

Review On Mid-Driven Advanced Electric Bicycle

Mitul Gohil¹, Shrey Londhe¹, Rujul Mehta¹, Rishabh Parekh¹, Sharvil Shah²

¹UG Student, Mechanical Department, ITM Universe, Vadodara, Gujarat, India

²Assistant Professor, Mechanical Department, ITM Universe, Vadodara, Gujarat, India

ABSTRACT

With the increase in demand of non-renewable resources and the pollutants produced due to the use of it, it becomes crucial to have a pollution free transport medium. Bicycles are a better way for transportation but have limitation of range of travel. Thus, our project concentrates on increasing this range by advancing the bicycle with introduction of electrically driven mechanism. The idea is to combine gear system with electric motor and batteries while also availing pedal drive. Our project also introduces disc brake for effective braking power.

Keywords : Mid-Drive, Electric bicycle, Dual-Assist, Advanced Features

I. INTRODUCTION

The main objective is to ease the effort of the rider by providing electric drive along with the manual pedal drive. When there is need of faster transportation, changing the drive to electric will become very useful and avoid unwanted human fatigue. Moreover, the places like industrial estates, townships, educational campuses; health centers etc. require constant mobility of people between distant sectors. Using fossil fuel driven vehicles for such purpose becomes uneconomical and also non preferable for surrounding environment.

Increased use of non-renewable resources leads to the increase of emission of pollutants in the atmosphere. With the increasing population, it becomes difficult to reduce the yearly consumption rate of fossil fuels. It is crucial to find alternative way to the use of fossil fuels and thus every possible method to reduce the consumption becomes a lifeline. Our project takes the idea of using bicycles and increasing its travel range by providing electric drive assistance is a step to serve the similar purpose.

The Market is dominant with bicycles driven by the Hub motors. Hub motors are attached in the rear wheel's Hub. Also usage of the Planetary Gear system is getting Popular due to its attachment design in the front allows front wheel drive. Both have its Merits and Demerits. The Hub Motor is equipped with higher torque generation and efficient riding. But it moves the center of gravity way back due to its added weight. This creates difficulties in climbing inclined paths. Also this weight creates increased Inertia and spokes can get damaged when an impulse load is acted, upon for example the bicycle hits a puddle. The design of planetary gear driven bike is much costlier.

Overcoming the flaws of both designs we have centered our project to provide electric drive assist in the middle of the bicycle frame. The motor is connected to the front sprocket between the pedals. External mounting is used for attaching the motor to the frame. Together the motor and mounting forms the housing for the electric drive. Using Control circuit multiple features like introducing Thumb throttle for speed control, providing start switch, indicator system and digital display, can be made possible. A Hub motor is fixed at the center of the

wheel (hub) which directly drives the wheel without any transmission. It is also known as Wheel Motor or In-Wheel drive. These are the most popular type of motors used in bicycles due to their low maintenance and easy production.

Mid Drive Motors uses DC Motor attached to front Sprocket. The motor is mounted using designed attachments to the frame of the bicycle. The motor is located in the middle section of the bicycle, close to its centre of gravity providing better weight distribution and balance. Mid drive motor also provides better performance compared to same class of Hub motor.

This part of the paper aims on the designing process of our project to observe and correct the design if any changes are applicable. The target is to offer details of modifying the prevailed pedal operated system for operator which is based on both human propulsion as well as electric motor system. After establishing criteria for speed and weight, we began a process of selecting parts as per our requirement. Designing involved various models of attachment possible in our project and came to one for which the rider sounds safe and it is easy to use. The goal of the project is to design and integrate an additive power transmission system to an existing bicycle.

II. LITERATURE REVIEW

Name: Power Assisted Bicycles

Author: Izumi Yamashita, Yoshiharu Yokoyama,

Publish date: September 09, 2000

Link: <https://patents.google.com/patent/US6119801A/en?q=US6119801A>

In such embodiment, the prime mover and the pedal operated mechanism are both driving the rear part of the bicycle. The transfer shaft i.e. chain is inclined vertically above the pedal operated mechanism so as to improve the ground clearance of the bicycle. This also simplifies the construction of a bicycle. The transmission understanding is that the power is always in step-down condition coming from prime

mover while pedal operated mechanism deals in step-up condition in transfer shaft. There is many people having interest in this invention by utilizing the power assist system, it allows the individuals to operate the vehicle which they weren't able to before.

Generally, the power assist system is either consisting of an internal combustion system or an electric motor to drive the vehicle or just to give the amount of power required. The amount of power required by an individual is controlled by him by varying the input force given as response. These mechanisms are firstly employing a transmission which drives the output from the prime mover to the pedal operated mechanism of the bicycle. Secondly, the transfer shaft (in this case is chain) is then used to drive the final transmission from the sprocket of the pedal operated mechanism to the rear part of the vehicle. This invention gives rise to some disadvantages such as lowering of ground clearance as the chain are positioned in such a manner in final transmission that it is located comparatively low side of a vehicle causing lower ground clearance. A prime mover is supported by frame assembly for driving the first transmission drive and crankshaft of pedal operated mechanism is coupled to drive the second and final transmission.

Name: Electric and paddle driven bicycle with solar charging

Author: Henry m. Gannon

Publish date: May 31, 1994

Link: <https://patents.google.com/patent/US5316101A/en?q=US5316101A>

This review paper relates to an electric impulsive system for a multi-wheeled vehicle. This particular embodiment consists of a standard bicycle with multi-speed transmission, an impulsive electric system and a solar charging apparatus to charge the battery. The power drive system is coupled in such a manner that either or both can provide power any time given.

Electric bicycles are quieter and cleaner than the other vehicles driven by gasoline. They do not require any kind of warming up and is having very less maintenance requirement.

Accordingly, it is an objective of the invention to overcome the problems and inefficiencies faced in an ordinary bicycle. There is a universal presentation where the pedal and the electric motor are used in a combination to increase the range of travel. This combination also improves the speed and the hill climbing ability. A related problem faced in any electric system is its involvement interference with normal pedaling and handling of bicycle. Decreasing the size of battery improves the handling and pedaling though decreasing the range and may also affect the speed gained with large battery. A DC motor is widely considered as powerful, efficient in low cost. Only disadvantage of it is that frequent ratio changes are to be stayed within 1500 to 3000 rpm having window for maximum efficiency as well as providing sufficient power. Another advantage or reason is that having power in standard bicycle can be used over normal bicycle routes and in option as conventional bicycle. Regenerative braking system can increase the range of travel by a significant amount. Yet another objective of this invention is to provide a throttle to incorporate a variable voltage regulating circuit. Another aim or goal and an important purpose are to position the electric impulsive system in such a way to have a balanced and optimal weight distribution.

Name: Power assist system and a method for a vehicle

Author: Harold Spanski

Publish year: August 10, 2010

Link:<https://patents.google.com/patent/US7770682B2/en?q=US7770682B2>

A simplified mid drive system includes all the electronics and allows only throttle operation of the motor. The drive system is having such an arrangement allowing the motor and pedal drive mechanisms to work in conjunction to each other or independently. Drive system can be easily modified

i.e. in gear ratio can be changed for the effective riding and meet the requirements of the rider/operator.

The present invention relates to electric bicycle in particular mid drive system for electric bicycles in the current market. In current e-bicycle market, hub motor or in-wheel motor has been the dominated configuration. In hub motor, mechanical advantage cannot be gained as well as the operator has to input power through operating the pedals as there is no direct connection between the wheel motor and the transmission. Mid drive system have been produced/ developed to replace the in-wheel motor or hub motor. This system uses a complicated system of gears to input power when combined with pedal mechanism. Mid drive system package can be easily integrated in the bicycle frame so as to greatly simplification of manufacturing, wiring and maintenance.

Name: Mid drive system for an electric bicycle

Author: Britt Jackson, Thomas Boyle, Percy Chien

Publish year: March 16, 2017

Link:<https://patents.google.com/patent/US20170073039A1/en?q=US20170073039A1>

A pedal operated vehicle i.e. bicycle is indulged with electric motor assist system. The assistance ratio can be varied according to variation of vehicle condition such as speed to save the electrical energy generated and avoid over speeding. This invention relates to the bicycle having electrical power support. It has been proposed the usefulness of pedals over the time by incorporating the electrical assist for the bicycle. Primarily, the system senses the force applied on the pedals to drive the bicycle and the exact amount of power is generated to drive the bicycle by the motor so as not to use the pedals. The power is applied by the electric motor is directly related to the driving force given by the operator. Principle objective of this invention is to be providing power as per needs i.e. it can be varied as per requirements. This invention is helpful to operate as it eases of the human effort and gives convenience to drive bicycle freely.

III. DESIGN COMPONENTS

Frame Structure: It is the Skeleton of the bicycle which holds the components together and withstand the force between driven and driver wheels. Rigidity is the fundamental requirement of a structure. Also provides joints and forms the mechanical core of the bicycle.

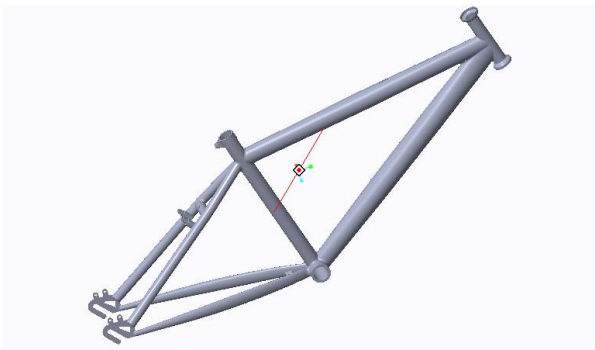


Figure 1. Frame Structure

Extended Spindle Design consideration: It is an Axle that lies in between the pedals. In our design this part needs to be extended for the spacing of the motor.

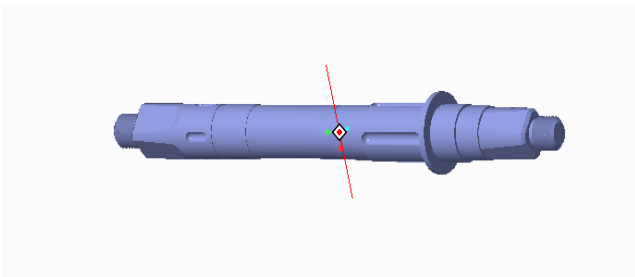


Figure 2. Extended Spindle Design consideration

Mounting of the motor: The mounting of the motor is done using sets of Top clamp, Bottom Bracket, Holder and springs.

Top Clamp: Used to hold the motor from the upper side.

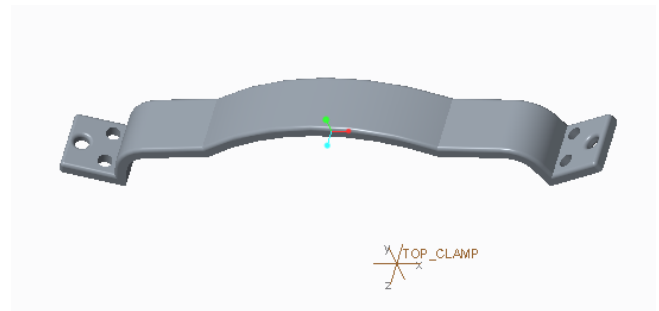


Figure 3. Top Clamp

Bottom Clamp: Covers the Bottom from below.

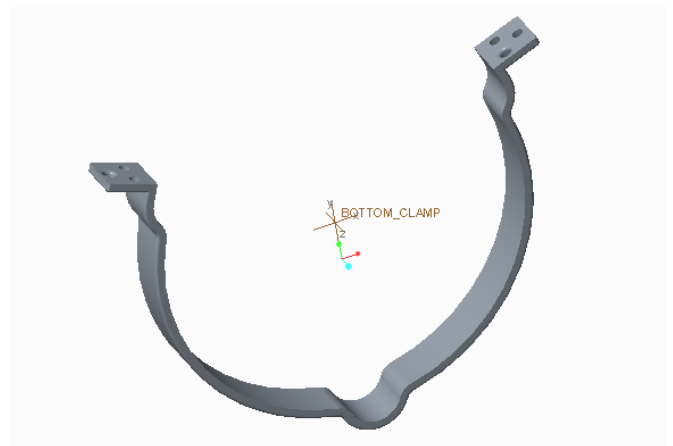


Figure 4. Bottom Clamp

Holder: Attaches the Motor housing To the frame of the Bicycle.

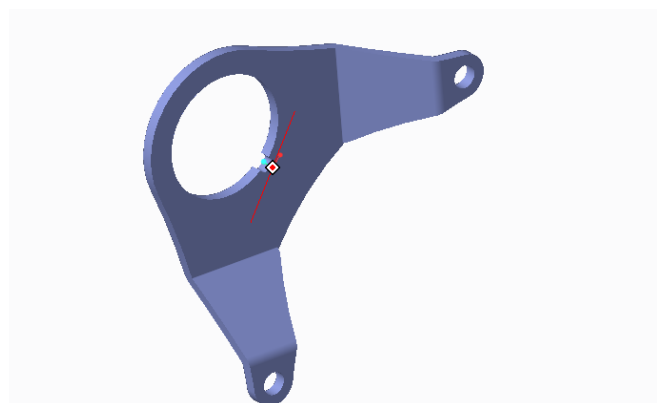


Figure 5. Holder

Spring: Damping against sudden inertia forces due to jerks.

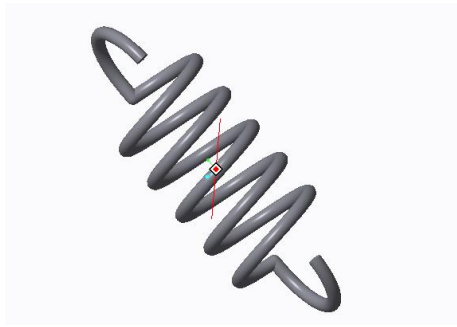


Figure 6. Springs

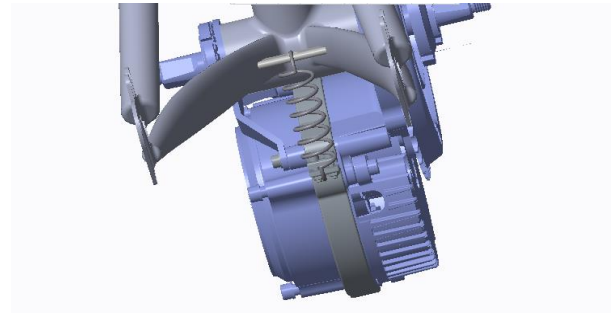


Figure 9. Front View of Motor Attachment

Assembly of Motor Attachment:



Figure 7. Assembly of Motor Attachment

Motor Attachment Assembly: This research paper relates to the power assistance given to the manually operated vehicle such as a bicycle to improve its drive arrangement.

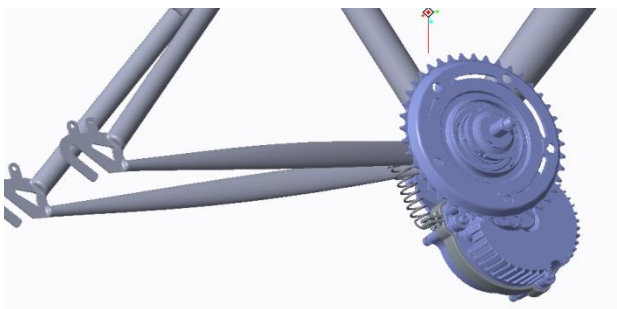


Figure 8. Side view of Motor Attachment

I. CONCLUSION

This project relates to the bicycle having electrical power support. It has been proposed the usefulness of pedals over the time by incorporating the electrical assist for the bicycle. The power is applied by the electric motor is directly related to the driving force given by the operator. Principle objective of this project is to be providing power as per needs i.e. it can be varied as per requirements. This invention is helpful to operate as it eases of the human effort and gives convenience to drive bicycle freely.

IV. REFERENCES

- [1]. Definitions and Nomenclature;
https://en.m.wikipedia.org/wiki/Electric_bicycle
- [2]. Patents and Research papers
<https://patents.google.com>
- [3]. Project related information
<https://www.evelo.com/evelo-difference/advantages-mid-drive-motor-vs-hub-motor/>
- [4]. Present Market scenarios
<https://electricbikereport.com/electric-bike-motor-comparison/>
- [5]. Understanding of mechanical components
<https://youtu.be/gwUCcX15KiU>