Monowheel

Research paper submitted in partial fulfillment of the requirement for the degree of

Bachelor of technology
in
mechanical engineering

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Introduction

A **monowheel** is a one-wheeled single-track vehicle similar to a unicycle. Instead of sitting above the wheel as in a unicycle, the rider sits either within the wheel or next to it. The wheel is a ring, usually driven by smaller wheels pressing against its inner rim. Most are single-passenger vehicles, though multi-passenger models have been built. Hand-cranked and pedal-powered monowheels were patented and built in the late 19th century; most built in the 20th century have been motorized. Some modern builders refer to these vehicles as **monocycles**, though that term is also sometimes used to describe motorized unicycles. Today, monowheels are generally built and used for fun and entertainment purposes, though from the 1860s through to the 1930s, they were proposed for use as serious transportation.

The world speed record for a motorized mono wheel is 98.464 km/h (61.18 mph).

1. Design

1.1 design of mono wheel

Then mono wheel with an effective power transmission system has to be designed such that it can be handled and controlled by a single person even in the rest position. The main and basic constraints that are being taken into consideration are :-

1. Height of the person riding the vehicle

2. Maximum weights that the vehicle can withstand

3. Power transmissions

1.2 height of the person riding the vehicle

According to the survey conducted an independent research organization average height of the person in india is 1.67m.this includes the people from both the genders .so the vehicle has been designed for people whose height lies in the range of 1.6m (5’ 2”)-1.8m (5’ 9”).the average length of a leg person is 1.0m and the height variation is mainly due to the variation in the growth of upper part of the body. So the vehicle accounts to a mean diameter of 1.4m of which 0.6m consists of the transmission system and the lower part of the body i.e. The legs and the lower abdomen manage this area of the vehicle and the upper part of the body occupy the rest of the

area. The key advantage of this design is that the rider can easily balance the entire vehicle with the help of his legs and the person can feel comfortable while riding the vehicle.

1.3 maximum weight the vehicle canwithstand

The vehicle that is fabricated should be able have a specification of the weight that it can bear. This is the maximum weight bearing capacity of the vehicle. So, we have taken into consideration that the maximum weight of the rider to be 80kgs.

2. Statement of the problem or hypothesis

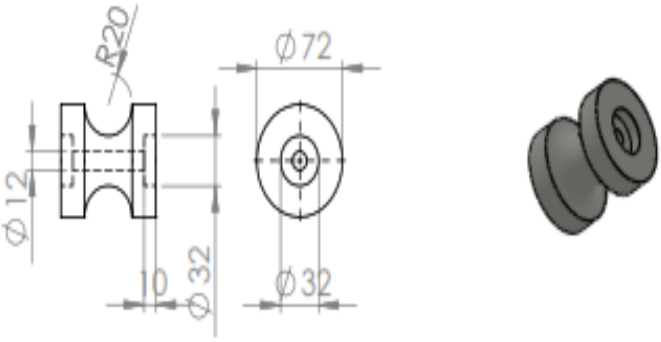
1. The monowheels are very unstable in low speed but very stable in speeds over 30km.

2. As we are talking about a stability of the vehicle we have to ensure that center of gravity and center of mass stays low so rider don't feel unstable when taking turn or vehicle doesn't falls to one direction.

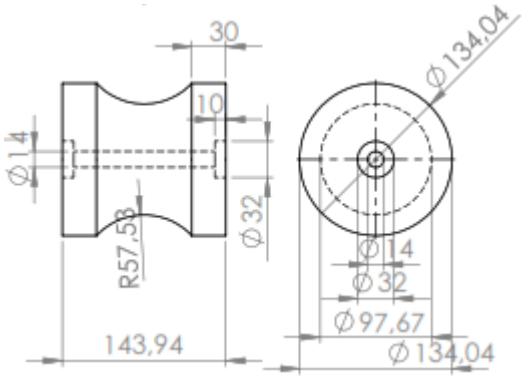
3. As for braking system instead of using hard braking we have to use soft braking.

3. Progress

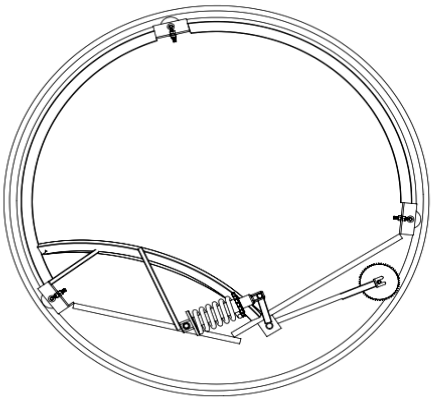
We have completed design phase 1 which includes main design of mono wheel and some parts design. Case study have to be done and proper analysis needed which will take around i week.



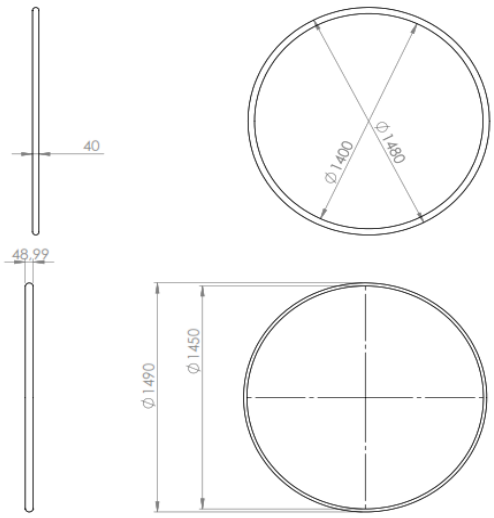
Supporting wheel



Driven wheel



basic design of mono wheel



Main wheel andtyre dimension

3.1 whatisclaimedits:

1.avehiclecomprising:awheelhavingadiameter,anouterperipheryofthewhelforcontacting asurfacefor movingrelativetothesurfaceasupportstructurecircumscribed bythe wheel,wherein thewheelrotatesaboutthesupportstructure;a propulsion systemcircumscribedbythewheelandconnectedtothesupportstructure,thepropulsion system beingcoupledtothewheelforrotatingthewheelaround thepropulsion system,thuspropellingthewheelalong thesurface;andanautomaticbalancingsystemcircumscribedbythewheelandconnected tothe supportstructure,thebalancing systemcomprising:aflywheelthatiscontrollabletospinaroundaflywheelspinaxis,theflywheelspinaxisbeingconnected to the supportstructurebyapivotthat isrotatable to orientthetheflywheel indifferentdirections, whereby changingadirectionofthetheflywheelspinaxis placesa torqueonthesupportstructure;andacontrolsystemconfiguredtoreceivesignalsfromoneormoresensorsinthevehicle providingbalancingapropulsionmotor;atransmission systemcoupledtothepropulsionmotor,thetransmission system providingadrivetorque;adifferentialgearassembly coupled tothetransmissionsystemandtothefirstwheelandthesecondwheel,the differentialgearassemblysplitting thedrivetorque between the firstwheel and the secondwheel while allowingthefirstwheelandthesecondwheeltorotateatdifferentspeeds;andasteeringassemblycoupletothedifferentialgearassembly,thesteeringassemblycomprisingasteeringmotor,thesteeringassemblybeingconfiguredtosupplyasteeringtorquetothedrive torque,wherethesteeringtorque isoppositelyappliedtothefirstwheelandsecondwheel tocontrol relativerotations ofthefirstwheel andthesecondwheel,enablingthefirstwheel andtheseCondwheeltorotateinoppositedirectionstoturnthevehicle.

2.the vehicle ofclaim**1**whereinthewheelisafirstwheel,thevehiclefurthercomprising

asecondwheel,whereinthesupportstructure,propulsion system,andbalancing systemarecircumscribedbythefirst wheelandthesecondwheel, whereinthefirstwheelandthesecondwheelarecoupled to thepropulsionsystemsuchthatthefirstwheelandthesecond wheel

3.Thevehicleof claim**1** whereinthepropulsion systemcomprisesa propulsionmotorandtransmission couplingthe propulsionmotortothewheel.

4.Thevehicleofclaim**1**whereinthecontrolsystemorients theflywheelindifferentdirectiontosteerthevehicle.

5.Thevehicle ofclaim**1** wherein theflywheelisafirst flywheel, thevehicle furthercomprising asecondflywheel thatiscontrollabletospinaroundits associatedflywheel spin axis,theassociatedflywheelspinaxisbeingconnectedto theseCondwheelare coaxial andthewheelarepiratedbyalmost20o%1 ofonewheeldiameter.

6. thevehicleofclaimwhereinthesecondflywheelis configured tocancelanyunwantedtorquegenerated bythe firstflywheel.

7. thevehicleofclaim**1**whereinthecontrolsystemcompriesaflywheelorientation motorcoupledtotheflywheel spinaxistochange the directionoftheflywheelspinaxis.

8.thevehicleofclaim**1**whereinthecontrolsystemcomprises abraking structurethat decelerates rotation ofthe flywheel toprovideatorqueonthe supportstructurefor changingatiltothevehicle.

9.the vehicleofclaim**1**whereintheflywheel comprisesamotorthatrotates abouttheflywheel spinaxis,thecontrol systemcomprisingapowersystemcoupledtothemotor ,thecontrol systembeingconfiguredtosupplydifferentdrivesignalstothemotortovaryarotationalspeedofthemotorto adjustheattitudeofthevehicle.

10. Thevehicle ofclaim **1** wherein thewheel is afirstwheel, the vehicle further comprising a secondwheel, whereinthesupportstructure,propulsionsystem,andbalancingsystemarecircumscribedbythefirstwheelandthesecondwheel,whereinthefirstwheelandthesecondwheelare coupledtothepropulsionsystemsuchthatthefirstwheeland thesecondwheelmayrotateatdifferentspeeds,andwhereinthepropulsionsystemcomprises:thefirstwheelfor contactingafirst portionofasurface;asecond wheelhavingadiameterequaltothefirstdiameter,anouterperipheryofthesecondwheelcontactinga secondportionofthesurface;asupportstructurecircumscribedbythefirstwheelandthe secondwheel,wherein thefirstwheel andthesecond wheelrotateaboutthesupportstructure;apropulsionsystemcircumscribedbythefirstwheelandthesecondwheelandconnectedtothesupportstructure, thepropulsion system beingcoupledtothefirstwheel andthesecondwheelforrotatingthefirstwheelandthe second wheelaroundthepropulsion systeminasame directiontopropelthevehicleinaforwarddirection,the propulsion system providingadrivetorquetothefirst wheelandthesecondwheel;anda steering assembly coupled tothe firstwheel andthe secondwheel,thesteeringassemblycomprisingasteeringmotor,the steeringassembly being configured to supplyasteering torquetothedrivetorque,wherethe steeringtorque isoppositely appliedtothefirstwheel andsecondwheeltocontrolrelativerotationsofthefirst wheelandthesecondwheel,enablingthefirstwheeland thesecond wheeltorotateinoppositedirectionstoturn

thevehiclewhenthefirstwheelandthesecondwheelare bothincontactwiththesurface.

11.thevehicle ofclaim **1** wherein thevehicle hasroll,pitch,andyawaxes,andwherein theautomatic balancing systemprovidestorquesabouttheroll,pitch,andyawax es.information,thecontrolsystembeingcoupledtothe 20pivottoorientthe flywheelin different directionsto adjustanattitudeofthevehicleformaintaining balanceofthevehicle.

12.thevehicleofclaim**1**whereintheoneormoresensors compriseaplurality ofattitudesensorsfordetermining orientationofthevehicle.

13.thevehicleofclaim**1**whereinacenterofmassofthe vehicleislocatedbelowanaxisofrotationofthewheel.

14. Thevehicle ofclaim **1** wherein thewheel is afirst wheel, the vehicle further comprising a second wheel, whereinthesupportstructure,propulsionsystem,andb alancingsystemarecircumscribedbythefirst wheelandthesecondwheel,whereinaxesofrotationoft hefirstwheelandthewheelmayrotateatdifferentspeed s.

15.thevehicleofclaim**1**whereinthewheelcomprisesa tire,wherein aprofileofthetireperpendiculartothetire's diameter isacurve,thecurvebeingconvexawayfromthecenterof massofthevehiclesuchthatthevehicle'scenterofmass isataminimum gravitationalpotential energystateat zeroleanofthevehicle.

16.avehiclecomprising:afirstwheelhavingafirstdiam eter,anouterperipheryofsupportstructurebyanassoci ated pivotthatisrotatable to orientthesecondflywheel indifferentdirections,whereby changing adirection ofthe associated flywheel spinaxis placesatorqueonthesupportstructure.

17.thevehicle ofclaim**16**wherein thedrivetorqueis substantially zerowhenthesteering assemblyrotatesthefirst wheelandthesecondwheelinoppositedirections.

18.thevehicleofclaim**16**whereinthepropulsion system comprises:apropulsionmotor;atransmission systemcoupledtothepropulsionmotor,the transmission systemprovidingthedrivetorque;andadifferentialgea rassembly coupled tothetransmission systemandtothefirstwheelandthesecondwheel,the differentialgear assembly splittingthe drive torque between thefirstwheel andthesecondwheelthereby allowingthefirstwheelandthesecondwheeltorotateat differentspeeds,whereinthesteeringassemblyiscoupl edtothedifferentialgearassembly.

19.thevehicleofclaim**16**whereinthepropulsionsyste m comprises:adifferentialgearassembly,thedifferential gearassemblycomprisingafirst differentialgearcoupledtothefirst wheelandasecond differentialgearcoupledtothesecondwheel,thedifferentialgearassembly splittingthedrive torquebetween the firstwheel andthe second wheelthereby allowingthefirstwheelandthesecond wheeltorotateatdifferentspeeds;whereinthesteeringa ssembly comprises asteeringgearengagingthefirstdifferentialgearandth eseconddifferentialgear,the steeringgearbeing coupled tothe steeringmotorforrotatingthesteeringgeartocausethef irstdifferentialgearandtheseconddifferentialgearto rotateinoppositedirections.

20.thevehicleofclaim**19**whereinthesteeringgearisa piniongearthatengagesteethofthefirstdifferentialgea rand theseconddifferentialgear,whereinthepiniongearrot ates

aboutitsaxisofrotationtorotatethefirstdifferentialgearandtheseconddifferentialgearinoppositedirections.

21.thevehicleofclaim**20**whereinthepiniongearalso rotates inaplane parallel tofirstdifferentialgearandthe seconddifferentialgear when the vehicle is moving ina forwarddirection.

22.amethod forautomaticallybalancingavehicle, thevehicle being ofthe type comprising awheel, the wheel havingadiameter,anouterperiphery ofthewheelforcontactingasurfaceformovingrelativet othesurface,thevehicle furtherincludingasupportstructurecircumscribedby the wheel,whereinthewheelrotatesaboutthesupportstructure,the vehicle furtherincludingapropulsionsystemcircumscribed bythewheelandconnectedtothesupportstructure,thep ropulsionsystembeingcoupledtothewheelforrotating thewheelaroundthepropulsionsystem,thuspropellin gthewheelalongthesurface,thevehiclerequiring anautomatic balancing systemtobeinabalanced state,themethodcomprising:providingaflywheel, circumscribed bythe wheel, that spinsaroundaflywheelspinaxis,theflywheelspinaxis beingconnectedtothesupportstructurebyapivot;sensi nganimbalanceinthevehicle;andinresponsetosensin gtheimbalance,automaticallyrotatingtheflywheelaro undthepivottochangeadirectionof the flywheel spinaxis so astoplace atorqueonthe supportstructuretoadjustanattitudeofthevehicle.

23.themethodofclaim**22**furthercomprisingchanging arotational speedoftheflywheelaroundthespinaxistherebyplacin gatorqueonthesupportstructuretoadjust anattitude ofthevehicleformaintaining balanceofthevehicle.

24.themethodofclaim**23**whereinchangingarotationa lspeedofthefl y w h e e l around t h e spinaxis comprisesrollaxis beingparalleltothesurfaceincontactwiththewheel andinthedirectionofmovementofthevehicle.

25.themethodofclaim**22**whereinrotatingtheflywheel aroundthepivotcorrectsforimbalanceaboutarollaxis,t hedirection topropelthe vehicle inaforwarddirection,the propulsionsystemprovidingadrivetorquetothefirst wheel andthesecondwheel;themethodcomprising:providin g asteeringassembly coupledtothefirstwheel andthesecondwheel,thesteeringassemblycomprisin g asteeringmotor,separatefrom thepropulsionsystem; andactuatingthesteeringmotortosupplyasteeringtor quetothedrive torque,wherethesteering torqueisoppositely appliedtothefirstwheel andsecondwheeltocontrol relativerotationsofthefirstwheelandthesecondwheel enablingthefirstwheelandthesecondwheeltorotatein opposite directions totum thevehicle when the firstwheelandthesecondwheelarebothincontactwitht he surface.

26.the methodofclaim**22**furthercomprisingrotatingthe flywheel around thepivot, so astoplace atorqueonthe supportstructure,causingthevehicletolean in ordertosteer thevehicle.

27.themethodofclaim**22**furthercomprisingchanging arotationalspeedoftheflywheelaroundthespinaxis,so asto placeatorqueonthesupportstructure,causingthevehic leto leaninordertosteerthevehicle.

28.the methodofclaim**22**furthercomprisingperforming atleastoneofrotating the flywheel around thepivot and changingarotational speedoftheflywheelaroundthespin axisforrightingthevehiclefromahorizontalposition.

29.themethodofclaim**28**whereinthevehiclehasaroll axis,whereinrightingthevehiclefromahorizontal position comprises:establishingafirst angularmomentumoftheflywheelorientedsubstantial lyparalleltotherollaxis;and changingtheangular momentum tocause areactionarytorque,rightingthevehicle.

30.themethodofclaim**29**whereinchangingtheangular momentum comprisesbrakingtheflywheel.

31.themethodofclaim**30**whereinbrakingtheflywheel is sufficientlyrapid tocause the vehicle toexperience an aerialphaseasitisrighted,wherethevehicleistemporari ly notincontactwiththesurface.

32.themethodofclaim**22**whereinsensinganimbalanc einthe vehicle androtating the flywheel around the pivot comprises:determining apresentattitudevectoroftthevehicle;determining anet torquevectorthat, ifprovidedtothe vehicle,wouldprovidean accelerationaboutroll,pitch, andyawaxesofthevehicle;determining controlsignalsneededtochangeanangularmomentum oftheflywheel;andapplying said control signals to produce a desired net torquevector.

33.themethodofclaim**22**whereinsensinganimbalanc e inthe vehicle androtating the flywheel around the pivot comprises:determining apresentattitudevectoroftthevehicleandatimerateofc hangeoftheattitudevector;determining anet torquevectorthat, ifprovidedtothe vehicle,wouldprovidean accelerationaboutroll,pitch, andyawaxesofthevehicle;determining controlsignalsneededtochangeanangularmomentum oftheflywheel;andapplying said control signals to produce a desired net torquevector.

34.amethodforsteeringavehicle,thevehiclebeingofth e typehaving afirstwheel having afirstdiameter, anouter periphery of thefirstwheel contacting afirstportion ofa surface,thevehiclealsoincludingasecond wheelhavinga diameterequaltothefirstdiameter,anouterperipheryof the secondwheelcontactingasecondportionofthesurface ,the vehiclealsoincludingasupportstructurecircumscrib edby thefirstwheelandthesecondwheel,whereinthefirstwh eel andthesecond wheelrotateaboutthesupportstructure,the vehiclealsoincludingapropulsionsystemcircumscri bedby thefirstwheel andthe secondwheel andconnected tothe supportstructure,thepropulsionsystembeingcoupled tothe firstwheelandthesecondwheelforrotatingthefirstwhe el andthesecondwheelaroundthepropulsion systeminasamemechanically brakingtheflywheel.

35.themethodofclaim**34**whereinthepropulsion systemcomprises adifferentialgearassembly,thedifferentialgear assembly comprisingafirstdifferentialgearcoupledtothefirstw heelandaseconddifferentialgearcoupledtothesecond wheel,thedifferentialgearassembly splittingthedrive torquebetweenthefirstwheelandthesecondwheelwhi leasecondoutputshaftcoupledtoasecondwheelforrot atingthe secondwheel, the secondoutput shaftbeing coupledtotheseconddifferentialgearsuchthatrotatio n ofthseconddifferentialgearrotatesthesecondwheel adifferentialgearcouplingengagingboththefirst differential gear and the second differential gear so asto substantiallyevenly splitafirstinputtorquefromthe

firstrotatingelementbetweenthefirstoutputshaftand thesecondoutputshaft;andasecondrotatingelementdr ivenbyaseconddrivesystem, thesecond rotatingelementengagingthefirstdifferentialgearandt hesecond differentialgear,whereinrotatingthesecondrotatingel ementchangesatorqueapplied tothe firstdifferential gearby afirstmagnitude and changesa torqueappliedtothesecond differentialgear byasecondmagnitude oppositetothefirst magnitude.

36.themethodofclaim**35**whereinthesteeringgearisapi nongearthatengagesteethofthefirstdifferentialgeara ndtheseconddifferentialgear,whereinthepiniongearr otates aboutitsaxisofrotationtorotatethefirstdifferentialgea randtheseconddifferentialgearinoppositedirections.

37.themethodofclaim**36**whereinthepiniongearalso rotatesinaplaneparalleltothefirstdifferentialgearandt he seconddifferentialgear when the vehicle is moving ina forwarddirection.

38.adifferentialgearassemblycomprising:afirstrotati ng elementdrivenbyafirstdrivesystem;afirstdifferential gearcoupledtothefirstrotatingelement.

39.thedifferentialgearassemblyofclaim38whereinth e secondrotatingelementcomprisesapiniongearthateng ages teeth ofthe first differential gear and teeth of the second allowing the first wheel and the second wheel to rotate at different speeds, and wherein the steering assembly compasses a steering gear engaging the first differential gear and the second differential gear, the steering gear being coupled to the steering motor, the method further comprising: differential gear, wherein the pinion gear rotates about its axis of rotation to change the torque applied to the first differential gear by the first magnitude and change the torque applied to the second differential gear by the second magnitude opposite to the first magnitude actuating the steering motor for rotating the steering gear to cause the first differential gear and the second differential gear to rotate in opposite directions.

40.thedifferentialgearassemblyofclaim39whereinth e teethofthefirstdifferentialgearandtheteethofthesecon nddifferentialgearfaceeachother,andwhereinthepini ongear issandwichedbetweenthefirstdifferentialgearandthe seconddifferentialgear.

41.thedifferentialgearassemblyofclaim40whereinth e piniongearhasashaftthatextendsbeyondaperipheryofth he firstdifferential gearandtheseconddifferentialgear,whereintheshafti sengagedandrotatedbythesecondrotating element.

42.thedifferentialgearassemblyofclaim41wherein the pinion gear, by simultaneously engaging the teeth of the first differential gear and the teeth of the second differential gear, revolves around an axis of rotation of the first differential gear and the second differential gear while also allowing thepin whereinrotationofthefirst rotatingelementrotatesthefirstdifferentialgear;afirst outputshaftcoupledtoafirstwheelforrotatingthe firstwheel,thefirstoutputshaftbeingcoupledtothefirst differentialgearsuchthat rotationofthefirstdifferential gearrotatesthefirst wheel;asecond differentialgearcoupledtothefirstdifferential gearsoastoallowthesecond differentialgearandthe firstdifferentialgeartorotateatdifferentspeeds; angeartoindependently rotateaboutitsaxisofrotation.

43.thedifferentialgearassemblyofclaim42whereinth e secondrotating elementcomprisesaringgearthatcircumscribesthefirs tdifferentialgearandthesecond differential gear,theringgearengagingteethformedaroundthepini

ongearshaft,wherein rotation oftheringgearbytheseconddrivesystemrotatesthepiniongearaboutitsaxisofrotation.

4. Working methodology

We have to start our structure by making a big, metallic wheel with 140cm diameter using a tube of 40mm diameter. Then, we have to line the metallic wheel with a rubber in order to achieve having the benefits that all the tyres have on the street. Also, due to the fact that the wheel is big in size, we took 4 tyres from small motorbikes and we cut they as well as we glued the one with the other in order to form a tyre. Afterwards, we made 3 wheels with a bearing using teflon ptfe and on which the big wheel rolls. These three wheels were attached with the inside part of the wheel on a framework. On this framework, another machine 110cc 4 stroke was placed. This machine using a chain, enables a rubber wheel to move so this wheel enables the big