Design of Low Cost Hybrid Electric Bicycle

Prepared by
Mr. Kiran Raut,

Abstract

- Increasing the cost of fuel, particularly petrol and also Increases the amount of pollution due to the vehicles in urban and major cities.
- Most of the researcher identified another solution as a energy source for electrical vehicle.
- low cost solar-assisted bicycle is designed that is propelled by a BLDC motor installed in the rear axle housing.
- The solar-assisted bicycle is equipped with a 250 W BLDC motor, allowing it to move at a speed of about 24–30 kmph. It is equipped with two 7.5 Ah lead acid batteries, a 50 watt photovoltaic panel, a 250 W, 24 V, 21 Amp voltage regulator, and a 24 V, 21amp accelerator and motor controller.

Introduction

- In India, heavy traffic has become a daily obstacle for everyone travelling from one place to another.
- Cycling is an effective mode of transportation. Electric-bicycles (E-bicycles) offer a solution to the problems of excessive CO2 emissions, excessive air pollution, and traffic congestion in cities.
- The prize of petrol is also increasing drastically in the automobile sector.
- The main benefits of an E-bicycle are both economically viable and environmentally friendly.
- The E-bike, as a new mode of private transportation, has resulted in a new approach to mobility, particularly in metropolitan areas, for both countries with huge populations and those concerned about the environment.

E-Bicycle Block Diagram

Mainly consist of the following parts

- **Battery**
- **Controller**
- **Solar panel**
- **Electric Motor**

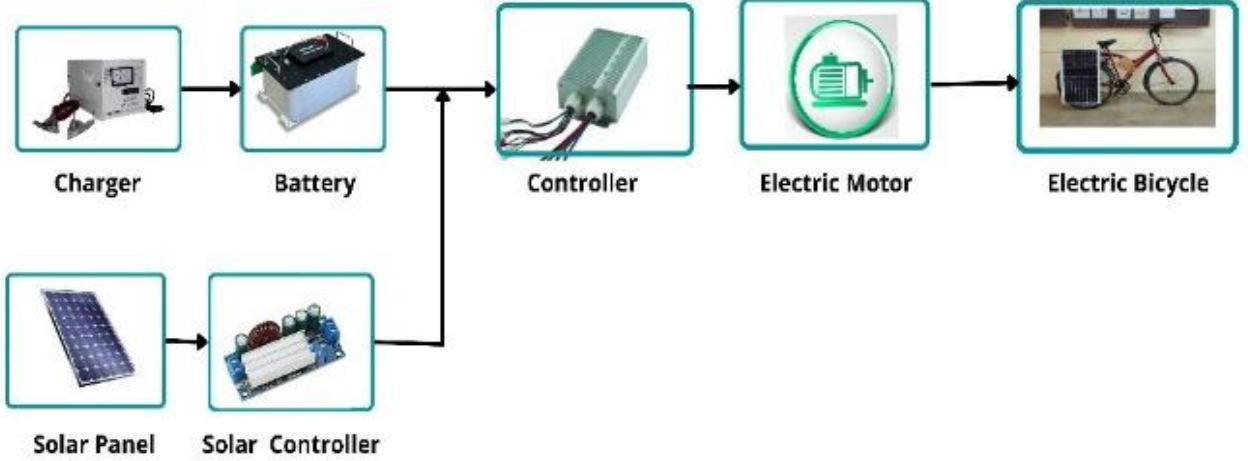


Fig. 1. Proposed E-bicycle block diagram

Block Diagram

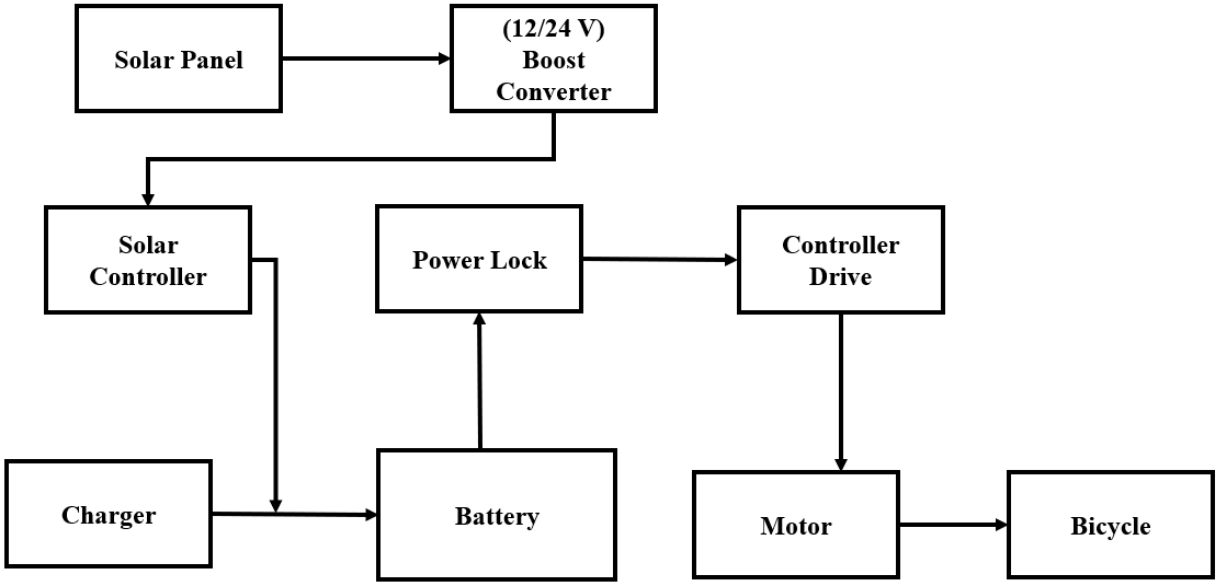


Fig. 2. Block diagram of proposed system

Battery

- Battery store the electrical energy and uses it to power the motor.
- Advantages of batteris are eco-friendly, low costs, reasonably good energy density and longer life of 4-6 years

Table 1. Specification of battery

Specifications		Details
1	Size (l×b×h)	150mm ×60mm×90mm
2	Number of Batteries	2 Batteries (Connected in Series)
3	Voltage	12 V (Each)
4	Ampere Hour	7.2 Ah (Each)



Fig. 3. Lead acid battery

BLDC Motor

Table 2. Specification of Motor

	Specifications	Details
1	Rated Voltage	24 Volt DC
2	Rated Power	250W
3	RPM	400rpm
4	Rated Current	10.41A
5	Full Load current	14.2A
6	Under Voltage Protection	20.5V
7	Current Limiting Protection	20A
8	Constant Torque	9 Nm (90 kg-cm)



Fig. 4. BLDC Motor

Solar Panel

Table 3. Specification of Solar Panel

Specifications		Details
1	Maximum Power (Pmax)	50 W
2	Voltage at Pmax	20 V
3	Open Circuit Voltage	22.5 V
4	Short Circuit Current	2.65 A
5	Sprocket	9 Tooth only fits

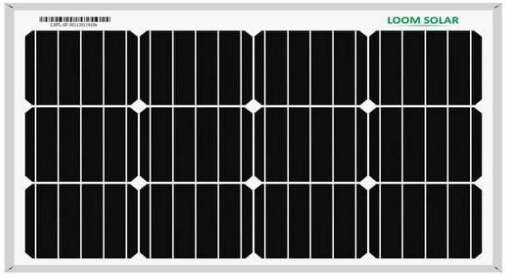


Fig. 4. Solar Panel

Controller

Table 4. Specification of Controller

Specifications		Details
1	Voltage	24 V DC
2	Power	250 W
3	Under Voltage	20 V±1
4	Level Brake	low level
5	Current Limit	21 A ±1

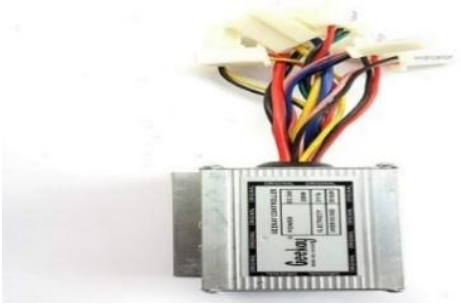


Fig. 5. Controller

Design Model



Fig. 6. Design Model

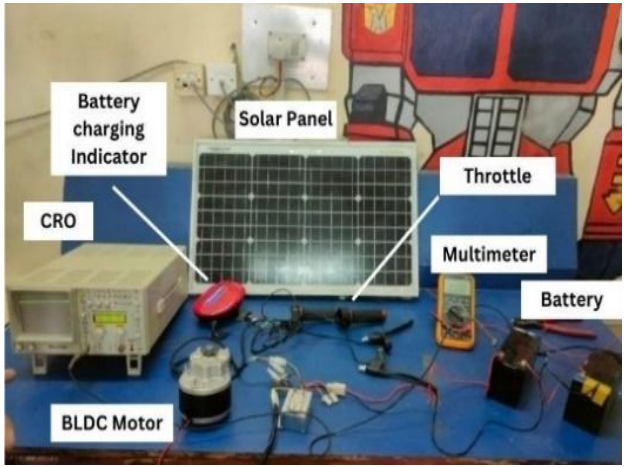


Fig. 7. Hardware Model

Cost Estimation

Table 5 Cost Estimation of E-Bicycle

Sr.No.	Equipment Required	Specification	Cost in Rs
1	BLDC Motor	250 W, 24 V	3,450/-
2	Solar Panel	50 W, 20 V	3,500/-
3	Boost Converter	12-35V	350/-
4	Normal Cycle	-	Available
5	Batteries	12*2=24 V, 7.2 A	1,800/-
6	Extra Component	Headlight, Charger component	2,000/-
Total Cost			11,100/-

Cost Comparison

Table 6 Cost comparison of E-bicycle with TVS 50 two stroke bike

S. No.	Ownership cost after 3 years	E-bicycle	Petrol bike
1	Actual cost of Vehicle	Rs 11,100/-	Rs 35,000/-
2	Fuel/Electricity Cost incurred	Rs 1,000/-	Rs 17,760/-
3	Range (km/ltr)	5.5 km/charge	50 km/ltr
4	Petrol Consumption/Units of Power Consumed	2,400 units per charge	240 ltrs of petrol
5	Maintenance	Rs. 2,000/-	Rs 3,000/-
6	Total cost in a year	Rs. 14,100/-	Rs 50,760/-
7	Cost per km	Rs. 1.45/-	Rs. 4.23/-

Conclusion

- In this paper, the complete design of an E-bicycle is proposed.
- This hybrid bicycle can substitute a bicycle for short-distance travel and for energy-saving purposes.
- In this study, a low cost solar-assisted bicycle is designed that is propelled by a BLDC motor installed in the rear axle housing.
- The cost of electric bicycle is nearer to 11000/- Indian rupees. The proposed E-bicycle is also compared with the TVS 50 two stroke bike.
- It is observed from the cost analysis that the E-bicycle is more efficient than the petrol bike.
- Petrol-powered 2-wheelers are responsible for 32% of the air pollution produced by the transportation sector; these emissions can be decreased by regularly using an electric hybrid bicycle.

References

- Tim Jones, Lucas Harms, Eva Heinen.: Motives, perceptions and experiences of electric bicycle owners and implications for health, wellbeing and mobility, Journal of Transport Geography, Volume 53, May 2016, Pages 41-49, doi.org/10.1016/j.jtrangeo.2016.04.006.
- P. R. Reddy, K. S. S. Gowda, S. Charitha and R. Mahalakshmi.: Review and Redesign of Pedal Energy - Solar Power Augmented Hybrid Bicycle, Third International Conference on Smart Systems and Inventive Technology (ICSSIT), Tirunelveli, India, 2020, pp. 376-380, doi: 10.1109/ICSSIT48917.2020.9214286.
- Weinert, J.; Ma, C.; Yang, X.; Cherry, C.: Electric two-wheelers in China: Effect on travel behavior, mode shift, and user safety perceptions in a medium-sized city. Transp. Res. Rec. J. Transp. Res. Board 2007, 62–68.
- Hatwar, N.; Bisen, A.; Dodke, H.; Junghare, A.: Khanapurkar, M. Design approach for electric bikes using battery and super capacitor for performance improvement. In Proceedings of the 16th International IEEE Conference on Intelligent Transportation Systems-(ITSC), The Hague, The Netherlands, 6–9 October 2013; pp. 1959–1964.
- Thomas, D.; Klonari, V.; Vallée, F.; Ioakimidis, C.S. Implementation of an e-bike sharing system: The effect on low voltage network using PV and smart charging stations. In Proceedings of the International Conference on Renewable Energy Research and Applications (ICRERA), Palermo, Italy, 22–25 November 2015; pp. 572–577.
- Cherry, C.; Cervero, R.: Use characteristics and mode choice behavior of electric bike users in China.Transp. Policy 2007, 14, 247–257

Thank You !