

Design And Fabrication of Dynamic E- Bike

Sandesh S. Rangari¹, Dr. Kirti K. Khandelwal², Prof. Pramod N. Wadaskar³, Parvez B. Khan⁴,
Vaibhav D. Jambhulkar⁵, Snehal S. Vahadane⁶
^{1,2,3,4,5,6}*Anjuman College of Engineering and Technology*

Abstract-The core objective of this project is to design an electric bicycle that is not only practical and cost-effective but also highly adaptable to meet modern urban transportation needs. With the global number of motor vehicles increasing rapidly, there is a parallel rise in the consumption of petroleum-based fuels. This growing reliance on non-renewable energy sources significantly contributes to environmental degradation—particularly through greenhouse gas emissions—and poses health risks for people in densely populated areas. Moreover, concerns about the long-term availability and stability of fossil fuel supplies are escalating.

In light of these challenges, substantial efforts are being made worldwide to promote electric vehicles (EVs) as cleaner and more sustainable alternatives. This project aligns with that vision by focusing on the development and evaluation of a simple electric bicycle design. The approach involves modifying a traditional bicycle by eliminating components such as the internal combustion engine and exhaust system, and replacing them with an electric drivetrain, intelligent control unit, rechargeable battery system, wiring infrastructure, and basic monitoring instruments.

Motivated by the urgent need for cleaner mobility options and the strain that increasing urban populations place on finite natural resources, this project introduces a user-friendly e-bike model intended for daily urban commuting. The prototype achieves a balance between simplicity and functionality, capable of reaching speeds of 20 to 30 km/h and offering a range of approximately 40 kilometres on a single charge.

This initiative not only supports efforts to mitigate air pollution and conserve energy but also aims to provide a practical solution for environmentally conscious users seeking efficient and affordable transportation.

INTRODUCTION

In today's highly connected and fast-paced world, efficient mobility has become essential. To fully participate in modern society, individuals must be able to travel easily, affordably, and quickly. With the increasing depletion of conventional fuels such as petrol and diesel, the demand for sustainable and alternative energy sources is becoming more urgent.

Electricity has emerged as a viable and cleaner alternative, forming the foundation of this project: the development of an electric bicycle.

An electric bicycle, or e-bike, utilizes an electric motor powered by a rechargeable battery, which can be replenished using an external power source. In this project, we incorporate a brush-type controller to regulate motor performance effectively, allowing for smooth acceleration and deceleration. Our goal is to reimagine the traditional bicycle by introducing an affordable and user-friendly electric alternative, particularly suited for urban commuting.

The rise of global warming and the continued depletion of non-renewable resources have highlighted the need for environmentally responsible transportation. While the invention of the internal combustion engine significantly advanced mobility in the last century—offering increased speed, comfort, and convenience—it also led to higher fuel consumption and pollution. These negative impacts have prompted a global shift toward cleaner modes of transport.

Electric vehicles (EVs) represent a key response to these environmental concerns. One of the most accessible categories within EVs is the electric bicycle, which is especially well-suited for city travel. E-bikes are essentially conventional bicycles integrated with electric motors to aid propulsion. These range from pedal-assist models that reduce physical strain to more robust designs that resemble light mopeds. Crucially, all e-bikes maintain manual pedaling functionality, ensuring continued usability in the event of battery depletion or system failure.

Some advanced e-bike models also incorporate dynamos to convert mechanical energy from the wheels into electrical energy, further improving efficiency. By combining mechanical simplicity with intelligent electrical assistance, the electric

bicycle offers a sustainable, low-emission alternative for everyday transportation.

METHODOLOGY

To develop our electric bicycle, we followed a systematic process to ensure effective integration of electrical components with mechanical parts, while maintaining performance, safety, and user comfort. The following steps outline the procedures carried out during the fabrication:

1. **Selection and Preparation of the Bicycle Frame**
A sturdy bicycle frame was chosen to serve as the base structure for the electric bicycle. The frame was evaluated for its strength, geometry, and size to ensure compatibility with the motor, battery, and other components. This selection was crucial to achieving stability, efficient load distribution, and rider comfort.
2. **Disassembly, Cleaning, and Lubrication**
The bicycle was partially disassembled to accommodate electrical installations. Components such as the chain, pedals, and wheels were removed and thoroughly cleaned to eliminate rust, dust, and grease build-up. Lubrication was applied to moving parts, including wheel hubs and bottom brackets, to reduce friction and improve mechanical efficiency.
3. **Mounting of Electrical Components**
We strategically mounted the motor, battery, controller, generator, and related accessories on the bicycle frame. The motor was fixed near the crank set, providing direct torque to the drivetrain. The battery was mounted on the downtube for balanced weight distribution, while the generator was installed on the rear wheel to support regenerative capabilities. The controller was positioned in a location that provided easy access and protection from water and dirt. Care was taken to ensure all components were firmly secured using clamps, bolts, and reinforced brackets, maintaining the overall balance of the bicycle.
4. **Electrical Wiring and Integration**
All electrical elements—motor, battery, throttle, controller, generator, and sensors—were connected based on a customized wiring layout. We used high-quality insulated wires and secure connectors to minimize power loss and avoid loose connections. Soldering and

heat-shrink insulation were applied to protect joints. The system was then programmed to allow smooth throttle control and motor regulation based on rider input.

5. **Component Functionality Testing**
After assembly, a detailed system check was performed. This included verifying motor output, throttle responsiveness, battery discharge behaviour, and the charging capability of the generator. The controller's logic was adjusted as required to ensure optimal performance under various load conditions. Safety checks were also conducted to ensure all electrical connections were properly insulated and components were functioning within safe operating ranges.
6. **Road Testing and Performance Evaluation**
The e-bike was tested under real-world conditions on various terrains. Key performance metrics such as acceleration, braking efficiency, speed, balance, and rider comfort were evaluated. These tests helped identify minor adjustments needed in controller calibration, component placement, and cable routing. The results confirmed that the design objectives in terms of efficiency, handling, and range were successfully met.
7. **Fabrication Completion and Final Enhancements**
Upon successful road testing, final touches were added to complete the e-bike. These included:
 - Installing LED indicators and reflectors to improve visibility and safety.
 - Adding a basic digital display to show battery level and speed.
 - Applying cable organizers and protective sheaths to neaten the wiring.
 - Painting or touch-up work on the frame to give it a clean and finished appearance.
 - Conducting a final inspection checklist covering mechanical integrity, electrical safety, and visual aesthetics.
 - Providing user operating instructions and safety guidelines for responsible use of the e-bike.

These final enhancements ensured that the fabricated electric bicycle was not only functional but also safe, reliable, and user-friendly.



CALCULATIONS

Input Specifications Summary

Component	Specification
Motor Power	250 W (DC geared)
Motor Torque	~10 Nm
Battery Type	Lead-Acid
Battery Rating	24V, 16Ah
Wheel Diameter	21 inches (≈ 0.5334 meters)
Vehicle Load Capacity	100 kg (including rider)
Charging Time (Estimated)	6–7 hours

Battery Energy Capacity

Battery Energy (Wh) Energy=Voltage Capacity=24×16=384 Wh
 Battery Energy (in Joules)
 1 Wh=3600 J⇒384×3600=1,382,400 J

Theoretical Range Estimation

Assuming the motor consumes about 60–70% of its rated power under average conditions, we consider:
 Average Power Consumption ≈180 W
 Operating Time (Hours) Time=180 W384 Wh =2.13 hours
 Estimated Range (km)
 Assuming an average speed of 20 km/h:
 Range=2.13×20=42.6 km

Torque to Force at Wheel

Wheel Radius Diameter=21 inches Radius=21 ×0.0254=0.2667 m
 Force at Wheel Force=Radius Torque=0.266710 =37.5 N

Maximum Speed Estimation

Using the formula:
 Power=Force×Velocity⇒Velocity=ForcePower =37.5250=6.67 m/s≈24 km/h
 This theoretical speed is in line with the intended design range of 20–30 km/h.

Charging Power and Time

Assuming a charger output of 3A at 24V:
 Charging Power P=V×I=24×3=72 W
 Ideal Charging Time Time=72384=5.3 hours
 Realistic Charging Time
 Taking into account energy losses and inefficiencies, actual time is approximately: 6–7 hours

Load Capacity and Gradeability Check

Total Force due to Load F=m·g=100·9.81=981 N
 Maximum Gradeability (Slope %)
 Gradeability=r·m·gTorque=0.2667·100·9.8110 ≈3.8%
 This indicates the e-bike can support 100 kg on flat and mildly inclined surfaces but may require manual pedalling assistance on steeper slopes.

Energy Consumption per Kilometer

Energy Used per km Energy/km=42.6 km384 Wh ≈9.01 Wh/km
 This value is within the typical efficiency range for commercial e-bikes (6–12 Wh/km).

CONCLUSIONS

Electric bicycles offer several benefits compared to motorcycles and scooters, notably by providing a cleaner mode of transport that reduces environmental impact. Unlike fossil fuel-based vehicles, e-bikes do not emit toxic gases because they are powered by DC motors running on batteries.

One way to extend the range of an e-bike is through self-charging, where the motor's power is used both for propulsion and to recharge the battery with the help of a generator. This feature can improve the affordability of e-bikes, making them a more economical alternative to motorcycles and addressing concerns about the limited availability of charging stations for short-distance travel.

Electric bicycles represent a growing technology, with many reputable companies now producing them. As fossil fuels like petrol and diesel become increasingly scarce, the adoption of electric vehicles is expected to rise in the near future. The use of electric bicycles can significantly decrease greenhouse gas emissions from traditional vehicles. E-bikes are also user-friendly and relatively inexpensive. Many technological advancements

enhance their functionality compared to other two-wheeled vehicles, including features like an odometer, electrical and mechanical braking systems, pedal assist, and a Hall-effect sensor.

Early versions of electric-assisted bicycles had some shortcomings, primarily due to cost considerations that influenced design choices based on earlier models. Key components such as the battery, motor, and bicycle frame had limitations. For example, the motor attachment design made it challenging to modify the connection between the motor and the bicycle. However, these limitations did not prevent innovation. In this project, a pre-owned bicycle was successfully converted into a functional e-bike with nearly all the features found in commercially available models. This conversion is both cost-effective and environmentally responsible. Using a lead-acid battery, the converted e-bike can reach a top speed of 30 km/h and has a range of 35 km or more, depending on riding conditions.

REFERENCES

- [1] K. Schleinitz, T. Petzoldt, L. FrankeBartholdt, J. Krems, T. Gehlert, The German Naturalistic Cycling Study – Comparing cycling speed of riders of different e-bikes and conventional bicycles, ScienceDirect- Ekseveir July- 2015
- [2] Ajinkya Parab, Ankit Kamath, SatwantSingh Rajpurohit, Zeeshan Mulla , Urban Electric Bike, IJSRD - International Journal for Scientific Research & Development| Vol. 3, Issue 02, 2015 ISSN (online): 2321-0613
- [3] R.S Jadoun, Sushil Kumar Choudhary, Design And Fabrication Of Dual Chargeable Bicycle, Innovative Systems Design and Engineering, www.iiste.org ISSN2222-1727 (Paper) ISSN 2222-2871 (Online) Vol.5, No.8, 2014
- [4] Rahul Sindhvani, Punj L. Singh, Anjum Badar, Ankur Rathi, Design of Electric Bike with Higher Efficiency, International Journal of Advance Research and Innovation Volume 2, Issue 1 (2014) 247-251 ISSN 2347 – 3258
- [5] Design and Experimental Study of Solar Hybrid Bicycle: 6th National Conference RDME 2017, 17th- 18th March 2017.
- [6] An innovative solar powered electric bicycles, International Conference on Science, Technology, Engineering & Management 2018.
- [7] Design and Development of Solar Assisted Bicycle, International Journal of Scientific and Research Publications, March 2017. <https://www.jetir.org> Design and Fabrication of Solar powered Bicycle <https://www.ijser.org> Fabrication and Testing of Solar Smart Bicycle
- [8] European Environment Agency. Air Quality in Europe– 2016 Report; EEA Report; No. 28/2016; Publication Office of the European Union: Luxemburg, 2016.
- [9] European Environment Agency. Air Quality in Europe– 2017 Report; EEA Report; No. 13/2017; Publication Office of the European Union: Luxemburg, 2017