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Electrically Assisted Bicycle Adapted to Urban Mobility

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Abstract: ***Traffic congestion, energy conservation and environmental issues are fuelling the interest in light electric vehicles. In particular, electric vehicles are compelling because of their low cost, ease of use, lightweight, and extremely small footprint. This project deals with design and fabrication of a low-cost portable electric bicycle kit which makes use of electric energy as the primary source and can be mounted on any non-geared bicycle. It has two modes of drive; one is manual i.e. by pedalling and the other one is electric by using electric power from a DC battery. The kit consists of 250W PMDC motor which is powered by a 24V Li-ion battery. One of the major disadvantages of traditional bicycle is that it increases rider's fatigue during long distance travel. The electric bicycle provides a better riding experience as it runs on electric power thereby reducing the rider's fatigue. This helps in travelling longer distances comfortably. The electric bicycle is also faster compared to a traditional bicycle. It is also an environment friendly means of transportation as it does not depend on fossil-fuels for energy. The expected range of the bicycle is around 30-35 km on a single charge and expected speed is 20 kmph.***
Keywords: Electric Bicycle, PMDC Motor, Li-ion Battery, EV Technology, Rechargeable, Pollution Free

I. INTRODUCTION

In the recent times, using motor vehicles using internal combustion has proven to be uneconomical as it depends on fossil fuels for energy. Combustion of these fossil fuels results in emission of harmful gases which is responsible for degradation of the environment. Careless usage has also led to a significant depletion in fossil fuels resources. To tackle the above mentioned problems, we designed and fabricated an electric bicy- cle kit that can be mounted on existing bicycle. The electric bicycle does not harm the environment as it runs on electricity. Bicycles are cheaper than cars, this means that is easier to purchase and maintain an electric bicycle than a car. Bicycles are more agile and fast because they are more manoeuvrable and can easily bypass obstacles that would greatly slow down cars. Bicycles are also easier to park because they are so portable. All of these features make the electric bicycle a very interesting vehicle that could become a better mode of transport in the traffic dominated areas such as big metropolitan cities.

II. LITERATURE SURVEY

[1] Deep R Prajapti, Kunjan Shinde, Abhishek Mhakshe and Aniket Prabhu "Design and Fabrication of Electric Bike" This paper details about the electric bicycle which runs on the battery thereby providing voltage to the motor. This paper compromises with design and fabrication of electric biycle which makes use of electric energy as the primary source and solar energy if possible by attaching solar panels. This bicycle works on the principle that the electromotive force of an A.C. motor which receives electrical energy stored in D.C. battery is converted with the help of D.C. to A.C. converter. It can be charged with the help of AC adapter if there is an emergency.

The solar panels can also used as an alternative source for charging the battery when stationary. The obtained AC current after conversion is amplified and fed to the stator winding of the AC motor. [2] Gandhi, Aryan and Mistri, Sohrab R and Gangrade, AK "Design and Per- formance Testing of an E-Bicycle" In this project, they have taken regular bicycles and integrated them with a motor to reduce or eliminate the load on a cyclist while riding. [3] Randhir, T and Prabhu, Pratik Gaurshettiwa and Waghmare, Shubham and Mogre, Kunal "Design and Development of Electric Bicycle" In this paper, the authors have designed an electrical-assisted device that is designed to deliver the electromagnetic momentums to a present bicycle therefore relieving the user of producing the energy essential to run the bicycle. It contains a strong motor and enough battery power.

III. PROPOSED METHODOLOGY

An electric bicycle is a bicycle with an electric motor integrated used to assist the rider propelling the bicycle. This project aims to propel the bicycle using motor and battery. The motor used is Permanent Magnet DC (PMDC) motor and lithium-ion battery. The motor is integrated to the rear axle of the bicycle. The motor is powered by the lithium-ion battery.

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When the battery is ON the current flows to the motor and the power is transmitted to the rear wheels with the help of chain drive shaft. The bicycle can be propelled independently using the pedals or by using the torque generated by the motor and also as a combination of both. Based on this bicycle can be driven in various modes. In the pedal mode, the rider rides the bicycle by applying muscular force on the pedals. Thus the motor does not draw any power from the battery but generates power which charges the battery through the controller. In the electric mode, the rider rides the bicycle with the help of motor which draws power from the battery. The speed of the motor is controlled by using a throttle, hence the speed of the bicycle can be varied. However the rider can also pedal in this mode if required. An electric bicycle has conventional bicycle frame, pedals, cranks, chain and free-wheel assembly. The bicycle must have low practical mass as lower mass gives more range. The goal of this project is to ensure efficiency of operation and to meet the drive requirements and the design of the e-bicycle should be compact and comfortable to the rider. The following is a block diagram of the electric bicycle model.

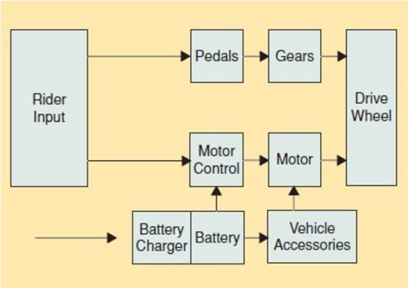


Fig 1. Block Diagram

All of the components like LEDs, motor, battery, throttles are connected to the to watt controller that supplies the required amount of voltage to each component depend- ing on the input from the rider. The motor control or the watt control is like the brain of the bicycle that controls all the other components that is why it is an essential part of the design. We Decided to fix the motor on the rear axle of the bicycle and mount the battery on the frame (lower bar) for simple design.

IV. MODEL DESIGN

A. Motor

We have chosen a permanent magnet DC (PMDC) motor for our project. In a DC motor, an armature rotates inside a magnetic field. A permanent magnet DC motor (PMDC motor) is a type of DC motor that uses a permanent magnet to create the required magnetic field. This motor does not require field winding, thus, they do not have field circuit copper loss. No input power is consumed for excitation which improve efficiency of the motor, and no field coil is used which reduces the overall size of the motor.

B. Battery

When you plug a lithium-ion battery into a device or piece of equipment, the positively- charged ions move from the anode to the cathode. As a result, the cathode becomes more positively charged than the anode. This, in turn, attracts negatively-charged electrons to the cathode. A separator in the cell includes electrolytes that form a catalyst. This promotes ion movement between the electrodes. The movement of ions through the electrolyte solution is what causes the electrons to move through the device the battery is plugged into. Lithium-ion batteries are rechargeable. When recharging, the lithium ions go through the same process, but in the opposite direction. This restores the battery for additional use.

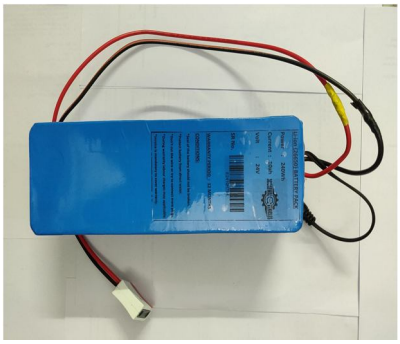


Fig 2. Li-ion Battery

C. Watt Controller

The controller listens to various signals and determines the appropriate output and timing signal. The throttle signal is basically a request to the controller to set the motor at a specific speed (revolutions per minute). The controller monitors the motor speed either via a hall sensor and modulates the motor signal in order to achieve the speed requested by the throttle. The motor rotation is obtained by supplying to the stator windings an electrical signal produced according to a suitable sequence (waveform). It is necessary to know at all times the position of the rotor to produce the correct acti- vation sequence, and for this purpose Hall effect sensors are placed on the stator. Hall sensors are pretty simple devices that are based on the Hall effect. They determine the position of the rotor relative to the stator. Due to the output level of the throttle being observed as a hall-effect driven DC voltage bias level, the analog circuitry needs to han- dle the conversion from that voltage level to a duty cycle on output waveform. Because the processor is a relatively fragile, low power component, it cannot drive the motors directly. Instead, it supplies a relatively weak signal to a network of field- effect transistors (FETs), that drive the motor. These FETs are the business end of the controller and essentially serve as a valve to precisely control the flow of current from the battery to the motor. To control the speed of the motor, the controller's processor drives the FETs with a high frequency signal — switching them on and off rapidly. This high frequency switching produces the characteristic electric motor whine. By varying the duty cycle, the controller can make the motor spin slower or faster.



Fig 3. Watt Controller

V. IMPLEMENTATION

After selecting all the components, we studied how we would mount each of them on the bicycle. For the motor there are two options, hub mounting (motor is incorpo- rated into the hub of the wheel) or side mounting. In the former case, if we have to replace any broken spokes, worn out tyres or any kind of mending is needed near the rear wheel area, then it is difficult to repair because of the motor placement between the wheels. Due to this reason, side mounting was preferred for the motor. We decided to mount the e-bicycle kit on a regular bicycle. First, we removed the mud guards, chain cover and the seat carrier to decrease the weight of the bicycle because the lighter bicycle, more is it's range and speed. Next, we added a secondary free wheel to the rear axle to have an independent drive between pedalling and electric drive. This allowed us to ride the bicycle in two modes, electric and manually by pedalling. Then we mounted the motor onto the rear axle of the cycle using a mounting plate, and adjusted the length of the drive chain between the motor and free wheel. After this, we disassembled the front and rear brake lever assembly from handle bar and installed new a brake lever assembly, then we added a full twist throttle to the handle bar. Later, we made the temporary connections to the battery, motor and the controller to check for any manufacturing defects in the parts. After ensuring that all the components were working properly, we added all the other remaining parts like headlight etc. We adjusted the wire lengths of all connections and secured then using clips so that they remained fixed onto the bicycle while riding.

VI. RESULT

After successfully fabricating our e-bicycle kit and mounting it on a bicycle, we started to test the battery performance of the e-bicycle to determine the maximum range or the distance which can be travelled in a single charge. We determined the maximum speed of the bicycle by riding a motorcycle in parallel with the it and matching it's speed with that of the motorcycle.

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We found that a top speed of around 15 kmph was easily attained by it. The range of the e-bicycle was found to be around 25-30 km. We also tested the prototype in hilly terrains and rough paths to ensure that a comfortable riding experience and desirable e-bicycle performance was achieved. It also has two modes of drive, electric and manual by pedalling, hence one can ride it normally to maintain their health or one can ride it in electric mode for an effort free ride. E-bicycles are getting popular due to their non dependence on fossil fuels and are eco-friendly.



Fig 4. Electric Bicycle

VII. CONCLUSION

With the increasing consumption of natural resources of petrol and diesel, it is nec- essary to shift our way towards alternate resources like the electric bicycle and others because it is necessary to identify new way of transport. The electric bicycle kit was successfully designed and implemented on a regular bicycle to convert it into an elec- tric bicycle. Thus increasing it's speed and reducing the mechanical effort of the rider. Since it is energy efficient, this bicycle is cheaper and affordable to anyone. It can be used for short distance travels by people of any age. The bicycle was propelled by twisting a throttle that changed the speed of the PMDC motor that was powered by a lithium ion battery. The whole unit was controlled by an electric motor controller or watt controller. These bicycles also have a significantly lower environmental impact because they cause less pollution than conventional auto-mobiles.

VIII. FUTURE PROSPECTS

The future prospects of this project include:

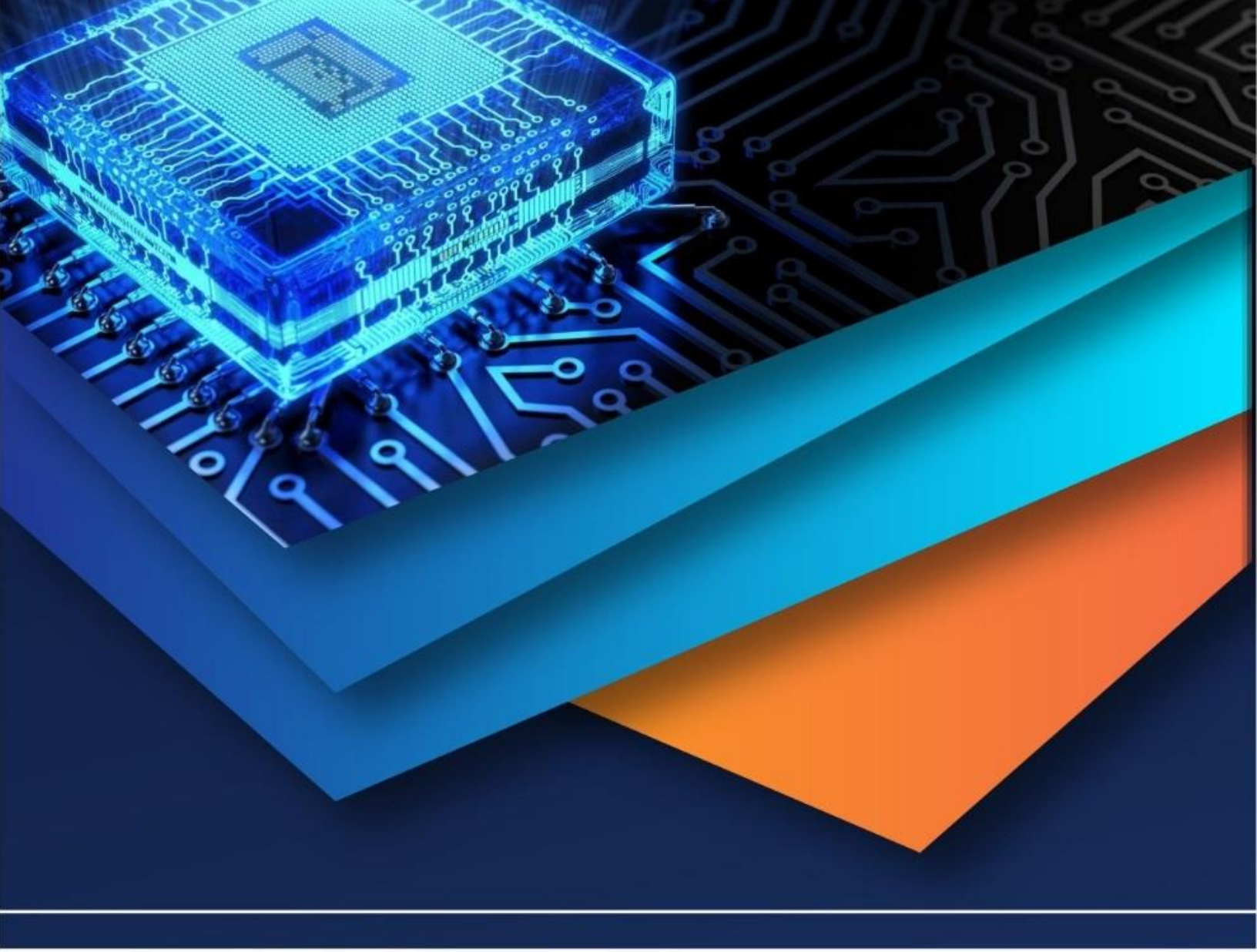
1) A solar panel can be employed in order to charge the battery reducing the depen- dence on the charger, giving longer bicycle.
2) Electronic used to know the speed, time, amount of battery left or other information.
3) Process of increasing the efficiency and power is to be improved and further steps will be taken.

IX. ACKNOWLEDGEMENT

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