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Electric Wheelchair for Physically Challenged

P. Swapna [1], Dr. B. Sharmila[2], Y. Dharshan[3]

[1] PG Scholar, Dept. of Control and Instrumentation Engineering, swapnashakthi12@gmail.com
[2] Professor, Dept. of Electronics and Instrumentation Engineering, sharmila.rajesh@srec.ac.in
[3]Assistant Professor, Dept. of Electronics and Instrumentation Engineering, dharshan.y@srec.ac.in
Sri Ramakrishna Engineering College, Tamilnadu, India

Abstract - *Mobility of the Physically Challenged people or crippled people is a great concern of the society. This Project focuses on designing a mobility aid for the physically challenged people to travel from one place to another. Joystick controller based mobility aid wheelchair has been designed for the all possible direction of movements like left, right, straight and back. Moreover the DC geared motors are used for the movement of the wheels for the purpose of lower speed movement of chair which will be convenient for the physically challenged. As the wheelchair has been named as electric / powered wheelchair, this project utilizes the power from the lead acid batteries which are rechargeable, harmless, and weightless compared to others available. This work also concentrates on integration of GPS and GSM system for localization task and also a mobile application with the help of MIT application developer has been developed for the convenience of the care taker in order to know the position of the person in wheelchair through Google maps. The proposed wheelchair system has the idea to run both in indoor and outdoor environments. Moreover the wheelchair has been designed to convert as a stretcher and semi stretcher which will make the physical challenged people to feel better during relaxation and night times. This has been brought to live with the concept of motorized scissor jack mechanism for the change of wheelchair positions.*

Key Words: **Electric wheelchair, Joystick controller, DC motors, Rechargeable batteries, Motorised Scissor Jack, Stretcher, GPS/GSM.**

1.INTRODUCTION

A wheelchair is a wheeled mobility device in which the user sits. The device is propelled either manually or via various automated systems. Wheelchairs are used by people for whom walking is difficult or impossible due to illness, injury, or disability. People walking disability often need to use a wheel bench. Wheelchairs are often variations on this basic design, but there are many types of wheelchairs, and they are often highly customized for the individual user's needs. The seat size (width and depth), seat-to-floor height, footrests/leg rests, front caster outriggers, adjustable backrests, controls, and many other features can be customized on, or added to, many basic models, while some users, often those with specialized needs, may have wheelchairs custom-built. This paper focuses on the emerging trend of electric wheelchair. The electric-powered wheelchair was invented by George Klein who worked for the National Research Council of Canada, to assist injured veterans during World War II. Three general styles of electric powered chairs exist: rear, center, front wheel driven or four wheels driven. Each style has particular handling characteristics. Electric powered chairs are also divided by seat type; some models resemble manual chairs, with a sling-style seat and frame, whereas others have 'captain's chair' seating like that of an automobile.

Electric powered chairs are designed for indoor use, outdoor use, or even both. They are generally prescribed for persons who have difficulty in using a manual chair due to arm, hand, shoulder or more general disabling conditions, and do not have the leg strength to drive a manual chair with their foot, which is not generally recommended by most Health Professionals. They may also be issued to those with cardiovascular conditions. EPWs can offer various powered functions such as tilt, recline, leg elevation, seat elevation, and others useful or necessary to health and function. Electric powered chairs use electric motors to move the wheels. They are usually powered by 4 or 5 amp deep-cycle rechargeable batteries, similar to those used to power outboard boat engines. These are available in wet or dry options; currently dry cell batteries are more popular. Many EPWs carry an on-board charger which can be plugged into a standard wall outlet; older or more portable models may have a separate charger unit.

2. NEED AND THE CONCEPT BEHIND ELECTRIC WHEELCHAIR

Power wheelchairs are used predominantly by people with both lower and upper extremity impairment resulting from cerebral palsy, high-level spinal cord injury, or muscular dystrophy. The propulsion system of powered wheelchairs typically consists of a pair of motors, one for each drive wheel, and a drive train consisting of gears, belts that couples the motor's shaft to the wheel shaft. Most wheelchairs uses the permanent magnet DC motors (PM motors), with two 12V lead acid batteries providing a 24 V supply. PM motors have a linear torque-speed characteristic making them easy to control.

A DC-DC converter drives each motor with a high frequency, square wave, pulse train that turn the motors on and off. Speed and torque generated by each motor is controlled by modulating the pulse width. Solid state relays are used to switch supply voltage polarity to change the driving direction of DC motors.

Wheelchairs have both three- and four-wheel models using direct or indirect drive systems (belt/chain). Most wheelchair are rear wheel drive for increasing the traction while the front wheel drive systems are lighter and they may result in difficult traction maintaining on inclination or rough terrains. No load, PM motors can provide an efficiency of about 70%. Under loaded condition, typically for power wheelchairs, these motors attain about 45% efficient. The wheelchair's controller module takes the positional information from the joystick and converts into power signals to the PM motors. Control modules are microprocessor based and have many adjustable parameters according to the user needs.

The drive train is a mechanical system that transfers rotational power from the propulsion motor to the wheels shaft. There are two types of drive trains 1) direct transfer and 2) indirect transfer. In a direct drive transfer system, the motor shaft is directly connected to the wheel shaft (through gears for instance). Direct drive transfer requires a low speed, high torque motor which will be mechanically efficient. However, the gears in the direct drive system are prone to wear and/or breakage that make them expensive to repair or replace.

For an indirect drive transfer system, the motor is coupled to the drive wheel shaft through a system of gear train and flexible machine element (belts or chains). The gear train and belt typically serve to reduce the motor speed while proportionately increasing motor torque. They also act as a "shock absorber" when the drive wheels are stuck or under heavy load. Excessive stress on the system can cause an increase in noise and misalignment of the drive system. However, realignment is easily done and the cost of maintaining the system is relatively low if adjustments are made on a regular basis.

The torque delivered by motors and drive trains, places constraints on the environments that a power wheelchair user can access, work or recreate in. The speed and efficiency of motors and drive trains, constrains the travel distance and time between battery recharge. The size and configuration of the battery, motors and drive trains constrains the physical dimensions of the wheelchair's power base and impacts a user's ability to access home, work, recreational and educational environments. Seat height impacts a users access to desks and tables. Vans generally require extensive modification to accommodate the seated height of a power wheelchair user.

3. BLOCK DIAGRAM OF THE PROPOSED ELECTRIC WHEELCHAIR

The block diagram of the proposed electric wheelchair is shown in the Figure 1. The block diagram describes the flow of proposed electric wheelchair working. The flow starts with the rechargeable battery which is the heart of the system provides power to the whole assembly. It is then followed by the wheelchair controller come joystick module which receives the supply from battery in order to start up with the movement of wheelchair directions choice given by the person in wheelchair with the help of joystick mounted on the arm rest assembly. The joystick receives the command from the user which in turn given to the wheelchair controller for the control action according to the user choice which is already been programmed in the controller. Once the control action has been taken, the control signal is directed towards the DC geared left and right motors for the movement of wheelchair in respective directions.

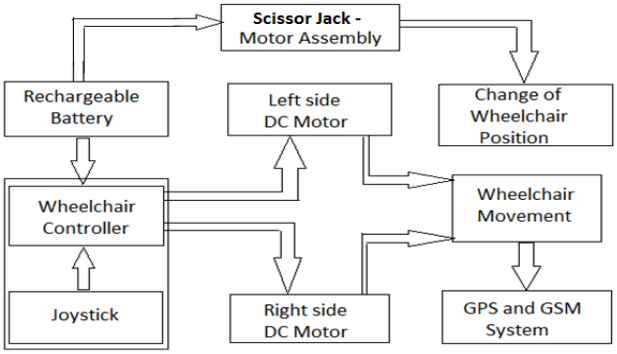

Fig -1 Block diagram of proposed electric wheelchair

The flow of work then passes on to the wheelchair position changing i.e as it has been already mentioned that the proposed electric wheelchair will be converted to semi and complete stretcher positions. This action has been brought to live with the scissor jack – motor assembly which receives the power from rechargeable battery in order to make the motor to run which in turn make the scissor jack to work i.e to lift or drop the wheelchair plats. This can be made possible with the help of limit switches. A limit switch is an electromechanical device that consists 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.

Next the GPS and GSM modules play a role for identifying the position of the wheelchair. This idea will be very useful to the person who is taking care of the physically challenged. The work is done with the help of arduino which receives the power from battery with voltage regulator because the arduino, GPS and GSM modules require less power compared to the motors and other assemblies. Also a

mobile application has been created in order to view the disabled position through the google maps.

4. HARDWARE SPECIFICATIONS

As for concern the specifications are the important part in this work. The DC motors are the heart of the system for the purpose of wheelchair propulsion. They have been chosen as DC geared motor of 24 V, 120 rpm. The batteries have chosen as lead acid rechargeable batteries of 12V, 17 Ah. The Joystick controller which is joystick position based wheelchair controller of 24 V supply. The material used for the construction of wheelchair is mild steel whose properties well suit the environmental and other conditions. The Motorised Scissor Jack which is utilized for the conversion of wheelchair into stretcher is of two types one is 1000Kg and the other is 700 Kg capacity of lifting, the motors attached to the jack are DC motor of 10 Amps and 12V. The GPS/GSM module used is of model SIM808A for the purpose of tracking the wheelchair. Arduino UNO board has been used for implementing the same.

5. FABRICATING AND ASSEMBLING OF WHEELCHAIR

As the proposed wheelchair should withstand for all the circumstance and adopt for all the environments, should withstand for all stress and strains. To meet all these requirements, the basement of the wheelchair should be very strong. So it is necessary to focus on the material to be used for the formation of wheelchair. The material selected must possess the necessary properties for the proposed application. The material selected for the particular application is mild steel. The various requirements to be satisfied can be weight, surface finish, rigidity, ability to withstand environmental attack from chemicals, service life, reliability etc. The following four types of principle properties of materials decisively affect their selection Physical, Mechanical, From manufacturing point of view, Chemicals.

The various physical properties concerned are melting point, thermal conductivity, specific heat, coefficient of thermal expansion, specific gravity, electrical conductivity, magnetic purposes etc. The various Mechanical properties Concerned are strength in tensile, Compressive shear, bending, tensional and buckling load, fatigue resistance, impact resistance, elastics limit, endurance limit, and modulus of elasticity, hardness, wear resistance and sliding properties. The various properties concerned from the manufacturing point of view are Cast ability, Weld ability, Surface properties, Shrinkage, Deep drawing etc. From considering all the factors mentioned above, the material chosen for the wheelchair fabrication is mild steel flat rod of gauge 1.25 inch.

Assembling of wheelchair plays a major role in this proposal. It's very important to note that the assembling should be perfect so that the working of wheelchair will lost long. It's a known fact that joystick cum wheelchair controller module is the heart of the system. The following discussion shows the connection of joystick controller with battery and motor to form a electric wheelchair. The overall flow diagram of electric wheelchair is shown in the Figure 2.

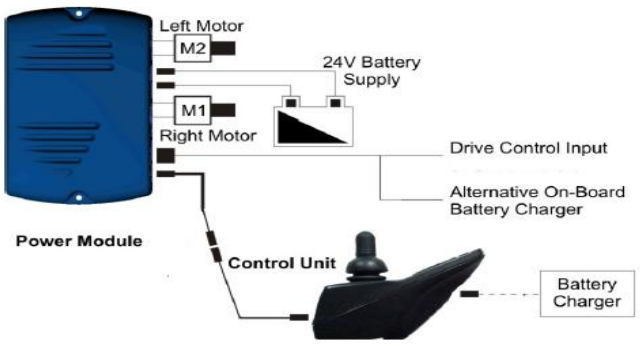

Fig -2 Flow diagram of electric wheelchair

The power module is the heart of the system. It contains connection provisions for all other modules like battery, motor, joystick, control input etc.,. By following the flow shown above the wheelchair can be easily made and tested.

6. CONVERSION OF WHEELCHAIR INTO STRETCHER

Jack is a mechanical device used to lift heavy loads. A mechanical jack employs a square thread for lifting heavy equipment. The most common form is a car jack, floor jack or garage jack which lifts weights so that needed task can be performed. Mechanical jacks are usually rated for a maximum lifting capacity of 1.5 tons to 3 tons. Scissor jacks are mechanical devices and have been in use since 1930s. A scissor jack is a device constructed with a cross-hatch mechanism, much like a scissor, to lift up a vehicle for repair. It typically works in a vertical manner. The jack opens and folds closed, applying pressure to the bottom supports along the crossed pattern to move the lift. When closed, they have a diamond shape. Scissor jacks are simple mechanisms used to handle large loads over short distances. The power screw design of a common scissor jack reduces the amount of force required by the user to drive the mechanism.

Motorised Scissor Jack play a vital role in the proposed wheelchair. It has already been mentioned that the proposed work focuses on the idea of converting the wheelchair into the semi cum complete stretcher model. It has been made possible through the concept of motorised scissor jack. Here the Jack has been fitted at the back plate as well as in the leg plate in order to lift and drop the same according to the user choice and convenient. As the design prototype discussed in chapter 2 has been brought to live

here. Two types of jack has been used which differ in their capability to lift weights i.e 1000Kg and 700Kg capability Jack has been used here. 1000Kg jack has been used for lifting the whole back body weight and 700 Kg jack has been used for lifting the legs. As the weight of legs are less when compare to the back body weight, less capacity 700Kg jack has been used here. As the 12V, 10 Amps motor has been fitted to these jack, once it get energised from the battery, the Scissor shaped jack starts to expand and contract its 'Z' shape through the gear mechanism in order to convert the rotational motion of motor into the mechanical motion of levers and screw threads for the purpose of lifting the weights of wheelchair.

7. RESULT ANALYSIS

As discussed earlier the wheelchair has been constructed with the material of mild steel. The basement of wheelchair is provided in order to balance the weight of the patient and other components assembled. The length of the basement provided is of 3 feet. It covers the half length of the total wheelchair length. The Figure 3 shows the full top view of the wheelchair with three plates

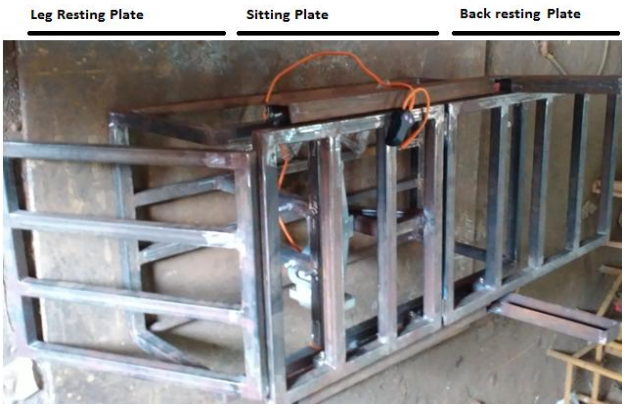

Fig -3 Top view of wheelchair at initial stage

The total length of the wheelchair is 6 feet. It contains three steel plates, sitting, leg resting and back resting plates with the basement at the bottom. The next Figure 4 shows the motorised jack fitted at the back side of wheelchair for the stretcher conversion.

Fig -4 Motorised scissor jack attached at the back of wheelchair

A doubt arises at the time of conversion of wheelchair to stretcher mode, i.e when the wheelchair is in chair mode, the jack will be in expanded condition, when the user choice is to switch to stretcher mode, the back resting plate should be dropped down and the leg resting plate should be raised up with the control of corresponding jacks provided under the wheelchairs. When the back resting plate is dropped down, with the lack of balance the wheelchair / person may slip down. In order to avoid this, a concept called "Saddle wheels" has been fixed at the side bars of the wheelchair as shown in the Figure 5 which will move the sitting plate in front to certain position which in turn the plate gets seated in a balanced position so that the weight is balanced. The heart of the propulsion system is the battery and the motor which are to be fitted at the basement as shown in the Figure 6. The whole system is tested by driving the chair with the help of joystick position.

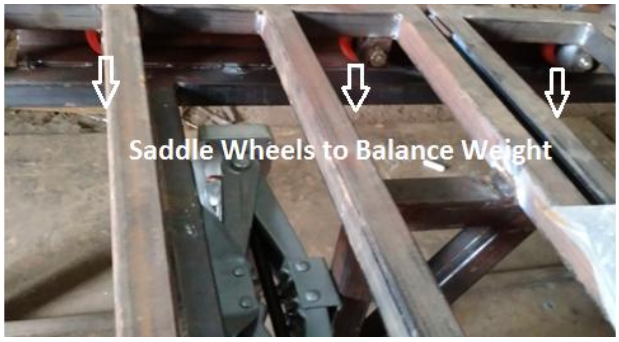

Fig -5 Saddle wheels provided at the side bars of wheelchair

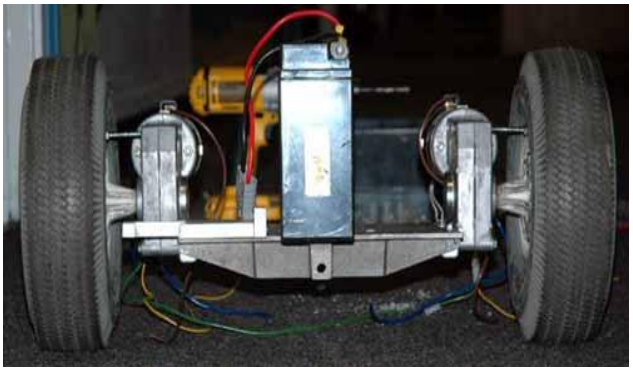

Fig -6 Base of the wheelchair with motor and battery assembled

As the person who is taking care of the physically disabled give their request to know the current location of wheelchair and ensure whether disabled is in safe premise. A mobile application has also been created for this task to happen in a successful manner. The screen shots of the mobile application and its results are shown in the Figure 7.

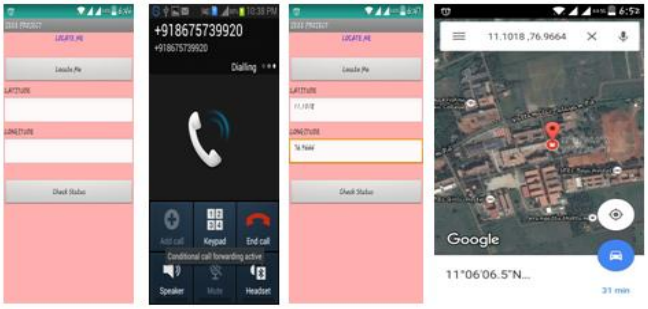

Fig -7 Mobile application created and it's result

The application has been developed with the help of MIT application developer which has been discussed in chapter 3. It has been named as 'Locate me' and some bars have been developed for the user interface with the arduino. On seeing the application, when the user touch the 'check status' bar, it automatically makes a call to the SIM in the GSM, on receiving a call, the arduino cuts the call in 5 seconds and it triggers the GPS in order to get the location information like latitude and longitude, on separating the information mentioned above, arduino will send the same information to the mobile number from which it had received a call through the GSM. The application has been designed to receive the latitude and longitude in the bars given. Then if the 'locate me' bar is touched, it automatically opens the google map to locate the given latitude and longitude information so the care taker can ensure that the disabled is in safe zone.

8. CONCLUSION

The project carried out here will make an impressing task in hospitals and homes. This project has also reduced the cost involved in the concern. The production of this multipurpose wheelchair will be helpful in hospitals to improve the comfort of patient during their required movement such as to scan centre, during night sleep etc. It is expected that production of low cost stretcher cum wheelchairs for patient handling will relive patient and nursing staff from a lots of physical discomfort. The extension of the project may use solar panel for the power supply. Here the solar energy will be given to the dc to dc converter through the rechargeable battery to the embedded controller and the motor system which will be useful in the idea of saving energy. Some intelligent sensors can also be used i.e a sensor that sensors our brain thinking, that automatically grabs the direction we need to move. The path required to travel can also be guided with the help of google map through voice controller. These developments would make the proposed work a complete power pack application.

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