THE ELECTRIC BICYCLE

K.MANOJ KUMAR REDDY, AsstProfessor, Department of Mechanical Engineering, Narayana Engineering College (Autonomus),Gudur, Andhra Pradesh
P.V.SIVA KRISHNA, K.NITHYA SRI,G.SHIVAJI ,N.RANGANAYAK. UG Students, Department of Mechanical Engineering, Narayana Engineering College (Autonomus),Gudur, Andhra Pradesh

ABSTRACT : Electric bike is a pedal and handle just like regular bicycle. Need green, health preserving, fast mode of transportation. Generate back electric power by the use of pedal power through generative mode a mean of sustainable urban transport energy saving and sustainable energy.There are many uses of an electric bike like it is now also being used in heart rehabilitation centers for patients having heart, lungs problems. These bikes are more convenient than regular ones. Our main aim is to fabricate an electric bike which can be used for commercial and medical purpose.

1.INTRODUCTION

A In the new era the e- bicycle has the more importance than other fuel vehicle like motor cycle, car etc. basically for the short distance travel the bicycle is more useful and e-bicycle is effortless. It is also eco-friendly technology bicycle was the most depended mode of transportation. A self-charging battery electrical bicycle which utilize the mechanical energy to electrical energy of wheels to charge the battery. A system which make the vehicle pollution free. We are using the component like hub motor, dynamo, controller, battery, etc. It is pollution free and no fuel consuming type of vehicle and itis good for greenhouse effect. The rider cab is chosen that the bicycle can be driven completely with the hub motor or to be driven manually by him with a pedaling.

The electric bicycle offers a cleaner alternative to travel short-to-moderate distances rather than driving a gasoline-powered car. The idea of a motorized bicycle isn't a recent conception and has been around for over a century. Until 1895, the electrical bicycle created its place in history. That year, Ogden Bolton developed a powered bicycle with a six-pole brush- and-commutator DC hub motor mounted within the rear wheel. E-bikes use rechargeable batteries and the lighter varieties can travel up to 25 to 32 km/h, depending on the laws of the country in which they are sold, while the more high-powered varieties can often do in excess of 45 km/h. In some markets, such as Germany, they are gaining in popularity and taking some market share away from conventional bicycles, while in others, such as China, they are replacing fossil fuel-powered mopeds and small motorcycles. Bikes with Kinetic Energy Recovery Systems (KERS) by means of Flywheel Energy Storages (FES) are also used where the energy is stored in a flywheel instead of a battery using chain and sprocket mechanism.

II. LITERATURE REVIEW

Components including chassis, transmissions, wheels and brakes are presented. Information will be basics for design of the conversion .electrical hazards of batteries, and high ampere and high voltage wiring will be presented [1].

The Electric Bicycle System is a systems project that incorporates three different ways of charging a lithium-ion battery: the 120V AC wall outlet, regenerative braking, and solar power; which is used to power an electric hub motor running a
bicycle. The purpose of the project is to show that it is possible and relatively simple, to build an electric bicycle by oneself [2].

So we intend to design a cycle which would run on an alternative source and also reducing human efforts called as Battery Operated Cycle. It contains a strong motor and enough battery power that just needs charging to help in hill climbing, generate greater motoring speeds and provides completely free electric transportation [3].

The hybrid powered electric bicycle is a system that involves three different ways of charging a battery: solar power, Dynamo and 220V Ac wall charge. The power from these three modes is used to charge an electric PMDC motor running a bicycle [4].

METHODOLOGY

Projecting a vehicle has several factors inherent to it, even more, if the vehicle is designed for a specific purpose and application as it is in this work. Therefore, it's important to define some base requirements, despite some do have more importance than others. We will be defining its main requirements and objectives that the vehicle has to be able to show or to achieve during its normal use:

- Autonomy - It is a very important factor in any kind of vehicle, but especially in an electrical one, as it limits the range and reduces the possibilities for the rider. Also, recharging the battery is not an instantaneous process, and it is necessary to use the battery charger and a power outlet, in other words, if the battery fully discharges during the path, it can not be charged without specific conditions and instruments. We've considered that the bicycle has a specific purpose of concept, two daily routes and a constant route, house-work-house or house-public transport-work and returning home again. A census analysis made in 2011 and covering the regions of England and Wales concluded that residents living and working in London had an average daily distance to cover of 11 km, traveling to work and returning back home. With this in mind, we defined a minimal autonomy of 25 km, considering that it would be enough for the daily routine or to be able to cover more distance in case of need. This autonomy can be easily enlarged by having two sets of batteries, one substitute to replace the other as it discharges, or by using a bigger battery with higher capacity, but bigger capacities lead to bigger andheavier batteries which collides to the weight requirement.
- Weight - It is an important requirement and one that it's commonly used to characterize and evaluate bicycles. The bicycle has of course to be as light as possible, but we have to keep a realistic mind, once we are limited by the building processes available and building materials we won't be able to build a really light bicycle compared to the today's market. Nevertheless, the weight will be an ongoing concern during all the project and will play an important role in every choice that we will have to make.
- Ease of transportation - The bicycle, with all its components will be quite heavy, possibly too heavy to be easily transported in weight for long paths. Thus should find a solution so that it can be easily transported when folded, compensating its weight. The desired way of doing it is by folding the bicycle in a way so that it can be transported folded, in a compact shape, with both wheels on the ground and in a balanced and friendly user way.
- Practical to fold - The folding system is a crucial component of a folding bicycle. It has to be safe and strong, to keep the bicycle rigid and stiff, but also has to be practical and easy to lock and unlock. It must allow a practical and fast way of folding and unfolding the bicycle, but also it must guarantee that when it is locked it will not unlock by accident or withoutthe intention of doing it, as it can lead to dangerous situations for the rider.
- Safe - As in every vehicle, the safety is an important and crucial requirement, all the project must be designed and conceived taking into account the rider safety and the safety of any bystanders, as the bicycle is designed to be used in public environments.

Component and material selectionMotor

The motor is a crucial component in an electrical bicycle, therefore its choice must be made carefully and thoughtfully. Tochoose the most suitable motor we must take into account the bicycle components as the frame, wheel size and gear system. Equally or even more important for the motor selection is the purpose that the bicycle is supposed to be applied in. For instance, a bicycle designed to be used in a metropolis environment as a mean of transportation has very different set of characteristics and features compared to a bicycle designed to be used for weekend rides or to ride in off-road terrains thereare three types of motors available to apply in bicycles: mid-drive, hub and friction-drive motors.

Each one of the three presents their own advantages and disadvantages and are better suited for different purposes and environments. From the three given possibilities, the friction-drive motors are the first to be excluded, as they present considerable disadvantages comparing to the others. Despite its simplicity, whether the motor or the ease on transforming a common bicycle in an electrical one, they are more likely to fail than the other types of motors considered.

As explained in the previous chapter, the power transmission is made through friction between the rear tire and motor drive. The friction coefficient between these components has a major impact on the motor performance and output obtained. This friction coefficient may vary widely and can easily be reduced or even became nonexistent, making the motor drive slip on the tire, making the motor fail its purpose. Such situations may reveal to be problematic to the bicycle use and may occur commonly and due to several different reasons: with wet weather, due to the tire tracks, with the vibration caused by uneven terrain or even when trying to departure in a steep hill, a situation that requires high torque rates, such forces can easily overcome the friction needed to propel the bicycle. The choice of the motor type remains nowbetween mid-drive and hub motors.

There are both considered good options and to be the best alternatives for the purpose in question. Each one present its own advantages and disadvantages and in order to be able to contemplate all the criteria that affects this choice we will be appealing to the Pugh Method. With this, it is expected that we will be able to do a thoughtful and justified choice between both alternatives. First it's important to define the criteria that are meant to influence the motor choice, as well as the weight and importance that each of the criteria presents according to the bicycle's purpose and range of applications.

Weight

Weight, is an important factor in any case when the subject is a bicycle. The weight of the motor in an electrical bicycle has a big influence on the total weight of the bicycle, in general they represent 25% or even more of the total weight of the bicycle. Thereby this factor was determined to the one with major importance within the others for the motor choice. For the purpose that this bicycle is meant to do in particular, it can reveal to have even a bigger importance, as it will most likely have to be carried in weight at some part of the path. Regarding the classification attributed, it was 5 tohub motors and 4 to mid-drive motors. Despite both motor types present similar weight variations in general, hub motors usually tend to be lighter. Even though it depends heavily on the motor itself and which of the manufacturers produced it.

Mass center

This criterion focuses in the influence that the mounting position of the motor has in the bicycle mass center. As referred before, the motor usually represents 25% of all the bicycle weight, therefore it has a strong influence on the bicycle mass distribution. The localization of the mass center of the bicycle or the rider and the bicycle, considering it as a whole, plays an important role on how the bicycle handles and behaves when riding it. Thus is also one very important factor for the motor choice. Hub motors are mounted in the wheel hubs, this takes the mass distribution closer either to the front or the rear wheel, depending on which wheel it is mounted. Considering that our objective, concerning the mass distribution, is tohave the mass center as low and centered in the bicycle as possible, this is not the best option, specially taking in account the mid-drive alternative. This type of motor, as it was explained earlier, it is mounted near or in the crank set, which is considered to be the best position to be placed, once it lowers and centers the mass center. Given this, we've attributed 1 tothe hub motor and 5 for the mid-drive alternative.

Performance

Regarding the performance, mid drive motors are able to achieve better results and with higher toques. This is mainly because they can transmit more power, as it is directly transmitted to the crank and chain, allowing them to work with the bicycle own gear system. By contrast, hub motors are mounted in the wheel center, compelling the motor to do more effort to obtain the same output. Hub motors aren't able to achieve the same torques that mid-drive systems do, also because if they did, and considering a front hub motor option, a motor with big torque rates would make the front wheel spin and lose traction. Given this, we've attributed 2 to hub motors and 4 to the mid-drive alternative.

Driving control

These criteria focuses on the influence that the different motors have on the handling characteristics of the bicycle. With a mid-drive motor, the bicycle will be operated virtually the same way that a common bicycle would be, keeping it simple and near unchanged. This would make the bicycle more user-friendly and not requiring any extra skill than knowing how toride a common bicycle.

Wear and tear

This is a criterion that despite showing no influence at first in the bicycle, after some use it can reveal to be problematic and generate some extra costs. Of course there are measures to prevent or reduce as much as possible the wear and tear, a constant lubrication and inspection on the components that suffer major wear and tear can prevent or predict accidents. Hub motors have all the components confined inside the hub and few moving parts, this results in virtually no tear either on the motor or the bicycle components. Mid drive motors have more moving parts and as known, they transmit their power

through the bicycle components, as the crank, chain and chain rings, therefore this system requires more maintenance and leads to higher wears on some of the bicycle components.

Climbing capacity

Climbing capacity defines the capability for the motor to overcome steep terrain. It can be an important feature in this type on bicycle, depending on the city that it will be used in. Hub motors are known by struggling or even failing in steep hills, revealing low capacity to overcame such obstacles. This is mainly because this type of motors are made to operate at a fixed ratio, making them more trustworthy to operate in flat terrains and with some speed. On the contrary, mid-drive motors can easily overcame steeps hills, being able to produce higher torques. This added up to the fact that these work and take advantage of the bicycle own gear system, makes them the best choice in what matters to performance in uneven terrains. Given this, we’ve attributed 2 to hub motors and a 5 to the mid-drive alternative.

Wheels

As referred before, wheels, and the wheel size has a big influence in the bicycle. They have a big impact on how the bicycle handles, rides and how comfortable and smooth the bicycle feels. Once one of the main objectives is to reduce the volume occupied by the bicycle as much as possible, we should opt to chose a small wheel size. Even though, small wheels reduce the bicycle maneuverability and make it hard or dangerous to overcome obstacles as kerbs or potholes in the roads. Therebywe’ve chosen 20” to be the best suited size for a bicycle with this type of applications. Their small sizes is enough to keep the bicycle compact, but are still big enough to be safe and easily overcome most of the obstacles that a metropolis environment presents.

Gear system

Regarding the gear system to be used in the bicycle, we first must choose which of the systems are better suited for this kind application. There are four alternatives, as it was presented in section 2.5.4, fixed-gear, single-speed, multi-speed and internal gearing. Both fixed and single-speed gear systems are the first to be discarded. Despite their best asset being its simplicity and low weight, they are not the best choices for this type of application, as they only allow one fixed gear ratio. Given that we’ve chosen a mid-drive motor, and that one of the main advantages of choosing a mid-drive motor is that themotor propels the crank, allowing it to work with the bicycle own gears, it wouldn’t make sense to use a gear system with a fixed gear ratio. The choice lies then between multi-speed and internal gearing system. With mind that the bicycle is designed to be used in a metropolis environment, the smart choice must be an internal gear system.

Prototype design

In this section we will be describing the model that we’ve designed to be built and to create a fully working prototype. Describing and justifying what choices we had to made regarding the model components and describing its main features and characteristics. Since we had to depart from a frame already built, we opted t to use a frame and components from an old bicycle. We’ve tried to maintain its basic aesthetics and classic appearance. This way we intend to build a cheap prototype that keeps its classical and old appearance but restored and improved. This way the final result will create a bridge between new and old technologies in order to achieve a better outcome.

IV . EXPERIMENTAL WORK

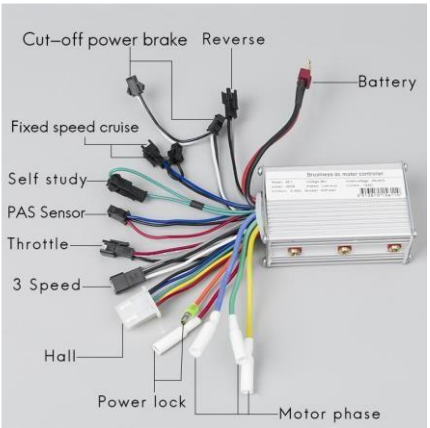
DC Motor

A DC motor is one of a class of rotary electrical machines that converts direct current electrical power into mechanical power. The most mutual types rely on the forces created by magnetic fields. Nearly all types of DC motors have specific internal mechanism, either electromechanical or electronic, to periodically change the direction of current flow in portion of the motor. DC motors were the first type commonly used, since they could be powered from present direct-current lighting power distribution systems. A DC motor's speed can be controlled over a extensive range, using either a variable supply voltage or by changing the strength of current in its field windings. Tiny DC motors are used in tools, toys, and appliances. The universal motor can operate on direct current but is a lightweight motor used for convenient power tools and appliances. Bigger DC motors are used in propulsion of electric vehicles, elevator and hoists, or in drives for steel rolling mills. The arrival of power electronics has made replacement of DC motors with AC motors possible in many applications.

DC Motor is an electrical device which converts electrical energy into mechanical energy. A simple DC motor has a stationary set of magnets in the stator and an armature with one or more windings of insulated wire wrapped around a soft iron core that concentrates the magnetic field. The windings usually have multiple turns around the core, and in large motors there can be several parallel current paths. The ends of the wire winding are connected to a commutator. The commutator allows each armature coil to be energized in turn and connects the rotating coils with the external power supply through brushes. (Brushless DC motors have electronics that switch the DC current to each coil on and off and have no brushes. DC motors can operate directly from rechargeable batteries, providing the motive power for the first electric vehicles and today's hybrid cars and electric cars as well as driving a host of cordless tools. Today DC motors are still found in applications as small as toys and disk drives, or in large sizes to operate steel rolling mills and paper machines. Large DC motors with separately excited fields were generally used with winder drives for mine hoists, for high torque as well as smooth speed control using thyristor drives. These are now replaced with large AC motors with variable frequency drives.

Motor Controller

A motor controller is a device or group of devices that serves to govern in some predetermined manner the performanceof an electric motor. A motor controller might include a manual or automatic means for starting and stopping the motor, selecting forward or reverse rotation, selecting and regulating the speed, regulating or limiting the torque, and protecting against overloads and faults. A Motor Controller is a device that acts as intermediary between your robot's microcontroller, batteries and motors. A motor controller is necessary because a microcontroller can usually only provide roughly 0.1 Amps of current whereas most actuators (DC motors, DC gear motors, servo motors etc.) require several Amps.



I. Figure: Motor Controller

Function

The electric bike speed controller sends signals to the bike's motor in many voltages. These signals detect the direction of a rotor relative to the starter coil. The suitable function of a speed control depends on the employment of various mechanisms. In a purpose-built electric bike, Hall Effect sensors help detects the location of the rotor. If your speed controller does not include such sensors and the speed controller on an adaptive bike may not the electromotive force of the un-driven coil is calculated to get the rotor orientation.

The mechanism of an electric speed controller differs depending on whether you own an adaptive or purpose build electric bike. An adaptive bike includes an electric drive system installed on an normal bicycle. A purpose built bike, more expensive than an adaptive bike, provides easier acceleration and affords extra features.

Throttle

A throttle is the mechanism by which fluid flow is managed by constriction or obstruction. An engine's power can be increased or decreased by the restriction of inlet gases (by the use of a throttle), but usually decreased. The term throttle has come to refer, informally and incorrectly, to any mechanism by which the power or speed of an engine is regulated, such as a car's accelerator pedal. What is often termed a throttle (in an aviation context) is more correctly called a thrust lever, particularly for jet engine powered aircraft. For a steam engine, the steam valve that sets the engine speed/power is often known as a regulator.

Bridge Rectifier

A diode bridge is an arrangement of four (or more) diodes in a bridge circuit configuration that provides the same polarity of output for either polarity of input. When used in its most common application, for conversion of an alternating-current (AC) input into a direct-current (DC) output, it is known as a bridge rectifier. A bridge rectifier provides full-wave rectification from a two-wire AC input, resulting in lower cost and weight as compared to a rectifier with a 3-wire input from a transformer with a center tapped secondary winding.

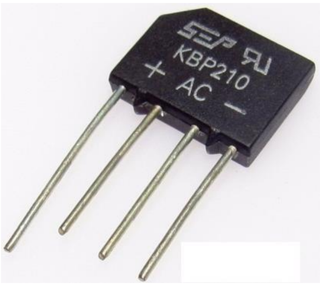


Figure: Bridge Rectifier

Generator

If external mechanical power is applied to a DC motor it acts as a DC generator, a dynamo. This feature is used to slow down and recharge batteries on hybrid car and electric cars or to return electricity back to the electric grid used on a street car or electric powered train line when they slow down. This process is called regenerative braking on hybrid and electric cars. In diesel electric locomotives they also use their DC motors as generators to slow down but dissipate the energy in resistor stacks. Newer designs are adding large battery packs to recapture some of this energy.

Working

The switch is switched ON and the battery connected to the motor supplies energy to the motor. The motor starts and the cycle start moving the shaft through the housing and make the sprockets at the other end move and thus the rear wheel. When the motor is switched ON, the motor draws current from the batteries connected in series that would give an effective discharge of 12V.The motor uses maximum current during starting and later on the current drawn reduces to 12Ah.The generator is mounted on side shaft of the bicycle, supports in such a manner that dynamo shaft is touching the back wheel tyre. The battery pack 1 supplies energy to the motor and when the battery is fully discharged the 2 way switch is turned ON the other battery pack. Then the generator wires are connected to the discharged battery. As the battery runs the rotation of the shaft produces an alternating voltage and to be passed through the bridge rectifier. The bridge rectifier converts the alternating voltage into direct voltage which is then charged into the battery. As the electric bike runs the voltage will be produced by the generator and the battery discharged will be recharged. When the second battery runs out, the motor will rotate with the help of energy charged by the generator thus by increasing the mileage of the bike.

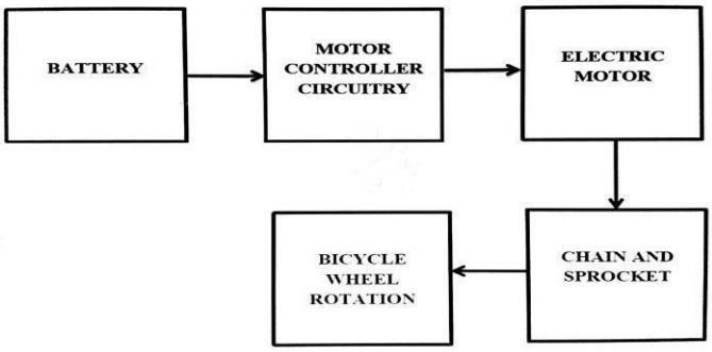


Figure: Block diagram of the Electric bicycle construction process

Speed

V.RESULTS AND ANALYSIS

Average speed 12 mi/h 19 km/h
Maximum speed 20 mi/h 32 km/h**
Travel range 10–50 mi 16–80 km(Full charge)

Batteries

Charging time 2–6 h
Cycles of charge/discharge Up to 400

Power

Power consumption 100–500 Wh(Each full charge)On-board power supply 12–36 V

Torque

Hill climbing ability up to 6% slope

Weight

Electric bicycle kit 10–50 lbs 4.6–22.8 kgexcluding originalbicycle weight

Price range

Electric bicycle kit only US$250–US$800Electric bicycle kit and US$800–US$2600
bicycle (Custom built electric bicycles)

CONCLUSION

The issues associated with electric bicycles may be addressed by custom-designed drives that are most efficient over a given operating cycle. These include city bicycles, hill bicycles, distance bicycles, and speedy bicycles.

The results of the studies listed here can serve as a platform to improve electric bicycle performance if new drive systems are designed around key parameters that will result in improvement of the system perfor- mance. Furthermore, they can be used for comparison of existing drives in a systematical, comprehensive, and technical way.

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