

Energy Efficient Electric Bicycle Design using Solar Panel

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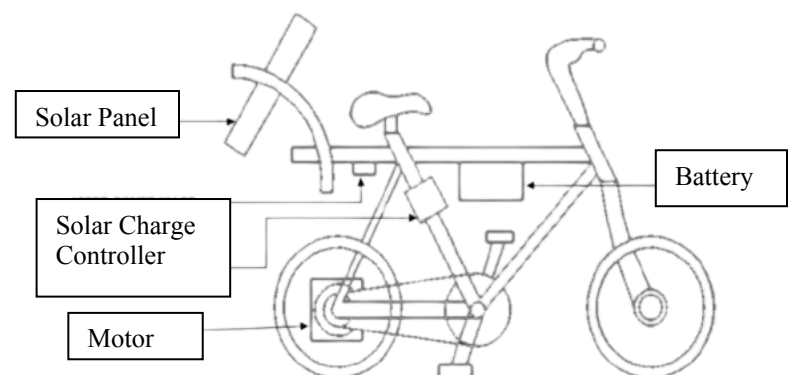
Abstract - People are becoming more conscious of the advantages of using electrical technology and renewable energy in products that improve the environment. Since people have begun to notice the impact non-renewable energy has been having on our environment, interest in renewable energy has been expanding quickly. Researchers have been looking into improved ways to use renewable energy, including solar energy, in order to protect our environment. In light of this, the necessity to find alternatives arose when fuel prices increased globally, leading to the attachment of solar energy to recharge batteries, which in turn supply voltage to power the engine. Electric bicycles (e-bikes) are considered a sustainable alternative to automobile transportation today. The electric bike includes all the benefits that conventional bicycles offer, plus faster, more comfortable and longer trips, as well as less effort for the user. In this paper, we specifically focus on a new type of e-bike, the so-called 'solar-powered e-bike'. Therefore, this review paper explores existing literature findings for the use of solar energy in transportation, and more specifically in e-bikes. This paper aims to capture the status of and experiences with the use of e-bikes; more specifically, with solar-powered e-bikes. It presents research conducted so far on e-bikes and solar-powered e-bikes, as well as the main technical features of the solar e-bike.

Keywords: Electric Bicycle, Battery, Solar Panel, Controller, Chopper, Motor, Solar Charge Controller, Power Lock and Boost Converter.

I. INTRODUCTION

The rise in enthusiasm for using powered power for individual movement is due towards the increased demand for non-polluting mechanized transportation. A bicycle is a low-cost substitute for a car. The system that transforms solar energy into electrical energy is the subject of this project. Our invention is an electric bicycle powered by solar energy that can be pedaled and powered by sunshine. Solar panels, batteries, and converters turn sun energy converted to electricity, which is then sent to the hub motor to drive the cycle. As a result, cycling for shorter distances will become more popular in the future and contribute to a reduction in noise and air pollution[1].

Over the past few years, development of electric vehicles in the world has experienced a tremendous increase. Electric vehicles (EV) are one of the modern transportation concepts that are environmentally friendly. EV does not emit exhaust gas, like that occurs in conventional vehicles that use fuel oil. Since 2008 there has been a revival in the production of electric vehicles, this is as a result of battery technology innovation and the commitment of countries around the world to reduce greenhouse gas emissions that cause global warming. According to a Reuters analysis of 29 global car manufacturers, it is concluded that top car manufacturers plan to spend \$ 300 billion over the next 5 to 10 years [2]. The application of solar energy as solar panel technology (photovoltaic) to overcome the current global energy crisis. In the future, the solar panel technology is not only for household energy needs (solar rooftop) but has a very potential as an energy source for electric vehicles. It can be an application by the solar charging station or solar hybrid methods that are installed directly on electric vehicles. Nowadays, one type of electric vehicle that growing rapidly is an electric bicycle (e-bike)[3]. Solar panels are an important component to produce electrical energy as long as there is sunlight. The electrical energy generated can be stored in the battery. The system of battery charging is good if it's capable of charging electricity even in conditions of low solar radiation. Previous research has been conducted to combine solar energy sources with electric bicycles. Hybrid solar e-bike system with installing solar panels on an electric bicycle. The energy produced by solar panels is stored in batteries and then used to drive an electric motor. Over the past few years, from several existing studies there are still many weaknesses, namely low filling efficiency, heavy loads, and large dimensions. These deficiencies will



reduce the stability and aesthetics of the electric bike.

Figure.1. Electric Bicycle using solar panel

Previous system only allowed charging of electric bicycle using Electricity so we added solar panel so that it will charge using renewable energy that is solar radiation. Weight of the solar panel is being managed which was bit heavy in previous system. Headlights are used which are charged using solar energy as well as Electric charging using adapter and is waterproof. People are increasingly relying on this since it has no negative environmental impact [4][5].

II. RELATED WORK

A vehicle propelled by an electric motor is an electric bicycle. Depending on the law, different countries use different power sources for electric motors. This study was about a multi-wheeled vehicle that wasn't just a motorcycle This same favored set - up seems to be a common evaluation bicycle with such a number of co transfer of data, and even an electricity. This favorite configuration is typically powered by either a combination of a motor and pedaling that's also linked so that one or both of the provide authority at any time. A DC connector motor, lead acid rechargeable battery, a hand mechanical device that continues to operate a throttle, and an accelerator that tries to control the battery having switched circuit comprise the electrical system [1][2][3]. To overcome these difficulties, an attempt has been made to find alternative energy sources for the vehicles. Poor people cannot afford to buy expensive cars. Bear this in view, a search for a result of the environmental pollution as well as a way and provide for these underprivileged people was underway. The sola-assisted bicycle is energized by an energy from the sun battery and a DC connector motor mounted at the front of the or rear axle housing. The carriage's solar panels will charge it up, which would then power the wheel drive [4][5][6]. Researched their study in integrated hardware and found out how we can make full use of components so that we get maximum output. We learned how to make maximum use of the components. Again, vehicle-related pollution in major cities and urban regions is constantly rising. The newly created solar-powered bicycle is propelled by a DC motor installed in either the front or rear axle housing.[7][8]. Then this paper have as their main focus the development of a vehicle that is cost-effective and how we can find an alternate way to the traditional method used by the developers. Solar energy is defined as the force coming from the sun within the sequence of beams but also heat. A range of techniques, including solar panels, can be used to capture this energy. Solar panels are composed of solar cells that convert energy into electrical signals [9].

III. METHODOLOGY

Solar panels convert solar energy into electricity, which will then be stored in batteries using a charge controller. The power supply is connected to the primary control system, which controls the bicycles' various parameters. The accelerometer, in conjunction with both crankshafts, needs to regulate the same speed of something like the bicycle. The solar panel converts the sunlight into electricity. Thermal energy is converted to electric energy and stored in batteries. The power output varies depending on the size, quality, and total protein of something like the solar array. The aptamers of a solar array vary depending on its size. As a result, the charging time for the battery will vary. the various parameters of the bicycles. The accelerometer, in conjunction with both crankshafts, needs to regulate the same speed of something like the bicycle. The solar panel converts the sunlight into electricity. The power output varies depending on the size, quality, and total protein of something like the solar array. The aptamers of a solar array vary depending on its size. As a result, the charging time for the battery will vary. An electric bicycle that is powered by sunlight and is fueled by solar energy. The bicycle is outfitted with solar panels and a hub motor for easy riding. The battery stores electricity and directs it to the crankshaft of the engine, allowing it to run. Apart from being a non-polluting. Solar panels convert solar energy into electricity, which is then stored in the battery using a charge controller. The power supply is connected to the primary control system, which controls the bicycles' various parameters. The accelerometer, in conjunction with both crankshafts, needs to regulate the same speed of something like the bicycle. The solar panel converts the sunlight into electricity. Thermal energy is converted to electric energy and stored in batteries. The power output varies depending on the size, quality, and total protein of something like the solar array. The aptamers of a solar array vary depending on its size. As a result, the charging time for the battery will vary. An electric bicycle is also an excellent method for recharging battery cells by utilizing freely available natural resources such as the sun. The solar panels on this bike might very well encapsulate sun's radiation and turn it into electricity. To purchase this repurposed energy in the batteries, chapter will deal control strategies are used. The battery, which is linked to the main controller, powers all of the other components of an electric bicycle. The spinning of the motor, like a regular engine, determines the speed of the vehicle, which is measured using an accelerometer. The amount of electric energy produced by a solar panel is determined by the magnitude of the panel and the number of platelets present in it.

Charging time:

The charging equation for a bicycle using solar of 36V



battery and 7.2Ah capacity can be calculated using the following formula:

Charging time (hours) = Battery capacity (Ah) / Charging current (A)

Assuming an ideal charging current of 1A from the solar panel, the charging time for the 7.2Ah battery would be:

Charging time = 7.2Ah / 1A = 7.2 hours

This means that it would take approximately 7.2 hours to fully charge the 36V, 7.2Ah battery using a charging current of 1A from the solar panel.

The charging time of an electric bicycle with a 36V battery can be estimated using the following equation:

Charging time = (Battery capacity in Ah) x (Battery voltage) / (Charging current)

For example, if a 36V battery with a capacity of 7.2Ah, and you're charging it with a charger that delivers a current of 1 amps, then the charging time would be:

Charging time = (7.2Ah) x (36V) / (1A) = 260minutes or 4hours and 20 minutes.

The actual charging time may vary depending on factors such as the temperature of the battery, condition of the battery, and the efficiency of the charging system. It's also important to use a charger that is specifically designed for your bike's battery to ensure safe and effective charging. Whenever the electric bicycle isn't in use, the panels' energy is stored in a battery. This electric bicycle makes efficient use of solar energy which reduces the ultimate cost of transportation. Being a electric cycle this does not need fuel maintenances and combustion engine. solar panel converts sunlight into electrical energy, which is then stored in a battery. The battery is linked to the main controller, which controls the various parameters of the bicycles. The accelerometer, in conjunction with the motor, regulates the speed of the bicycle.

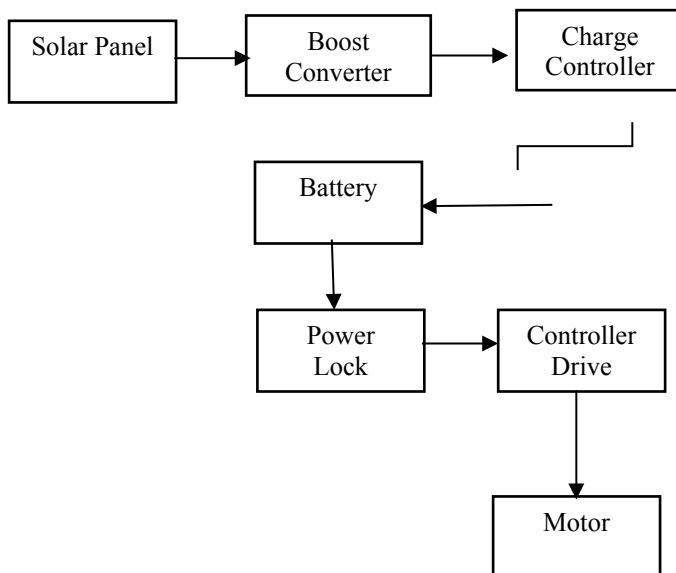


Figure.2. Schematic of the proposed system

Discharging time:

The discharging time of a 36V 7.2 Ah battery can be calculated using the following equation:

Discharging Time = Battery Capacity / Load Current

Load Current is the amount of current that is being drawn from the battery during the discharge.

For example, if the load current is 1.8A, then the discharging time can be calculated as:

Discharging Time = 7.2 Ah / 1.8 A = 4hours

So, with a load current of 1.8A, the 36V 7.2 Ah battery would last for approximately 4 hours before it needs to be recharged.

TABLE I. COMPONENT SPECIFICATIONS

Components	Specifications
Solar Charge Controller	12V, operating temperature 0 - 50 degree Celsius, two step charging algorithm
Battery	36V, 5-7A, Charging time 8 - 10 hours Maximum Speed 25 -30 km/hr
Throttle	Efficiency: $\geq 98\%$, DC0.8V-4.2V.
DC Motor	36V, 410 rpm, torque > 1.8Nm Power 600W, Weight 5.6Kg, Diameter 17mm Thickness 5mm
Solar panel	16V, 40W, Junction box ip65, ip67, Aluminum alloy.

IV. EXPERIMENTAL EVALUATION



A vehicle propelled by an electric motor is an electric bicycle. Another name for it is an "e-bike." Depending on the law, different countries use different power sources for electric motors. The development of the electric bicycle allows it to compete with older models of bicycles on the market, serving as evidence that engineering continues to advance. Even though electric bicycles have motors, they are still referred to as bicycles rather than motorcycles. This is due to the fact that its identification as a bicycle—to which the majority of its parts belong—is still fixed. The electric bicycle is not a fully motorized vehicle; it still has pedals, gearing, brakes, a frame design, and soon. Previous system only allowed charging of electric bicycle using Electricity so we added solar panel so that it will charge using renewable energy that is solar radiation. Weight of the solar panel is being managed which was bit heavy in previous system's headlight are used which are charged using solar energy as well as Electric charging using adapter and is waterproof. There are several performance metrics that can be used to evaluate the energy efficiency of an electric bicycle design that incorporates a solar panel Energy Efficiency: The energy efficiency of the electric bicycle can be calculated by dividing the total distance traveled by the total energy consumed. The power output of the electric bicycle's motor can be measured in watts.

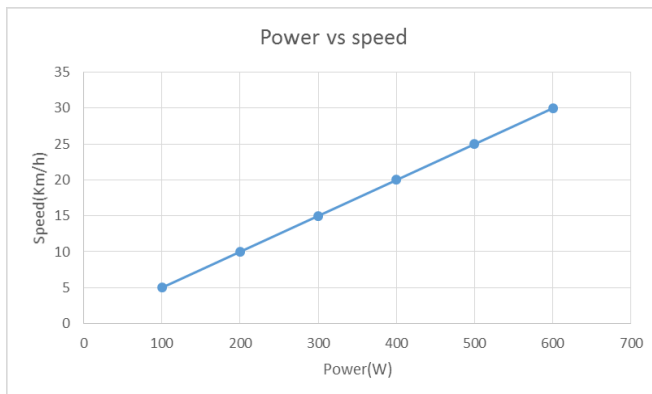


Figure.3. Graph between Speed vs power on a horizontal road (30 degree)

The charging time of a battery is determined by the value of the solar panel used. Even though the Driving is made easier because of solar module is assembled on the electric bicycle. The motor can directly use the authority battery pack to catapult the electric bicycle.

TABLE II. COMPARATIVE ANALYSIS OF PROPOSED BICYCLE WITH PREVIOUS MODEL

Parameter	Solar Electric Bicycle	Ordinary Bicycle [3]
Speed Limit	35- 40	10 to 15

(km/h)		
Pedaling	No (if required)	Yes
Cost	23200	8000
Weight	30 kg	14 kg
Charging time	8-9 hr. For 40 W.	Not applicable
Driving noise (dB)	noiseless	noiseless

V. CONCLUSION

Transportation has always been an important aspect of daily life. Increasing travel needs have elevated the consumption of naturally available fuels from the extraction of crude oil. This makes it very important for humans to find alternatives to travel that will help preserve our resources. An electric bicycle is an excellent option for travelling because it makes use of freely available sources like solar energy. These are cheaper in a long-term investment scenario and will save a lot of money on maintenance. It is designed to produce no air pollution or noise pollution. The To fulfill the project criteria and features that the system is expected to do, as well as to successfully achieve the desired system's expected results, hardware components were carefully selected. The system's output should be a workable computerized cycle which thus strives effectively limit electricity usage through using sunlight as a biofuel, which will have a positive impact on the environment and be economically beneficial in the long run. This Solar powered bicycle is one of the cleanest and sustainable form of transportation. It is very environmentally friendly and also have minimum investment cost. In this project, bicycle uses solar energy for its working. In future, other renewable sources like Wind energy can also be used for this purpose. We can also use indicators, advance sensors, Navigation system etc. for its more advancements. In future various machine and deep learning schemes can be presented for the energy management system of the electrical vehicle and renewable energy sources [10-19].

VI. REFERENCES

1. Nunez, P., Farias, T., Brito, M. C. "Day Charging Electric Vehicles With Excess Solar Electricity For A Sustainable Energy System." Energy. 80, Pp. 263-274. 2015. <https://doi.org/10.1016/j.energy.2014.11.069>
2. Apostolou, G, Reinders, A, And Geurs, K 2018, ' An Overview Of Existing Experiences With Solar-Powered E-Bikes', Energies 2018, 11, 2129; [Doi:10.3390/En11082129](https://doi.org/10.3390/En11082129)



3. M. S. Badadmegha, Vlsi, Fpga, And KSIT Engineering College, "Step Down Transformer: Working Principle, Equation, Types, Advantages, And Disadvantages," *Electricalfundablog.Com*, October 23, 2018.
4. Adhisuwnjo, I. Siradjuddin, M. Rifa'I, And R. I. Putri, "Development Of A Solar-Powered Electric Bicycle In A Bike-Sharing Transportation System," *IOP Conference Series: Earth And Environmental Science*, Vol. 70, P. 012025, 2017.
5. D.S..Kanchan, "Solar And Pedal Powered Electric Bicycle Concept," 2016 *Electrical And Electronic Engineering*.
6. Dr. Shivprakash Barve, Shubham Gadhave, Kartik Mishra, And C. Chaudhari, Dhiraj (2016).
7. Energy, Issue 87, Pedro Nunes Et Al., "Enabling Solar Electricity With Electric Vehicle Smart Charging" (2015).
8. Pandit G. Patil, Energy Sysyems Division, Argonne National Laboratory, June 2009.
9. Sonawane, M. U. Inamdar And K. B. Bhangale, "Sound Based Human Emotion Recognition Using MFCC & Multiple SVM," 2017 *International Conference On Information, Communication, Instrumentation And Control (ICICIC)*, 2017, Pp. 1-4, Doi: 10.1109/ICOMICON.2017.8279046
10. Bhangale, Kishor, And K. Mohanaprasad. "Speech Emotion Recognition Using Mel Frequency Log Spectrogram And Deep Convolutional Neural Network." In *Futuristic Communication And Network Technologies*, Pp. 241-250. Springer, Singapore, 2022.
11. Bhangale, Kishor Barasu, And K. Mohanaprasad. "A Review On Speech Processing Using Machine Learning Paradigm." *International Journal Of Speech Technology* 24, No. 2 (2021): 367-388.
12. Bhangale, Kishor & Kothandaraman, Mohanaprasad "Survey Of Deep Learning Paradigms For Speech Processing" *Wireless Personal Communications*. 1-37. 10.1007/S11277-022-09640-Y, 2022.
13. Bhangale, Kishor B., Pranoti Desai, Saloni Banne, And Utkarsh Rajput. "Neural Style Transfer: Reliving Art Through Artificial Intelligence." In 2022 3rd *International Conference For Emerging Technology (INCET)*, Pp. 1-6. IEEE, 2022.
14. Biradar, Priya, Priyanka Kolsure, Sujata Khodaskar, And Kishor B. Bhangale. "Iot Based Smart Bracelet For Women Security." *Int. J. Res. Appl. Sci. Eng. Technol.(IJRASET)* 8, No. 11 (2020): 688-691.
15. Sarraf, Rajan, Shalini Ojha, Damini Biraris, And Kishor B. Bhangale. "Iot Based Smart Quality Water Management System." *International Journal Of Advance Scientific Research And Engineering Trends*5, No. 3 (2020).
16. Mapari, Rahul, Kishor Bhangale, Laukik Deshmukh, Prashant Gode, And Ankit Gaikwad. "Agriculture Protection From Animals Using Smart Scarecrow System." In *Soft Computing For Security Applications*, Pp. 539-551. Springer, Singapore, 2022.
17. Anand, Tejveer, Sourabh Upare, Siddhant Jain, Maithili Andhare, And Kishor Bhangale. "Deployment Of Real-Time Energy Monitoring System Using Iot." In 2022 3rd *International Conference For Emerging Technology (INCET)*, Pp. 1-4. IEEE, 2022.
18. Mapari, Rahul G., Kishor B. Bhangale, Pranjal Patil, Harish Tiwari, Shivani Khot, And Sanjana Rane. "An Iot Based Automated Hydroponics Farming And Real Time Crop Monitoring." In 2022 2nd *International Conference On Intelligent Technologies (CONIT)*, Pp. 1-5. IEEE, 2022.
19. Mapari, Rahul G., Harish Tiwari, Kishor B. Bhangale, Nikhil Jagtap, Kunal Gujar, Yash Sarode, And Akash Mahajan. "IOT Based Vertical Farming Using Hydroponics For Spectrum Management & Crop Quality Control." In 2022 2nd *International Conference On Intelligent Technologies (CONIT)*, Pp. 1-5. IEEE, 2022.



