Electrical Bicycle Using Solar Panel

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Abstract- *Fuel prices are continuously growing across the globe, demanding an urgent search for alternatives to conserve these natural resources.A solar bicycle, for example, is an electric bike that offers that option by charging the battery with solar energy and therefore providing the necessary voltage to run the engine. Because India has nine months of sunshine, the idea of a solar bicycle appeals to Indians in particular. This solar bicycle is also pollution-free and environmentally friendly. Because it is powered by a solar panel, it requires very little upkeep. This is a less priced bicycle that is popular among middle-class families.*

Keywords- Battery, Bicycle, BLDC Motor, Solar Controller, Solar Panel

I. INTRODUCTION

We'd like to introduce our new project, an "ELECTRICAL BICYCLE USING SOLAR PANEL" that works on sunlight and requires no fuel. We have implemented our thoughts for conveyance to future generations in this endeavour. Solar energy is turned into electrical energy in our solar bicyclevia a solar panel, battery, and solar controller. The battery stores the electrical energy, which is then provided to the hub motor via the controller. This project is about a system that converts solar energy to electricity. Due to pedaling, time, and other factors, the use of bicycles for shorter distances has decreased in recent years. Our idea is for a solar-powered electric bicycle that can be fueled by both sunshine and pedalling. Solar panels, batteries, and converters transform solar energy into electrical energy, which is then delivered to the hub motor, which drives the cycle. We hope that this model bicycle operates in a zero-emission mode.

As a result, bicycle riding over shorter distances will increase in the next few years, helping to minimise pollution such as air and noise. Grid- connected and off-grid (also known as stand-alone or isolated) solar systems are the two types of photovoltaic solar systems. Grid-connected systems use an inverter to feed the electricity generated by solar panels to the grid. When electricity is required at night or during seasons when there is little sunlight, the energy is reclaimed from the grid.

Excess electricity is typically stored in batteries during the day in isolated systems, and batteries are used to power appliances when photovoltaic panels do not produce enough energy. In isolated solar systems, solar regulators (also known as charge controllers) play a significant function. Their purpose is to guarantee that the batteries are operating at peak efficiency, primarily by preventing overcharging (by disconnecting solar panels when the batteries are full) and over discharge (by disconnecting the load when necessary). The PVs, or solar panels (module) or array, used to charge a battery diminish the battery's lifetime. The DC electrical energy is stored in the battery and can be used when there is no solar energy available (night time, cloudy days, etc.). The PV/Solar Panel (Module)/Battery may power DC loads directly. The inverter converts the DC electricity generated by the PV, solar panel (module), or battery into AC power, allowing AC loads to be powered.

II. BLOCK DIAGRAM AND DESCRIPTION

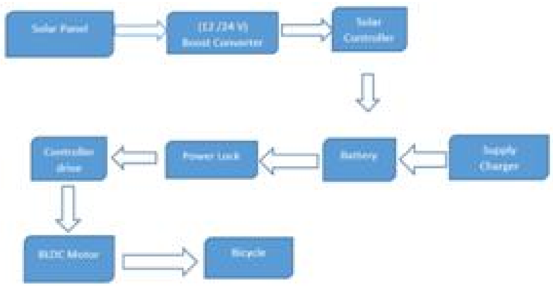


Figure 1: Block diagram of the project

The fig 1 gives the block diagram of the project. Each section could be explained as follows.

Solar Panel :- Solar panels use sunlight as a sources of energy to generate direct current electricity.

Solar Controller :- A solar charge controller is usedto keep the battery form overcharging by regulating the voltage and current coming from the solar panel to thebattery.

BLDC Motor :- A Brushless DC Electric Motor (BLDC) is an electric motor powered by a direct current voltage supply and commutated electronically instead of by brushes like in conventional DC motors.

Battery :- Vehicle battery is a main component that acts as the power source for propulsion of electric vehicle. Rechargeable batteries which are secondary batteries act as the source of energy for electric vehicle.

Process Flowchart

The Fig 2 provides us the detailed knowledge about the process of the project.

First, I'm starting this project for the first time, and our team is looking for high-quality materials to use in it. For example, there are two types of solar panels available on the market: polycrystal and monocrystal, both of which are excellent, but their output varies depending on the season, which is why we're looking for high-quality materials. Then there's component specification and rating verification. More components are assembled, then all connections are joined, and the charging time is calculated. First and foremost, all of the testing

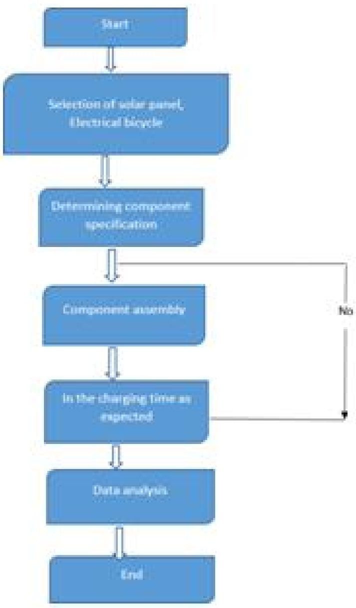


Figure 2: Process Flow Diagram

III. IMPLEMENTATION OF WORK

1) Solar Panel

The bicycle is powered by solar energy, as the name implies. A solar cell is used to charge the lead acid battery using solar energy. Using the photovoltaic effect, solar cells convert the energy of sunshine directly into electricity. In the photovoltaic effect, a voltage is converted into electro-magnetic radiation. The photoelectric and photovoltaic effects are both related to sunlight, but they differ in that in photoelectric, electrons are ejected from a material's surface upon exposure to sufficient energy radiation, whereas in photovoltaic, generated electrons are transferred to different bands of valence to conduct within the material, resulting in a voltage build-up between two electrodes.

A solar panel is a collection of solar cells that can directly convert light to electricity. Part of a family's electrical needs can be met by combining the capacity of several solar panels. Currently, depending on the type of panel, 5 to 19% of light energy can be converted into electricity. This is referred to as the panel's "output." Because technology is always improving, the output should continue to rise. Solar panels allow you toturn sunshine, which is both free and infinite, into electricity. This conversion is made possible by the "semiconductor" substance that each solar cell is comprised of.

Silicon is the most common material for solar cells. This substance can take three different forms:

- Monocrystalline silicon
- Polycrystalline
- Amorphous silicon

Direct current is generated by a solar panel. To use this current in the home or feed the surplus back into the grid, it must first be converted to 230 V alternating current. The converter, which is integrated into the electrical circuit near the solar panels, accomplishes this.

Figure 3: Solar Panel

2) Boost Converter:-

A boost converter (step-up converter) is a DC to DC power converter that steps up voltage (while stepping down current) from its input (supply) to its output (load). It is a class of switched-mode power supply (SMPS) containing at least two semiconductors (a diode and a transistor) and at least one energy storage element: a capacitor, inductor, or the two in combination. To reduce voltage ripple filters, made of capacitors (sometimes in combination with inductors) are normally added to such a converter's output (load-side filter) and input (supply-side filter). Boost converters are highly nonlinear systems and a wide variety of linear and nonlinear control techniques for achieving good voltage regulation with large load variations have been explored.

3) Solar charge Controller:-

When the battery bank is full, pulse-width modulation (PWM) is used. In order to attain the goal voltage for the charge stage the controller is in, the controller allows as much current as the PV panel/array can generate during charging. The charge controller swiftly switches between connecting the battery bank to the panel array and disconnecting the battery bank as the battery approaches the target voltage, regulating the battery voltage and keeping it constant. PWM stands for pulse width modulation, and it guarantees that your battery bank is charged efficiently while also protecting it from being overcharged by the PV panel or array. The rate at which electric current is added to or extracted from electric batteries is limited by a charge controller, charge regulator, or battery regulator. It protects against overcharging and overvoltage, which can impair battery performance and lifespan while also posing a safety risk. Depending on the battery technology, it may also prevent a battery from totally draining ("deep discharging") or perform controlled discharges to extend battery life. The phrases "charge controller" and "charge regulator" can apply to separate devices as well as control circuitry built into a battery pack, battery-powered device, or battery charger. A PWM (pulse width modulation) controller can be thought of as an (electronic) switch between the solar panels and the battery: The switch is ON when the charger mode is in bulk charge mode. The switch is “flicked” ON and OFF as needed (pulse width modulated) to hold the battery voltage at the absorption voltage. The design consists of four stages which include current booster, battery level indicator, battery charge controller and power supply unit. The designed system is very functional, durable, economical, and realizable using locally sourced and affordable components.

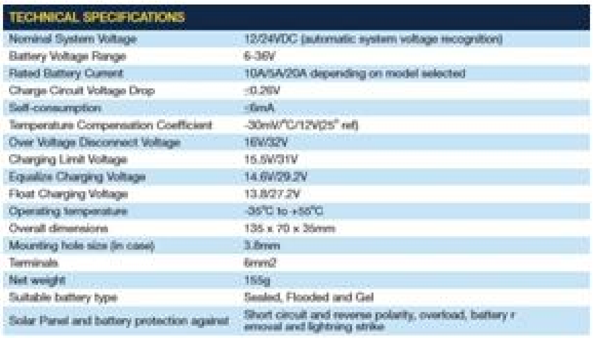
There are four general types of charge controllers, categorized by the method used to regulate the charge from the solar modules to the batteries: shunt type charge controllers; series type charge controllers; pulse-width modulation charge controllers and MPPT charge controllers. An MPPT controller matches its internal resistance to the solar panel Characteristic Resistance, drawing power at the Maximum Power Point. A PWM controller pulls the solar panel voltage down to just above battery voltage, away from the Maximum Power Point of the panel. MPPT is up to 30% more efficient. The PWM charge controller is a good low cost solution for small systems only, when solar cell temperature is moderate to high (between 45°C and 75°C**)**. To fully exploit the potential of the MPPT controller, the array voltage should be substantially higher than the battery voltage. The disadvantages of PWM may be described by under: Due to the variable pulse width, the pulses have variable power contents. Hence, the transmission must be powerful enough to handle the maximum width, pulse, though the average power transmitted can be as low as 50% of this maximum power. More modern charge controllers use Pulse Width Modulation (PWM) to slowly lower the amount of power applied to the batteries as the batteries get closer and closer to fully charged. This type of controller allows the batteries to be more fully charged with less stress on the battery, extending battery life. A PWM controller operates at a relatively constant harvesting efficiency regardless of the size of the array. A PWM controller is less expensive that a MPPT, so is a more economical choice for a small system. A MPPT controller is much less efficient in low power applications.

Figure 4: Solar Charge Controller

IV. PRODUCT FEATURES

- 12V/24V Automatic Recognition of Both Battery & Solar Connections
- Unique Single Or Dual Battery Charging Function
- Efficient Series PWM Charging
- Charging & Status LEDS
- Reverse Current Protection

V. TECHNICAL SPECIFICATIONS



TECHNICAL SPECIFICATIONS	
Nominal System Voltage	12/24VDC (automatic system voltage recognition)
Battery Voltage Range	6-36V
Rated Battery Current	10A/5A/20A depending on model selected
Charge Circuit Voltage Drop	≤0.26V
Self-consumption	<6mA
Temperature Compensation Coefficient	-30mV/°C/12V(25° ref)
Over Voltage Disconnect Voltage	16V/32V
Charging Limit Voltage	15.5V/31V
Equalize Charging Voltage	14.6V/29.2V
Float Charging Voltage	13.8/27.2V
Operating temperature	-35°C to +55°C
Overall dimensions	135 x 70 x 35mm
Mounting hole size (in case)	3.8mm
Terminals	6mm2
Net weight	155g
Suitable battery type	Sealed, Flooded and Gel
Solar Panel and battery protection against	Short circuit and reverse polarity, overload, battery r emoval and lightning strike

Figure 5: Technical Specifications

Battery Connection :--

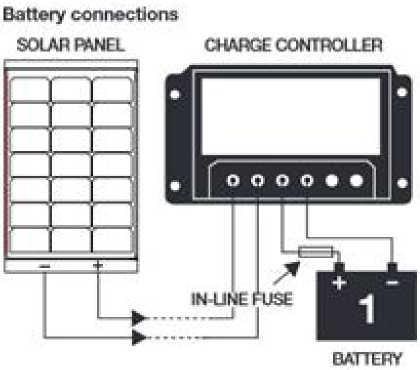


Figure 6: Single Battery Solar Connection

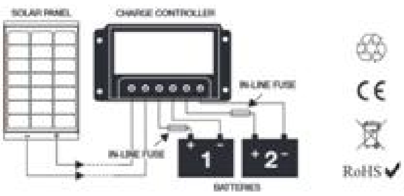


Figure 7: Double Battery Solar Connection

Lithium ion battery:-

The car battery is a key component that serves as the vehicle's power source for propulsion. The energy source for electric vehicles is rechargeable batteries, which are secondary batteries. Various battery technologies are utilized depending on their benefits, applications, and cost. The vehicle's range is mostly determined by the battery's capacity. As the vehicle's battery capacity grows, so does its size and expense. The cost of an electric car battery has decreased in recent years and will continue to fall as the automotive industry focuses on developing low-cost, high-efficiency, high-capacity batteries. Aqueous batteries (such as lead–acid, nickel–metal hydride, and nickel– cadmium) have a higher open-circuit voltage. [Verification failed] Cycling and ageing both increase internal resistance. Although this is highly dependent on the voltage and temperature at which the batteries are kept, under load, increasing internal resistance causes the voltage at the terminals to drop, lowering the maximum current flow. Eventually, the battery's resistance will rise to the point that it will no longer be able to withstand the usual discharge currents required of it without experiencing excessive voltage drop or overheating.

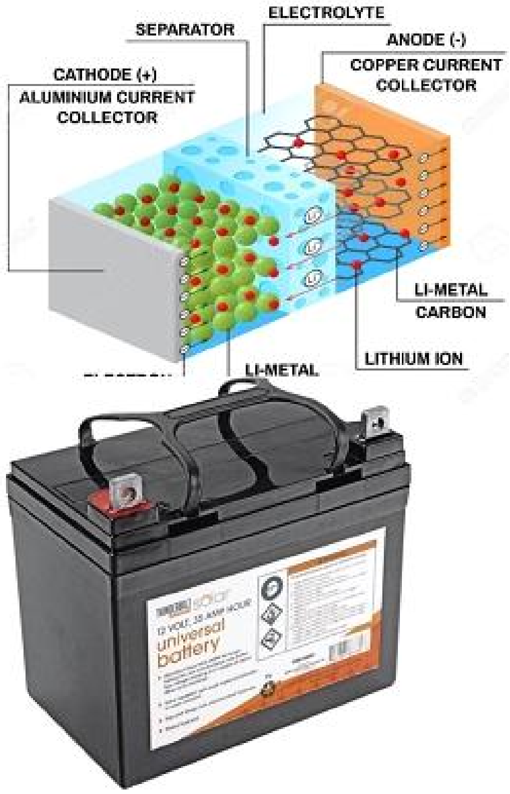


Figure 8: Lithium Ion Battery

The nominal open-circuit voltage of lithium iron phosphate positive and graphite negative electrode batteries is 3.2 V, with a typical charging voltage of3.6 V. The nominal voltage of lithium nickel manganese cobalt (NMC) oxide positives with graphite negatives is 3.7 V, with a maximum of 4.2 V while charging. With current-limiting circuitry, the charging procedure is carried out at constant voltage (i.e., charging with constant current until a voltage of4.2 V is reached in the cell and continuing with a constant voltage applied until the current drops close to zero). The charge is usually halted at 3% of the initial charge current. In the past, lithium-ion batteries could not be fast-charged, and it took at least two hours to fully charge them. In 45 minutes or less, current-generation cells can be fully charged. In 2015, researchers showed that a small 600mAh battery could be charged to 68 percent capacity in two minutes and a 3,000 mAh battery could be charged to 48 percent capacity in five minutes in 2015. The latter battery has a 620 Wh/L energy density. In the anode, hetero atoms bound to graphite molecules were used.

BLDC Motor:-

Brushless DC motors (also known as BLDC motors or BL motors) are brushless DC motors that do not have brushes. The controller sends current pulses to the motor windings, which govern the synchronous motor's speed and torque.These motors are incredibly efficient at providing a lot of torque across a wide speed range. Permanent magnets move around a fixed armature in brushless motors, solving the problem of connecting electricity to the armature. Electronic communication has a wide range of capabilities and flexibility. They're noted for their quiet operation and the ability to hold torque when stationary.

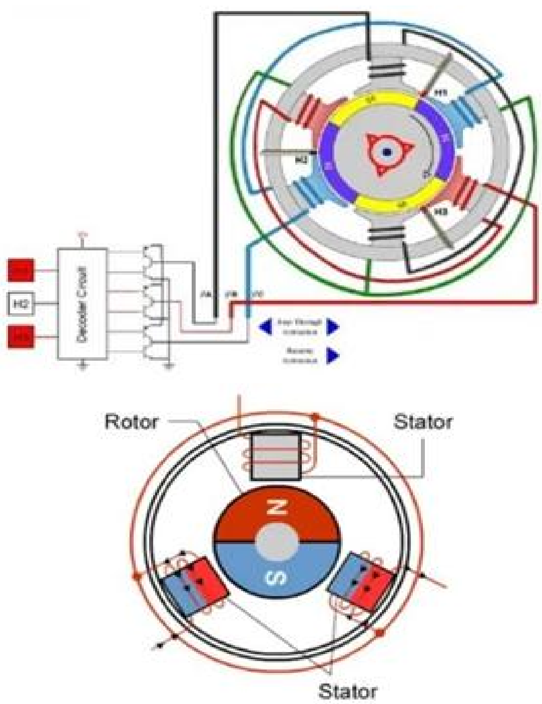


Figure 9: Cross Sectional View Of BLDC

It is necessary to understand the function of a brushed motor before understanding the operation of a brushless DC motor. Brush motors have permanent magnets on the outside and an electromagnet-filled spinning armature on the inside. When the electricity is turned on, these electromagnets create a magnetic field in the armature, which aids in the rotation of the armature. To keep the armature rotating, the brushes adjust the polarity of the pole. Brushed DC motors and brushless DC motors both use the same basic operating concept, which is internal shaft position feedback.

VI. TYPES OF BRUSHLESS DC MOTORS

BLDC motors are divided into two types: outer rotor motors and inner rotor motors. The only variation between the two is in design; their operating principles are identical.

Theoretical Background

The total power Ptotal required to drive the bicycle is given by the sum of the power to overcome the air Pdrag , the power to overcome the slope Phill , and the power to overcome the friction Pfriction . Equations (1)–(4) show the relationships as discussed , where the symbols for the parameters, their units, and some remarks are summarized .

$$P_{total} = P_{drag} + P_{hill} + P_{friction} , (1)$$

$$P_{drag} = C_d \cdot D \cdot A\, 2 \cdot (v_g + v_w)\, 2 \cdot v_g , (2)$$

$$P_{hill} = 9.81 \cdot G \cdot v_g \cdot m , (3)$$

$$P_{friction} = 9.81 \cdot m \cdot R_c \cdot v_g . (4)$$

The three cases that can be distinguished according to Wilson’s Bicycle Science [8] correspond to the following riding conditions:

- Case 1 At speeds greater than 3 m/s (≈6 mi/h), the majority of the power is used to overcome the air drag → Flat ground, high speed: → Pdrag ↑↑, Phill, = 0, Pdrag > Pfriction .
- Case 2 At speeds less than 3 m/s (≈6 mi/h) and at level surfaces, the majority of the power is used to overcome the rolling resistance → Flat ground, low speed: → Pfriction ↑↑, Phill, = 0, Pfriction > Pdrag .
- Case 3 On steep hills, the power required for overcoming air drag and rolling resistance is small when compared with the power required to overcome the slope → Hilly ground, low speed: → Phill ↑↑, Phill,> Pdr

Inner Rotor Design:-

The rotor is positioned in the centre of the motor, and the stator windings surround the rotor in an inner rotor arrangement. Rotor magnets do not insulate heat inside the rotor because it is positioned in the core, so heat is easily dissipated. As a result, inner-rotor designed motors create a lot of torque and are widely employed.

Parameter	Theoretical	Actual
Torque	45.1392 N-M (Single seat)	42.3474 N-M (Single seat)
RPM	300 RPM	288 RPM
Battery charge time	4.166hrs	4.37hrs
Battery discharge time	1.5hrs	1.7hrs
Speed	25km/hr	30 kmph
Average	45 km	44.57 km
Battery type	Lithium ion battery	-
Motor type	BLDC	-
Battery capacity	48v/20 ah	-
Payload	87 kg	-

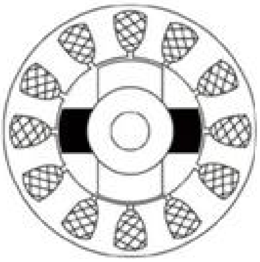


Figure 10: Inner View

Outer RotorDesign:-

In an outer rotor design, the rotor surrounds the winding, which is located in the motor's core. The heat from the motor is trapped inside the rotor by the magnets, which prevent it from dissipating. This type of motor has a low starting torque and runs at a lower rated current.

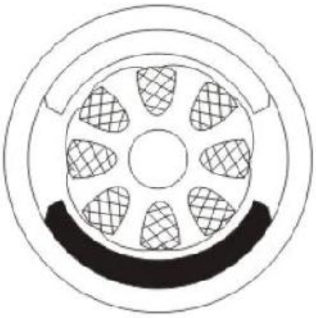


Figure 11: Outer View

VII. RESULT AND DISCUSSION

An attempt was made to test the electrical bicycle. The current levels to the motor control circuit's relay contact reached critical ampacity, destroying the relay and rendering the circuitry unworkable. The electric bicycle jerked forward slightly just beforethe relay was damaged, indicating that power was transferred through the drive train to the rear wheel. To make the E-bike functional again, the motor control circuit would have to be redesigned. The MQP team's problem was tackled with a pragmatic understanding of the project's enormous scope. The team's awareness of the interdisciplinary and deeply varied issues inherent to this type of engineering project grew as a result of overcoming those impediments.

VIII. CONCLUSION

Conclusion Conclusions can be reached based on the findings of the discussion and testing of electric bicycles with solar panels, including:

- Electric bicycles designed with the use of solar panels work well.
- With a current of 1.2 A, the assembled solar panels can charge the battery in 4hours.
- With a distance of 16 km and a weight of 80 kg, the maximum speed of an electric bicycle with solar panels is as expected: 20 km/h. The weight of the vehicle has an impact on mileage and journey time.

The design requirements for an effective selection of the key components of the electric bicycle, such as the motor, battery, and controller, are also listed in this paper. Additional controller protection measures, as well as random mechanical component choices for designing a beautiful electric bicycle, are also provided. The user can choose which microcontroller to utilize . TI offers a variety of alternatives for this design, as well as a dedicated applications team to support the appropriate TI microcontroller.

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This bicycle is less expensive, has a simpler design, and may be used for short-distance travel by schoolchildren, college students, office workers, peasants, and postmen, among others. It is well suited to the needs of young, elderly, and handicapped people, as well as the economically disadvantaged. It can be used at no cost throughout the year.

The most crucial characteristic of this bicycle is that it does not use valuable fossil fuels, saving billions of dollars in the process. It is environmentally friendly and pollution-free because it produces no emissions. Furthermore, it is silent and can be recharged using an AC converter in the event of an emergency or gloomy weather. The cost of operation per kilometer is low, at around Rs. 0.70/km. In the event that the solar system fails, it can be powered by human pedalling.

It has fewer components, is easy to install and disassemble, and requires less maintenance. From the standpoint of a future energy system, it's critical to find new modes of transportation and electricity generation, and solar- powered E-bicycle pools could be one of them. E- bikes use an order of magnitude less energy than a car, bus, or other kind of heavy transportation. Based on simulated system usage (3–10.8 trips/(E-bike & day)), a solar panel with a surface area of 0.2–0.8 m2 per E-bike has been shown to be sufficient to meet the E-bike pool's early energy requirements. The computed area is less than the expected maximum area of 3–3.8 m2/E-bicycle, indicating that yearly energy self-sufficiency can be achieved without running out of room. In a grid-connected system, using larger panels than 0.2-0.8 m2 per E-bike will result in a net electric energy output. The hardware design guidelines are stated in this application report.

XI. FUTURE SCOPE

As more individuals explore alternatives to driving gasoline-powered vehicles for their morning commute, electric bicycle sales are expected to rise. We may see many more applications for these e- bikes as technology advances, from off-roading to grocery shopping and everything in between. As a result, we believe that a new battery source should be developed. We believe that solar-powered vehicles will be developed in the future to provide a continuous charging source. This project is divided into two sections: hardware and software.

The bicycle will be the hardware, and the software will be the controller's programme for controlling the bicycle's operation. To be more specific about this project, the following items will be used:

1. Use solar energy to recharge the battery.
2. Use a PIC microcontroller for the charging system.
3. Drive the bicycle using a high-torque motor.

XI. APPENDIX

Electrical bicycles are quite important in the current situation because the price of fuel is increasing day by day. Because of rising fuel prices, a middle-class family cannot afford to drive or ride a bike on a daily basis. This bicycle charges through solar rays as well as electricity. It is less expensive than a bike or a car, and it requires less maintenance. As a result, this initiative will be extremely beneficial in the future.

XII. ACKNOWLEDGMENT

We take this opportunity to convey our heartfelt gratitude and warm regards to our project supervisor, Prof. S. K. Awaze, for his zealous leadership, frequent monitoring, and unwavering support throughout the production of this seminar report. We have a profound regard for his inherent goodness and boundless passion, which has aided us in working in the proper way to achieve our goals. Prof. G. K. Shirsath, Project Coordinator, and Prof. Dr. A. R.

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XIII. MODEL

Figure 11: PROPOSED MODEL

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