International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 5 May 2021, pp: 89-97 www.ijaem.net ISSN: 2395-5252

Design and Development of Balancing System and Chassis for One Wheeled Vehicle

Mahmmadabararkhan N. Diwan
[1]*Student,Department of Automobile Engineering, Knowledge Institute of Technology and Engineering, Bakrol, Anand, Gujrat (388315).*

Submitted: 01-05-2021 Revised: 09-05-2021 Accepted: 10-05-2021

ABSTRACT: Thisresearch paper is about One Wheeled Vehicle to improve transportation method.As we know transportation becomes the unavoidable and important problem of the world nowadays. The day-to-day life becomes faster and faster and the need of transportation is increases but at the same time there is degradation in environmental condition.The main problems that world is facing now are Pollution, Traffic and Parking and these all can be eliminated by One wheeled vehicle. The balancing system of OWV is made up of Microcontroller, Motor, Potentiometer, Gyroscope, Accelerometer, Battery and other basic electric components. Where the design of chassis and body is done by the virtual modeling.

KEYWORDS: One wheeled vehicle, Monowheel vehicle, Balancing System, Chassis, Body Design, Electric Vehicle.

I. INTRODUCTION

In an Automotive industry the upgradation of the conventional methods becomes necessary and the try is to build a totally new and effective transportation vehicle which can carry one passenger with some extra good . The vehicle is having a EV powertrain with the capacity to rode about the range between 30-40 km and the maximum speed range is about 30-40 km/hr depending upon the various rod and vehicle factors as well as the environmental condition. Vehicle having an high power motor hub that can survive in almost every condition of the environment. The balancing system with advance tilting detection and the two way control of the vehicle. The breaking and acceleration is done by the potentiometer by just twisting the knob on the handle bar. The strong chassis can carry almost 100 kg of the weight. And the unique design of the steering system pivoted at the rear. As The aim is to design a vehicle containingthe solution of the problem that are major in this time. The solution for this problem is vehicles the parking problem is create because the space available for the parking getting by examines the problems. And the various problems are discussed below :

[1]Fuel Consumption & Pollution: Drastic daily fuel consumption & pollution is the Global problem. Somehow ,the automotive industries are changing the little it focus from conventional to EV/HEV but the amount that is needed is still not archived due to inconvenienceThe pollution directly affects the life of humans as well as the lifestyle of

creatures on the earth and it degrades that badly. Environmental condition like global warming, greenhouse effect ,less visibility due to fog by dense pollution particle and the increment and decrement in temperature drastically etc. According to survey daily consumption of oil in India is 4,99,000 bbl./day (approximately).

Where , 1 bbl. = 422 gallons 1 gallon = 4.5 litters

And the consumption of fuel in countries like USA and China is far more than India. The India is having a dense population or in other words a large no of inhabitants living in per square km area , so the travelling distance is small compared to other countries. In addition to that the economy of India is a lot poor then the other so large number of inhabitants are travelling in public transportation , Although the usage of the fuel is great. So, countries like USA , China ,UAE and Russia and other are having strong economy as well as less dense population.

[2]Parking : Population in India is increasing rapidly. According to reports , Inhabitants per square kilometre in India. In 2018-19 is approximately 454.95. And it is increasing still drastically in big cities like Mumbai, Delhi and Chennai etc. Inhabitants in Mumbai per kilometre square is 26453 people where in Delhi it is 11900. So as the population increases the number of vehicle increases day by day. Due to more Inhabitants & becomes less. Due to the limited land resources , it is needed to solve the problem to solve the problem

International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 5 May 2021, pp: 89-97 www.ijaem.net ISSN: 2395-5252

of parking. So instead of increasing available parking space ,andeffective technology based solution must be employed.

[3]Traffic :India is the country having second largest road network in the world .Out of total stretch of 5.4 million km of road network, almost 97991km is covered by national highways.Remaining is the local road network having a narrow road width. Average Indian youth owing a two wheeler and almost same amount of cars are little less of other transportation vehicle.Another thing is , It is noted that according to survey almost 67% of the passenger are riding their vehicle with less number of passenger that vehicle actually can carry. One man is riding two wheeler or four wheeler occupies the space on road of 2 to 4 people but in actual only one is there. And that also causes the increment in traffic.

From the problem of drastic fuel consumption and pollution the solution is obvious either we can go for (electric vehicle) or solar vehicle. But as we are trying to build such a compact vehicle then EV is appropriate. So, the power source of our vehicle is electric.From the problem of parking we came up with solution like foldable bike and one wheeled vehicle. This two are very appropriate in parking because they are very compact compare to the normal vehicle.From the problems of traffic, we came up with the solution of one wheeled vehicle.Due to its less space occupancy, it becomes such a perfect vehicle.

II. COMPONENTS OF BALANCING SYSTEM

A. Battery:

"Battery is the device consisting of electrochemical cell or no. of electrochemical cells with external connection". It stores the energy in form of chemical energy.Battery that we are using is Lithium Ion battery.

A lithium ion battery or Li-ion battery is rechargeable type battery so it has a long-life acceptancy.Lithium ion battery is commonly used for portable electronics and electric vehicle.From the calculation it was concluded that the battery required must have the 48V max voltage 50 amp rated current and power capacity of 2400 watts.

So information of battery is as follows :

Specifications :

NAME:

48 V 50 AH Portable lithium ion battery pack by PACTO POWER.

PRICE: 24000 Rs.

- General specification:

Dimensions	300 * 220 * 70 mm
Weight	10.2 kg
Cell type	3.7V NMC Cylindrical

- Electrical specification :

Nominal voltage	48.1 V
Nominal capacity	50Ah
Energy	2405 Wh
Resistance	20mΩ at 50%SOC
Efficiency	99%
Self-discharge	<5% per month

- Charging and Discharging parameters:

Recommended Charge Current	1A – 20A
Recommended Charge Voltage	54.5V – 55.0V
Recommended Discharge Current	1A – 60A
Recommended Discharge Voltage	34.5V – 35.0V

International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 5 May 2021, pp: 89-97 www.ijaem.net ISSN: 2395-5252

(ACTUAL IMAGE OF THE PRODUCT)

B. Controller:

A controller is used to connect all electrical components of an e-bike together.It takes energy from the battery and directs it to the motor. By twisting the throttle ,the user can regulate the power that is being sent to the controller and this is how the bike speed is controlled.By depending upon the power required by the motor and power possess by the battery we must have to choose 48V controller.

So, the detail of required product is as follows :

Specifications:

NAME :CY Plus Electric controller 48V 50Amp

PRICE : 4150 Rs.

- Features :

Tube	24 Tubes
Weight	3 kg

(ACTUAL IMAGE OF THE PRODUCT)

C. Arduino Board:

The Arduino UNO is an open source microcontroller board based on the Microchip ATmegha328P.The board is equipped with 14 digital Input/Output pins.It is programmed to generate the specific type of output when the vehicle tilts up to certain limit and it is combined with accelerometer and gyroscope.

So, the details of the required prod is as follow:

Specifications:

NAME :

UNO DIP R3 ATmega328

PRICE : 529 Rs.

- Features and details :

Operating Voltage	5V
Input Voltage	7-12 V
Number of memory stick	3
Product Dimension	15 * 14 * 3 cm

International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 5 May 2021, pp: 89-97 www.ijaem.net ISSN: 2395-5252

(ACTUAL IMAGE OF PRODUCT)

D. IMU :

An Inertial Measurement Unit is an electronic device that measures and reports a body's angular rate, specific force and orientation of body using combination of gyroscope and accelerometer.Typically used in unmanned aerial vehicle in other word drone.

So the details of the required product :

Specification :

NAME :REES52 GY-521 Mpu6050 Module

PRICE : 220 Rs.

- Features and Details :
  - 3 Axis Accelerometer , 3 Axis Gyroscope

Number of memory stick	1
Item weight	18.1 g
Product dimensions	2.54 * 2.54 * 2.54 cm
Voltage	5

(ACTUAL IMAGE OF PRODUCT)

E. Switch:

A switch is the device which is designed to interrupt the current flow in a circuit i.e. it can make or break current circuit.

So the details of the required product :

Specification :

NAME :

Heavy Duty Toggle Switch

PRICE : 159 Rs.

- Features and Details :

Mounting Dia.	12 mm
Size	3.3 * 2.1 * 5.3 cm
Number of memory stick	1
weight	200 gm

(ACTUAL IMAGE OF PRODUCT)

International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 5 May 2021, pp: 89-97 www.ijaem.net ISSN: 2395-5252

F. Digital to Analog Converter:
Digital to analogue converter is a system that coverts digital signals into an analog signal.
So the details of the required product :

Specification :
NAME :
PCF8591 Module Analog to Digital
PRICE : 208 Rs.

- Features and Details :

Voltage Range	2.5V- 6V
Power supply	Single
Size	3.6 cm * 2.3 cm (1.6 mm thick)

(ACTUAL IMAGE OF PRODUCT)

G. HUB MOTOR:
It is basically a wheel containing an electric motor inside the hub of the wheel.From the calculation of motor required power is obtained .
So, the products specification is as follows:
Specification :

NAME :
GoGoA1 17 inch 3000W Electric Motorcycle Wheel Hub Motor
PRICE : 27000 Rs.

- Features :

Motor type	BLDC
Max. torque	180 n.m
Max. efficiency	89%
Continuous current	50 A
Max current	100 A
Rated voltage	48 V
Max. Rpm	1220 RPM
Weight	25 Kg

(ACTUAL IMAGE OF THE PRODUCT)

III. CALCULATIONS

Our OWD is EV based so, there are definitely some basic components like Motor, Battery, Controllers and Wires are needed.
So, to Match the requirement we need to calculate and pacify the component. Which is as follows.

❖ Calculations of MOTOR During the start of Vehicle:

Following calculations is for worst case scenario
Wheel with 17-inch rim
Tyre with 150/70 R-17
So, the total Diameter = 0.6418m, Radius = 0.3209m

International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 5 May 2021, pp: 89-97 www.ijaem.net ISSN: 2395-5252

Linier distance by 1 revolution = 2πr = 2.02m

- Speed of 30km/hr.
  RPM = $\frac{30000}{60\times2.02}$ = 247.524 = 250 rpm
- Required torque for wheel:

Gross vehicle weight=130kg (50 + 80)
Maximum speed= 30km/hr.

- For finding tractive effort:

  $TTE = R_R + G_R + F_a + A_D$

- Rolling resistance (R_R):
  R_R = GVW × g × 0.02
  = 130 × g × 0.02 = 25.48 N

- Gradient resistance (G_R) :
  G_R = m × g × sin10 = 130 × 9.8 × 0.1735
= 238.73 N

- Acceleration force (F_a) :
  F_a = m × g ×($\frac{v_{max}}{g\times ta}$) = 130 × $\frac{8.33}{10}$
= 108.33 N

- Tractive effort (TTE) = $R_R + G_R + F_a$
= 372.52 N

- Torque required to reach top speed:

T = TTE × R = 372.52 × 0.320
= 119.21 Nm

- Power required for worst scenario:
  P = TTE × v =372.52 × 8.33
= 3103.0916 watts

- Battery calculation:
  Watt of battery = voltage × ampere
= 48 × 50 = 2400(power that we need)

- Battery pack capacity = $\frac{1260}{0.85}$ = 1500W

- By all other we conclude that we required a battery pack of 48V, 50amp and 2400W.

❖ Calculation of Motor, while vehicle is Plying:

When Vehicle is moving it has a certain speed and during the tilt we need balance that by moving it in reverse direction for the fraction of time. And this Reverse motion of the motor Obviously requires some torque according to need. Assume,that vehicle speed is 20kmph and vehicle weight is 100kg.

For angular velocity,

ω = $\frac{60v}{2\pi}$ (V = 20kmph = 5.56m/s)
= 53.12rad/s

Now,for angular acceleration,

α = $\frac{\omega}{t}$ (max time needed to reach top speed is 6.5s)
= 53.12/6.5
= 8.17 rad/s^2

Angular momentum,

L = m × v × r
= 100 × 5.56 × 0.3209 (where, radii of tire is 0.3209m)
= 178.42 Kgm^2 / s

Inertia,

I = $\frac{L}{\omega}$
= $\frac{178.42}{53.12}$
= 3.35 kgm2

Angular torque,
Ƭ = I×α
= 3.35×8.17
= 27.44 N.m

27.44 N.m is the torque required to balance the vehicle when it is moving at the speed of 20kmph.

❖ Battery calculation:

The purpose of Battery calculation is to find Battery Volts, Ampere and the power of it as we needed to match the requirements of Motor.

1. WATT OF BATTERY:

- Voltage × ampere
- 48 × 50
- 2400 WATT

[Our requirement for the battery was approximately 3000 watts, but that was for worst case scenario. As we are considering the other factors like availability & affordability it is okay to buy 2400-watt battery.]

- Gross weight = 130 kg
- BLDC motor = 3000-watt, 48 volts
- Travel range = 50 km
- Speed of bike = 30 kmph
- Current taken = 15 amp
- Acceleration current = 5%

[5% current increases when we accelerate vehicle]

International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 5 May 2021, pp: 89-97 www.ijaem.net ISSN: 2395-5252

- Effective current = 15 × 1.05
  = 15.75 amp.

❖ Power = V × I
= 48 × 15.75
= 756.

❖ Travel factor = total travel/travel in speed
= 50/30
= 1.666.

❖ Now, power for range of 50 km.
P50 = 756 × 1.666
= 1260W.

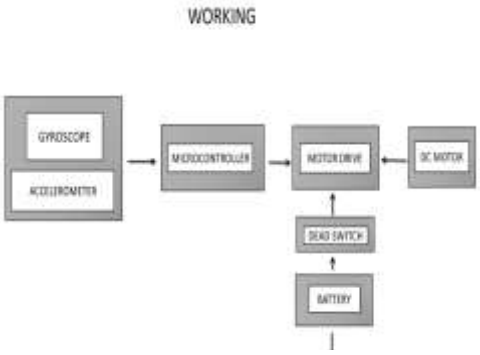
❖ Efficiency of lithium Iron battery = 85%

❖ Power = 1260-watt (we require 2400-watt)

❖ Battery pack capacity = 1260/0.85
= 1482.5-watts
= 1500-watts(approx.)

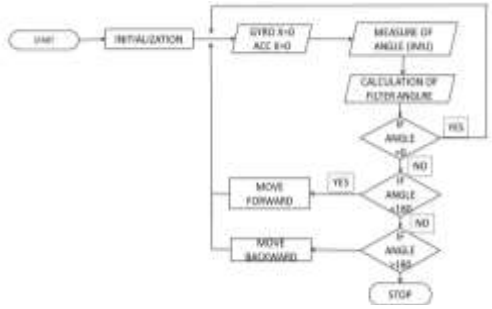
But by all the other factor we conclude that we required a battery pack of 48volts & 50 amps & 2400 watts.

IV. WORKING OFBALANCING SYSTEM



Twist throttle, like motor cycle to advance an input signal to the control system.

The control command MC to advance through an algorithm, which compensates for all, or a substantial number of, the variable needed to propel the cycle forward while reducing the need for the rider to lean forward back.The control system looks at the position of the twist grip to change the tilt angle, the motor then modifies its speed to maintain the right tilt angle.



Position of some throttle also sets an acceleration curve that modified by the ability of the motor to accelerate in a given time frame and the need to keep the tilt angle within a range where the cycle will not fall forward or backward.

This balancing system is achieved through tying the acceleration rate of the motor to the tilt angle. As long as the motor have enough torque to move cycle forward at an increasing speed, the tilt angle will be allowed to the center of gravity, or center of mass, ahead of the tilt angle in turns this keeps the cycle from falling ever backward during acceleration; in turns this keep the cycle from falling over backward during acceleration.

As the torque curve of the motor flatters out and slows in its ability to keep accelerates the cycle, the tilt angle will slowly move past center and fall on the other side or negative angle in relation the center of mass.[this keep the cycle from falling forward as the speed increase but G force of the acceleration starts to dimensioning] As the cycle reaches full speed the tilt angle will return to an almost vertical position in relation to ground.

H. COMPONENTS OF VEHICLE

1. LOWER PORTION:

Balancing frame: In this frame wheel and wheel hub is mounted at the center axle. At the front end of frame Steering mechanism is fitted. This frame support the upper frame which contain battery and all that.

International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 5 May 2021, pp: 89-97 www.ijaem.net ISSN: 2395-5252

And it has the pivoting knob which takes almost all load of the passanger.

➢ SPECIFICATIONS :

Material: Aluminum (AA2011)

Tensile strength	365 – 420 Mpa
Shear strength	50 – 250 Mpa
Elongation	11-13 %
Fatigue limit	350 Mpa
Thermalconductivity	0.57

2. UPPER PORTION OR MAIN BODY:

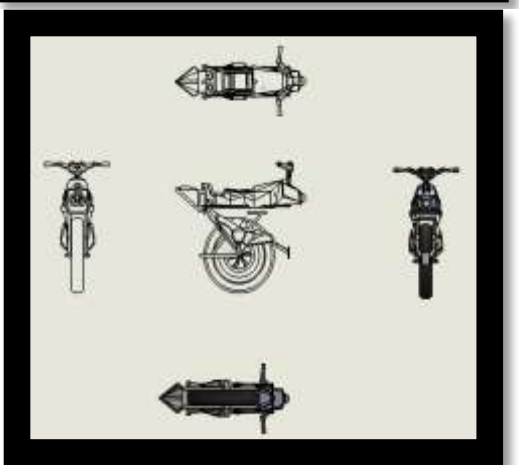
Upper Frame: In this frame the Battery, Microcontroller, Gyroscope, Accelerometer etc. are assemble.
This frame attaches with another frame which mounted on wheel hub axle.
This portion rotates 10 deg. both sides during the cornering.
It is linked with the lower portion via linkages.

SPECIFICATION:
Material: Aluminum (AA2011)

3. HANDLE BAR

Handle bar: The steering system is mounted on the balancing frame at the front end this steering mechanism is separate from the balancing system.
It is connected with lower portion via linkages.

V. THE COMPLETE DESIGN OF THE VEHICLE



VI. CONCLUSION

After testing it is concluded that the model of OWV has very improvised design and effective balancing system. The design of vehicle is totally unique having a very accurate steering system, and it is design in such a way that the forces are distributed all over the body and not only concentrated at any one portion. The balancing system worked effectively as shown in video (https://youtu.be/qhVlbwd3JTM) . The vehicle that I have designed is only for the short distance around 40-50 kms with the maximum speed around

30kmph. The vehicle is only design for the short distance used to travel like travelling for office or local travelling. However in actual model of balancing system I have to put 2 wheels due to the height that system gains and unavailability of wheel with bogger diameter. And the design was created on SOLIDWORKS its actual model is not made up. But in future balancing system can be easily obtain by the perfectly required components and the design is in such a way that it is very easy to fabricate.

REFERENCES

[1]. Aravindanvaradan, S. Krishnamoorth, RaghulShivakumar,PintuSah, P. kumar, "Mono Wheel Transportation System for Commotion Areas," International Journal of Innovative Technology and Exploring Engineering (IJITEE) ISSN: 2278-3075, Volume-9 Issue-2, December 2019.

[2]. Sreevaram Rufus Nireekshan Kumar, Bangaru Akashand T. Thaj Mary Delsy, "Designing the Mono Wheel by Using Self Balancing Technique",IJCTA, 9(4), 2016, pp. 29-34.

[3]. Gheorghe DELIU, Mariana DELIU, "MONOWHEEL DYNAMICS,"International Conference on Economic Engineering and Manufacturing Systems, Braşov, 26 – 27 November 2009.

[4]. Shatakshi Singh,"FABRICATION AND DESIGN OF MONOBIKE,"Asia Pacific Journal,DOI:10.16962/EAPJMRM/ISSN2349-2317/2014, Volume 10 Issue 3.

[5]. Mukesh Sahu, Naved Shaikh, Saurabh Jadhao, Yash Yadav, A Review of One Wheel Motorbike, IRJET, Volume: 04 Issue: 03 | Mar -2017.