EXPERIMENT ON WORKING MODEL OF ELECTRIC PORTABLE VEHICLE

Prof. Bhavik Soneji[1], Avishkar G. Patel[2], Sarthak D. Patel[3], Rohit R. Panchal[4], Dhruval M. Patel[5]

[1]*Assistant Professor, Dept. of Mechanical Engineering, Indus Institute of Technology and Engineering, Gujarat, India*

[2,3,4,5] *UG-Students, Dept. of Mechanical Engineering, Indus Institute of Technology and Engineering, Gujarat, India*

---***---

Abstract - *Pollution and parking for vehicles is the biggest issue faced by the cities as there is a rise in the automobile market in the last few years. This opens up a requirement of a compact electric vehicle that is portable, light in weight, low cost, environmentally friendly, and easily controllable. This model comprises a platform with two wheels on the front side and one wheel on the backside. The front wheels run with help of a DC motor powered by a lithium-ion battery and the rear wheel is kept to rotate freely. Also, the design of the battery section is kept as a swappable system, so users can easily plug in or plug out for charging purposes.*

***Key Words*: Micromobility, Electric Vehicle, Portable Vehicle, Hoverboard, Segway, E-scooter**

1.INTRODUCTION

In every city parking spaces plays the main role to provide their resident and visitors a place to park their vehicle. but, from the past few years, the problem for parking vehicles rises as more number of vehicles is running in the cities. following the increasing trend in parking space demand, there is a need of smart vehicle which is portable enough and lightweight. Also, it has made to be emission-free as there is a problem of rising pollution in Mega Cities.

With the advancement in science and technology, a new segment of transportation comes into the market called Micro-mobility. It refers to a segment in which a vehicle can operate below 25 kilometers per hour speed limit with a maximum power output of 250watts and driven by its user itself. The devices include in micro-mobility are electric scooter, electric hoverboard, e-bikes, Segway, e-skateboard. These vehicles are battery-operated. However, most of this device is heavy and not much portable for the user to carry with them for day-to-day life. So keeping in mind, we developed a device which is portable lightweight and low cost for the public to use them in everyday life. This device is working on the electric battery so there is no impact of pollution in the city. Moreover, we are trying to make it further low cost, so more public can use it for transport.

1.1 HISTORY

After the increase in demand of the micro-mobility segment, many companies started developing products to fulfill customer requirements. In June 2018 segway introduced its first product in the personal electric transportation category named the Segway Drift W1 [1]. It has already been commercialized, this system has developed has paired of two similar units, where each unit has the dimension of 12.5×10.6×8.7 in (318×269×219 mm). The overall weight of Segway Drift W1 is 7 kg and it has a payload capacity of 10-100 kg. It can provide a run time of 45 min with a battery capacity of 44.4 Watt hours which takes 3 hours for charging. Fig-1 show image of Segway Drift W1.

Fig -1: Segway Drift W1

A similar product has been introduced by the Chinese company Fwheel that also manufactures e-bike under the brand name of DYU. It comprises of four wheels two in front and two on the rear side. the total size of Icarbot is 383.5*310.5*106.3 mm and its weight is 5.5 kg, it can reach a maximum speed of 12 kilometres per hour with a motor giving a power output of 130 watts*2 for motor located on the front. Figure 1 shows the iCarbot which is proposed prototype of our model.

Fig -2: iCarbot

Honda developed the U3-X with technology originally developed for ASIMO the bipedal human-robot project[3]. this U3-X weighs 10kg and can travel up to 6 km/hr. the dimension of u3-X is Length 313 mm (12.3 in)*Width 160 mm (6.3 in)*Height 647 mm (25.47 in). It is run on the most advanced omnidirectional rolling system with control over the human balance. Fig-3 show image of Honda U3-X. Toyota Winglet is made by the Japanese company Toyota[4], which has the following specification: the maximum speed is 6 km per hour, its operating ranges are 4-kilometre, charging time is 1.5 hours and used Lithium-ion battery. Fig-4 show image of Toyota Winglet

Fig -3: Honda U3-X

Fig -4: Toyota Winglet

2. DESIGN AND FABRICATION OF ELECTRIC PORTABLE VEHICLE

2.1 DESIGNING

Current available personal portable vehicles are quite bulky and their dimension is not appropriate for carrying while traveling. Table 1 shows the Details of Commercial Portable Vehicles available in the recent market.so, we have developed a prototype model which overcomes the above problem of portability. Our main consideration for our design development is: (1) It can be used by all age groups in their day-to-day life. (2) It must be small in size to carry with one hand and packed inside a bag pack. (3) It should be also lightweight and easy to operate for the user. Keeping the above points in mind, our Prototype dimensions are as follow: a length of 280 mm, a width of 380mm, and Height of 125mm and total weight is 4.5kg with 120kg payload.

Table -1: Details of Commercial Portable Vehicle

NAME	SIZE	WEIGHT
Segway Drift W1	318×269×219 mm	7 kg
iCarbot	383x310x106 mm	5.5 kg
Honda U3-X	313x160x647 mm	10 kg
Toyota Winglet	520x494x1168 mm	20 kg

2.2 COMPONENT SELECTION

2.2.1 FRAME

As this is a prototype model we have made the platform of our device of wood which is supported by a frame of Aluminum having the material class of 6061 which is welded by MIG Technology. Here we have used aluminum 6061 because it is a very light material and strong enough to carry high weight, also easily available in the market.

2.2.2 MOTOR

For the requirement of 15 kilometers per hour max speed, we have selected this motor having a power output of 250 watts[5]. the selected motor is in a high RPM low voltage motor category so that the size of the motor is quite small, also weight reduces and at the same time it can provide a large amount of power. Table 2 shows the details of DC motor and gear box used to reduce the RPM.

Table -2: Base Motor Specifications

Nominal Voltage (V)	18 V DC
No load Speed (RPM)	18100 RPM
Rated Torque (gcm)	1510 gcm
No-load current (A)	2.7 A
Load current (A)	18.7 A (Max)

Table -3: Technical Specifications of Motor

Motor Type	INDUSTRIAL PLANETARY DC GEARED MOTOR
Operating Voltage	18 V DC
Motor Speed at Output Shaft (RPM)	780 RPM
Stall Torque (Kgcm)	60 Kg cm
Rated Torque (Kgcm)	39 Kg cm
Gear Ratio	1:25

Weight	0.850 Kg
Gearbox Breaking Torque (Kgcm)	200 Kgcm

2.2.3 CONTROLLER

The motor is controlled with a pulse width modulation controller also known as PWM controller this system uses pulsating voltage to control the speed of the motor. The PWM controller used in our prototype is operated with analog input given by a 10k potentiometer. This analog signal is converted by ne555p IC digital PWM signal. Now, this PWM signal from NE555p is to power the DC motor. Fig 6 shows block diagram of PWM controller.

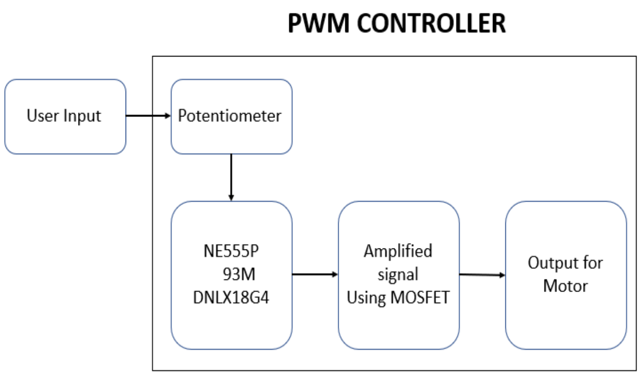

Fig -5: Block diagram of Controller

2.2.4 BATTERY

To reduce the weight and size of the battery pack we have used NCA cells lithium-ion battery cell which stands for Nickel Cobalt Aluminum. NCA cell has a power density of 260 watts per kg in comparison to regularly used Lithium cell which is NMC type which stands for Nickel magnesium Cobalt. this NMC cell has a power density of 240 watts per kg which is comparatively less than NCA. so using NCA we have reduced the conventional weight of lithium batteries and also its size. we have also integrated a swappable battery system for the interchangeability of battery packs to make it user-friendly[6].

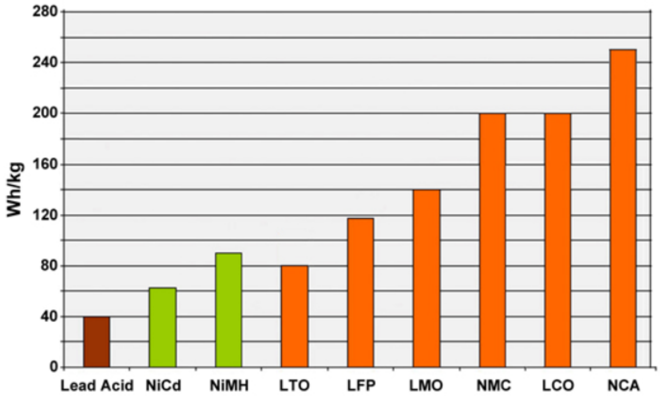

Chart -1: COMPARISION OF BATTERY CAPACITY

2.2.5 WHEEL

To overcome the obstacles that came in the path, we have selected the wheels with a height of 125 mm which is made up of polyvinyl chloride material as it is used in industrial equipment to manufacture trolleys, children's toy, e-scooter, and similar different areas.

2.2.6 SAFETY SYSTEM

For the safety of the user, we have used a safety limit that allows the user to operate the board only when the user is riding else the board will automatically cut off its power. In case of accident or fall from the board, the switch will be activated and automatically cut off its power thus it stops in its position Before any further damage. Fig.-7 shows the used safety switch.

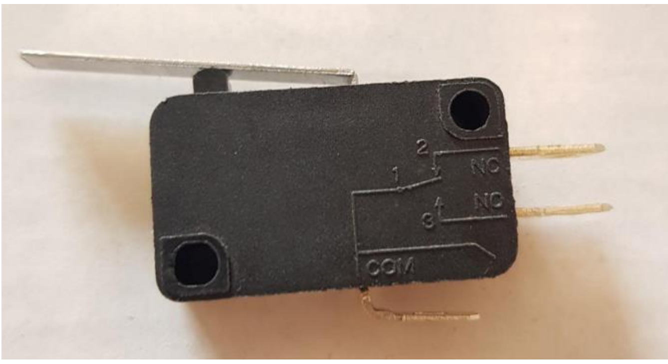

Fig -6: Safety switch

2.2.7 CONTROL SYSTEM

To make input more user-friendly we have developed our own 3D printed joystick module using potentiometers that give input to PWM Controller. The 3D printed joystick module consists of two joysticks each operating each wheel so that the user can easily operate the board as per the desired motion. The user can use two joysticks to operate for the forward motion, for the leftturning motion, the user has to just push the right joystick forward keeping the left side joystick in normal position and vice versa for a right turn. Fig-7 shows the 3D printed joystick.

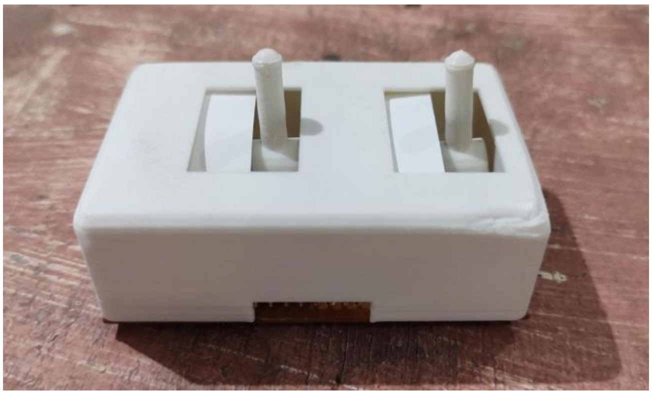

Fig -7 : Joystick

3. EXPERIMENTAL TESTS

3.1 TESTING SETUP

For testing the device we have arranged the setup as shown in Fig 8.

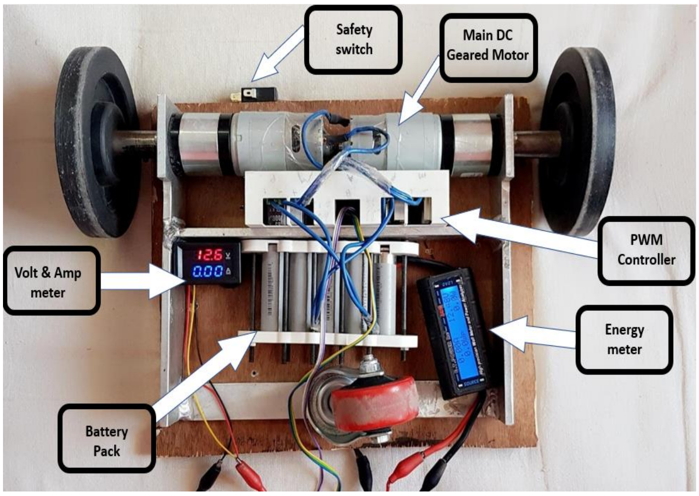

Fig -8: Testing setup

With the use of ammeter, voltmeter and energy meter we have taken reading for voltage, ampere and power consumption of motor in different loading condition using varying loads. Here, voltmeter was connected in parallel to the load connection and ammeter is connected in series to take ampere reading. In this setup safety switch was not connected so that it does not interrupt in Reading.

3.2 TESTING READINGS AND RESULTS

In our testing we found that the power consumption for one motor under maximum loading condition reaches Upto 192.6 Watts. Motor used in our prototype is 250Watt rated by the manufacturer. We have found that On road testing our prototype reaches speed Upto 15km/hr of maximum speed also, the overall runtime of our prototype gives us range of 5.2 km. Chart 2 shows the values for voltage and ampere of single motor under testing load condition. Fig-9 shows model testing on road.

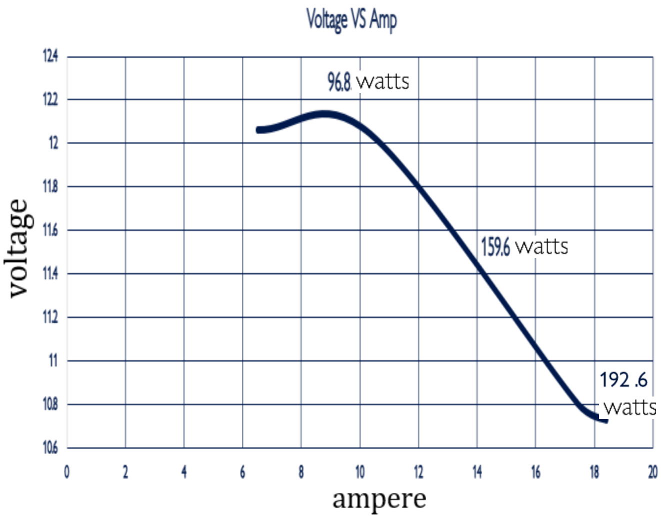

Chart -2: voltage vs ampere with power

Fig -9 : On Road Testing

4. CONCLUSIONS

From this experiment, we concluded that the prototype results are confirmed and ready to use for transport application because it is tested successfully on streets and outdoor conditions. As the prototype is compact and portable it has many other applications areas like Patrolling by police in Railway Station Platforms, Adventure Parks, and Large campuses like Facebook and Google for Internal travel.

REFERENCES

[1] Segway Drift W1, https://store.segway.com/segway-drift-w1

[2] I-Carbot by Fwheel, https://www.fwheel.cc/product/product-self-balancing-electric-unicycleicarbot-walkcar-four-wheel-scooter/

[3] Honda U3-X, IEEE Spectrum, https://www.youtube.com/watch?v=PENSEenxRQo

[4] Toyota Winglet, https://mag.toyota.co.uk/toyota-winglet-personal-mobility-robot-tests-begin/

[5] Motor Manufacturer, https://rhinomc.com/products/

[6] Battery University, https://batteryuniversity.com/index.php/learn/article/types_of_lithium_ion

[7] Hun-ok Lim, Development of a Portable Motor Vehicle for Personal Transportation, International Conference on Control, Automation and Systems 2008 Oct. 14-17, 2008 in COEX, Seoul, Korea

[8] Zhang Mingkun, Design and Study of Electric Portable Vehicles, 2011 International Conference on System Science, Engineering Design and Manufacturing Informatization

[9] Ashok B. Shyora, EXPERIMENT ON WORKING MODEL OF SELF BALANCING VEHICLE, International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056 Volume: 06 Issue: 04 | Apr 2019

[10] Ella Seshu, DESIGN AND FABRICATION OF PORTABLE ELECTRIC VEHICLE, International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056 Volume: 07 Issue: 05 | May 2020