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DESIGN OF ECONOMIC AND AMBULATORY SMART WHEELCHAIR

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Abstract: Independent transport and mobility in the micro miles is the need of the hour for every individual in every age group. A huge technological upgrade is seen where such transport mobility solutions are available ranging from skates to bicycles but a little is being done for the physically challenged or differently-abled. This project is based on the fundamental principle to develop an exclusive set of features that could be added to the Electric wheelchair whilst reducing the overall cost of the wheelchair to more than 3 times.

Keywords: *- Smart wheelchair, hub motor, DIY lithium ion battery, solar charging, automatic detachable seat, remote mobile control application*

I INTRODUCTION

In a developing society like India there are tons of new technologies coming in for the micro mile transportation or known as the last mile transportation. Though all these technologies are targeted towards the majority of the population, which is physically fit and doesn't have any problems in adapting to these new technologies. According to the census of 2011 (data updated in 2016) with a population of 121 Cr 2.21% of the people are differently-abled, which counts to a 2.68Cr population, which is projected to increase by at least 20% until 2020. Almost 70-80% of the differently-abled cannot afford a standard Electric wheelchair to fulfil their basic transport needs. The cost of an average Electric wheelchair starts from 60,000 in India which may go up to 2,00,000 if a long mile range and other features are required. The fundamental principle of the project is to develop an electric smart wheelchair with exclusive features embedded in it with an affordable price range of 20,000-25,000.

II OBJECTIVES

The aim of the project is to develop a smart wheelchair which:

1. Is foldable and sleek in design.
2. Has an automated detachable seat for excretory purposes.
3. Has a smart mobile application for remote control of the wheelchair.
4. Has a long mile range up to 40km
5. Has a solar panel for shading and charging the battery.
6. Has a different speed range for indoor and outdoor operation.
7. Has a sound and light assistance for crowded area driving.
8. Offers all this at an affordable price.

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III SIGNAL FLOW DIAGRAM

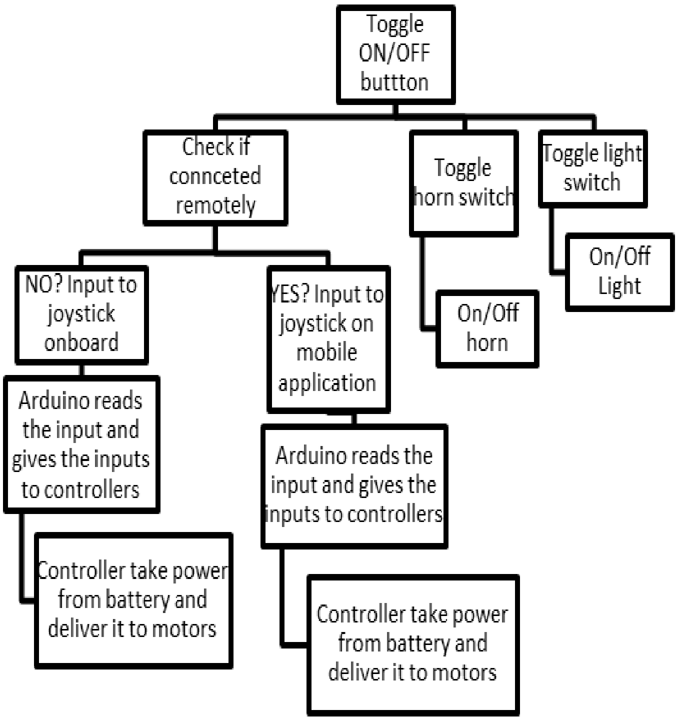

Figure 1: Signal Flow Diagram

IV EQUIPMENT AND TECHNIQUES

For the project to succeed both Electrical and electronic equipment are used.

BLDC Hub motor: The hub motor with planetary gear set in built helps achieving two objectives, which are sleek design and more torque compared to other BLDC motor. A 48V 350W BLDC hub motor is used. A BLDC hub motor has a better power to weight ratio compared to its alternatives which are not designed as a hub, which helps us reduce the overall weight of the wheelchair.

DIY lithium ion battery: The Electric wheelchairs available in market are using batteries which are not custom made to adapt to the design of the wheelchair. They use a traditional Lead acid battery typically used in cars, which is at lower voltages and its energy density is very low about 35-40 Wh/Kg. Compared to that a DIY custom made lithium ion battery helps us design it to adapt and merge into our design also the energy density is about 8 times that of lead acid about 200-250 Wh/Kg. We can also achieve higher voltage of around 36-48V which will reduce the use of electronic choppers which were used in the traditional model.

Arduino: To interface our joystick with the controllers and also our remote control mobile application with the controllers we used an Arduino Uno.

Dual Axis Joystick: A dual axis joystick is basically a potential divider which has two resistance windings connected to the arm of the joystick which when moved over will change the potential across the pins which can be read by the Arduino for understanding the user's expectation for movement.

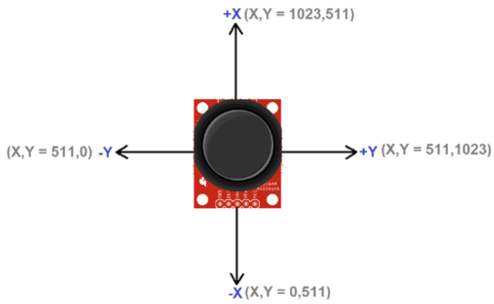

Figure 2: Joystick graphical digital output details

V SPECIAL FEATURE

Foldable and sleek design: The hub motor and wheel assembly helps us to make the wheelchair foldable as the area beneath the seat is free of any housing for motor or battery

Automated detachable seat: Every differently user has a huge struggle in changing seats between the wheelchair and every other seat for different operation. A research shows that switching between seats could lead to some major injuries as the user is already not physically fit for such movements. An automatic detachable seat with an inbuilt hole for excretory purpose will allow the user to move the wheelchair over the washroom seat and not switch between seats.

Long mile range: Up to 9 times of energy density in lithium ion batteries compared to lead acid batteries and a better power to weight ratio of the BLDC hub motor promises a better mile range which is really important in terms of charging cycles of the wheelchair.

Solar panel: A solar panel which could be controlled over a single axis can be used as a multi-purpose roof for shading the user and also charging the battery in outdoor application, it is also detachable so the user whilst indoor can move around freely mobile application for remote control: An android mobile application which is password protected and uses a Bluetooth connection to communicate and control the electric wheelchair remotely.

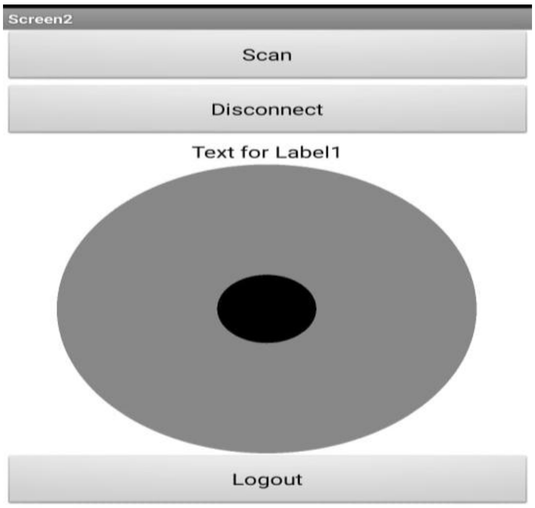

Figure 3: Mobile application interface

- Different speed range: In indoors the speed is limited to a 5kmph top speed while for outdoor the speed limit is 10kmph which can be toggled by a single switch
- Sound and light assistance: This offers the user a sense of communication between the wheelchair and the environment as the user can light the headlights move in dark places without any external need. Also the horn allows the user to alarm people in the way of the wheelchair.

VI CALCULATIONS

Max Speed: V=10 Km/h = 2.8m/s

Radius of Wheel: r =0.5m

Force = m*a = 150*2.8m/s / 30sec = 14Nm

Torque = F*r = 14*0.5 = 7Nm

Linear Velocity: V= w*r

2.8m/s = rps*2*(22/7)*1

Rps = 1

Rpm = 60

Max Power: 2*(22/7)*NT/60

Pmax = 2*(22/7)*60*7/60 = 50W

Motor Voltage = 36V

Current drawn at max power = 60/36 = 1.66A

18650 cell voltage = 3.7V

Hence, a 10S4P battery configuration.

VII DESIGN

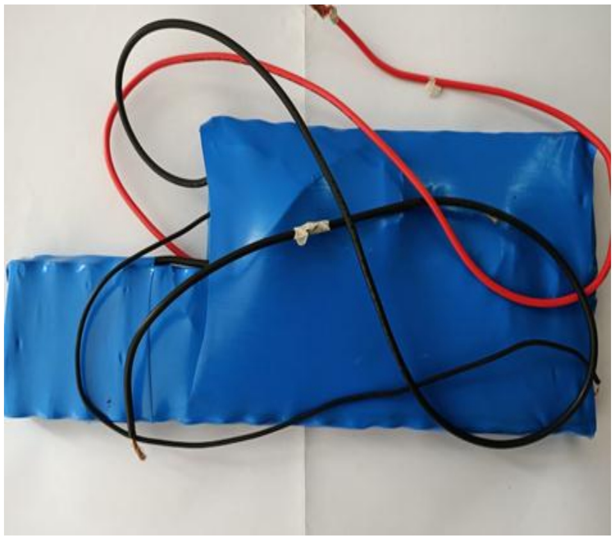

Figure 4: DIY Lithium-ion battery

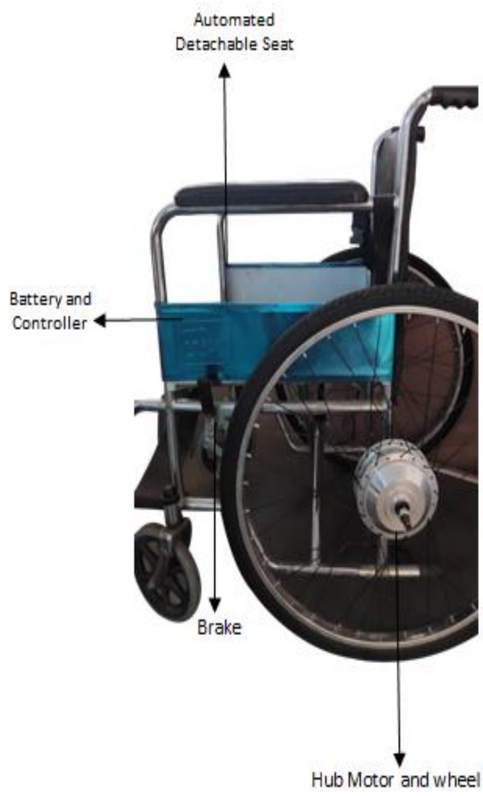

Figure 5: Wheel assembly and other components

VIII COMPARISON

Features	Market wheelchair	Our smart wheelchair
Mile range	20km	40km
Mobile application for remote control	No	Yes
Automated detachable seat	No	Yes
Top speed	7-8kmph	Upto10kmph
Different speed ranges	No	Yes for indoor and outdoor operation
Design	Complicated	Simple
Weight	50-60kg	< 50kg
Overall efficiency	70-75%	>80%

Table1: Market Model and proposed design comparison

IX LIMITATIONS

The major design constraint we had was the wheelchair itself, as we didn't design it ourselves and used a market available wheelchair hence the whole project turned into a modification or retrofitting project. This could be revised in the future models. The components used are not manufactured keeping in mind the wheelchair's design; since we bought those from our local market it is difficult to scale this up to manufactural product at this stage.

X FUTURE SCOPE

The model can be improvised with a quality assured design which can be then scaled for manufacturing. The electronics used is highly underutilized which can be eliminated in further designs to decrease the cost and increase the effective efficiency.

XI CONCLUSION

The idea to build a smart wheelchair at an affordable price is successfully achieved while the exclusive features could be improvised in the further design the project might help the market understand that one of the fundamental role of wheelchair is independent mobility which could be achieved in small acute places as well and at an affordable price.

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