Design & Fabriction of Smart Hoverboard

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Abstract. Hoverboard is a three-wheeled motorized personal vehicle consisting of a platform for the feet mounted above an axle an upright post surmounted by handle with one guiding wheel, controlled by the toggle switches. Hoverboard is mainly used for the short distance travel where there is no use of fuel and no pollution. The main objective of this project is to produce an easy way to move and a comfortable space for the user and reduce pollution as this model is eco- friendly. The present project proposes a cost effective and innovative design compared to the existing hoverboard available in the market. The proposed project also aims to reduce the e-waste by eliminating few electronic components.

1. Introduction

This Fabrication of smart hoverboard is a personal transporter which moves in short distances from place to place [1]. This Hoverboard is a device that moves in the forward and backward directions. It has a potential to speed up to (15 km/h) indoor and outdoor operation, capable of turning in place, and has a weight carrying capacity of up to 100 kilograms which carries the person while riding [2]. The main principle behind the load carrying capacity is the type of material used in building the Hoverboard that is Iron which is durable and strong which in return supports high weight carrying capacity . Generally the expenditure of these components, along with the expenditure of operating experimentation and testing[3]. This Hoverboard is a human transporter (HT) conferred an contemporary economic product for the human transportation [4]. Hoverboard which is working on batteries balances and moves on three wheels which are guarded by DC motor controller [5]. The mobility platform has a miniature impression , a zero turning radius ,the capability to carry over distinct terrains and the capability to bear up to the load setup. These properties made researchers experiment considering the locomotive part of their robotic systems[6]. It is furnished with a motionless T- shaped control shaft attached into a platform seated on two parallel wheels. Hoverboard's are directed continuing up and operate according to human instruction [7]. The Hoverboard has braking system and an accelerator to boost up the speed, it has a handgrip on the handle of Hoverboard which is helpful for the rider while operating it also it is used while taking turns by the switches attached on to the handle .The steering mechanism of hoverboard is also given by the switches attached which are used to turn in opposite directions forward and backward [8]. Basically, a Hoverboard is mostly used for personal transportation in urban environment. This was invented by Dean L. Kamen. Hoverboard is like a scooter but the wheel arrangement is placed side by side instead of parallel to each other. The advantages of hoverboard's are zero emissions, zero turn radius, no noise and higher degree of freedom. Hoverboard is used for urban police patrolling, military surveillance, off road riding and urban sightseeing.

Fig. 1 Smart Hoverboard

2. Literature survey

Meyer et al. studied the HT Hoverboard which is regulated and powered by the consumer product safety commission rather than the national highway traffic safety administration. The study examined the challenges for transportation by HT Hoverboard which includes types of pavements, travels on sloped surfaces, and issues on safety purposes. Brain .G.R. huges investigated on the onboard computers to control the power directly on to the wheels to balance the forces by the rider, this study also shown that the Hoverboard balances at various conditions such as constant velocity, acceleration and deceleration. Thompson et al. studied on the mechanical Hoverboard design and fabrication by using gyroscopic sensors, and electric motors driven by battery. The designed model of Hoverboard costs around Rs. 20,000/- which is very much less compared to the one which is in the commercial market which made highly cost effective. Brett Browning et al. studied on the RMP Hoverboard which is a balancing robot base and it is also be able to play soccer autonomously.

The existing Hoverboard's in the market costs around Rs. 28,000/- which is most expensive

and robust in design. The present project proposes a cost effective and innovative design which costs around Rs. 15,000/- which is very less compared to the existing Hoverboard available in the market . The proposed project also aims to reduce the e-waste by eliminating few electronic components.

3. Components of Mechanical Hoverboard

The following are components of mechanical Hoverboard [16]:

3.1 Frame and Base plate
3.2 Handle Bar with Accelerator and Brake
3.3 Silicon tires
3.4 DC Gear motor
3.5 Ball bearings
3.6 Batteries
3.7 Toggle switches
3.8 Chain and Sprockets
- Gears
- Chain Belt
- Shaft

3.9 Guiding wheels

3.1 DC Gear motors

The Dc Gear Motor coverts the electrical power into mechanical power. Two Dc Gear Motors; each of 12-24v are used in Hoverboard each is attached to chain sprocket system which is further connected to wheel for the movement of Hoverboard

Table 1

Specifications of the Dc Gear Motor

PARAMETER	VALUE
Motor	Dc-12-volts
Material	metal
Speed of the motor	500 rpm
Torque of the motor	35kgcm
Power of the motor	1.099kw

3.2 Ball Bearings

Fig. 2 Pillow Block Bearings

A Ball bearing is a base which is used to give hold for a rotating shaft with the help of suitable bearings and different accessories. Two pillow block bearings are used in Hoverboard each is attached to the wheel .

Fig : Ball Bearing

3.3 Batteries

Battery is the main power source in the mechanical Hoverboard. There are two batteries used each is connected to Dc Gear Motor by means of cables. The power of the batteries is 12v each these are the rechargeable in both ways electric socket and solar plates.

Definite contrasting sequence of electrode materials and electrolytes are used along with lead-acid, zinc-air, nickel-cadmium(NiCad),nickel-metal hydride,(NiMH),lithium-ion(Li-ion),and lithium ion polymer. The type of batteries used in Hoverboard are rechargeable batteries which are more costlier than the disposable batteries but by the usage of this batteries the cost of ownership and environmental impact will be low. Recharging requires electricity while disposable batteries require the change of whole battery .

Table 2 Specifications of Battery

PARAMETER	VALUE
Type	lead-acid
Normal Capacity	7.6 Ah
Voltage Nominal	12V

3.4 Toggle Switches

Toggle switch is a type of switch that breaks and connects the electrical circuit by" Rocking" in one direction to break the circuit, and the other direction is connected to the circuit. These toggle switches are placed on the suspension handle the main function of these toggle switches is for the steering mechanism. The power is given to the mechanical Hoverboard for its movement only when the switch is
pressed .

Fig. 3 Toggle Switches

3.5 Throttle and Brake

The throttle pedal. accelerates the vehicle when you press on it, while the brake pedal activates the brakes and slows the vehicle down.

Fig : Throttle and Brake

The power generated from the electric motors,car engines and wind generators is by the rotary Motion of the drive shaft. The commonly used method for the transmission of of motion and force from the output drive shaft in a mechanism is by the means of a component called as SPROCKET.

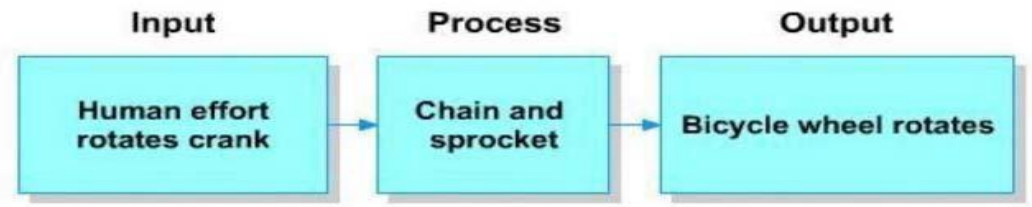

Fig. 4 Energy Transmission Process

A sprocket is generally a toothed wheel used in the bicycles and motorcycles to transmit the motion from one shaft to another whereas the chains used along with it are used to transmit the motion and force from one sprocket to another one such chains are called as power transmission chains

Fig. 5 Chain and Sprocket

The mechanism that is used in the bicycle for the movement is used in mechanism with the help of Chain and Sprocket system.

4. *Fabrication of Smart Hoverboard*

4.1 Making the basic design for the Hoverboard

First, we make a basic design for the Hoverboard, as our requirement. This design is made as comfortable for the transporter to run the Hoverboard. This helps the passenger to move freely at his own place. This Hoverboard is not self-balancing so that there is a guiding wheel at the front and two wheels at the back. This device consists of switches attached to handle to be controlled by the personal transporter. This basic model is made by using SolidWorks software.

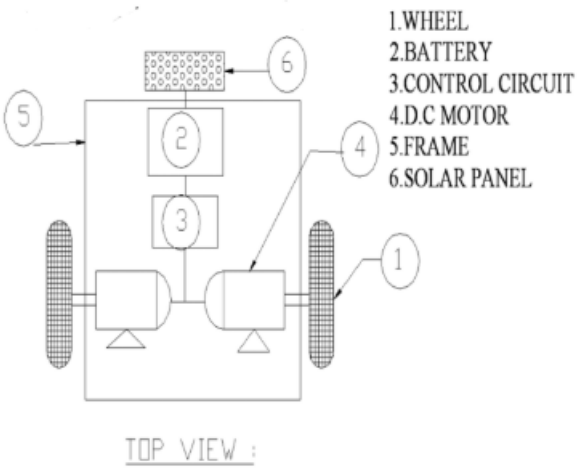

Fig. 7 Basic model of mechanical Hoverboard

In the above chapter we selected the materials foe the components required to male this project. Now we make the components ready by using some engineering techniques for the step by step assembly. First, we prepare the frame initially in which we have to attach the motors to it. This attachment is done by gas welding which we have discussed earlier and surface grinding too to get a good finish of the metal. Frame is 120 centimeters. The gas welding process and the surface grinding process is carried out accordingly. Now the motors of the 12-24 volts DC motors are taken along with the chain and sprocket setup. Then these motors are fixed by used the gas welding technique, which is also used to attach the frame of the mechanical Hoverboard.

One motor is fixed in the left is established on the right direction and the other motor is fixed to the frame in the reversed direction as the turning requirements. These motors are checked thoroughly before fixing them to the frame and they must be in the center of the shaft as the chain must be fixed. The sprocket must be at the center of the shaft as the center is taken between the tire and the frame where the bearings are fixed. Now the chain and sprockets are taken according to the shaft size. These sprockets are fixed to the shaft at the time when we attach tires and bearings itself, this helps us to not to work hard, so that we have to remove again the whole frame setup to fix this. Then the chain must be fixed to the motor output and to

the sprocket according to the bits and according to the length required. We have taken 51 bits of chain to attach one side of the tire and motor which is sprocket and the motor output. These bits which are the ends ones must be fixed by the clevis pin and link plates of the chain. These wheels are used to give support for the mechanical Hoverboard while driving it. These wheels are fixed one at the front end and the back end of the frame so that middle silicone tires are

used make front and back movements and also the turning movement. These small wheels which are attached at the front and back end are used to get the required turn additionally helping the main tires, as a result we get the turn. This works as if we want to take a left turn then we must hold the right toggle switch one for forward movement and the left toggle switch in the backward action. Similarly, if we want to take a right direction, we must hold the right toggle switch one for backward movement and the left toggle switch in the forward action.

Apart from the battery cables the connecting wires are used to connect the motor and the toggle switches in order to move the mechanical Hoverboard. These connecting wires are used to give the electric connection from the motors, batteries and the toggle switches. The circuit connection of the mechanical Hoverboard is as below.

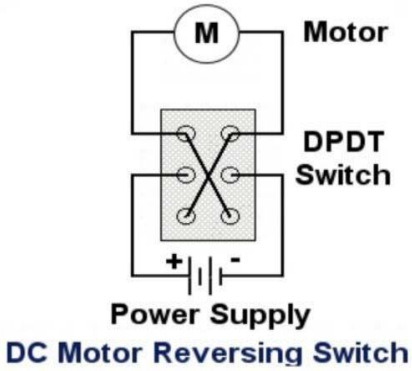

Fig. 9 Connection of Motors, Batteries with Toggle Switches

when testing the mechanical Hoverboard in the initial trails the operator advantages were naturally lower as a sign of safety. This trail was made to check the system performance and its efficiency also the which is controlled by the toggle switches was also tested. Which worked well in taking left and right turns along with this the expected speed was attained and the safety of the operator was also as expected.

Components	Quantity	Weight(Kg)
Frame	1	3.5
Tires	2	3
Motors	2	2.4
Batteries	2	2.3
Pillow block bearings	2	2
Chain and sprockets	2	1.5
Shaft	1	2
Guiding wheels	2	0.5
Other small components		1
Total		23.2

5. *Basic Modeling*

Fig. 10 Basic Design for Making the Mechanical Hoverboard

6. *Design Calculations*

Design Factors for the proposed Hoverboard

Load Capacity = 90Kgs.
Base Width = 22”
Base Length = 26”
Mast Length = 32”
Types of motion = Forward, Backward, Left, Right
Travel Speed = 5-7 Km/h
Power Supply = 12V, 7 AH Lead-Acid Battery

Materials Used for Each part

Body of the Hoverboard = Iron
Mast: Suspension Handle = steel
Wheels = Silicone -Eco-friendly

Power of Driving Motor

$P = 2\pi NT/60000$
Where, P = Power of Motor (KW), N = Speed (in rpm), T = Torque (Nm), T = W x R
Formula for power = 2(3.14) N*T/6000
Speed of the Motor = 30 RPM
Max Torque Produced, T = 35 kg-cm.
Therefore, the power of the motor, P = 2(3.14) (30) (35)/600 => P = 1.099KW = 1099 WATTS

Selection of the Sprockets

Number of Sprocket Teeth n = 15
Chain Pitch = 0.490m
Sprocket diameter = 40mm

Stress acting on the Base

Weight of the user = 100 kg (max)
Weight of the personal transporter = 25.2 kg (approx.)
Total weight = Weight of the user weight of the personal transporter = 125.2 kg.
Loads acting = Total weight*Gravity g=10m/sec
Thus, load acting = w*g = 125.2*10 = 1252N. P= N Area of the base, A=660.4*558.8=369032.52 mm^2.

Yield Stress

Maximum weight on the base = 125.2 kgs
Yield stress = maximum weight*gravity/area of base
Yield stress = 125.2*10/369032.52 = 0.0033928= 3.34*10 -3 n/mm^2.

Factor of Safety

FOS=ultimate-stress/allowable-stress

FOS = 1252/1000 = 1.252
FOS = 1.25

7. *Results and Discussions*

Firstly, it is balancing the mechanical Hoverboard without the usage of any type of sensors and programming. This is observed by some initial trails made and as per the initial

driving results and why the vehicle was unable to get the expected result so we made a lot of advancements in terms of loads and motor capacity and shaft and bearing which helped us to get desirable results we expected for. The results obtained are tabulated in table 4 and table 5.

Table 4 Driving Results

Observations	Speed
Speed expected	9-10 km/h
Speed obtained	6-7 km/h

Table 5 Results observed

Observations	Result
Stopping time	1.1 seconds
Stopping distance	0.3 ft.

Initial Driving Results:

The initial driving attempts were made to run the Hoverboard by controller and resulted in positive way. This test was made to check the mechanical Hoverboard operated by the toggle switches to move forward and backward as required. After many tests and changes, the operating planning with the remaining error serving as a origin of speed, turned out to be as successful and the speed controlled by the accelerator and toggle switch is very good for the forward and backward movement. Also the changes are made by replacing capacity and wires brought very good results overall.

Conclusions

In this project, a mechanical hoverboard is designed and fabricated, which is both cost-effective and innovative compared to the existing hoverboards available in the market. Rephrase Based on the current research, the following conclusions can be made.

1.The designed model of the mechanical hoverboard has been extensively tested in all its aspects and has proven to be highly effective.

2.The designed mechanical hoverboard can be utilized for a complete range of personal transportation purposes and is safe to use for traveling at low speeds.

3.The model that has been designed is more cost-effective than the model that is currently available in the market. The study also minimized electronic waste by eliminating certain electronic components.

4. In the future, we can make this model even better by adding sensors and servos to help the vehicle move and turn smoothly. Additionally, the load-carrying capacity of the vehicle can be adjusted by utilizing heavy-duty motors and reducing the overall weight by employing lightweight, durable materials for the vehicle's body.

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