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DETACHABLE E-DRIVE MODULE BASED POWER WHEELCHAIR

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Abstract: A good number of peoples in this universe are physical challenged, among them many of them at worst needs the assistance of a wheelchair. Every single individual in this world wants to carry on with a typical human life. However, mishaps, maladies, senior ship make their longing into incapacity. Normal wheelchairs have demonstrated to be good for the impaired however it has just dole out the motivation behind individuals with irrelevant incapacities. An individual experiencing halfway tetraplegia or sclerosis feels incredibly hard to makeover the seat, even inside the limitations of a house. Such an individual needs other help even to do his/her ordinary occupations. An elective decision is the utility of an electric wheelchair. Though latest electronic wheelchair technology helps, it's still not enough to make a handicapped user completely self-reliable. Especially for people with halfway tetraplegia and paraplegia, who form the major part of handicapped occupational population. An idea of "Detachable E-drive module-based power wheelchair" is proposed which offers this population an economical traversable model of wheelchair that enhances their capacities to travel distant locations with faster speed. Proposed model offers flexible use of wheelchair, extending its application beyond the limitations of home.

Index Terms **– Detachable E-drive, Power wheelchair, BLDC hub motor, Flexible & Cost-effective model**.

I. INTRODUCTION

In modern days, wheelchair is one of the most commonly used assistive device to promote mobility and enhance quality of life for people who have difficulties in walking (e.g. a person with spinal cord injuries resulting in quadriplegia or paraplegia, muscular dystrophy etc.). Wheelchair mobility opens up opportunities for wheelchair users to study, work, engage in social activities and access services. It also benefits the physical health and quality of life of the user by reducing common problems such as pressure sores, progression of deformities and improving respiration and digestion. Wheelchairs should be available in at least a small range of sizes and allow some basic adjustments. Wheelchair designs vary to enable users to safely and effectively use their wheelchair in the environment in which they live and work. The most important details in this text are the four general styles of powerchair drive systems that exist in India: front, Centre or rear wheel drive and all-wheel drive. Powerchairs are generally four-wheeled or six-wheeled and non-folding, but some folding designs exist and other designs may have some ability to partially dismantle for transit. The electric motor of powerchairs are usually powered by 12 to 80 ampere hour 12 volt rechargeable deep-cycle batteries, which are used in pairs to give the chair enough power to last at least one day between charges. Powerchairs are designed for indoor, outdoor or indoor/outdoor use. Indoor powerchairs are narrow and short, with simple controls and smoother tires. Indoor/outdoor powerchairs are as small as possible, with grippy tires and a kerb-climber. Access adaptations such as wheelchair spaces and lifts are often designed around a manual wheelchair, but powerchairs often exceed the size and weight limits of manual wheelchairs. New designs and innovations are being developed to overcome these issues. A concept of low-priced detachable E-drive module-based power wheelchair is introduced, which is flexible and makes the occupational handicapped population self-reliable.

II. LITERATURE REVIEW

In the literature, smart electric wheelchairs with both manual and automatic mode of operation are suggested for people with paralysis of the lower half of the body, that is people suffering from either paraplegia or tetraplegia. Researchers between the years of 1956 and 1999, created a wheelchair that could be controlled using joysticks and other switch-based controls [1]. Since using a joystick only needed a little amount of force, its utilization was constrained. The ideas of S. Padmapriya et al., who used Zigbee application with hand-glove control in 2014, overcame this constraint [2]. In the years 2012 and 2014, S.V. Anusha et al. and Dr. Shaik Meeravali et al. combined bend sensors with a hand glove control process employing Micro-electromechanical systems (MEMS) [3]. Later, a motorized wheelchair for elderly and disabled people was introduced with an Arduino (At mega 328) and voice recognition (Android phone) based control mechanism. In this case, in order to facilitate communication by hand motions and provide five physical movements (therapy treatment) for the patient, "flex-sensors" were conveniently incorporated into the hand glove of a severely crippled patient [4].

The literature has put forth a number of wheelchair models to increase the capabilities of the physically challenged, but these still fall short of making the working population with impairments completely self-reliable while being cost-effective.

III. PROPOSED MODEL AND SYSTEM ANAYLSIS

Travelling becomes a challenge as most of them would need help for another person. For those who are on wheelchairs, it becomes a bit more intimidating as they have to carry the wheelchair with them all the time. Many taxi drivers may not even allow the person to get into the cab with a wheelchair. To solve this problem, wheelchair that can be converted into a bike that can be used on the road. The wheelchair scooter gives him more freedom and he can freely roam around like anyone else. The motorized wheelchair has two parts.

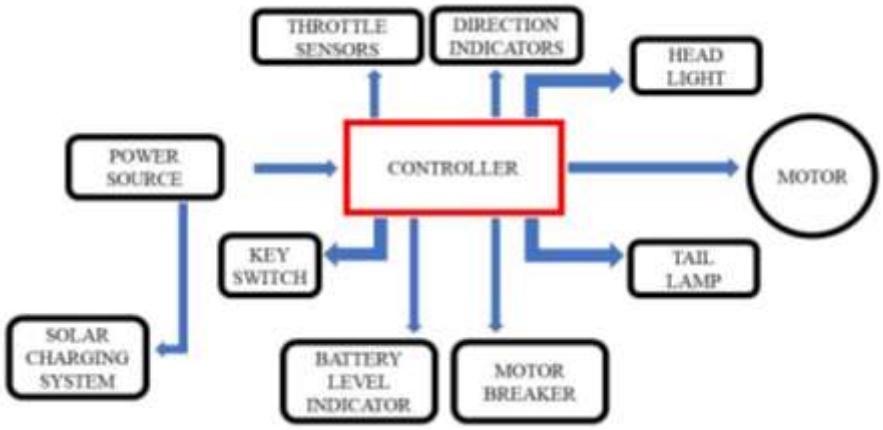

Fig 1: Block diagram

There is a wheelchair and the other part is the handle bar with accelerator, battery pack, motor and other features. When user is at home, they can simply use the wheelchair like any other differently abled person but, things change when he has to go out. They can simply connect his wheelchair to the handle part and simply drive it around like a scooter or a bike. In order to attach the wheelchair to the motorized part, user can simply align the wheelchair in front of the other part. There are couple of clamps that fit perfectly to the wheelchair and lift the small wheels at the front of the wheelchair. Once the wheelchair is on the clamp, there are set of additional locks to ensure that the wheelchair does not fall off or detach while riding on the road. Once the wheelchair is converted into a scooter, he can unlock the brakes on the wheelchair and turn the key on. It uses a hub motor to move the scooter around. There is a detachable battery at the front that can be recharged. The handle has bar-end lights and ORVMs to keep a track of the traffic. There is a digital instrument cluster that will show the speed, trip meter and odometer. There are multiple riding modes which control the speed. The maximum speed of this scooter is 25 kmph and user does not need a driving license for this. The motor-powered attachment, converts the wheelchair into a safe, road-worthy vehicle that can navigate any kind of terrain that we may normally encounter — drive through unpaved streets or climb a steep gradient. And do this comfortably as it has suspensions to absorb the shocks. It is powered by a Lithium-Ion Battery and can travel up to 25 km per charge. Some salient features of the proposed model are Universal wheelchair attachment, quick and easy attachment design, Safety anti-tippers, 4 hours recharge, digital dashboard, rugged built chassis. It empowers wheelchair users with a convenient, safe and low-cost mode of outdoor mobility when compared to cars, auto- rickshaws or modified scooters.

IV. METHODOLOGY

A wheelchair is appropriate when it meets the individual's needs and environmental condition, provides proper fit and postural support based on sound biomechanical principles, is safe and durable, is available and can be accessed, maintained and sustained in the country at the most economical and affordable price. A normal electric wheel chair provides several benefits from normal wheelchair such as they do the work for you, they are ideal for going long distances, they are ideal if you no longer have the strength to use a manual wheelchair, they can use used on many surfaces, they offer customable options to improve your comfort level but also there are several drawbacks for this wheel chair. That includes they can be cost prohibitive, they are significantly heavier than manual wheelchairs, they are difficult to transport – you may require a customized vehicle, you'll need to be conscious of power usage, they require regular maintenance, learning controls can be a learning curve. By considering as solution to overcome these drawbacks, an innovative model of a *detachable E drive module based electric wheel chair* is proposed. This proposal contains a detachable module that is powered by a 36v 350w BLDC hub motor connected to controller system with an electrical power source of 36v Lithium Ion battery. The module is designed as a simple bike like structure to acquire easy stability and controlling. Easy understandable controlling features of this proposed model stands different from normal electric wheelchairs. The advantage factor of the proposed model is that it can be connected to any wheelchair i.e. it is a universally connectable module. A clamp slot can be provided with the module to connect the module to any type to wheelchair. The wheelchair that is detached from the module can be further used as normal mechanical wheelchair. There is no issue in weight, dimension, usability etc. There is no need of depending of any other transportation measures. This proposed model provides easy transportation and provides a manual speed of 30 km/h. This model helps in solving a common issue of battery level indication that this model provides a battery level indicator that indicates exact battery level. This model provides a better cost-efficient proposal that fulfils all the emerged difficulties felt in currently used electric wheelchairs. Fig 7 shows the final outlook of the above-mentioned model. The drawbacks of the currently used electric wheelchair system will be fulfilled by the evolution of the proposed model.

V. DESIGN

Fig 2 is a pictorial representation of the designed model, which has the detachable module attached to the wheelchair for the purpose of moving over distances.

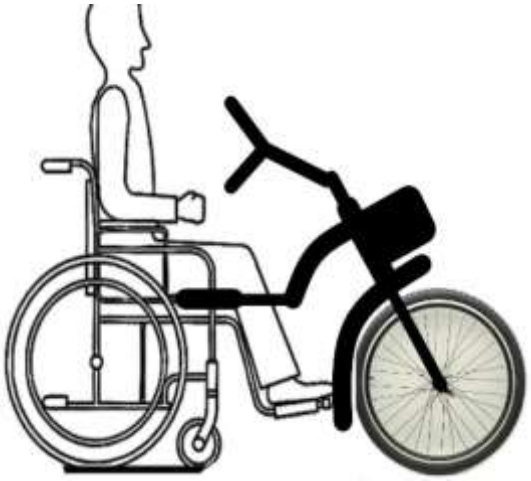

Fig 2 – Model design

Fig 3 – Wheelchair-power module Attachment lock

VI. HARDWARE REQUIREMENTS

Loading capacity and maximum speed are the significant factors taken into concern while selecting a motor. Motor capacity calculation depends upon vehicle dynamics. For a vehicle to move, as per vehicle dynamics 3 forces have to be overcome,

F_{roll}, $F_{gradient}$ and $F_{aerodynamic}$.

$$F_{total} = F_{roll} + F_{gradient} + F_{aerodynamic} ; \quad (1)$$

$$F_{roll} = C_r .m.a ; \quad (2)$$

$$F_{gradient} = m.a.\sin\alpha \ m ; \quad (3)$$

$$F_{aerodynamic} = 0.5.\delta.V_2.C_A.A_f \quad (4)$$

For loading capacity = 120 kg and maximum speed = 25 km/hr, minimum requirement is 250 W motor. Since weight of front module should be minimum with motor taking minimum space being cost effective a BLDC hub motor of rating 36 V 350 W is chosen as it can be incorporated within the rim of a wheel, thus also reducing space requirements.

Fig 4 – BLDC hub motor kit

Fig 5 – Battery and charger set

For battery, watt hour and Ampere hour of the battery is to be determined, as these are the terms commercially available to buy the battery.

$$Whr = V \times Ahr \quad (5)$$

To run a 350W motor for 1hr, 36 V,12 Ah Li ion battery is required.

A controller is highly recommended in the module for control and coordination of brakes, headlights etc. and most importantly to control or maintain the speed of the motor in the module. Since 350W, 36V motor is chosen, thus a 36V/48V, 350W controller suitable for the motor is chosen that has connection spaces for charging interface, throttle wire, brake wire, brake light wire etc.

Suitable Battery charger, Throttle, Brake lever, Indicator light, headlight etc. are some other accessories required as part of the hardware.

Sl no	Items	Specifications
1	Motor used	BLDC hub motor
2	Motor capacity	36V 350W
3	Battery Capacity	36V 12Ah
4	Loading capacity	120 kg
5	Charging Time	4-6 hrs
6	Breaking system	Disk breaking system
7	Battery type	Lithium-ion battery

Table 1 : Parameter specification

VII. COMPARISON OF PROPOSED SYSTEM AND EXISTING SYSTEM

The proposed system is less expensive compared to automated electronic wheelchairs. Existing system does not make user completely self reliable to travel and offers no privilege to the people with Halfway tetraplegia, Paraplegia, who form the highest portion of the occupational handicapped population. Whereas, the proposed system offers all these benefits and also increases flexibility of use. Furthermore it offers increased speed of motion (25-30 Km/hour) and can be used to travel (30-35 Km) distance at a single charge.

EXISTING SYSTEM	PROPOSED SYSTEM
Expensive (INR 1.2 Lakh (approx.))	Low- priced (INR 30K (approx.))
Doesn't make user completely self reliable	Makes user completely self reliable
Not focused on majority occupational handicapped section	Focused on majority occupational handicapped section
Not flexible	Flexible
8-10 km/hr speed	20-25 km/hr speed

Table 2 - Proposed system V/S Existing system

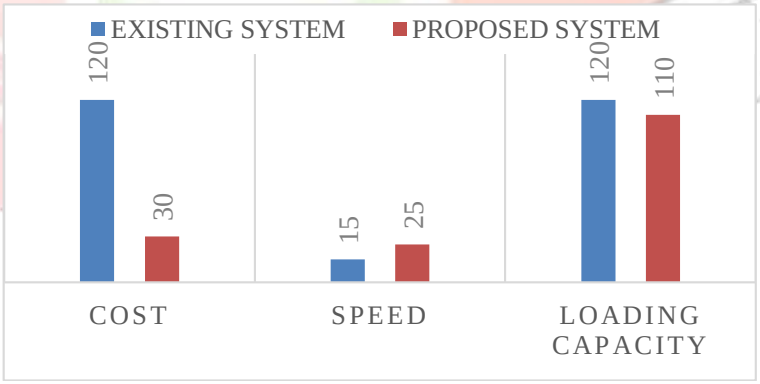

Fig 6 – Existing system v/s proposed system comparison graph

VIII. CONCLUSION

The proposed multifunctional smart wheel chair has been controlled by various sensors for the comfort of handicapped patients. It provides long distance travel to the disabled persons who have difficulty in moving. The ability to adjust or customize a wheelchair to meet the user's physical needs will vary, depending on the type of wheelchair. Wheelchairs should be available in at least a small range of sizes and allow some basic adjustments. A three-wheeled wheelchair would be well suited for outdoor use, while a short wheelbase but large castor wheels would be suitable for indoor use.

Fig 7 – Completed structure of Detachable module.

IX. FUTURE SCOPE

Our research work has been devoted to the development of smart system. So, we can still improve our system by empowering the sensors, LCD device, switches, motors etc. for the benefit of handicapped patients. A VLSI Based Medulla Spinalis Using Analog Comparator, Interference Detection and Mitigation of Over crowed Cells in Multiple Networking Environment, Arduino Powered Obstacles Avoidance for Visually Impaired Person these all features can be implement and improve the efficiency of the wheelchair. It will be useful for blind people also and we can add solar panels also to charge the battery. Since our system is flexible (user friendly) and highly reliable, in future our system can be upgraded to the requirement of any patient by incorporating face, brain, body temperature, sensing equipment's. Also therapy base improvement can be implemented to facilitate progressively logical treatment medicines, for example, transcutaneous electrical nerve incitement, arm development utilizing mechanical hand. The futuristic view includes implementing of solar energy cells in the proposed model as a power source.

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