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Hoverboard for Personal Transportation

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Abstract- **The emission caused by internal combustion vehicle is increasing day to day and so the traffic due to automobiles in urban areas has risen tremendously over the years. Traffic congestion increases the vehicle emissions and decreases the ambient air quality. There can be no immediate solution to this issue but an alternate solution for the conventional personnel transport is Personal Electrical Vehicle. The transition from the conventional to fully electrical vehicles will be a slow process but it is in evitable. This project is focused on developing a Personal Electrical Vehicle with various charging methods which will be useful for short distance travel. Most people use the vehicle for shorter distance (i.e. 10kms), this Personal Electrical Vehicle will widen the means of travel for such short distances. This will also have a direct impact on the fuel scarcity, which has led to the raise in the fuel prices over the decade**

Keywords: Emission, Personal electric vehicle, Range, Future transport system, travelling.

I. INTRODUCTION

Personal Mobility is a fun for some and a need for others. It is the freedom from the constraints of public transportation systems and from the high risks and costs of daily vehicles transportation. People who are free from these constraints of daily commute are more relaxed and are less stressed at home and at work. [3] Elder people and the physically handicapped who have adopted the personal mobility transport can experience greater freedom of movement and a happier lifestyle. Personal mobility vehicles include all types of bicycles including hybrids, folding etc. and electric vehicles like electric wheelchairs, e-scooters, e-bikes etc. Folding bikes have been growing in interest in recent times and its compactness and lightweight feature makes it very easier for urban travel. Compact electric vehicles are gaining some attention from the urban public as it provides a tireless way of connecting people from their homes to their workplaces or their neighborhood amenities. [4]

The personal electric vehicle (PEV) transports a single passenger over trip distances of around 30km and employ electricity as the energy source. Personal electric vehicles offers many potential benefits to consumers and to society including lower transportation costs, reduced trip times, and lower environmental impact. The Personal Electrical Vehicles therefore offers many intriguing possibilities for extending the human range of mobility. However, the full potential of the category is not yet realized, to a large extent because the vehicles aren't yet light enough, do not go travel far enough, and it is of higher cost. [19] Ashwini M. Welekar described about the brushless motor technology with a high reliability offers high efficiency, and for a lower cost. Brushless Direct Current (BLDC) motors are rapidly gaining popularity. BLDC has higher efficiency due to the use of permanent magnet rotor. It has high speed of operation even in unloaded and loaded conditions due to the absence of brushes that limits the speed. It needs lesser inspection and maintenance is required. [5]

The pollution in automobiles which is rising day to day due to which the pollution level at cities and urban areas are increasing due to use of automobiles. The use of electric vehicles for short distance travelling will reduce the pollution to some extent.[11] Lithium-ion batteries are the suitable for electric vehicles because they can deliver higher output because of having capability to store high power per unit of battery mass, allowing them to be lighter and smaller than other rechargeable batteries. [4] The available methods for personal mobility were learned such as Kick scooter, Segway, Hover boards, Stand on scooters, Unicycle. There are rules and regulation for them followed in other countries. [12] Helen Hoenig have investigated about the effects of providing a motorized scooter on physical performance and mobility. The walking distance was compared to the electric scooters, many factors such as the age, health, attitude towards EV were taken into account. It was concluded the scooters were more convenient to travel & it is being widely accepted. [7] A yearlong study presented the results into electric bicycle effectiveness for a large tropical campus, identifying barriers to bicycle use that can be overcome through the availability. So there is a change in trend in the world of personal travel, people are fine with the electric products so we can implement the hover board in India. It will be very helpful in the urban areas. [15]

The focus on personal vehicle transportation transitioning to electricity was discussed by Jack Barkenbus. The transition from oil to electricity for personal transportation is what every automaker is now seeking to produce an electrical automobile. It will take many years for more advanced technologies, to result in significant overall reductions in fuel consumption, due to their higher cost and slower development.[17] The move to full electrical vehicles may progress in stages from hybrid electric vehicles (HEVs), to plug-in hybrid electric vehicles (PHEVs), and finally to full electric vehicles (EVs). [9] Kaarina Hyvönen assessed at how different kinds of consumers assess the future uses of light electric vehicles. This paper assessed the opportunities of light electric vehicles to enter the transport system against the background of sociotechnical change. [10] The safety, durability, and performance of batteries. Improper use of a battery can significantly reduce its life and can be dangerous.

Battery chemistry was explained in a detailed manner. Also, the issues of battery-charging method, management and monitoring, and SOC (Safe Operating Condition) estimation were addressed. [6]

LITERATURE SUMMARY

- The available methods for personal mobility were learned such as Kick scooter, Segway, Hover boards, Stand on scooters, Unicycle. There are rules and regulation for them followed in other countries. [8]
- Currently the biggest disadvantage of EMCs is their higher price. Higher price could be compensated by lower operational costs.
- The Socio technical transition proves that the people are changing towards electric personal transporters.
- Many factors like the Demographic data, Health status, Mobility habits, Attitudes about Mobility scooters, Life quality were studied. Nearly 88% people were found normal with the Mobility scooters.
- The feasibility of implementing it in the market were analysed.

METHODOLOGY

Brushless Direct Current (BLDC) Motor

The Brushless Direct Current (BLDC) motor for its higher efficiency and reliability, smaller and lighter, better speed versus torque characteristics, longer life [1]. The motor is inbuilt with a regenerative braking system and a hall sensor. The hall sensor is used to measure the speed of the vehicle. The regenerative braking system used for braking and regenerating the power wasted while braking.

Table 1 : Comparison between Brushless DC motor and Brushed DC motor

Feature	BLDC motor	Brushed DC motor
Efficiency	High	Moderate
Maintenance	Little	Periodic
Output power	High	Moderate/Low
Speed range	High	Low
Lifetime	Long	Short

A 24v power supply 200 Watt BLDC motor was chosen as it is able to carry a load of up to 80 kgs.

Table 2: Specification of the motor used

S.No	Parameter	
1	Power supply	24 v
2	Power	200 watt
3	Phase	3
4	Torque	2.3 N.M
5	RPM	800
6	Top speed	25 kmph
7	Load	80 kgs

Controller

The controller is used to control and monitor the whole system. It will govern the battery charging and discharging, acceleration, braking, etc., of the vehicle.

The controller chose had the following processor PIC16F72. It had the following parts Main control chip, Power supply, Input of hall signal, Governor, Circuit of driving motor. Current detection, Brake circuit, helping function, checking of voltage supply. [14]

Battery

The selection of battery is a tedious process which involved in considering the following factors,

- Range
- Power output
- Weight
- Recharging time
- Availability
- Price

Table 3: Comparison between Lithium and Solid battery

Parameters	Solid battery	Lithium ion battery
Availability	High	Low
Charging time	6 hrs.	2 hrs.
Power output	14 Ah	12 Ah
Range	30 kms.	30 kms.
Overcharge tolerance	High	Low
Weight	4 kgs.	1.5 kgs

The price of the solid battery is very lower than the lithium ion battery and its availability is higher than the lithium battery. The charging time of the solid battery is higher than that of the lithium battery. The weight of the solid battery is slightly heavier than the lithium battery. So based upon the survey the solid battery was chosen for its lower price and easier availability. It had reasonably the same power

output as the lithium ion battery. The battery is a 12 volt 14 amps battery.

The battery is inbuilt with a battery management system which does not allow the battery to be overcharged and undercharged. [2]

Problem analysis is done to identify the problem, establishing the causes and effects related to that problem. The problem area was narrowed to personal transport for smaller distances (i.e., 10kms). The problem had many scopes but taking the current situation into account (i.e. fuel scarcity, pollution) the idea of Personal Electric Vehicle was found to be the most feasible solution. And according to the problem the literature survey was carried out. The literature survey is done to enhance the idea about the project. There are products similarly available in the current market, but the cost is found to be a major issue with the product.

Literature survey was done by considering the following

- About Personal Electric Vehicle
- Hover boards
- Scope of PEVs
- Feasibility of PEVs on road.

The layout of the Hoverboard was constructed and a model was created in the software. It was designed to reduce the defects of the hoverboard, a support wheel was added to increase the stability so this is designed to be viable as a commercial vehicle

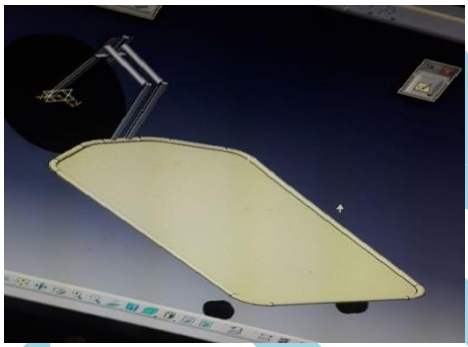
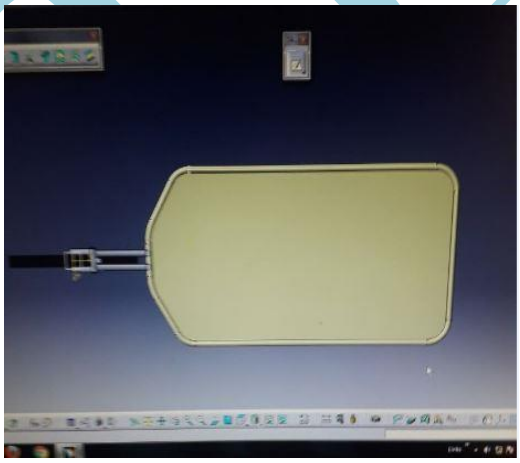


Figure 2: Top view



The motor used is a 24 v motor which has a power output of 200watts. It can carry a payload of 80kgs.

The solid battery was chosen for its reasonable price and its availability in the market. The battery is a solid battery 24volt 14 amps battery. The full charge time taken is 6 hours and it has a range of 30kms.

Table 4: Specifications of battery

Parameters	Value
Voltage	12 v 14 Ah
Weight	4 kgs.
Range	30 km
Toxicity	Low
Charging time	6 hrs.

The controller is used to control and monitor the whole system. It will govern the battery charging and discharging, acceleration, braking, etc., of the vehicle. The controller chose had the following processor PIC16F72.The fabrication included in building an body, it is incorporated with a safety belt, handle bar, fingerprint sensor for engaging, Light is present in the handle bar for visibility at night.

Test & analysis

The product was tested for a period of one month under different operating conditions and we found a problem arising in the motor, it was heating up while braking. The battery power was not fully used during the operation.

CALCULATION

Power, P = 2πNT / 60

200 = 2*π*500*T / 60

T = 4 N.m

Range = 30 kilometers

Top speed = 25 kmph (in test conditions)

Laden weight = 80 kilograms.

Force, F = ma

= 80*25*0.278 / 20

F = 28 N.

Torque required = FR

= 28*0.18

= 5.04 N. m

Battery working hours (without loss)

= volt * ampere hour / motor power

= 12*14 / 200

= 1 hour.

With loss considered (25 % loss considered)

= (volt * ampere hour / motor power) * 0.25

= (12*14 / 200) * 0. 25

= 30 mins.

Correction

The motor was malfunctioning during the test, to rectify the problem of the motor it was ripped out fully and it was found that the coil was damaged moderately. Thus we had to change the coils and the problem was rectified. For the problem arising within the battery it was found that the controller was malfunctioning and the problem was rectified by changing the electrical lines.

RESULTS AND DISCUSSION

The project was chosen based on many parameters such as [18]

- Pollution
- Easier travelling
- Availability of similar products on Indian market
- Reduced cost compared to other PEVs.

- Area of Operation
- Range of Operation
- Feasibility in the market.

The above parameters were analyzed in detail and based on the observation this project was manufactured with a reduced cost. It has a range of 30kms with a maximum payload of 80kgs. The main problem of higher cost was reduced. The feasibility of a product in a market is essential for its development and this project definitely has a higher scope in the near future.

Table 5: Result

Parameter	Available PEV	Project
Range	30 kms	30 kms
Battery type	Lithium ion battery	Solid battery
Total weight (vehicle)	25 kgs	15 kgs
Charging time	2 hours	6 hours
Payload	100 kgs	70 kgs
Battery voltage	12v	12v
Motor power	250w	200w
Top speed	30 kmph	25 kmph

The price of a Personal electrical vehicle that is available in the market is very higher for its range, it used cutting edge technologies which has increased the price, in this project the manufacturing methods were changed namely in available Personal electrical vehicle for balancing a gyroscopic sensor is used to balance and steer the vehicle, but in this project a support wheel is used to steer and balance the vehicle. The charging time is higher in this project as solid battery is preferred to reduce the cost. The range of both the vehicles is nearly the same for about 30 kilometers. The top speed of the available Personal electrical vehicle is 30 kmph and in this project the test speed achieved is 25 kmph.

So the feasibility of Personal electrical vehicle depends on reducing the cost and making it available for every person and in every place.

CONCLUSION

Personal electric vehicles are technically feasible now. However, suppliers have not yet arrived at a set of practical vehicles that best match technical feasibility and consumer demand.

- Part of the challenge is to under-stand the relative trade-offs among cost, weight, range and other dimensions of vehicle performance.
- The PEV is a revolutionary device that requires no special skills and that “virtually anyone can use.”
- It will be useful for the elderly people.

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