 12v and 6v batteries in series.

Fig.3.9. Batteries 12v and 6v

3.8. ELECTRONIC CONTROL UNIT

Electronic control unit controls all the functions of the stair climbing wheelchair such as moving through the floor, stair climbing and conversion of wheelchair into stretcher.
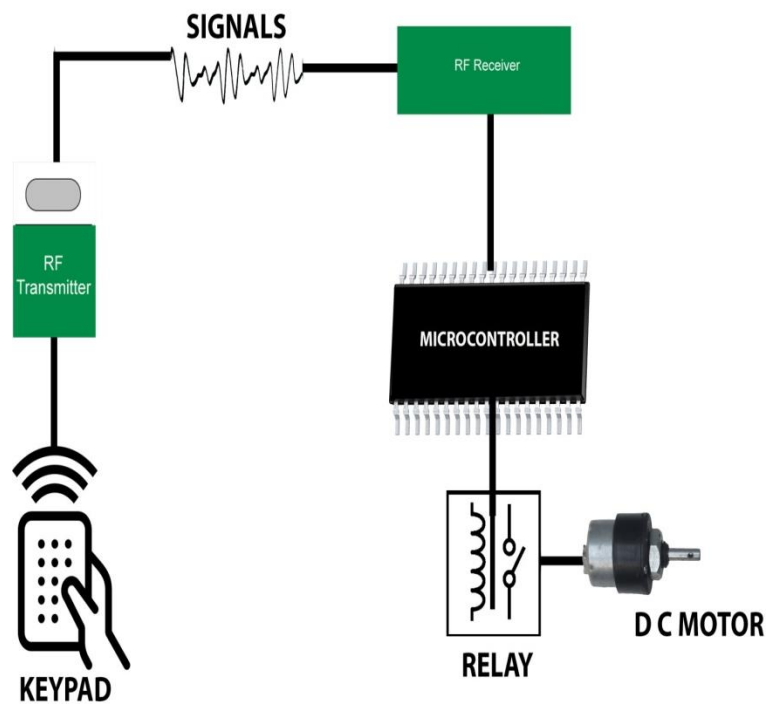
Fig.3.10. Electronic Control Unit

The electronic control unit consist of following components,

1. Keypad
2. Encoder
3. RF Transmitter
4. RF Receiver
5. Decoder
6. Microcontroller
7. Relay Switches
8. Limit Switches

3.8.1. Keypad

The keypad consists of sixteen key in which each key represents the one operation. The key board is interfaced with encoder data lines. If any one key is pressed the corresponding signal is given to encoder.
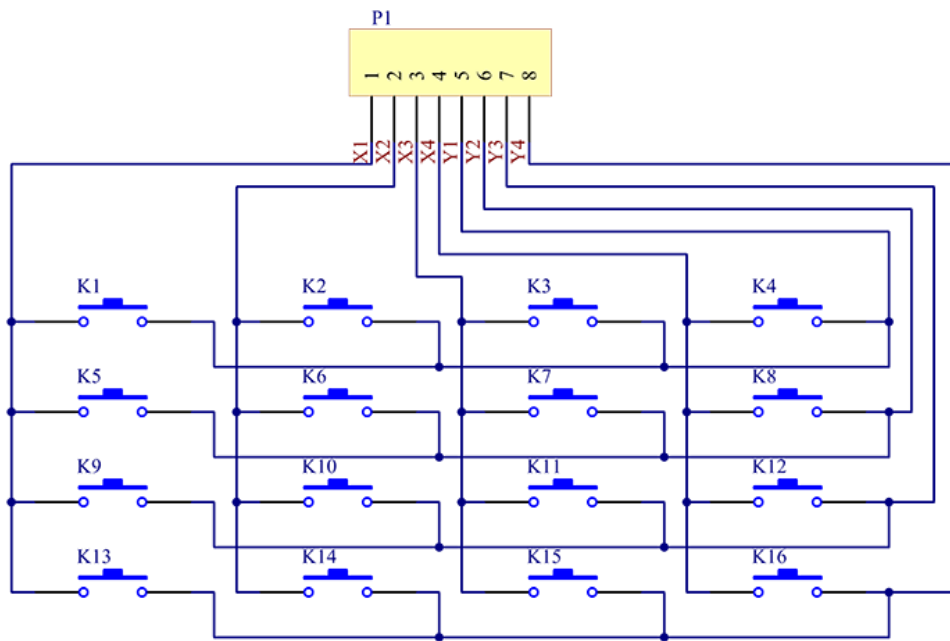
Fig.3.11. schematic diagram of keypad

First test whether any key is pressed down. Connect power to rows, so they are High level. Then set all the rows Y1-Y4 as Low and then detect the status of the columns. Any column of Low indicates there is key pressing and that the key is among the 4 keys of the column. If all columns are high, it means no key is pressed down. Next, locate the key. Since the column in which the pressed key lies is identified, knowing the line would finalize the testing. Thus, set the rows as Low in turns until any is unveiled accordingly other rows will still be high. Now the row can be identified. Detect the status of each column in turns. The column tested Low is the one intersecting with the line their cross point is just the key pressed.

Fig.3.12. Keypad

3.8.2. Encoder

In this circuit HT 640 is used as encoder. The 3^{18} encoders are a series of CMOS LSI s for remote control system application. They are capable of encoding 18 bits of information which consists of N address bit and 18-N data bits. Each address/data input is externally ternary programmable if bonded out. It is otherwise set floating internally. Various packages of the 3^{18} encoders offer flexible combination of programmable address/data is transmitted together with the header bits via an RF or an infrared transmission medium upon receipt of a trigger signal. The capability to select a TE trigger type further enhances the application flexibility of the 3^{18} series of encoders.

In this circuit the input signal to be encoded is given to AD7-AD0 input pins of encoder. The encoder output address pins are shorted so the output encoded signal is the combination of (A0-A9) address signal and (D0-D7) data signal. The output encoded signal is taken from 8th which is connected to RF transmitter section.

3.8.3. RF Transmitter

Whenever the high output pulse is given to base of the transistor BF 494, the transistor is conducting so tank circuit is oscillated. The tank circuit is consists of L2 and C4 generating 433 MHz carrier signal. Then the modulated signal is given LC filter section. After the filtration the RF modulated signal is transmitted through antenna. The transmission occurs at the rate of 1Kbps - 10Kbps.

3.8.4. RF Receiver

The RF receiver is used to receive the encoded data which is transmitted by the RF transmitter. Then the received data is given to transistor which acts as amplifier. Then the amplified signal is given to carrier demodulator section in which transistor Q1 is turn on and turn off conducting depends on the signal. Due to this the capacitor C14 is charged and discharged so carrier signal is removed and saw tooth signal is appears across the capacitor.

Fig.3.13. RF Receiver

Then this saw tooth signal is given to comparator. The comparator circuit is constructed by LM558. The comparator is used to convert the saw tooth signal to exact square pulse. Then the encoded signal is given to decoder in order to get the decoded original signal.

3.8.5. Decoder

In this circuit HT648 is used as decoder. The 3^{18} decoder are a series of CMOS LSIs for remote control system application. They are paired with 3^{18} series of encoders. For proper operation a pair of encoder/decoder pair with the same number of address and data format should be selected. The 3^{18} series of decoder receives serial address and data from that series of encoders that are transmitted by a carrier using an RF or an IR transmission medium. It then compares the serial input data twice continuously with its local address. If no errors or unmatched codes are encountered, the input data codes are decoded and then transferred to the output pins. The VT pin also goes high to indicate a valid transmission.

The 3^{18} decoders are capable of decoding 18 bits of information that consists of N bits of address and 18-N bits of data. To meet various applications they are arranged to provide a number of data pins whose range is from 0 t08 and an address pin whose range is from 8 to 18. In addition, the 3^{18} decoders provide various combinations of address/ data numbering different package.

In this circuit the received encoded signal is 9th pin of the decoder. Now the decoder separate the address (A0-A9) and data signal (D0-D7). Then the output data signal is given to microcontroller or any other interfacing device.

3.8.5. Microcontroller

The microcontroller contains full implementation of a standard microprocessor, ROM, RAM, clock, timers, and also serial ports. Microcontroller also called "system on a chip" or "single chip microprocessor system" or "computer on a chip".

PIC is a family of modified Harvard architecture microcontrollers made by Microchip Technology, derived from the PIC1650 originally developed by General Instrument's Microelectronics Division. The name PIC initially referred to Peripheral Interface Controller. PIC's are popular with both industrial developers and hobbyists alike due to their low cost, wide availability, large user base, extensive collection of application notes, availability of low cost or free development tools, and serial programming (and re-programming with flash memory) capability. They are also commonly used in educational programming as they often come with the easy to use 'pic logicator' software.

The microcontroller that has been used for this project is from PIC series. PIC microcontroller is the first RISC based microcontroller fabricated in CMOS (complementary metal oxide semiconductor) that uses separate bus for instruction and data allowing simultaneous access of program and data memory. Various microcontrollers offer different kinds of memories. EEPROM, EPROM, FLASH etc. are some of the memories of which FLASH is the most recently developed. Technology that is used in pic16F877 is flash technology, so that data is retained even when the power is switched off. Easy Programming and Erasing are other features of PIC 16F877.

The features of microcontroller are as follows:

  i.   10bit, up to 8-channel Analog-to-Digital Converter (A/D)
 ii.   Brown-out Reset (BOR)
iii.   Analog Comparator module with: Two analog comparators   Programmable on-chip voltage reference(VREF) module Programmable input multiplexing from device inputs and   internal voltage reference Comparator outputs are externally accessible.
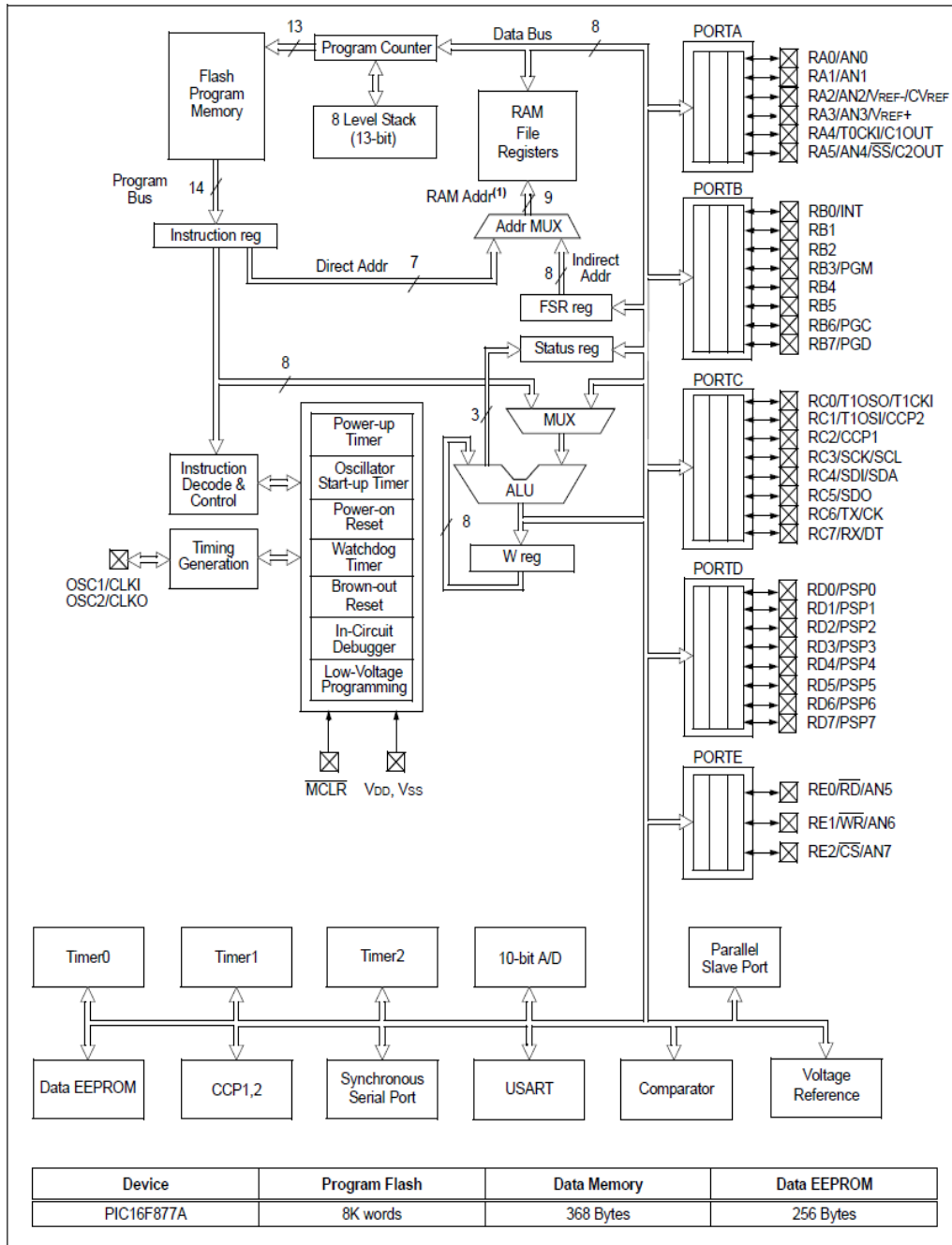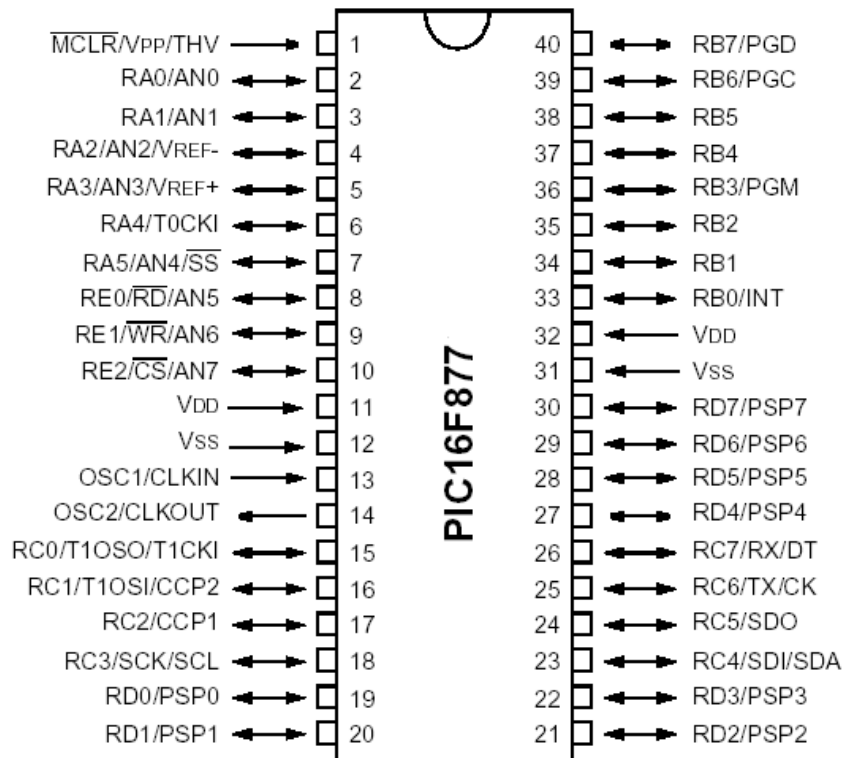
Fig.3.14. PIC Block diagram

Fig.3.15. Pin diagram

PIC PORTS:

In PIC microcontroller has five ports namely Port A, port B, port C, port D, port E

PORT A:

        PORT A is a 6-bit wide bi-directional port. The corresponding data direction register is TRISA. Setting a TRISA bit (=1) will make the corresponding PORT A pin an input (i.e., put the corresponding output driver in a hi-impedance mode). Clearing a TRISA bit (=0) will make the corresponding PORT A pin an output (i.e., put the contents of the output latch on the selected pin).Reading the PORT A register reads the status of the pins, whereas writing to it will write to the port latch. All write operations are read-modify-write operations.

PORT A BLOCK DIAGRAM:
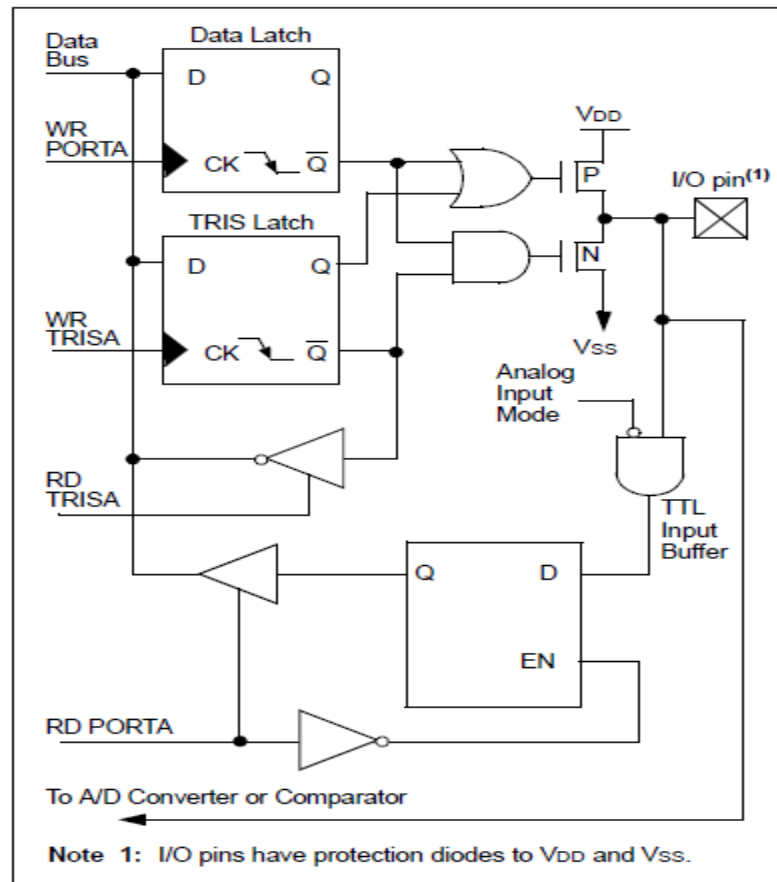
Fig.3.16.PORT A block diagram

PORT B:

PORT B is an 8-bit wide, bidirectional port. The corresponding data direction register is TRISB. Setting a TRISB bit (= 1) will make the corresponding PORT pin an input (i.e., put the corresponding output driver in a High-Impedance mode). Clearing a TRISB bit (= 0) will make the corresponding PORT B pin an output (i.e., Put the contents of the output latch on the selected pin).

PORT B BLOCK DIAGRAM:
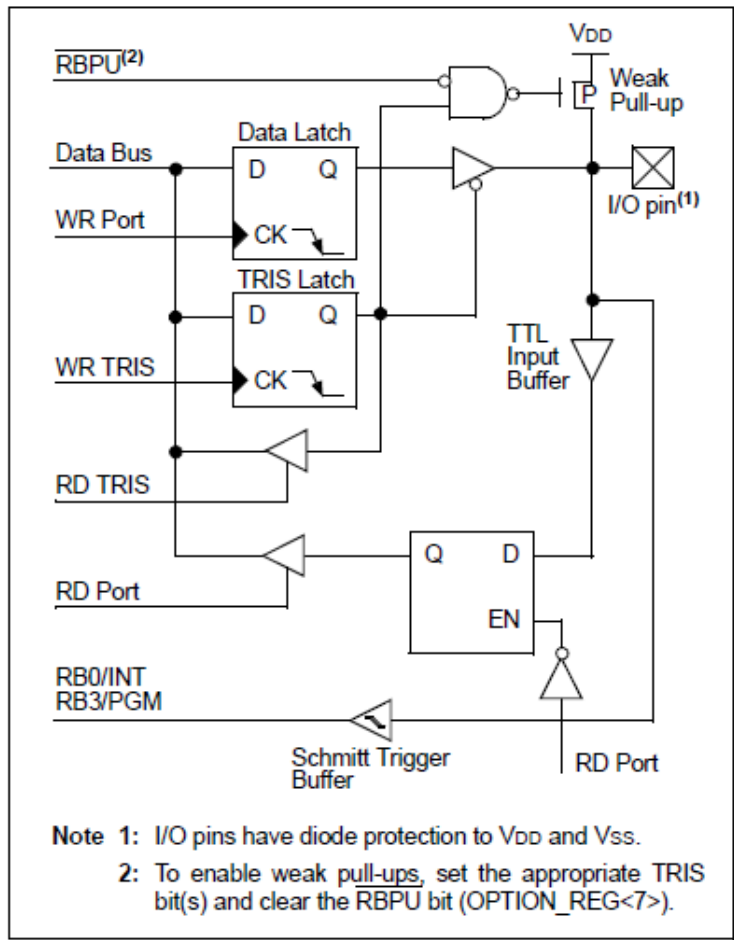
Fig.3.17. PORT B block diagram

Three pins of PORT B are multiplexed with the In-Circuit Debugger and Low Voltage Programming function RB3/PGM, RB6/PGC and RB7/PGD. The alternate functions of these pins are described in "Special Features of the CPU". Each of the PORT B pins has a weak internal pull-up. A single control bit can turn on all the pull-ups. This is performed by clearing bit RBPU (OPTION_REG<7>). The weak pull-up is automatically turned off when the port pin is configured as an output.

PORT C:

PORT C is an 8-bit wide, bidirectional port. The corresponding data direction register is TRISC. Setting a TRISC bit (= 1) will make the corresponding PORTC pin an input (i.e., put the corresponding output driver in a High-Impedance mode). Clearing a TRISC bit (= 0) will make the corresponding PORT C pin an output (i.e. put the contents of the output latch on the selected pin).PORT C is multiplexed with several peripheral functions. PORT C pins have Schmitt Trigger input buffers.
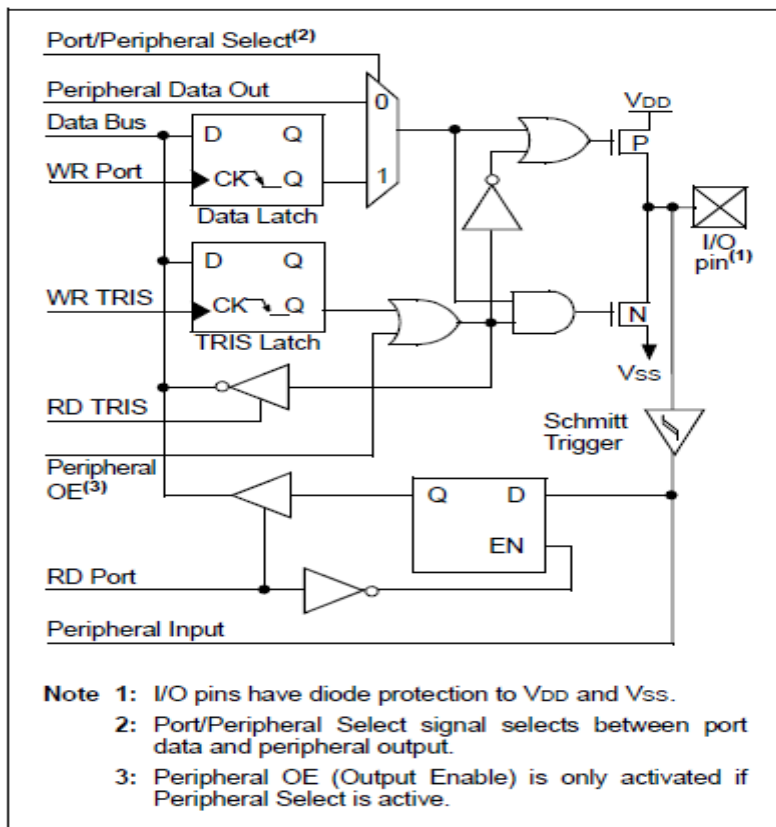
PORT C BLOCK DIAGRAM:

Fig.3.18.PORT C block diagram

PORT D:

PORT D is an 8-bit port with Schmitt Trigger input buffers. Each pin is individually configurable as an input or output .PORT D can be control bit, PSP MODE ISE<4> In this mode, the input buffers are TTL.
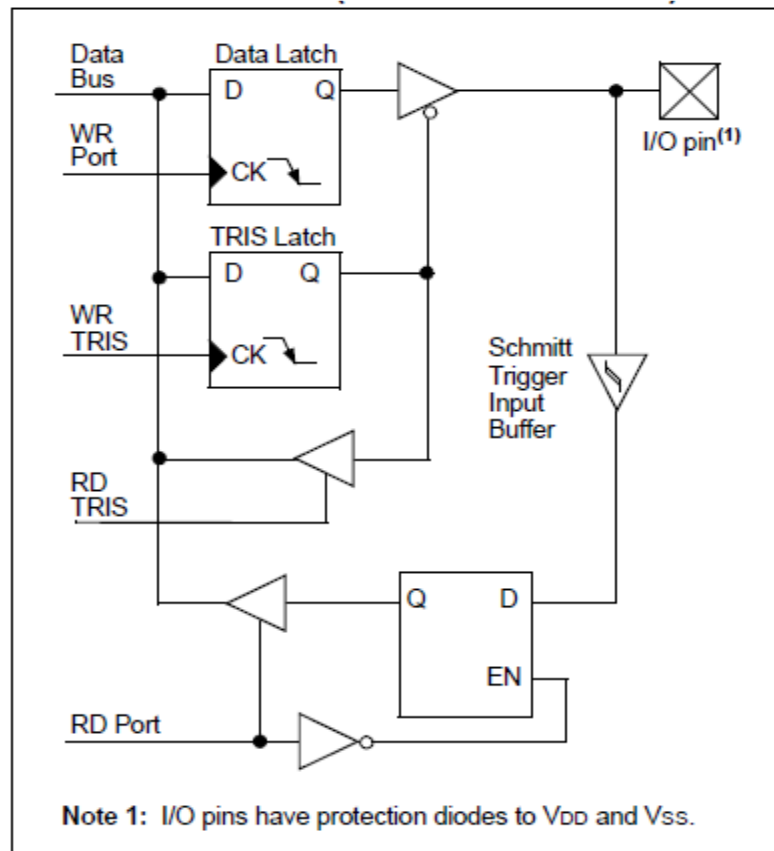
PORT D BLOCK DIAGRAM:

Fig.3.19. PORT D block diagram

PORT E:

PORT E has three pins (RE0/RD/AN5, RE1/WR/AN6and RE2/CS/AN7) which are individually configurable as inputs or outputs. These pins have Schmitt Trigger Input buffers. The PORT E pins become the I/O control inputs for the micro processor port when bit PSPMODE (TRISE<4>) is set. In this mode, the user must make certain that the TRISE<2:0> bits are set and that the pins are configured as digital inputs. Also, ensure that ADCON1 is configured for digital I/O. In this mode, the input buffers are TTL. Register shows the TRISE register which also controls the Parallel Slave Port operation. PORT E pins are multiplexed with analog inputs. When selected for analog input, these pins will read as '0's.TRISE controls the direction of the RE pins, even when they are being used as analog inputs. The user must make sure to keep the pins configured as inputs when using them as analog inputs.

3.8.6. Relay

A relay is an electrically operated switch. Current flowing through the coil of the relay creates a magnetic field which attracts a lever and changes the switch contacts. The coil current can be on or off. So relays have two switch positions and they are double throw (changeover) switches. Relays allow one circuit to switch a second circuit which can be completely separate from the first. The link is magnetic and mechanical. The coil of a relay passes a relatively large current, typically 30mA for a 12V relay, but it can be as much as 100mA for relays designed to operate from lower voltages. Most ICs (chips) cannot provide this current and a transistor is usually used to amplify the small IC current to the larger value required for the relay coil. The maximum output current for the popular 555 timer IC is 200mA so these devices can supply relay coils directly without amplification.

Relays are usually SPDT or DPDT but they can have many more sets of switch contacts, for example relays with 4 sets of changeover contacts are readily available. Most relays are designed for PCB mounting but you can solder wires directly to the pins providing you take care to avoid melting the plastic case of the relay. The animated picture shows a working relay with its coil and switch contacts. You can see a lever on the left being attracted by magnetism when the coil is switched on. This lever moves the switch contacts. There is one set of contacts (SPDT) in the foreground and another behind them, making the relay DPDT.

Fig.3.20. Relay switch

In our control unit, 16 relays used to control 8 motors. One motor contain 2 relays, one for forward motion and another for reverse motion.

Specification

- Electromagnetic relay: DC 12V
- Coil triggering current: Minimum 0.5Amps

- Switching capability:
- 120V   12Amps   DC
- 250V   10Amps   AC

3.8.7. Limit Switch

Limit Switches are electro-mechanical devices that consist of an actuator mechanically linked to a set of contacts. When an object comes into contact with the actuator, the device operates the contacts to make or break an electrical connection. Our limit switches work in a variety of applications and environments because of their ruggedness, simple visible operation, easy installation and reliable operation. Standardized limit switches are industrial control components manufactured with a variety of operator types, including lever, roller plunger, and whisker type. Limit switches may be directly mechanically operated by the motion of the operating lever. A reed switch may be used to indicate proximity of a magnet mounted on some moving part. Proximity switches operate by the disturbance of an electromagnetic field, by capacitance, or by sensing a magnetic field.

Rarely, a final operating device such as a lamp or solenoid valve will be directly controlled by the contacts of an industrial limit switch, but more typically the limit switch will be wired through a control relay, a motor contactor control circuit, or as an input to a programmable logic controller.

Fig.3.21. Limit Switch

CHAPTER 4

WORKING PRINCIPLE

The wheelchair is provided with a remote control with which the motion can be controlled. The receiver side has the controller which receives the command from the transmitter and the operated the DC motors as assigned. There are 16 buttons and 8 motors. Each motor can be driven in forward and reverse direction. The operation of the wheel chair is done by the user as required. The wheel chair can be used to climb and get down from the steps. The chairs height can be increased and decreased by rack and pinion mechanism.

The combined operation of sliding chair, foot rest, front and back legs, supporting legs are facilitate the stair climbing and down process. For stair climbing upward, the limbs of the wheel chair lift upward by using the rack and pinion arrangement. It is operated by dc motor and the sliding bed move forward. The foot portion extends and rest on the steps, and the wheels adjust the height. For stair climbing downwards, the foot portion advances down to touch the step and then the sliding bed move forward thereafter the limbs move down. For converting the chair into bed, spur gear mechanism is used. All these mechanisms are operated by using the dc motors, controlled by the wireless remote controller and the micro controller.

CHAPTER 5

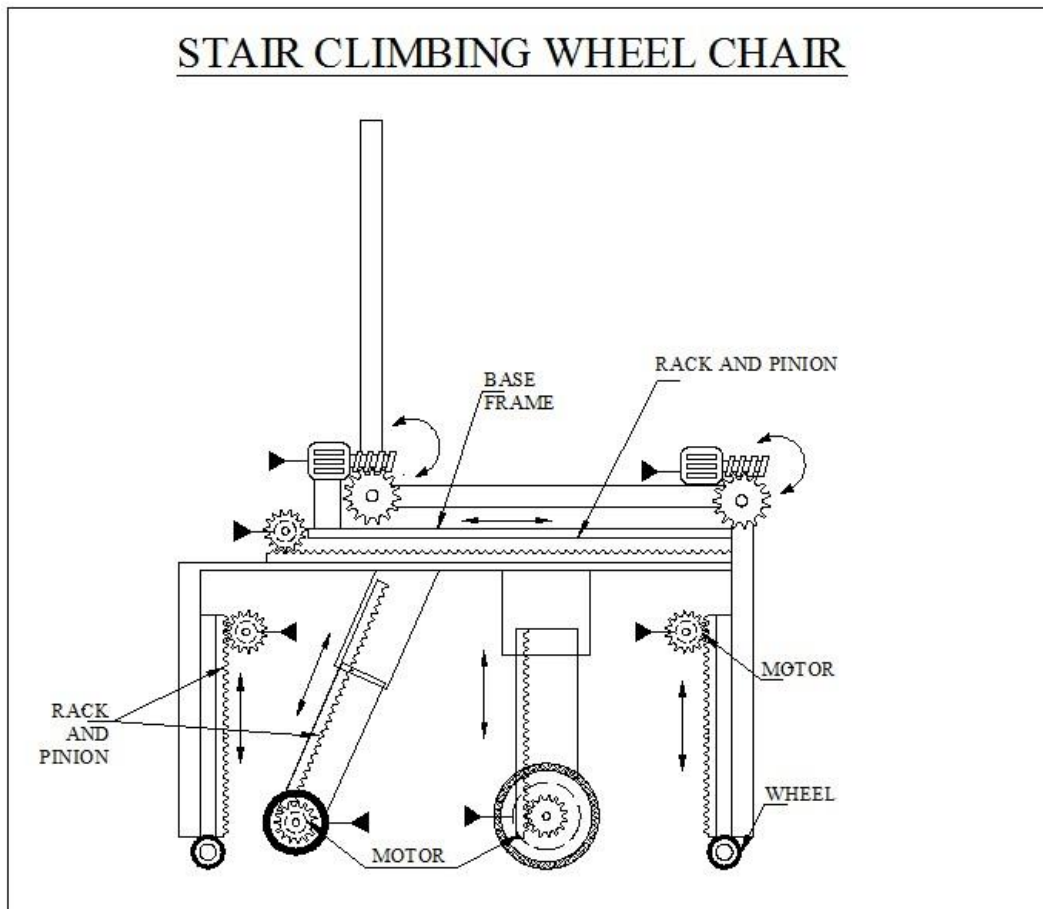# DESIGN DRAWINGS

5.1. 2D DWAWING OF STAIR CLIMBING WHEELCHAIR

Fig.5.1. 2D drawing of Stair Climbing Wheelchair
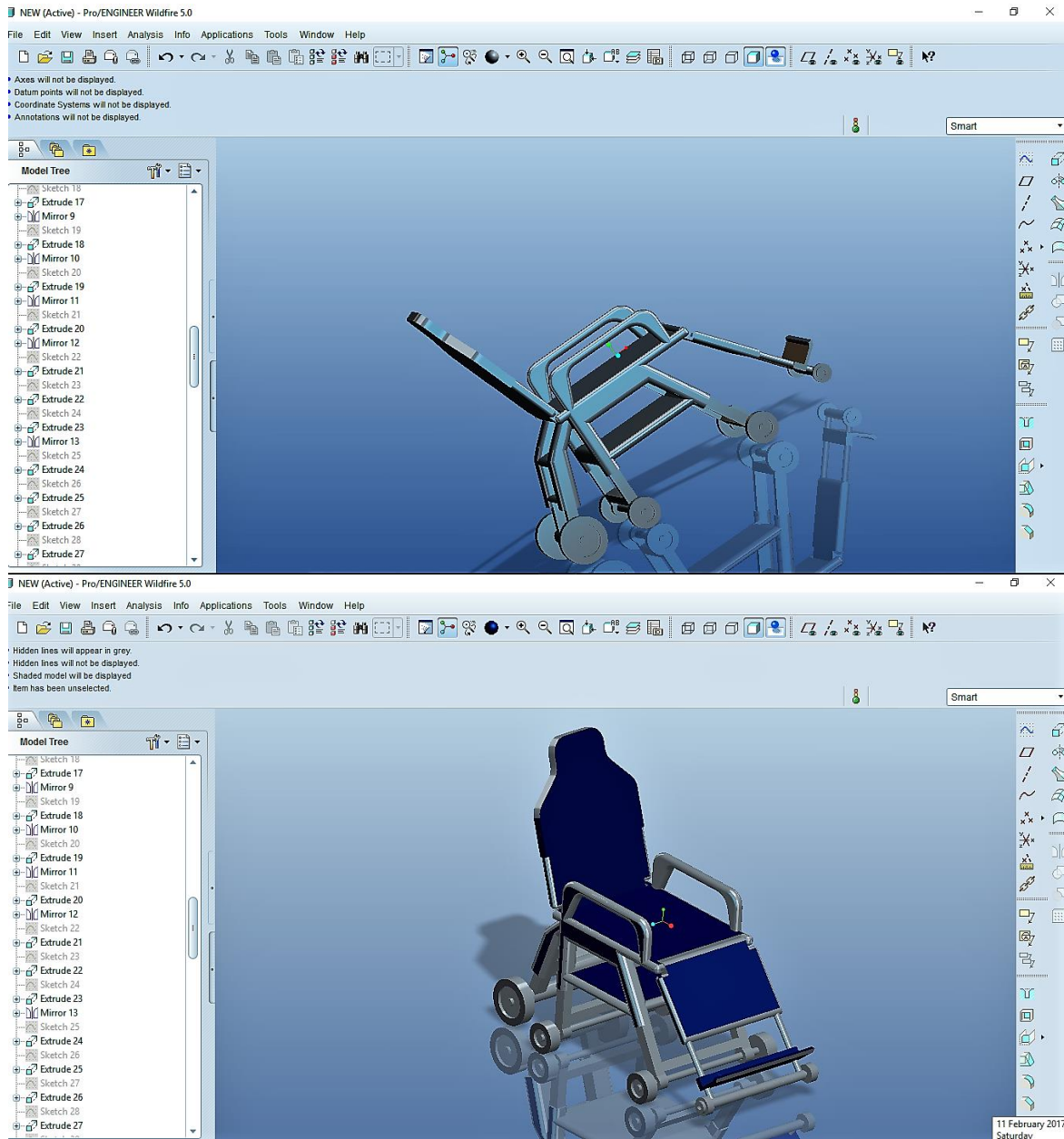
5.3. 3D VIEWS USING PRO/E SOFTWARE

Fig.5.2. 3D views using Pro/E software

CHAPTER 6

DESIGN CALCULATIONS

6.1. TORQUE CALCAULTION OF DC MOTOR

Speed   = 45 RPM

Voltage   = 12 V

Power   = 30 W

Current   = 2.5 A

Torque of DC Motor = $\frac{60 \times P}{2 \times \pi \times N}$

$$= \frac{60 \times 30}{2 \times \pi \times 45}$$

$$= \ 6.36 \text{ Nm}$$

$$= \ 6.36 \times 10^3 \text{ Nmm}$$

6.2. RACK AND PINION

Rack

Material   = Mild Steel

Number of teeth   = 40

Length of rack   = 400 mm

Width of rack   = 12 mm

Thickness of rack = 12 mm

Pressure angle = 20° full depth system

Module of rack (m) = 2 mm

Pitch of rack = $\pi \times m$

= 3.14×2 = 6.28 mm

Addendum (a) = 1×m

= 1×2 = 2 mm

Dedendum (d) = 1.25×m

= 1.25×2 = 2.5 mm

Tooth depth (h) = 2.25×m

= 2.25×2 = 4.5 mm

Working depth (hw) = 2×m

= 2×2 = 4 mm

Tip and root clearance = 0.25×m

= 0.25×2 = 0.5 mm

Pinion

Material = Mild Steel

Number of teeth (T) = 7

Diameter of pinion (D) = 14 mm

Thickness of pinion = 10 mm

Module (m) $= \dfrac{D}{T}$

$= \dfrac{14}{7} = 2$ mm

Addendum (a) $= 1 \times m$

$= 1 \times 2 = 2$ mm

Dedendum (d) $= 1.25 \times m$

$= 1.25 \times 2 = 2.5$ mm

Circular pitch (Pc) $= \dfrac{\pi \times D}{T}$

$= \dfrac{3.14 \times 14}{7} = 6.28$ mm

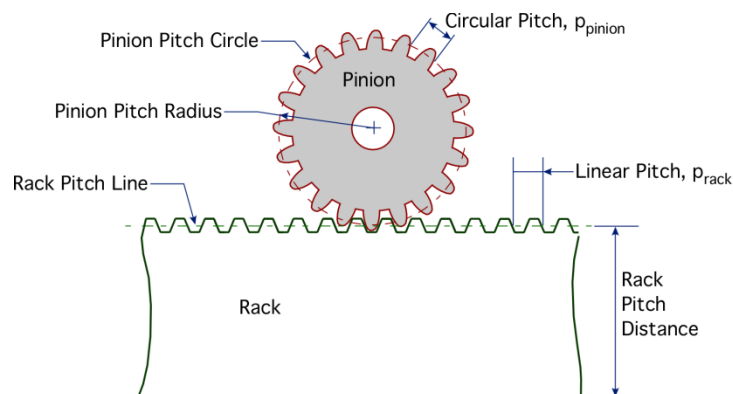Diametrical pitch (Pd) $= \dfrac{T}{D}$

$= \dfrac{7}{14} = 0.5$ mm

Fig.6.1. Rack and pinion Design

6.3. WORM GEAR CALCULATION

Number of teeth on worm wheel $= 29$

Outer diameter of worm wheel   = 60 mm

Inner diameter of worm wheel   = 15 mm

Number of starts on worm   = 7

Axial Pitch of Worm or

Circular Pitch of Gear P   = 6.23

Pitch Circle Diameter of Worm D1   = 16.07

Pitch Circle Diameter of Gear D2   = 63.47

Centre to Centre Distance between

Worm and Gear C   = 39.774

value of "L1   = $[C^{(0.875)}]/2 = 12.54$

value of "L2   = $[C^{(0.875)}]/1.07 = 23.45$

Motor speed   (N)   = 1440 rpm

Power of motor (P)   = 550 watts

Diameter of shaft   = 15 mm

Mild steel shaft shear stress (fs)   = 210 N / mm^2

Torque of the motor (T)   = p x 60 / 2 x π x N

Torque of the motor (T)   = 550 x 60 / 2 x π x 1440

                                      = 3.64 N - m

The gear ratio of a worm gear is worked out through the following formula

$$= \frac{\text{Number of teeth on worm wheel}}{\textit{Number of teeth on worm}}$$

$$= 29 / 7$$

$$= 4.14$$

Gear ratio (i) $= n1 / n2$

(n1) worm shaft speed $= 1440$ rpm

(n2) worm wheel speed $= 1440 / 4.14$

$$= 347.82 \text{rpm}$$

Torque of the worm wheel (t2) $= p2 \times 60 / 2 \times \pi \times N2$

$$= 550 \times 60 / 2 \times \pi \times 347.82$$

$$= 1.51 \text{N m}$$

Angular velocity of worm wheel (Θ) $= 2 \times \pi \times 347.82 / 60$

$$= 36.42 \text{ rad}$$

Worm wheel torque is limited to the maximum limit. So our design is safe.

CHAPTER 7

PRODUCT PHOTOS

Fig.7.1. Front View

Fig.7.2. Side View

Fig.7.3.Stair Climbing Mode

Fig.7.4. Bed Mode

CHAPTER 8

COST ESTIMATION

Table 8.1.cost estimation

SL.NO	PARTICULERS	QUANTITY	COST
1	Power Torque motor	9 Nos.	4500
2	Rack and pinion	5 Nos.	1500
3	Mild steel hollow rod(square)	6 metres	2000
4	Mild steel rod	2.5 metres	1000
5	Wheels	8 Nos.	500
6	Electronic control unit	-	6000
7	Other costs	-	2500
	Total cost		19000

CHAPTER 9

MERITS AND DEMERITS

9.1. MERITS

1. Self controlled operation of wheelchair without helper.
2. Reduction in overall cost of stair climbing wheel chair.
3. Limited usage of primary energy sources.
4. Simple in operation by using the remote controller.
5. Stair climbing is Autonomous operation on stairs, slopes and irregular terrain.
6. This is more efficient.
7. The wheelchair can be converted into stretcher.
8. It helps the disabled person to continue his normal life.

9.2. DEMERITS

1. It is only a model and not the capabilities for carrying the disabled persons
2. The movement of wheelchair become slow due the rack and pinion mechanism.
3. Lack of balance while stair climbing operation.

CHAPTER 10

FUTURE ENHANCEMENTS

We developed a model of an "Automatic Stair Climbing Wheelchair" with the available mechanisms like rack and pinion, spur gear, worm and worm wheel etc. In future we have to rectify the problems that we have encountered during the project and also provide,

1. Linear motion through electric actuators and speedup the wheel chair motion.
2. Sensors for measuring the height of stairs and the obstructers.
3. Reduce the keys in the remote controller and simplify the operation.
4. Optimise the design and provide balancing mechanism.
5. Make the full structure of stair climbing wheelchair with the capability for carrying the disabled persons.

CHAPTER 11

CONCLUSION

The project based on "Automatic Stair Climbing Wheelchair with Bed" Has been successfully completed and executed. In this project we introduced a new kind of stair-climbing wheelchair and also convert as a stretcher. It has compact structure, can cope with flat or inclined terrain, stairs and obstacles. We mainly focus the cost effectiveness and also introduce a new mechanism for the stair climbing. The mechanisms are simple and can be easily controlled. Future work is required in the development of the stair-climbing mechanism with electric actuators and sensors, and the production of a full size mechanism.

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