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Ergonomic Wheelchair with Enhanced Independency to Alight

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Abstract

There are many causes that leads to lower limb disabilities. Accidents, injuries, congenital defects, sprains, etc. are some of the most common reasons. The patients with such disabilities usually prefer the wheelchair as the most common augmentative option because of easy availability and user friendliness. Although there has been great advancements in the wheelchair design, (e.g. stair-climbing, standing, sports), there are certain areas in which developments has not been considered. One such area is the movement of the patient to the bed. The project aims to improve the self-sufficiency of the user to move to the bed by them. The wheelchair design involves four steps that aids in efficiently moving the user to the bed. The in depth study and work of the adjustable wheelchair will be discussed further in this paper.

Keywords: Ergonomic, wheelchair, height-adjustment, scissor-lift, independent, recline.

I. INTRODUCTION

Disabilities in mobility can occur due to aging, injury or acquired from birth. People with lower limb disability have problems with mobility. This may be as a result of amputation, cerebral palsy, multiple sclerosis, etc.Those patient with mobility dysfunction often are not able to deal with the sudden loss of the limb, which leads to anxiety, depression and other sociopsychological effects. They always rely on someone to perform the normal day to day activities. This results in exhaustion and tension for the caretaker who is helping the disabled. To avoid the problems on both the patient side and the person who is helping the patient, wheelchairs were developed. The already existing wheelchair solves most the problems associated with the mobility of the user such that they are independent. This reduces the stress on the aiding person. The disabled persons can sit in the wheelchair and the other person can push the wheelchair to different places with less effort compared to cradles, swing, which was used earlier for transporting. The wheelchairs can be large and bulky, can be propelled manually or it can be powered. A typical wheelchair will have 4 wheels. Two small wheels at the front that can swivel are called castors and 2 big rear wheels that support the user's weight. These rear wheels contribute to the stability of the wheelchair user so that they won't tip and fall.

A.History

In olden days, before the wheelchair was discovered transportation of disabled people was very difficult. They were transported in a recumbent position. The sick and lame were carried by people through the hard and rough path. People used litters to carry the disabled. While the rich used luxurious litter palanquins. The Greek and romans used cradles, hanging beds, swings, litters for carrying the patients. The oldest wheelchair dates back to ancient times. The evidences or the traces that the wheelchairs were used were found in a stone carving in china and in a Greek vase of a wheeled child's bed. In 1595, "Invalid's wheelchair" was the first ever wheelchair that was developed specifically for King Phillip II of Spain [8]. Invalid's wheelchair had small wheels attached at the end with an adjustable back rest. It was provided with a platform on which the legs can be placed. But the model couldn't be self-propelled so it required the aid of other people. However Later in 1655, a self-propelled wheelchair was developed by Stephen Farfel. Following the self-propelled wheelchair, the bath wheelchair came into light in 1783. It was invented by John Dawson. This wheelchair used two large wheels at the back and one small wheel at the front. Donkeys were used to pull this wheelchair since it was heavy. This model was sold in greater numbers since the early part of 19th century. But this bath wheelchair was not that comfortable to be used since it heavy and improvements had to be done. An 1869 patent showed a model with rear push wheels and small front casters for wheelchairs. Between, 1867 to 1875, new hollow rubber wheels similar to those found on metal rims of bicycles were used. In 1881, the push rims were used for self-propulsion. In 1900, the first spoke wheels were used on wheelchairs that make the wheelchair lighter and swifter. Canadian George Kleinand his team invented the first motorized wheelchair in 1916 which was manufactured in London to help the veterans during World War II. It uses small motors to drive the wheels. In 1932, Everest along with his fellow engineer Jennings developed the steel wheelchairs with 18 inch wide seats. This was developed for hospital use and not to optimize ergonomic variables. Power wheelchairs began in 1940"s which used standard cross-braced folding manual wheelchair with starter motors and battery. This remained as the standard

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wheelchair for a number of years. By 1970‟s wheelchair had evolved to a greater extent to help the patients with mobility disability.

B.Categories of wheelchair

(i) Manual wheelchair

Earlier, manual wheelchairs were used for transportation of people with lower limb disabilities. A manual wheelchair requires self-propulsion. Due to this constrain, the rider or the user becomes tired as a result of use of muscular strength of upper limbs for propulsion. These should be made light weighted so that even with less force propulsion takes place. There are many kinds of manual wheelchairs such as ultra-light manual wheelchair, manual tilt wheelchairs, Manual Power Assist Add-On Wheelchairs, manual sports wheelchair etc.

(ii) Electric wheelchair

People prefer electrically powered wheelchairs. Users who are actively using the wheelchairs and are distant travellers prefer electrically powered wheelchairs. These wheelchairs operate on battery together with integration of other assistive devices is made in powered wheelchairs. Therefore the powered wheelchairs integrate various needs of user.

C. Materials used

Wheelchairs must be designed to satisfy the various needs of the user. It should provide efficient mobility for the disabled. Various factors must be considered for the construction of wheelchair. Selection of suitable materials is very essential while considering the frame structures. It should provide strength, durability, and must be able to withstand the applied stress. People must consider the material of the wheelchair when they are about to use one.

(i) Aluminium

Aluminium is more popularly used in construction of wheelchairs because of its high strength to density ratio. They are light and mostly preferred by the users. Aluminium does not require specialized manufacturing equipment and techniques. Aluminium wheelchairs are electrically welded in the presence of Tungsten Inert Gas (TIG). Aluminium tubing is used for the construction of wheelchair frames. This makes the aluminium wheelchairs less costly, easily fabricated and is also available in abundance. It has good mechanical properties and is highly resistant to corrosion. Most of the folding type wheelchairs are made of aluminium.

(ii) Steel

In case of steel, mild steel is used for the construction of wheelchairs. Mild steel is found in abundance and are less expensive. It is easy to work with and is commonly used in standard wheelchairs. However, it has low strength to density ratio and it is heavier than the aluminium. In case of chromium – molybdenum, it has high fatigue ability and more ease of fabrication. In this type tubing of 0.028-0.035 inches are used.

(iii) Titanium

Titanium wheelchairs are the most expensive ones compared to other wheelchair materials. They are rarely used for everyday use. They are used for specific needs such as basketball wheelchairs and in wheelchair racing. Owing to its strength and light weight, they are high end wheelchairs. They have a comfortable propulsion and gives great support. Titanium wheelchair frames are TIG welded. Titanium is used because of its availability, appearance,corrosion resistant, very good strength and light weight. The major drawback of titanium is that, once it’s worn it will be destroyed rapidly.

(iv) Carbon fibre

For industrial and aeronautical applications advanced composites will be used. Kevlar, carbon fibre and polyester limestone composites are the materials which are widely used. Among these, Kevlar is an organic fibre that is yellow in colour. It is soft to touch but extremely strong and durable. On the other hand, carbon fibres are very strong with higher modulus of elasticity and have low density for a given volume. Carbon fibres are made by changing the molecular structures of rayon fibres during extreme stretching and heating.

(v) Composites

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A composite material is a combination of two or materials with different properties. When carbon fibre fabric is mixed with resin, composites are formed. These are commonly referred to as carbon fibre and are used to manufacture vehicles, sporting goods and Motion Composite wheelchairs (bottom). Composites have high strength to density ratio and it is very light compared to titanium and aluminium. People prefer this type because it is easier to propel lighter wheelchairs. They can operate in wide temperature range enabling them to expand and contract. They have high resistant to corrosion, more durable and cost efficient. Composite clothes are woven in two ways. Depending on the direction, it can be either unidirectional or bidirectional. Composite clothes woven in unidirectional, adds strength along a particular direction. The binding element of composite is resin. This resin or epoxy binds the composites together to achieve greatest strength.

D. Frame Design

The two basic frame designs are: box frame and cantilever frame. The tubing of wheelchair is either welded together or bolted using lugs. Box frame as the name suggests, it is rectangular in shape and the tube outlines the edges of the box. These box frames are hard and durable. They are resistant to corrosion depend on the material that is used for the construction of frames. They also provide great strength and rigidity. Proper construction of box frames results in minimal deflection during normal loading and most of the suspension is provided by the seat cushion, wheels and the wheel mounting hardware.

Cantilever frames – these frames when viewed from sides, the front and rear wheels appear to be connected using a single tube. This type of frame requires cross bracing. as a result of cross bracing , strength and stiffens is given to the wheelchair. The cantilever frame is based on two principles. They are 1) the frame can act as suspention2) there are fewer tubes and they are closer to the body which may make the chair less conspicuous 3) there are fewer parts and fewer welds which makes the frame easier to construct

(i) Manual wheelchair frames

Presently all common wheelchair frames centrearound a tubular construction. They can be made using various materials such as aluminium, titanium etc. in case of aluminium, it will be used in light weight wheelchairs. But the disadvantage of using aluminium in frames is that when its exposed to stain, it will result in structural damage. Standard frames are made out of steel. Ultra-light wheelchairs make use of titanium which is quite expensive. For manual wheelchairs, the frames must be designed lighter so that it is easier to propel with less force. Therefore titanium frames are mostly preferred in the design of manual wheelchair.

(ii) Folding wheelchair frames

Folding wheelchair frames consists of a cross frame along with two side frames. Today, the most common frames that are used in markets are the folding wheelchair frames. They are popular because of the ability to fold during transportation and storage. These frames are very useful for people who use the chair daily for most of their mobility needs and spend many hours a day in the wheelchair.

(iii) Rigid Wheelchair Frames

These are similar to folding wheelchair frames. The two side frames are attached using a straight bar instead of a cross frame forming a rigid structure. The frames are welded to form joints. They are stronger compared to other frames and are lighter. Due to these reasons, these frames are suggested for active users like teenagers. Reclining wheelchair frames are regular folding frames. These reclining wheelchair frames have back posts with hinges present at the back posts to allow the reclining of the back rest . The reclining wheelchair frames can be either steel or aluminium. Even though steel or aluminium is used it will still be heavier than compared to a conventional folding frame.

E. Wheels and castors

Choosing the right wheels and castors are very important in a wheelchair. Just like how the right materials provide good structure and durability, the right wheels and castors must be used for a comfortable and an effective ride. Castors: the front wheels of a wheelchair are called castors. They can be as small as 2in in diameter or can also be large as 12in. in diameter. There are different types of castors available for wheelchairs. They are broadly classified as pneumatic, semi-pneumatic and solid (polyurethane).

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Rear wheels come in three common sizes. They are 22, 24, and 26 in. They come in two styles: spokes and MAG. MAG is made up of alloys which mostly contain magnesium. They are affordable and more rigid.In case of spokes, wheels are lighter, more responsive and preferred for the construction of manual wheelchairs.

F. Height adjustment

For a wheelchair user, in order to reach distant and taller objects they have to adjust the height of wheelchair. But adjustment of wheelchair should ensure the safety of the user. The wheelchair should have stability otherwise the user may tip and fall. To avoid this proper design of height adjustment must be done that gives both safety and the user need should be satisfied.

Wheelchairs over the years have undergone various transitions and are modelled in various ways so as to benefit the user. With much more improvements in the design and structure of the wheelchair, it will increase the comfort of the user and improve the efficiency of the patient.

II.LITERATURE SURVEY

Willis G.ShafferandMichael J.Salazar patented a Convertible bed and Wheelchair unit(Patent number-4,717,169) in the year 1988. The wheelchair designed by them can be converted into bed and vice versa. This helped in various hospital applications. However it ended up being troublesome for the patients to move swiftly to bed from wheelchair. Later this wheelchair to bed conversion was improved with versatile body supporting segments by Weiss in 1997.

A literature review on "Smart Wheelchairs" written by Richard C.Simpson was published in the "Journal of Rehabilitation and Development" in 2005. The article compares the current state of the power wheelchairs and directions for future research. It was given that people who use the smart wheelchairs are not comfortable or find it impossible for Activities of Daily Living. "Smart Wheelchair" article was published by Kanazawa University, Japan in 2000. These wheelchairs use ultrasonic beacons to determine its location. The location can be obtained from time-of-flight calculations. The location information provides autonomous navigation of the wheelchairs. The University of Ancon, Italy published the article "Smart Wheelchair" between 1998–2000. In their design they modified the wheelchair in such a way that it either stops when obstacles are detected or steer around them so that the user is able to navigate properly without relying much on vision for navigation. Watson NAIST, Japan between 2001–2003 developed a "Smart Wheelchair" that uses light for the navigation of wheelchair. In their work the wheelchair interprets the users gaze for control and navigation of wheelchair, it uses lasers to identify obstacles. In the article "Smart Wheelchair" presented by Chinese University of Hong Kong, China in 2002, the wheelchair had been designed using neural network. These neural networks are used to map sensor readings in order to control the action.

"Synchronous EEG Brain-Actuated Wheelchair with Automated Navigation" published in 2009 suggests that the brain can be used for control of wheelchair. This paper focuses on brain actuated wheelchair. It is completely a new non-invasive technique that relies on a P300 neurophysiological protocol and automated navigation. This was tested for few subjects and the results were also positive and based on the results, this paper reports a technical evaluation of the wheelchair design and its study.

S. D. Suryawanshi, J. S. Chitode and S. S. Pethakar published a “Voice Operated Intelligent Wheelchair” article in 2013. In their work the user will give voice command through a head phone and the signal is processed using matlab® coding. A microcontroller is used to govern the motors. For patients with lower limb disabilities can use their normal upper limb for control of mobility through wheelchair. This was published by S. Paulose, M.P.F. Anooda, G. Mohan, M. S. Sajana and K. A. Anupama, in the article “Automatic Wheelchair using Gesture Recognition Along with Room Automation” in May 2014. This paper opens up the possibility of hand gestures for controlling the direction of wheelchair.

In the paper "Stretcher cum wheelchair for patients" given by P.A. Vaghela was published in 2014. They have discussed about the conversion of a wheelchair to bed and vice versa. Moving people from a wheelchair to bed is a tedious job. The users always need some assistance to transfer to and from a wheelchair. This paper converts the wheelchair to bed and it gets attached with an already available normal beds. Here the wheelchair is stretched and its height is adjusted so that it gets attached to the bed. Mobility is available both in wheelchair form and as a stretcher. For conversion mechanical linkage is used. Even hydraulic systems can also be used for the conversion.

In the paper "Design and Fabrication of Stretcher Cum Wheel Chair" by Jyothish K Sunny published in 2016, their wheelchair can be shifted to various positions such as a chair, semichair and as a stretcher by connecting a lead screw to a hinge joint. Hydraulic mechanisms are employed to adjust the height of the wheelchair. The chair is also provided with the facility to dispose the waste without any assistance.

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According to AkshayHirudka, in the journal, "Automatic stretcher cum wheelchair", published in 2017, they proposed a development of wheelchair cum stretcher in which the patients are self-reliant to transfer themself from wheelchair to bed. It uses electronic control over stretcher cum wheelchair for movement and functioning. These types of wheelchairs are used as the walking aids which can help with people with mobility disorder to walk using wheelchairs.

According to N.Vasudheva Reddy in the journal "Robotic assistive device for physically disabled people" published in 2017, has described the use of joysticks for controlling the wheelchair directions. These joysticks are used to rotate the wheels in desired directions. DC motor was also used for controlling the speed of wheelchair. Using jack mechanism the wheelchair can be converted into a semi stretcher for the comfort of user. This wheelchair can be used for indoor and outdoor purpose. This wheelchair proved that 50% space occupied was reduced rather than using the wheelchair alone.

In the journal "Wheelchair cum stretcher in hospital" by Harishkumar .M1, Mukilan .M2, Lokeshwaran .R published in 2018, has designed automated wheelchair using screw rod sprocket and the chain drive mechanism. DC motors and Lead acid batteries were used. The wheelchair is converted into a stretcher by pressing a button that will delivery power to the motor and that motor will drive the screw rod. The developments made to the wheelchair are drastic and is evident in this section. The already existing wheelchairs differentiated from being basic to the most developed. Hence, with such a variety of wheelchairs, little improvisations will make a slightest benefit to theuser in many ways.

III. MARKET SURVEY

A. Stretcher cum wheelchair

Health-Care Equipment & Supplies established in 1992 are hugely involved in the manufacture of various medical devices and export them. They also supply various health devices such as veterinary tables, hospitals chairs, hospital trolley and beds, multipurpose trolleys, arm &leg rests for wheelchair and cater health care centres. They developed a stretcher cum wheelchair. It consists of waterproof foamed cushion so that the user can be made comfortable by providing adjustable back rest. The handles on both sides are used for folding the legs mechanically. The stretcher height is adjustable, wheelchair can be adjusted to the required height. Aluminium alloy is used for this wheelchair which makes it lighter. The advantage of using aluminium is that they are highly corrosion resistant and light weight. It involves easy maintenance and low cost. These are mainly used in hospitals.

B. Stair climbing wheelchair

The Liftkar PT-S is a stair climbing wheelchair which assists the patients with lower limb disorder to climb the stairs using a wheelchair like a normal person does. The model130 is designed such that it can withstand people up to 130 kg and another model that can withstand up to 160 kg. It has a total width of 505mm. It can move at the rate of 3 steps per minute. It can also be used in two modes: single step mode and continuous mode. The wheelchair as a whole weights about 34.3 kg. It has various advantages such as independence, leaves no mark on the floor, light weight construction and easy to be transported. Thus the user can be independent and move around including the stairs.

C. HP1 Powered Wheelchairs

Powered wheelchairs are the most preferred ones. Manual wheelchairs require propulsion by the user. But in the case of powered wheelchairs, they are automated. It is easy for people with lower limb disability to move around. The HP1 powered wheelchair is a heavy duty wheelchair it is made of steel and uses double cross brace frames for stability. Seat width can also be adjusted from 22 inch to 24 inch. It can withstand heavy loads. It uses 4 high power motors. The whole device weights about 62 kg including the battery. The wheelchair operates to a maximum speed of 6Km/Hr.

D. PER Mobil c450 mx

Per Mobil c45mx is a powered wheelchair for children with lower limb disability. It must be designed to meet their comfort and needs. The wheelchair can be titled, the seats can be lifted and its width and height can also be adjusted. These wheelchairs are highly suitable for young adults. It can withstand a weight up to 60kg. It operates at a range of 25 to 30 km and moves with a maximum speed of 8.5Km per hour. The tires are made leak proof thereby having low maintenance. Intelligent Control Systems are used for effective control of wheelchair.

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E. F5 Corpus VS

F5 Corpus VS is a powerful vertical-standing wheelchair. It is highly durable and integrates the various needs of the user. This model offers powered seat functions providing the user with two options: Sit-to-stand or Lay-to-stand. This wheelchair is fully automated and user is completely independent. The range of operation is 25-30km. It can be operated at a maximum angle of 80 degree and adjustable backrest handle is 180 degree.

IV. PROPOSED METHODOLOGY

The project focussed on improving the self-dependency of the person during alight to bed. The main features of adjustable wheelchair are; (i) the height adjustment, (ii) reclining ability,(iii) armrest flexure and (iv) titling. These features will aid in improving the independency of the wheelchair user. The patients or user who is eligible or categorized for the use of our wheelchair are those who have lower limb disabilities and have sufficient upper limb capabilities. This was introduced so as to improve and utilize the residual capacity maximally.

The desired wheelchair will make the patient move independently from the chair to the bed. The process to assist this movement is through 4 steps. Firstly, the seat of the wheelchair is lifted to the height of the bed, so that the user can easily move to the bed using the minimal force to lift them off from the chair. The second step is the flexure of the armrest nearer to the bed in the upward direction. This is done so that when the patient moves towards the bed, there would not be any hindrance. In the third step the backrest reclines and the footrest lifts to an angle of 30-45^{o}, such that it would be easier for the user to lie onto the bed. The final step involves the tilting of the seat of the wheelchair towards the bed. This sequence enables the user to swiftly rest onto the bed with minimal effort.

A. Height Adjustment

For the height adjustment mechanism, the scissor lift approach is utilised. The scissor lift is commonly used in industries (example: Car Jack used to lift tyres, to lift cars during car servicing etc.). This method ensures high stability as the base has a wider surface area. The scissor lift has a “X” design which extends and distends vertically when a force is applied. The crossed “X” designs are held by a centre fixture with a screw interconnected by a long shaft. When a rotary force is applied, the shaft moves inwards and the scissor lift extends upwards and vice versa.

Fig 1.,Scissor Lift Mechanism

B.Reclining Mechanism

For the reclining mechanism, a belt and a spring arrangement is used. In day-to-day life various recliners used in chairs, bus seats, sofas, car seats and modern smart wheelchairs can be seen. These wheelchairs are most often preferred. The above mentioned type of recliners uses a lever mechanism. When the lever is pulled, the backrest reclines and the footrest lifts. Instead of a lever, a handle is used which is positioned in an accessible location to the user. When the handle is rotated in clockwise direction, the rotating wood turns the belt winds around the wood and results in the inclination of the backrest. Simultaneously as the wood turns, the spring kept at an angle to the wood stretches thus lifting up the footrest.

Fig 2.,Reclining Armchair

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C.Armrest Flexure

For armrest flexure mechanism, the class 2 lever concept is employed, where the force is acting further away and in opposite direction to that of the fulcrum. These armrest flexures are usually seen in seats of aircrafts, buses, armchairs, etc. The armrests flexures are generally included to as to remove the disturbance when moving from one place to another or when adjusting the seating posture. A fulcrum, a semi-fixed hand-rest is attached to the backrest, and a wooden block is fixed in between the seat and the armrest serving as a source of support. When, the person wants to shift to the bed, user can slowly move the armrest upward, this causes the semi-fixed end to turn slightly resulting in the hand-rest to be aligned parallel to the backrest.

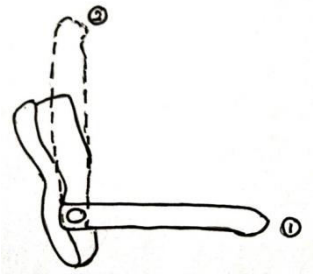

Fig 3.,Armrest flexure at 1.initial position of armrest 2. final position of armrest

D. Tilting Mechanism

The tilting mechanism works similar to that of the see-saw, utilizing the pivot of the Class III levers. The force(user) exerted is nearer to the pivot causing it to tilt in the direction towards the bed. In order to maintain the position, a mechanical locking method is implemented.

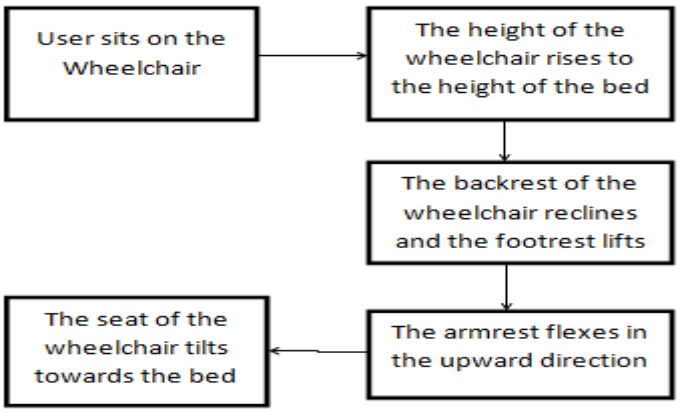

Fig 4.,Sequence of steps during patient movement from wheelchair to bed

V. RESULT

When lower limb disabled patient move from wheelchair to bed, a nurse or assistant is required thus making the user to be dependent on others. To overcome this, the wheelchair is designed in such a way that it provides independency to the user enabling them to move from wheelchair to bed and vice versa. The ergonomics of the wheelchair makes itsuitable for both hospital use and household use. The model is cost effective and the design of the wheelchair is compact. The developed wheelchair provides enhanced mobility for the elderly person and disabled people who have very restricted limb movements. Hence this appropriate design aids the user to shift from wheelchair to bed, tilt the seat to the required angle and easy operation of the wheelchair.

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The scissor lift consists of 8 rods of 25cm in length and 2 cm in height. Two rods are arranged together to form X frame in which the centre point act as fulcrum. Two X frames are linked together at two end of X structure. The entire arrangement is housed between two flat plates of 20cmX40cm and allowed to tilt from the centre. The maximum load that can withstand by the structure is 1.3kN which is well beyond the weight of an obese adult.

Fig 5.,Prototype of scissor lift constructed initial position (left) and final position (right)

The reclining mechanism is constructed upon the lifting structure. The top plate of scissor lift act as a support for seating and another plate of 20cmX40cm is used as backrest with one end of the plate as fulcrum point. A nylon belt of 7cm width and 75cm length is attached to the backrest at the midway. The other end of belt is attached to a rectangular bar and rolled to enable recline. A third plate of same dimension is employed for footrest. A spring is used to couple the footrest and the rectangular bar. This arrangement enables the lifting of footrest when reclining so that the patient can easily transport themselves to bed.

Fig 6.,Prototype of reclining feature constructed

Fig 7.,Prototype of Armrest flexure constructed

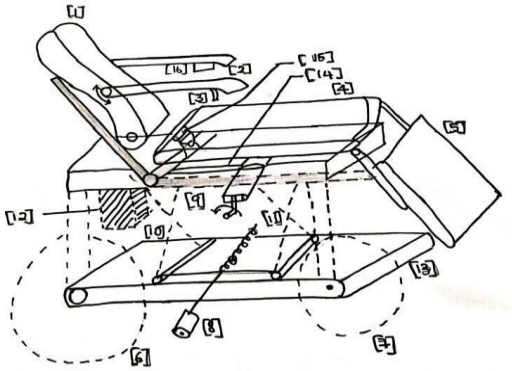

Fig 8.,Schematic diagram of modelled wheelchair 1.backrest 2.armrest 3.wheel brake 4.seat 5.footrest 6.rear wheel 7.castor wheel 8.motor and shaft 9.rotating handle 10&11.scissor lift 12.Power supply 13.reclining structure 14.belt 15.titling fulcrum16.pedal

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The entire prototype is of 120cmX 90cm X 50cm dimension. The load of the backrest is distributed close to the axis of X frames for preventing back fall during reclining. The battery housing is provided at the rear side of seat support. The switches for lifting is provided in the armrest to enable the patient to operate comfortably.

Fig 9., Developed Prototype

VI. CONCLUSION

According to the tests conducted, the smart wheelchair has a capacity of reclining the chair by using automated rotor-shaft system, height adjustment for lifting the chair by using automated crank or screw and using lever mechanism for flexure armrest and we included the wheel breaking system for break the wheels while patients move from wheelchair to bed without any movements or shaking of wheels. The scissor lift mechanism is coupled with DC motors for effortless operation. The design consists of seat, foot rests, wheels at front and rear, armrest, support, frames, motor, lifting arrangements. The wheels are chosen in such a way that it have more stabilityandless chance of falling by patient from the seat of the wheelchair while reclining, tilting or lifting mechanisms. However, the model can be automated by using motors and adding features like braking control, reclining, tilting, etc., a considerable amount of work has been already done by researchers in the field of smart wheelchairs but small amount of attention has given to the design of wheelchair. Design of smart wheelchair is a fruitful wheelchair research part for many years has to come. It offers an opportunity to develop new user input methods. The upcoming development of wheelchair provides enhanced mobility for the elderly person and disabled people who have very restricted limb movements.Hence the appropriate design of any wheelchair gives maximum independency to the user.

VII. FUTURE SCOPE

The wheelchair available in market is either powered manually or using DC motors but none of the category have the functionality to aid the patient during shifting to and from the bed. So the designed wheelchair is advanced in design when compared to existing ones. The frame weight can be reduced by using high strength, lightweight materials such as composites and carbon fibres.Thedesign can be modified for better maintenance, reduced manufacturing cost, compact size, light weight and efficient power consumption.

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