Mono Wheel Electric Vehicle

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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.

Index: Electric vehicle, Mono wheel, Hub motor, Lithum ion battery, Gyroscope.

1 INTRODUCTION

1.1 Overview

Electrical vehicles can become a best way for transportation. In he 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.

Fig:1.1

1.2 Unicycle

Unicycle is mechanical cycle which has only single wheel. It consist 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 in size 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

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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 rayed 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 gas 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 Electro Mechanical Systems) technology.

A monwheel electric vehicle reqires 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 lithum ion battery which gives 64v voltage and 600w power.

2 LITERATURE REVIEW

Mono wheels have actually been invented 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 mono wheel designs appeared as early as 1869. In 1869 the Craftsman Rousseau of Marseilles Built the first monocycle. 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 mono wheel was recognized as a difficult means of transportation: One publication remarked that the vehicle was "impracticable for ordinary mortals" But as you know, some ideas never die -- no matter how questionable they are. Up next, we'll look at mono wheels today and concepts In planned for the future. Today, mono wheels are still around.

e to dedicate specific time for his health, [1] **Craftsman Rousseau** [1869]: In 1869 a French craftman rousseau of Marseilles built an first mono cycle which is having a seating arrengment inside the monowheel, the rider steerd the contraption by shifting his or her weight in the desired direction. As if that wasn't difficult enough , the massice outer wheel remained directly in the drivers line of sight at all times. Braking was also potentially hazaeadous, as stopping too abruptly would cause the rider to be propelled forward along with the outer wheel.

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

[3] Trevor Blackwell [2004]: He 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 consist only seat [No handle].

[4] Janick and Marc Simeray et, al [2006]: They have introduced a motorized transport vehicle for a pedestrian and they filed a US patent for a compact seatless device.

[5] **Ryno motors** [**2008]:** They demonstrated their prototype unit of their Ryno bike.

[6] Ford Motor Company [2015]: They patented a "self propelled unicycle engaged with vehicle". "A self-propelled unicycle is selectively engaged with a vehicle for use with the vehicle and is selectively disengaged with the vehicle for independent use. The self-propelled unicycle includes a hub and a wheel rotatable coupled to the hub."

[7] **Ji-Hyun Park et, al [2018]:** This study introduces a two-wheeled self-balancing mobile robot based on a control moment gyroscope module. Two-wheeled mobile robots are able to achieve better mobility and rotation in small spaces and to move faster than legged robots such as humanoid type robots. For this reason, the two-wheeled mobile robot is generally used as a mobile robot platform.

[8] **Mayur Shelke et**, al [2018]: This paper proposes a folding bicycle that is designed to fold bicycle into a compact form for facilitates easy transport and easy parking. When folded, the bicycle can be more easily carried wherever we necessary. Folding mechanisms may vary, with each offering a distinct combination of folding speed and folding ease, compactness of frame, ride, weight, durability and price that changes with change in material specification.

[9] A. Kadis et, al [2010]: In this paper, the Micycle system is discussed in detail. This involves a discussion of the mechanical and electrical components used in the system. The mechanical steering mechanism, used to steer to and to assist the rider in balancing in the roll direction is discussed. Following this, the dynamics of a generic unicycle in the pitch direction are derived using

a Lagrangian formulation and simulated in Simulink. A linear PD control law which stabilizes the plant in the pitch direction is then proposed. This controller is implemented on the simulated and physical systems and data from both is used to quantitatively assess the control System.

[10] **Shishir S et, al** [2010]: In the present day lifestyle man is not abl importance is least given to exercise and body fitness due to time shortage and stressful life. To cope with time deficit, we can utilize the time spent on commuting efficiently to exercise by using bicycles, thereby also contributing to pollution control. But regular bicycles occupy sufficient space to park, are not easy to carry around and are probable to theft. Transport has been one of the most important issues to be dealt with in the present day situation as commuting from place to place within the city has become a tedious and an expensive task.

3 PROBLEM FORMULATIONS

According to the literature reviewed, many projects have been performed on monowheel vehicle. In which most of vehicle performed fully mechanical action, now in our project we are trying to implement the design which is suitable to balance and drive easily for the customers and also eco - friendly as well as compact in size.

By considering all the factors above mentioned where we are designing the frame which is suitable for off road conditions. And to overcome pollution issue, we are using electric motor to run the vehicle. For compact sizing and portable vehicle we are trying to make foldable mono wheel vehicle. By using new technologies we can build good, efficient, compact personal transport vehicle, which is self balanced mono wheel electric vehicle.

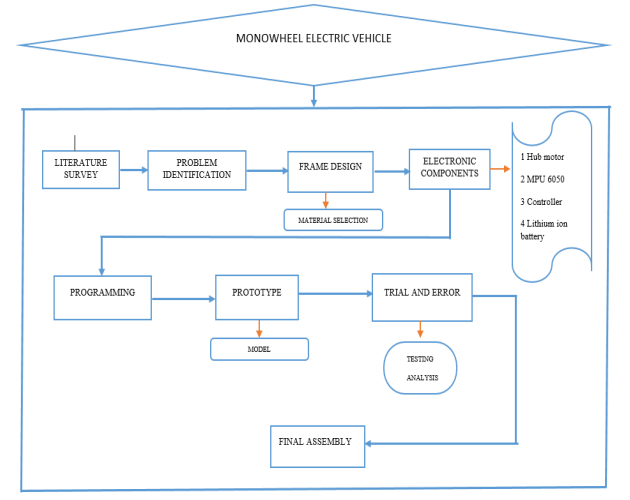

Fig 3.1

3.2 Mechanical component

Aluminium is the world's most abundant metal and is the third most common element comprise 8% of the earth's crust. The versatility of aluminium makes it the most widely used metal after steel. Pure aluminium is soft, ductile, and corrosion resistant and has a high electrical conductivity. It is widely used for foil and conductor cables, but alloying with other elements is necessary to provide the higher strengths needed for other applications. Aluminium is one of the lightest engineering metals, having strength to weight ratio superior to steel.

3.3 3D Design of the vehicle

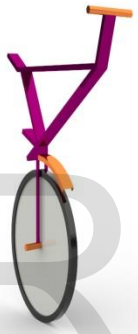

Fig 3.3

4 CALCULATION AND ALALYSIS

The following are design criteria for motor selection according to the project objectives;
Gross vehicle weight (GVW) - 100 kg.
Radius of wheel/tire (Rw) – 0.1778m
Desired acceleration time (ta) - 04 seconds.
Desired top speed (Vmax) - 20km/hr.
Maximum incline angle (α) - 12degree
Assumed working surface – fair

To choose motors capable of producing enough torque to propel the vehicle, it is necessary to determine the total tractive effort (TTE) requirement for the vehicle:
TTE = RR + GR + FA
Where:
TTE = total tractive effort [N]
RR = force necessary to overcome rolling resistance [N]
GR = force required to climb a grade [N]
FA = force required to accelerate to final velocity [N]

Step One: Determining Rolling Resistance
Rolling Resistance (RR) is the force necessary to propel a vehicle over a particular surface. The worst possible surface type to be encountered by the vehicle should be

factored into the equation.
RR = WW×g×Crr
Where:
RR = rolling resistance [N]
WW = Weight on wheel [kg]
Crr = Rolling Friction Coefficient
RR = 981 × 0.04 (Crr value for bicycle tire on concrete) =39.24N

Step Two: Determining Grade Resistance

Grade Resistance (GR) is the amount of force necessary to move a vehicle up a slope or "grade". This calculation must be made using the maximum angle or grade the vehicle will be expected to climb in normal operation. To convert incline angle, α, to grade resistance:
GR = WW × g ×sin(α)
Where:
GR = grade resistance [N]
WW = Weight on wheel [kg]
α = maximum incline angle [degrees]
GR =981 × sin(12) = 203.96 N

Step Three: Determining Acceleration Force

Acceleration Force (FA) is the force necessary to accelerate from a stop to maximum speed in a desired time.
FA = WW × g ×Vmax / (g ×ta)
Where:
FA = acceleration force [N]
WW = Weight on wheel [kg]
Vmax = maximum speed [m/s]
ta = time required to achieve maximum speed [s]
FA =981 × 5.55 / (9.81×4) = 138.75 N

Step Four: Determining Total Tractive Effort

The Total Tractive Effort (TTE) is the sum of the forces calculated in steps 1, 2, and 3.
TTE = RR + GR + FA = (39.24+203.96+138.75) = 381.95 N

Step Five: Determining Wheel Torque

To verify the vehicle will perform as designed in regards to tractive effort and acceleration, it is necessary to calculate the required wheel torque (Tw) based on the tractive effort.
Tw = TTE ×Rw
Where,
Tw = wheel torque [Nm]
TTE = total tractive effort [N]
Rw= radius of the wheel/tire [m]
Tw = 381.95× 0.1778×1.1 = 74.701 Nm.

Step Six: Reality Check

The final step is to verify the vehicle can transmit the required torque from the drive wheel(s) to the ground. The maximum tractive torque (MTT) a wheel can transmit is equal to the normal load times the friction coefficient between the wheel and the ground times the radius of the drive wheel.
MTT = Ww [lb] x μ [-] x Rw [in]
where:
Ww = weight (normal load) on drive wheel [N]
μs = static friction coefficient between the wheel and the ground [-]
Rw = radius of drive wheel/tire [m]
MTT = 981 x 0.35 0.1778 = 61.04 Nm.

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 foldable and electric features of our " Monowheel Electric Vehicle".
Due to its compact and foldable design it can be carried easily in the subways, metro, trains, etc. And it produce very low noise, which reduces the sound pollution.

6 SCOPE OF FUTURE WORK

- In the future work, the load carrying capacity can be increase.
- Distance travelled can be maximize.
- Charging time can be improved.

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