

DESIGN, MODELLING, ANALYSIS AND FABRICATION OF ELECTRIC MONO WHEEL BIKE

A PROJECT REPORT

Submitted by

G. GOPALA KRISHNA REDDY	(18104078)
P.V. NAVEEN KUMAR	(18104082)
M. JAYANTH REDDY	(18104095)
M. SAI KUMAR	(18104096)

In partial fulfillment for the award of the degree of

BACHELOR OF TECHNOLOGY

in

AUTOMOBILE ENGINEERING



HINDUSTAN
INSTITUTE OF TECHNOLOGY & SCIENCE
(DEEMED TO BE UNIVERSITY)
—————CHENNAI—————

DEPARTMENT OF AUTOMOBILE ENGINEERING

SCHOOL OF MECHANICAL SCIENCES

HINDUSTAN INSTITUTE OF TECHNOLOGY & SCIENCE

PADUR, CHENNAI-603103

MAY 2022



HINDUSTAN
INSTITUTE OF TECHNOLOGY & SCIENCE
(DEEMED TO BE UNIVERSITY)
CHENNAI

BONAFIDE CERTIFICATE

Certified that this project titled “**Design, Modelling, Analysis and Fabrication of Electric Mono Wheel Bike**” is the Bonafide work of **G. Gopala Krishna Reddy (18104078), P. V. Naveen Kumar (18104082), M. Jayanth Reddy (18104095), M. Sai Kumar (18104096)** who carried out the work under my supervision. Certified further that to the best of my knowledge the work reported herein does not form part of any other thesis or dissertation and based on which a degree or award was conferred on an earlier occasion on this or any other candidate.

HEAD OF THE DEPARTMENT

Dr. M. Jai Kumar
Professor and head
Department of Automobile Engineering
Hindustan Institute of Technology &
science
padur, Chennai-603103

SUPERVISOR

Dr. C. Prasad
Assistant Professor (SG)
Department of Automobile Engineering
Hindustan Institute of Technology &
science
padur, Chennai-603103

The Project Viva-Voce Examination is held on_____

INTERNAL EXAMINER

EXTERNAL EXAMINER

ACKNOWLEDGEMENT

We express our heartfelt gratitude to our Chancellor **Dr. Mrs. Elizabeth Verghese** Pro-Chancellor **Dr. Anand Jacob Verghese** and Director **Mr. Ashok Verghese**, the Management of Hindustan Institute of Technology and Science for providing all the facilities to carry out this project. We also express my sincere thanks to our Vice Chancellor **Dr.S.N. Sridhara** for approving and allowing us to undertake this project.

We wish to express our heartfelt gratitude to **Dr. M. JaiKumar, Professor & Head of Department of Automobile Engineering** for much of his valuable support and encouragement in carrying out this work.

We would like to thank our supervisor **Dr. C. Prasad Assistant Professor (SG), Department of Automobile Engineering** for guiding and actively participating in our project, giving valuable suggestions to complete the project work.

We would like to thank **Dr. V. Ramanathan, Assistant Professor (SG) Department of Automobile Engineering** for guiding and actively participating in our project, giving valuable suggestions to complete the project work.

We would like to thank all the teaching and non-teaching staff of the Automobile Engineering department, who extended directly or indirectly all support. Last but not the least, we wish to avail ourselves of this opportunity, express a sense of gratitude and love to our friends and family for their support and blessings.

G. Gopala Krishna Reddy
P. V. Naveen Kumar
M. Jayanth Reddy
M. Sai Kumar

ABSTRACT

Mono wheel as the name indicates consists of a single wheel. the main principle involved is application of GYROSCOPE. The main aim of Monowheel is that it reduces the space occupied compared to other vehicle and environment friendly. Electrical vehicles can become a key to personal transportation in the environment where atmospheric pollution must be restricted, traffic conjunction is a severe issue and parking space is big concern especially in urban areas. Considering all these issues there is immense necessity of developing the transportation system that will be able to solve these problems. Developing a one-wheeled electric vehicle which has features that can over-come all the problems mentioned above since it has small longitudinal length and low carbon footprint.

An electric unicycle is a self-balancing personal transporter with a single wheel. The rider controls the speed by leaning forwards or backwards, and steers by twisting the unit using their feet. The self-balancing mechanism uses gyroscopes and accelerometers in a similar way to that used by the Segway PT.

TABLE OF CONTENT

CHAPTER NO	TITLE	PAGE NO
	ACKNOWLEDGEMENT	i
	ABSTRACT	ii
	LIST OF FIGURES	iv
1	INTRODUCTION	
	1.1. Overview	1
	1.2. Unicycle	2
	1.3 Mono wheel electric vehicle	2
	1.4 Working of mono wheel	3
	1.5 History of mono wheel	4
	1.6 Turning of mono wheel	5
	1.7 Construction of mono wheel EV	5
	1.8 Parts of mono wheel	8
	1.9 Steering	8
	1.9.1 Possible steering options	9
	1.10 Components of mono wheel	10

2	LITERATURE REVIEW	13
	2.1 Objectives	19
3	METHODOLOGY	20
	3.1 Components	20
	3.2 Design of mono wheel	24
	3.2.1 Outer wheel	24
	3.2.2 Inner wheel	25
	3.2.3 Friction wheel	26
	3.2.4 Roller	26
	3.2.5 Assembled model	27
	3.2.6 Fabrication	28
4	RESULTS AND DISCUSSION	29
5	CONCLUSION	33
	REFERENCES	34

LIST OF FIGURES

FIGURE NO.	TITLE	PAGE NO.
1	Mono wheel bike	3
2	Electric motor	6
3	Rechargeable battery	6
4	Motherboard	6
5	Gyroscope	7
6	Metal rod	7
7	Shaft	10
8	Coupling	10
9	Wheels	11
10	Outer wheel	20
11	Drive train	21
12	Lead acid battery	21
13	Outer wheel	24
14	Inner wheel	25
15	Assembled model	28
16	Analysis	33

CHAPTER 1

INTRODUCTION

1.1 OVERVIEW

Electrical vehicles can become a best way for transportation. In the environment where atmospheric pollution increasing by conventional vehicle must be restricted, traffic conjunction is also a major issue and parking space is big concern especially in urban areas. Considering all these issues there is immense necessity of developing the transportation system that will be able to solve these problems. Developing a one-wheeled electric vehicle which has features that can over-come all the problems mentioned above since it has small longitudinal length and low carbon footprint. Moreover, they are suitable for all age groups; and does not require any registration, taxes. Most humans can learn to ride a bike without any problem because humans are skilled to balancing laterally left to right and the gyroscopic effect of the wheels makes it easy to stay up once on the move. Remove one of the wheels to make it a unicycle and the tendency to topple backwards or forwards around the single axle is almost impossible to avoid. Seasoned unicyclists manage it by using the directly connected pedals to constantly adjusting the wheel backwards and forwards underneath them. Using gyroscope, accelerometers etc., monitor the orientation of the unicycle and via a processor, and a bunch of clever algorithms, a hub-mounted motor either speeds up or down to maintain axial forwards/backwards balance. Just like the Segway you lean slightly forward to go forward and back to brake.

1.2 UNICYCLE

Unicycle is mechanical cycle which has only single wheel. It consists frame with a saddle, and also has a pedal-driven direct drive. Unicycling is practiced professionally in circuses, and used by street performers, in festivals and as a hobby. It also been used in sports such as unicycle hockey. And also used in mountain cycling. Unicycle design has developed since the Penny Farting and later the advent of the first unicycle into many variations including seatless unicycle and tall unicycle.

1.3 MONOWHEEL ELECTRIC VEHICLE

A mono wheel electric vehicle is a type of unicycle that uses sensors, gyroscope, and accelerometer in conjunction with an electric motor to assist a rider with balancing on a single wheeled vehicle, to develop one wheeled electric vehicle for efficient working it is necessary to design electric drive carefully such that it is be able to meet the desired results. Electric drive components selected ought to be small so that actuating mechanism should be fitted inside the wheel. Where the vehicle has been driven in the consumption of lithium-ion battery, The monowheel electric vehicle consist of a A brushless DC motor (known as BLDC) is a permanent magnet synchronous electric motor which is driven by direct current which may having rated power 600w rated voltage of 64v it will give speed of 25km/h. MPU6050 IMU sensors usually consist of two or more parts. They are accelerometer, gyroscope, magnetometer and altimeter. The MPU6050 has 6 DOF (Degree of Freedom) or it is a six axis IMU sensor, which means it gives six values as output, three values from the accelerometer and three values from the gyroscope. The MPU6050 is a sensor based on MEMS (Micro Electromechanical Systems) technology. A monowheel electric vehicle

requires a hub motor controller It is a 600W 64V 5.4A motor controller with a power lock feature. It has a wide range of input/ output pins. The battery pack delivers 64V which is fed to the motor controller. The controller provides output to the motor controller with 3 phase wire and 5 control pins. It has 3 pin input connection for throttle and 2 pin for reversing the direction of motor. The hub motor controller controls the speed of the controller using the position values from the controller, it also requires a lithium-ion battery which gives 64v voltage and 600w power.



Fig- 1 Mono wheel bike

1.4 WORKING OF MONO WHEEL

A monowheel is different from a unicycle because the rider sits inside the wheel's circumference, rather than on top of it or outside it. Usually, a monowheel will have a circle-shaped frame with a moving track on the very outside, often made of rubber. Think of the track as a giant tyre that surrounds the monowheel it's what's responsible for moving the vehicle forward.

A monowheel works like a giant ball bearing. The driver and the engine anchor the inner wheel, while the engine propels the outer loop.

It stays upright through the same principles as gyroscope, As long as an external generates motion -- in this case, an engine (although some monowheels are pedal- powered) -- the vehicle will stay in motion.

Of course, turning one of these is tricky, too. A monowheel's lack of other wheels and somewhat awkward stance makes handling difficult. A rider will typically want to keep his or her feet close to the ground so the monowheel doesn't tip over completely. In addition, if it has a powerful engine, it's unlikely that all of the power can be used in this kind of setup. Its lack of stability when forward motion is taken away make braking especially difficult, too.

These (and a few other) attributes are what keep a monowheel from being the vehicle of the future as some people once thought it would be. You heard right at one time, there were predictions that vehicles with one wheel would replace cars and bikes on the road.

1.5 HISTORY OF MONO WHEEL

Monowheels have been around in one form or another since the 19th century. They began with an early bicycle design. After all, if something works with two wheels, could it also work with just one. The first monowheel designs appeared as early as 1869. Several of these featured a seat for the rider with pedals connected to a small wheel, which was in turn connected to the outside wheel. The rider pedals the small wheel, and that drives the large wheel, creating motion. Even at that time, the monowheel was recognized as a difficult means of transportation: One publication remarked that the vehicle was "impracticable for ordinary mortals".

By the early 20th century, inventors were experimenting with monowheels powered by actual engines, including a 150cc single-cylinder engine prototype from 1910 that today sits in the Auto & Technik Museum in Germany. Some designers also built monowheels

with air plane propellers up front to aid in steering. None of these designs ever became mass-produced.

In the 1930s, science magazines began featuring designs for car-like monowheels that were enclosed by metal and glass and could seat several people. One article even featured a monowheel tank equipped with a machine gun

For the next several decades, inventors would experiment with different monowheel designs although, arguably, not with the fervor that they had in the late 19th and early 20th centuries. By now, the drawbacks of a monowheel had been firmly established, and its practicality as an everyday vehicle for ordinary people was pretty much discounted.

But as you know, some ideas never die -- no matter how questionable they are. Up next, we'll look at monowheels today and concepts planned.

1.6 TURNING OF MONO WHEEL

A bicycle held straight up will tend to go straight. It is tempting to say that it stabilized by the gyroscopic action of the bicycle wheels, but the gyroscopic action is quite small. In terms of the stability of the bicycle when riding, the association with leaning and turning does hold true. The construction of a bicycle is such that a left lean does cause the front wheel to turn left, contributing a kind of self-stability to the bicycle. If you feel yourself unbalanced and leaning left, then turning left does help you correct the imbalance because the centrifugal force associated with the turn does tend to push the top of the bicycle back toward the vertical.

1.7 CONSTRUCTION OF MONO WHEEL EV

Each unicycle is composed of the same basic parts:

1.7.1 Electric motor (usually: a brushless DC one), built directly into the rim



Fig-2 BLDC Electric motor

A brushless DC electric motor (BLDC motor or BL motor), also known as an electronically commutated motor (ECM or EC motor) or synchronous DC motor, is a synchronous motor using a direct current (DC) electric power supply. It uses an electronic controller to switch DC currents to the motor windings producing magnetic fields which effectively rotate in space and which the permanent magnet rotor follows. The controller adjusts the phase and amplitude of the DC current pulses to control the speed and torque of the motor. This control system is an alternative to the mechanical commutator (brushes) used in many conventional electric motors.

1.7.2 Battery



Fig-3 Battery

A lithium-ion battery or Li-ion battery is a type of rechargeable battery composed of cells in which lithium ions move from the negative electrode through an electrolyte to the positive electrode during discharge and back when charging. Li-ion cells use an intercalated lithium compound as the material at the positive electrode and typically graphite at the negative electrode. Li-ion batteries have a high energy density, no memory effect (other than LFP cells) and low self-discharge. Cells can be manufactured to prioritize either energy or power density. They can however be a safety hazard since they contain flammable electrolytes and if damaged or incorrectly charged can lead to explosions and fire

1.8 PARTS OF MONO WHEEL

1. Rollers

Needs to be big and sturdy enough to sit in and allow the drive to make it move. I used a 50mm diameter steel tube with a wall thickness of about 3.5mm, shaped into a 1.5m hoop. For tread, I cut up bicycle tires and pop-riveted them on the outside of the ring.

These allow the outer ring to revolve around the inner frame. I used custom-made 100mm nylon rollers with ball races to allow free movement. Mine has four, some designs use more. If cost is an issue, you can use skateboard wheels set at an angle.

2. Inner frame

Holds the rollers, power source, drive, and seat. Experiment with positions but keep the centre of mass as low as possible for stability.

3. Power source

This could be a petrol engine, an electric motor, pedals, or even steam power. It comes down to personal preference and engineering ability.

4. Drive

Usually a friction-type drive. I use the wheel from a Mini Moto, running against the inside of the outer ring.

1..9 STEERING

In a bi-wheel mode of transportation, two systems (wheels) affect motion. Typically, one wheel provides the force to control speed, while the other handles changes in direction - steering. For a monowheel, both direction and speed are controlled through the same physical apparatus. As such one usually suffers for the other, but in this case, steering is usually more difficult. In the majority of systems, change in direction is affected by the rider shifting its weight, or in the sudden movement creating a shearing force between a handhold and the axis that the driver is settled on. Better control can usually be achieved at slower speeds. As expected, monowheels have never caught on as a widely accepted mode of transportation.

1.9.1 POSSIBLE STEERING OPTION

Because of the unique method of steering this type of vehicle, there are many used and theoretical ways to effect a change in direction. Several methods are as follows:

- Leaning. The most common steering solution is that the rider must lean towards his intended direction of travel to turn, and then centralize his weight again once the turn is complete.
- Turning a gyroscope to provide turning force.
- Outboard skids to provide friction drag on one side.
- At speeds faster than a walk, lightly dragging a foot on the ground will cause the wheel to lean to the opposite side. Drag the other foot to bring it back upright. Do not *dab* your foot as this will cause you to topple over.
- Small wheels used for steering, either one to each side or a single unit either in front of or behind the vehicle. It is a matter of debate as to whether such a vehicle would still properly be called a monowheel.
- Steerable propellers, which could provide both steering and power to move the vehicle. It has been noted that having a propeller operating near pedestrians would likely be quite unsafe.
- Steerable tail surfaces, similar to those on airplanes. This solution would not work at low speeds.

1.10 COMPONENTS OF MONO WHEEL



Fig-6 Metal rod

A shaft is a rotating machine element, usually circular in cross section, which is used to transmit power from one part to another, or from a machine which produces power to a machine which absorbs power.



Fig-7 Shaft

The term shaft usually refers to a component of circular cross-section that rotates and transmits power from a driving device, such as a motor or engine, through a machine. Shafts can carry gears, pulleys, and sprockets to transmit rotary motion and power via mating gears, belts, and chains.



Fig-9 Coupling

A coupling is a device used to connect two shafts together at their ends for the purpose of transmitting power. The primary purpose of couplings is to join two pieces of rotating equipment while permitting some degree of misalignment or end movement or both. In a more general context, a coupling can also be a mechanical device that serves to connect the ends of adjacent parts or objects. Couplings do not normally allow disconnection of shafts during operation, however there are torque-limiting couplings which can slip or disconnect when some torque limit is exceeded. Selection, installation and maintenance of couplings can lead to reduced maintenance time and maintenance cost.



Fig-10 Wheels

- Seat Robber
- Handle Rods
- Supporting frame
- Mounts & Joints

ADVANTAGES

- Due to the more vehicle population and pollution, there is a need of alternative options for automobile.
- To connect our personal electronic gears such as Tablet or Mobiles, there is a standard 12V DC socket just like in the dash of our car.
- Easily check remaining battery percentage, System Status, and other useful information on the easy-to-read and Digital display.
- For parking that's another aspect of the monowheel design. The front of the vehicle's frame comes together in a rubber footed bar. Simply tipping the vehicle forward rests it on the bar like an oversized kick.

CHAPTER 2

LITERATURE REVIEW

Craftsman Rousseau et al. Rousseau of Marseilles built a first mono cycle which is having a seating arrangement inside the monowheel, the rider steered the contraption by shifting his or her weight in the desired direction. As if that wasn't difficult enough, the massive outer wheel always remained directly in the driver's line of sight. Braking was also potentially hazardous, as stopping too abruptly would cause the rider to be propelled forward along with the outer wheel.

Bombardier et al. announced a conceptual design for such a device used as a sport vehicle, the Embryo. In which the vehicle is powered by a hydrogen fuel cell. Bombardier [2003]: He announced a conceptual design for such a device used as a sports vehicle, the Embroil. In which the vehicle is powered by a hydrogen fuel cell.

Trevor Blackwell et al. Demonstrated a functional self-balancing unicycle, using the control mechanism similar to that used by the Segway PT and published the designs as the unicycle. In which the unicycle consists only of a seat.

J. Suresh et al. Mono wheel as the name indicates consists of a single wheel. Driver of the wheel sits inside the wheel and the main principle involved is application of GYROSCOPE. The main aim of Mono wheel is that it reduces the space occupied when a single occupied vehicle is necessary and environment friendly. The main discipline of engineering that is applied is mechanical engineering where we find applications of topics like stress calculation, trusses, gyroscopic couple, and concepts of a circle etc .It can be both human powered or motor driven type.

Shatakshi Singh et al. Elk Asia Pacific Journal of Marketing and Retail Management, in this paper the work has been done on Mono bikes This machine can beat the problem of driving energy sources as well as pollution as they are the key problems of modern time. Mono wheels can be used in various places such as industries to travel between various working sites, in transportation, and in public, going to make the hardware of a mono bike, which we can drive like a bike but with few skills as it is a unibike. In this bike there is a self gyro sensor and accelerometer. Gyro Sensor and accelerometer will provide the input to the microcontroller and as according to this input to run as according to the required commands. which MEMS accelerometer and MEMS gyroscope both are integrated on a single chip. The microcontroller is Arduino uno which will run at 16MHz.

Sujata Shankar et al.: The monowheel is a one wheel which is driven by four stroke petrol engines; the power is transmitted from engine to friction wheel by using chain sprocket. There is outer wheel, inner frame and three rollers. The three rollers mounted between the outer wheel and inner frame. The outer wheel rotates relatively to the inner frame by using three rollers.

Sangeetha Krishnamoorthy et al. The project is about Mono-Wheel Bike. In these present economic statistics, the cost of fossil fuel is increasing day by day and the time taken to reach the destination with existing bike is very time consuming because of the road traffic. To give solution Mono-Wheel Bike has developed with Portable design in weight parameters where is easy to carry along with us also it gives hassle free drive for the user when passing in commotion area or road traffic it moves rapidly faster rather than the existing bike. The bike is powered with BLDC motor, and it is provided with secondary batterie

MOHD MERAJ et al. Both speed and direction are controlled through the same physical apparatus; this generally makes Steering more difficult. In a majority of systems, change in direction is affected by the rider shifting their weight, or in the sudden movement creating a shearing force between a hand hold and the Axis that the driver is settled on, better control can usually be achieved at lower speed. Outboard skids provide friction drag on one side.

DEEPAK CHANDRAN et al. Electric Vehicles and Driving Range Extension, Electric vehicles are gaining popularity due to their low carbon footprint and ease of integration with renewable energy. They are an important element in the smart grid ecosystem. Increasing the driving range of storage driven electric vehicles is the biggest challenge facing the lightweight electric vehicle industry. A literature review has been performed to identify various techniques to improve the driving range. Various methods of driving range improvement such as new storage topologies, switching techniques, motor configurations are studied. A new quantitative measure called as impact factor has been derived to see the effect of each technique on the driving range. Impact factor for different methods has been calculated. It is shown that increasing the storage capacity has the highest impact factor on the driving range.

S. V. PAVAN KUMAR et al.: The scope of this project is to design a rideable unicycle, primarily for transport. Therefore, the term 'self-balancing unicycle' is used to refer to a rideable unicycle in which roll stability is provided by a control system. This scope has led to a focus on four core values: practicality, user safety, marketability, and education. The idea of a practical unicycle, let alone a practical self-balancing unicycle, is often met with incredulity. In the public imagination, unicycles are comical devices employed by clowns with juggling balls, and unicyclists regularly endure such witty comments as, "lost a wheel, mate?" [4]. This may well be an example of 'tall poppy syndrome', as a unicycle is inherently difficult to learn and thus people find it easier to ridicule the idea

Dilip Sankar Reddy et al. electric motors First Test remind in London, and it is called dynosphere. later the very famous and well-equipped riot wheel was introduced in 2003. It contains the travels used to seated at the front of the wheel and it is well balanced with having heavy counterweight.

Sadat ali et al. the Rousseau mono wheel can be viewed as a unicycle riding of a large wheel by pedaling the unicycle the outer wheel revolves moving the unit forward no steering mechanism was provided.

Arjun Dave et al. one more important goal to design this bike to run less expensive this issue of balancing is reduced by using pendulum with but here we are using inverted pendulum is which has its weight and it's carried the form of simple mass and road to a full system mental.

Mukesh Sau et al. When it comes to self-balancing personal transportation devices, it's look like the Solo wheel, Honda U3- X, Uno and Segway could all be in for a little competition. Portland, Oregon based RYNO Motors is currently in the process of launching its own entry in the cool-little-electric vehicles race, which it appropriately calls the RYNO. It has just one wheel. Of nothing else, that feature will get riders noticed. Unlike some of its potential competitors, the RYNO is intended to take the place of a motorcycle. With a top speed of 25 mph and a range of up to 30 miles, it's intended for short distance, low speed jaunts, possibly even being ridden amongst pedestrians. The RYNO has a lithium phosphate battery that is said to recharge in just an hour and a half. The weight of RYNO is 160 Lbs. and the carrying capacity is up to 250 Lbs. It's turning radius ranges from zero to three feet (0.9 meters), and it can manage inclination up to 30 percent. Its auto balance system will first provide warning to the user, and then temporarily take control of machine.

SHATAKSHI SINGH et al.: In this paper the work has been done on mono by our way know which is based on the concept of unicycle this mission can beat the problem of driving energy shows as well as pollution as they are the key problems of modern time monowheel can be used in various places such as industries to travel between various working sites in transportation and in public areas also here in this. We are going to make the hardware of mono bike which we can drive as like bike but with fewer skills as it is saying the unibike.

BANGARU AKASH et al. mono wheels designed used to be personal vehicle to carry a human operator that sandstone and drive it in industries moment should walk long distance to travel from work on work site to another work site which will consume lot of human energy by using this mono wheel we can reduce human energy we can use this mobile industries to travel from one place to another place in recent years because of the global pollution and energy shortage automobiles and motorcycles are no longer the best food transportation the device which we proposed will consume energy from battery which will reduce pollution and it is very small compared to the other vehicle.

A. KADIS et al. In this paper the outcomes from a 1 year honours project to design build and control a self-balancing electric unicycle known as the messaging and presented the design of system along with the associated mechanical and electrical components is presented this is followed by a derivation of the system dynamics using the language and method which are simulated using Simulink a linear control strategy to stable eyes in the pitch direction is been proposed finally a comparison between the control systems results from the Simulink simulations and experimental results from the physical system is presented

YUSOF et al. Proceeding of mechanical engineering research, recently many investigations have been done regarding to the problems of controlling two wheel self-balancing workload this paper reviewed based on five previous journal in order to find out which method is suitable to design a self- balancing bicycle and it will focus on the control system of the structure, there are several ways in order to gyroscope, cmg mass balancing steering control and reaction wheel based on previous research the usage of cmg is the suitable choice since it can produce large amount of free it has no brown reaction forces and the system can be stable even when the bicycle is stationary.

Jasoon Moore et al. unicycles are inherently dynamically stable, and this stability can be beneficial to the handling qualities a dynamical model can predict the self-stability previous models determine the sensitivity of stability to changes in parameters, but we have often used after parameters. occurring in the equations of motion that were not possible to realistically change Independently mathematical model of a bicycle is developed and verified. the model is using together with a physical parameter generation algorithm to evaluate the dependence of four important casual design parameters of the self-stability.

Deekshith Sai et al. Mono wheel as the name indicates consists of a single wheel. Driver of the wheel sits inside the wheel and the main principle involved is application of GYROSCOPE. The main aim of Mono wheel is that it reduces the space occupied when a single occupied vehicle is necessary and environment friendly. The main discipline of engineering that is applied is mechanical engineering where we find applications of topics like stress calculation, trusses, gyroscopic couple, and concepts of a circle etc .It can be both human powered or motor driven type.

2.1 OBJECTIVE

- To achieve the body weight forcing the handlebar in the direction of turn.
- To be used as short distance transportation for a single person.
- To reduce the weight of the vehicle
- To improve the durability of the vehicle.
- To its limited speed, risk of accidents can be reduced.

CHAPTER-3

METHODOLOGY

3.1.1 Outer wheel & Frame configuration

The outer wheel of a monowheel bike is made up of hollow pipe, bent according to the required dimensions. The monowheel bike looks like a circular shaped doughnut. The inner frame is a hollow metal which holds the outer wheel and chassis with the help of smaller wheels which are pressed against the outer wheel.

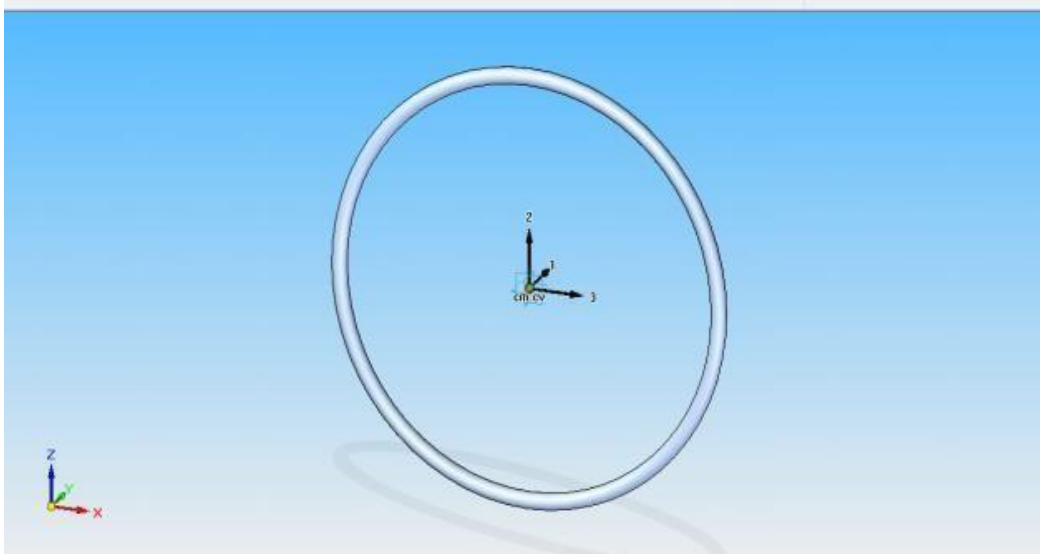


fig 11 Outer wheel

3.1.2 DRIVE TRAIN

The vehicle is driven by electric power. The motor will be made to rotate by alternating current supplied by the batteries. The AC is converted into DC by the controller.



fig 12 Drive train

3.1.3 BATTERY

Battery is a primary storage of the electric power and whenever power is required that time battery provides the power of the motor & vehicle drive. We used number of lead acid battery which are connected in series & produce output of 48 volts. These batteries are rechargeable with charger provided to them & it takes 6-7 hours for complete charge up of batteries.

BATTERY SPECIFICATIONS

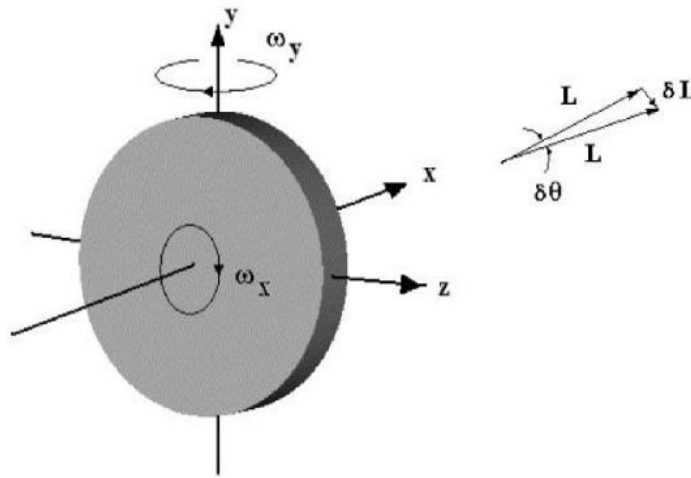
Types of battery	Lead-acid batteries
Voltage	48 volts (12 volts each)
Operating temperature range	-35°C to 45°C
Discharge rate	25Ah



fig 13 Lead acid batter

3.1.4 GYROSCOPE

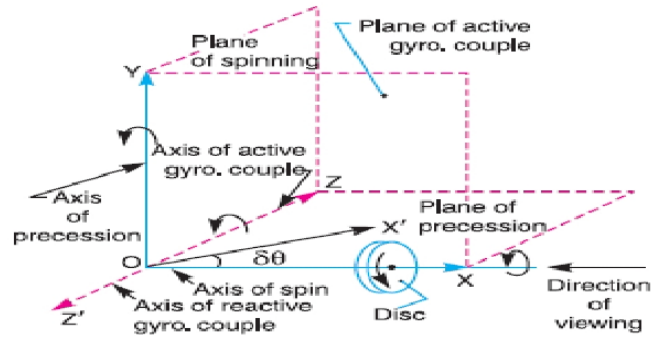
A gyroscope is a spinning mass arranged in gimbals which helps it to pivot in the x, y and z axis. Consider a wheel spinning about x axis with some angular velocity ω as shown in figure. Therefore, angular momentum of the wheel is given by $L = I\omega$



Force on rotating

So, change in angular momentum is given by $\Delta L = \delta (I \omega)$.

Hence because of this change in angular momentum, because of inertia, a gyroscopic torque will act on the wheel in z direction (amount of torque will see in next point). In short, a spinning disc given a small angular displacement in perpendicular direction, then it will experience a torque which will be in mutually perpendicular to those of two axes i.e. Z axis in this case.



Mutually perpendicular forces

X axis: Axis of rotation of wheel (spin axis)

Y axis: Axis of small angular displacement (input axis)

Z axis: Gyroscopic torque axis (output axis)

Change in Angular momentum is given by:

$$= ox' - ox = xx' = ox.\delta\theta \dots (\text{in the direction of } xx')$$

$$= I.\omega. \delta\theta$$

And rate of change of angular momentum:

$$= I.\omega. \delta\theta/dt$$

Torque applied to the disc causing the disc precession is given by:

$$T = \lim_{\delta t \rightarrow 0} I\omega. \delta\theta/\delta t = I.\omega. \delta\theta/dt$$

$$= I.\omega. \omega p \dots (\because d\theta/dt = \omega p)$$

From the above equation, we get to know that torque we can generate on a bike to balance is given by the product of moment of inertia of rotating mass, angular velocity of rotating mass and angular velocity of tilting motion of the mass.

ω =Angular velocity

p =Precision

θ =Angle of displacement

T=time

3.2 DESIGN OF MONOWHEEL

3.2.1 OUTER WHEEL

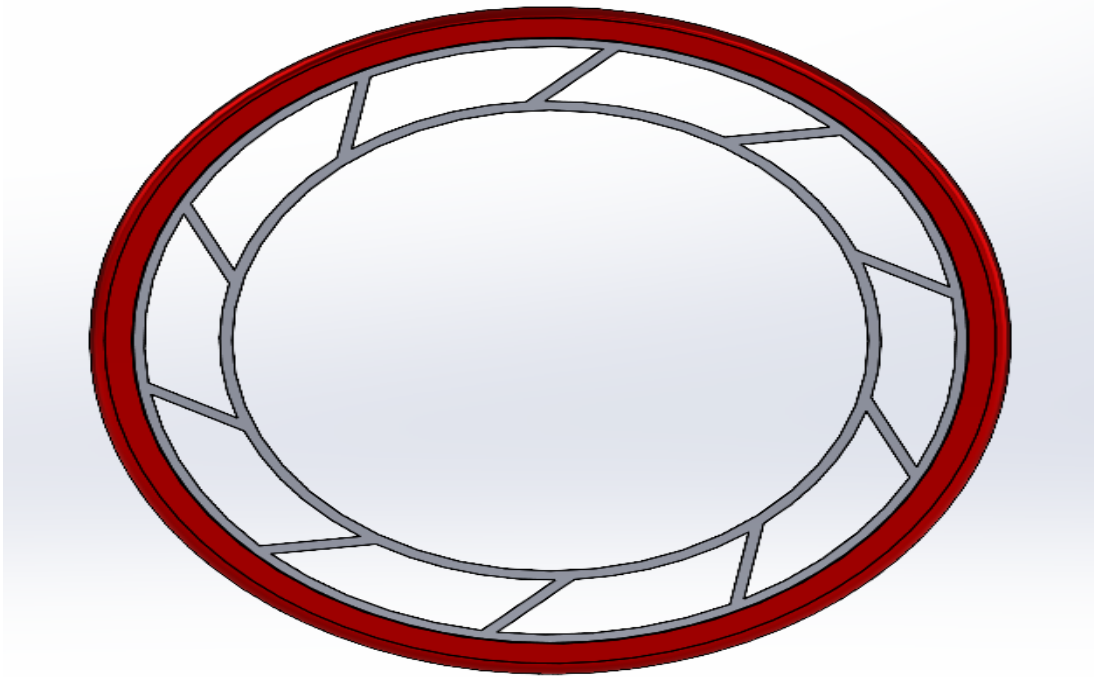


Fig-17: Outer wheel

Material used for this model is mild steel. The combination of materials that create low carbon steel gives the metal particular qualities that make it suitable for a variety of industrial projects and also make it a popular type of steel for steel fabrication companies to work with. Some of the physical properties of mild steel include.

The radius of the outer wheel is 970 millimeter and the material we used is mild steel, mechanical properties are suitable for automobile parts. This implies it tends to be expertly machined contrasted with harder steels.

Outer wheel is connected with the help of the inner wheel and the speed of the outer wheel is 60kmph, it gets the power from the rechargeable electric battery and bldc dc motor is connected to the friction wheel, friction wheel rotates the inner wheel and rollers are connected to the outer wheel.

3.2.2 INNER WHEEL

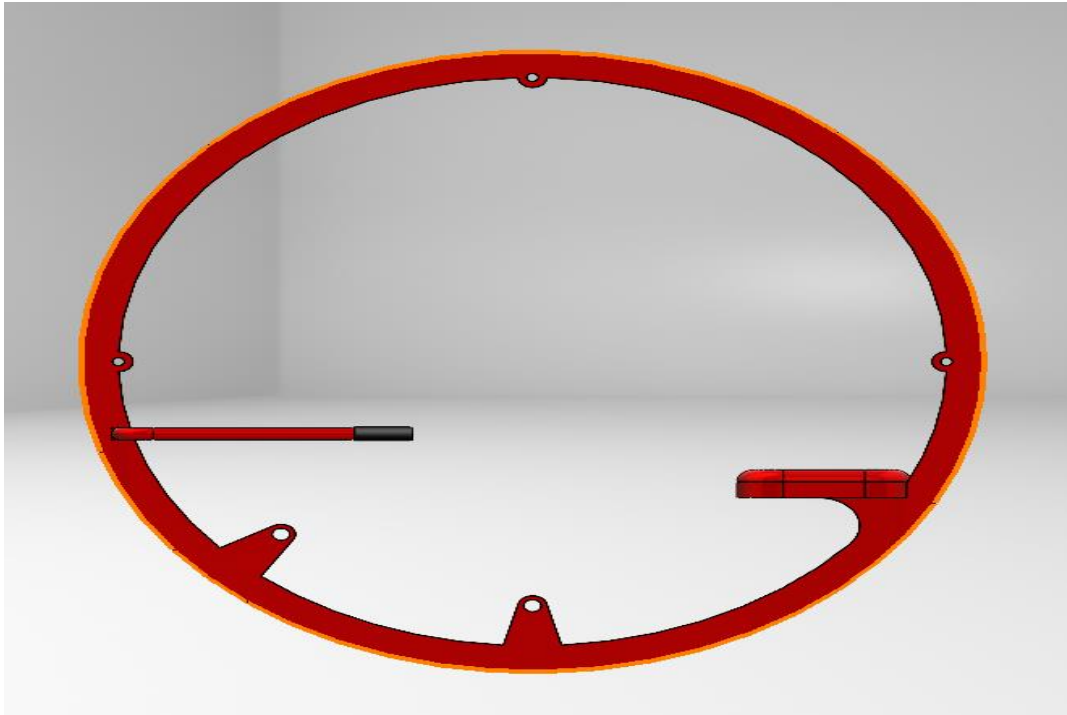


Fig 18 Inner wheel

The radius of the inner wheel is 710mm and it holds the rollers, power source, drive, and seat, but keep the center of mass as low as possible for stability.

Inner wheel is consists of handle, seat, rollers, motor ,friction wheel which helps to rotate the outer wheel were the inner wheel does not move and rotates only the outer wheel is only moves, it has holder which is helps to holds the friction wheel.

Material used for this is mild steel. Mild steel is a ferrous metal made from iron and carbon. It is a low-priced material with properties that are suitable for most general engineering applications. Low carbon mild steel has good magnetic properties due to its high iron content, it is therefore defined as being 'ferromagnetic'.

The main principle used for this mono wheel is gyroscope sensor which is self-balancing the vehicle.

3.2.3 FRICTION WHEEL

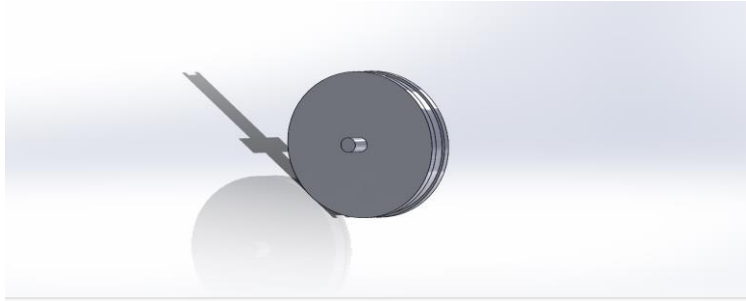


Fig-19: Friction wheel

Friction wheels are used in systems that use friction for power transmission in which the circumferential force used for movement is transmitted by the wheel by means of friction locking. The friction force transmitted is dependent on the wheel load and the coefficient of friction. The radius of the friction wheel is 29mm, friction wheel consists of a rubber compound and metal hub

3.2.4 ROLLER

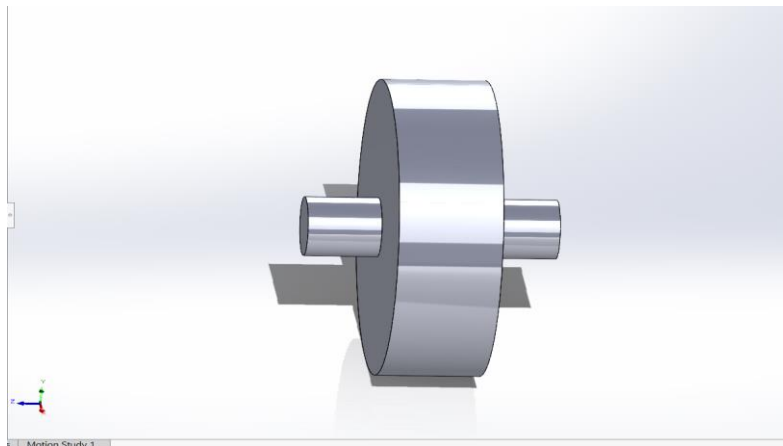


fig-20: Roller

The inner and outer frames are connected by a set of rollers. These small wheels let the inner frame stay upright as the outer frame rolls around it. That's why the driver doesn't spin inside the wheel. The outer frame spins while the driver's weight holds the inner frame in place. The diameter of the roller is 25mm.

3.2.5 ASSEMBLED MODEL

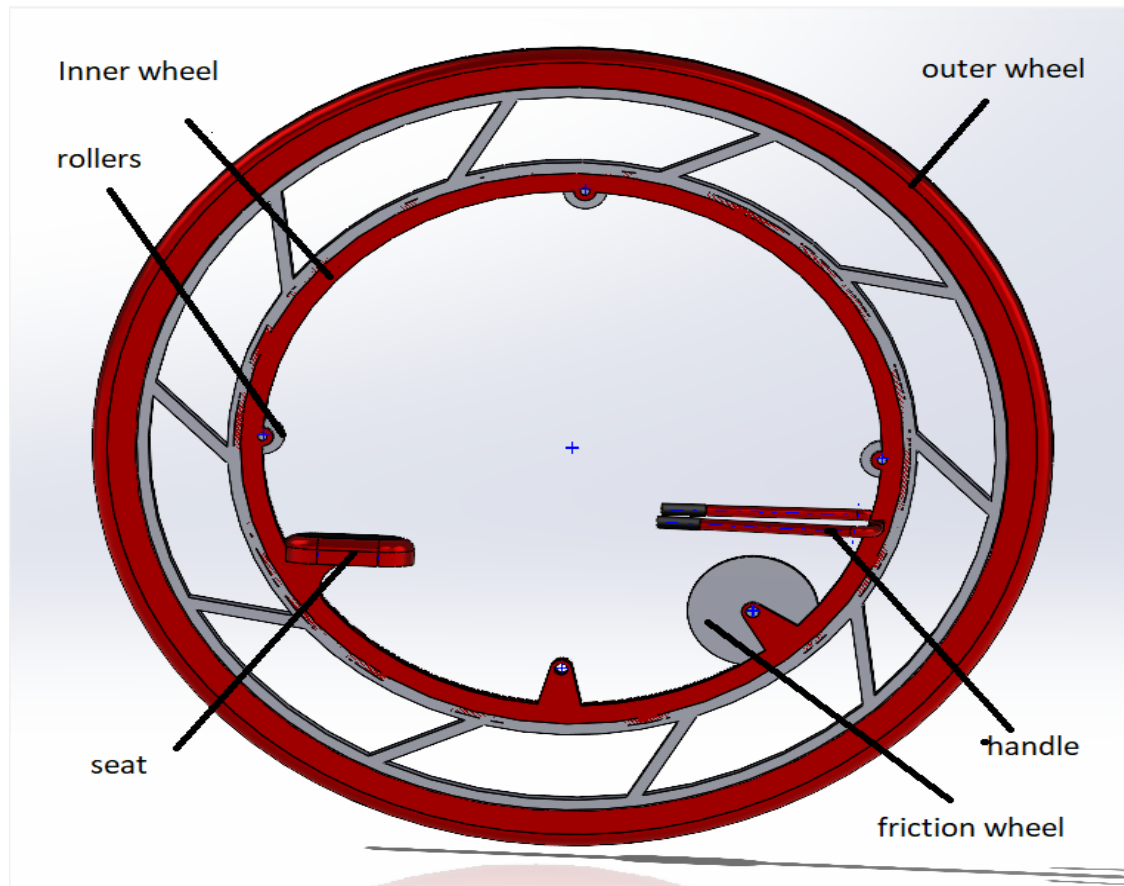


Fig-21: Assembled model

The total assembly of the mono wheel is shown in above fig-21, the main parts of the mono wheel are inner wheel, outer wheel, rollers, handle, seat, friction wheel, battery and a motor.

3.3 FABRICATION



fig-21: 3d model

3D printing is a new type of manufacturing and processing technology. Visually speaking, ordinary printers print graphics and text on 2D paper with ink, while 3D printers convert raw materials (such as metals, ceramics, plastics, etc.) into thin layers by heating, light, laser, etc. Then, like building a house, the layers are added up to form an entity in the space. Mainstream 3D printing technologies is FDM (fused deposition modelling). The FDM is the most common technology, which will be focused on in this article.

After slicing is complete, you can upload the slice file to the printer, and calibrate the printer to prepare for printing. The extruders and the printing base need to be calibrated, to improve the accuracy of printing. During the printing process, you can observe the printing process through the transparent panel of a Raise3D Pro2 Series printer, or you can also monitor the printing progress remotely through our APP Raise Cloud in real-time.

CHAPTER 4

RESULT AND DISCUSSION

STATIC STRUCTURAL ANALYSIS

4.1 MESH

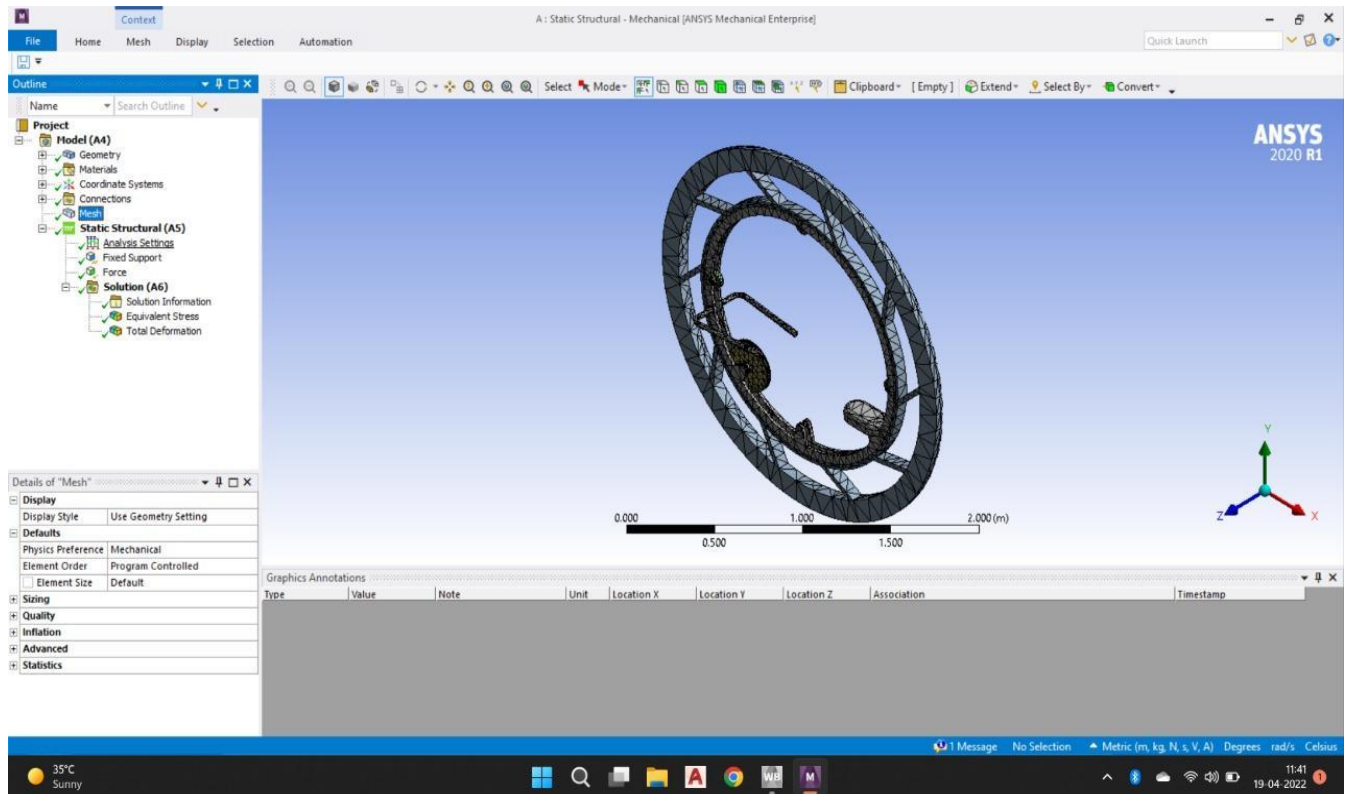


fig-22: Mesh

the meshing is done to improve the efficiency of the flow simulation and flow trajectory lines, total cells 34519, element size default ($2.044e^{-002}m$). Global mesh size sets a mesh size a that will be used as a default in the value in the process of overall meshing, global size applied only as a default value, meshing is very crucial step in design analysis. The automatic Mesher in the software generates a mesh base on a global element size, tolerance, and local mesh control specifications. Mesh control lets u specify different sizes of element for components, faces, edges, and vertices.

4.3 STATIC ANALYSIS

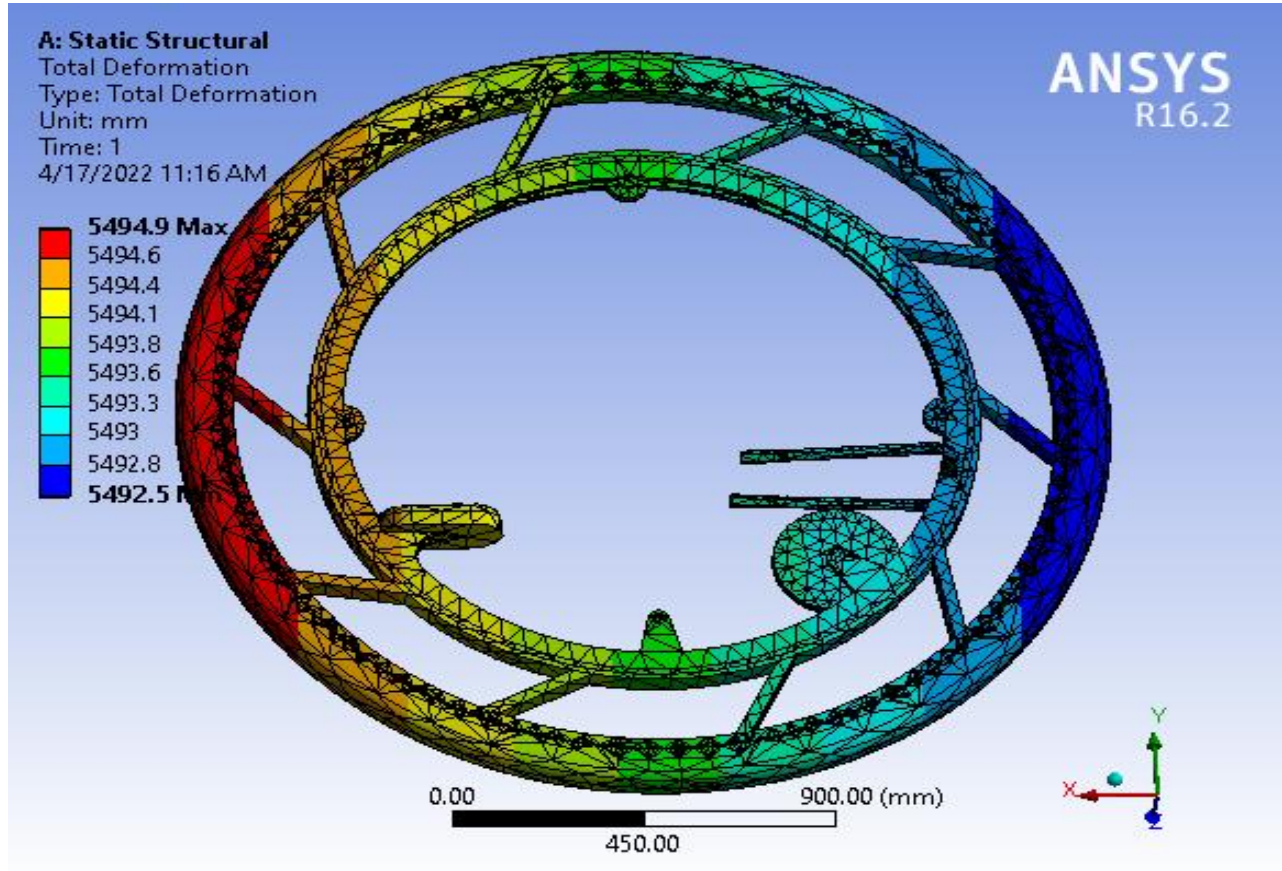


Fig-24: Static analysis

4.3.1 Stress Analysis Results

Maximum stress on the frame	7.060e5 pa
Minimum stress on the frame	1.2009e5 pa
Maximum deformation occurring on the frame	5494.9 mm

CHAPTER-5

CONCLUSION

The completion of our project results in the sleek design and self-balancing structure, which is helpful for customers to handle and drive easily. The air pollution and parking /spacing problems can be solved by electric features of our “Monowheel Electric Vehicle”. It produces very low noise, which reduces the sound pollution.

In the future monowheel is a research product in which continuous study on the existing design in the future helps it to increase its effectiveness to a greater extent.

This system reduces the work of humans as well as no pollution and provides an Eco-Friendly environment.

Before concluding, it is worth mentioning that this project would never have been possible without the tremendous amount of encouragement by the staff and guides of our department.

REFERENCES

1. Kavita Burse, Siddharth Shukla, Vikas Jain, "Study of Energy Saving Through Regenerative Braking in DC Drive", IJAIR ISSN: 2278-7844, 2012.
2. Karthik, Ashraf, Asif Mustafa Baig and Akshay Rao, "Self-Balancing Personal Transporter" 4th Student Conference on Research and Development, pp. 180-183, June. 2006.
3. M. Ehsani, K. M. Rahman, and H. A. Taliya, "Propulsion system design of electric and hybrid vehicles," IEEE Transactions on Industrial Electronics, vol. 44, pp. 19-27, 1997.
4. F. Salamis, "Control strategies for hybrid electric vehicles: Evolution, classification, comparison, and future trends," IEEE Trans. Veh. Technol., vol. 56, no. 5, pp. 2393–2404, 2007.
5. Krunal Shah, Vidhi Shah, Deepak Mistry, "Chopper Based Speed Control of DC Motor" International Journal of Electrical and Electronics Research, Vol. 3, Issue 1, pp: 254-259, 2015.
6. Chinnaiyan V. Kumar, Jerome Jorita, Karpagam, J. S. Sheikh Mohammed, "Design and Implementation of High-Power DC-DC converter and speed control of dc motor using TMS 320F240DSP", Proceedings of India International Conference on Power Electronics, 2006.
7. C. Huang, "The Development of Self-Balancing Controller for One-Wheeled Vehicles," Engineering, Vol. 2 No. 4, 2010, pp. 212-219.
8. Keagan Malan, Michael Coutlakis, James Braid, "Design and Development of a prototype Super-Capacitor Powered Electric Bicycle", IEEE International Energy Conference (ENERGYCON), Cavtat, pp. 1434-1439, 2014

9. Mrs.Lekhsmy. S, Aleesha George, Athira C.V, “Self-Balancing Robot”,
- 10.International Journal of Computer Engineering in Research Trend, Volume2, Issue 12, pp.1091-1095, December-2015
- 11.Lindsay G, Macmillan A, Woodward A, “Moving urban trips from cars to bicycles: impact on health and emissions”, Australian and New Zealand Journal of Public Health, Volume 35, Issue 1, pages 54–60, February 2011
- 12.Varun Rohit Vadapalli, Hemanth Kumar Kella, T. Ravi Sekhar, David Samson, N. Avinash, “Speed Control of D.C. MOTOR Using Chopper”, International Journal of Electrical and Electronics Research, Vol. 3, Issue 1, pp: (289-295), Month: January - March 2015.
- 13.Felix Freiberger (2015), Saarland University, “On the Control of Self-Balancing Unicycles”, the problem of designing a self-balancing unicycle.
- 14.Botezatu D., Deliu, G.: The Study & Design of Monowheel Vehicle Model using CAD software. Proceedings of COMEC 2007 2nd International Conference, Transylvania University of Brasov, pg. 213-216, October 2007 Brasov, Romania.
- 15.International Advanced Research Journal in Science, Engineering Technology (IARJSET), J. Suresh & V. S. Subramanyam, July 2018, Design and Analysis of monowheel.
- 16.Mannyam sairam, Sitaram Sandeep, Oct 2014, International Journal of Engineering Research & Application (IJERA), “Fabrication of Mono Roue”, Vol 4, issue 10.
- 17.Felix Freiberger (2015), Saarland University, “On the Control of Self-Balancing Unicycles”, the problem of designing a self-balancing unicycle.
- 18.Botezatu D., Deliu, G.: The Study & Design of Monowheel Vehicle Model using CAD software. Proceedings of COMEC 2007 2nd International.

19. International Advanced Research Journal in Science, Engineering Technology (IARJSET), J. Suresh & V. S. Subramanyam, July 2018, Design and Analysis of monowheel, Vol 5, issue 7.
20. Mannyam sairam, Sitaram Sandeep, Oct 2014, International Journal of Engineering Research & Application (IJERA), "Fabrication of Mono Roue", Vol 4, issue 10.
21. s. Matey, A. Prabhu, "Design and Fabrication of Electric Bike" International Journal of Mechanical Engineering and Technology- Vol. 8 Issue 3- March 2017.
22. Carmelina Abagnale, Massimo Cardone , A dynamic model for the performance and environmental analysis of an innovative ebike, ScienceDirect Energy Procedia.
23. Nasser Hashernnia and Behzad Asaei, "Comparative Study of Using Different Electric Motors in the Electric Vehicles," Proceedings of the 2008 International Conference on Electrical Machines.
24. Department of Automobile Engineering Medi-caps Institute of Science Technology Indore, M.P.
25. Sreevaram Rufus Nireekthion Kumar, Bangaru Akash and T. Thaj Mary Delsy "Designing the Monowheel by Using Self Balancing technique", 2016.
26. Karthik, Ashraf, Asif Mustafa Baig And Akshay Rao, "Self Balancing Personal Transporter" 4th Student Conference on Research and Development, pp. 180-183, [11]. Plamen Petrov and Michel Parent, "Dynamics..
27. Plamen Petrov and Michel Parent, "Dynamic Modeling and Adaptive Motion Control of a Two-Wheeled Self-Balancing Vehicle for Personal Transport", 2010 13th International IEEE Annual Conference on Intelligent Transportation Systems, Madeira Island, Portugal.

INDIVIDUAL CONTRIBUTION

1. Maalavath. Sai Kumar

- Analysis
- Ppt editing
- Purchasing 3d model
- Collecting papers

2. Gogireddy Gopala Krishna Reddy

- Report content
- Report preparation
- Calculation of 2d components
- Collecting papers

3. P.V. Naveen Kumar

- 3d design in solid works
- 2d design in solid works
- Report editing
- Collecting papers

4. Maligireddy Jayanth Reddy

- Collecting papers
- Ppt content collection
- Report content
- Gyroscopic calculation

PO-PROJECT MAPPING

PO NO	PO DESCRIPTION	PROJECT MAPPING
PO 1	Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3
PO 2	Problem Analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	3
PO 3	Design Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	3
PO 4	Conduct Investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusion	2
PO 5	Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations	3
PO 6	The Engineer & Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety,	2

	legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.	
PO 7	Environment & Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.	3
PO 8	Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	3
PO 9	Individual & Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	3
PO 10	Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	2
PO 11	Project Management & Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.	2
PO 12	Life-Long Learning: Recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.	3

PSO PROJECT MAPPING

PSO NO	PSO DESCRIPTION	PROJECT MAPPING
PSO 1	Design, Analysis, Fabrication and Testing of vehicles, which enable the students to compete globally.	3
PSO 2	Carry out research in emission reductions, Environment friendly, pollution reduction and Electric vehicle for the benefit of the society and environment.	2