INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH IN ENGINEERING AND MANAGEMENT (IJSREM)
VOLUME: 09 ISSUE: 04 | APRIL - 2025 SJIF RATING: 8.586 ISSN: 2582-3930

The Journal Review on Design and Fabrication of Multidrive Electric Bicycle.

.P.CH.Manikanta achari[1], G.Akhil[2], N.Balaji[3],M.Dhanush[4],D.Hemanth Kumar[5]. K.Anusha Nandini[6]
[1]Student, Department of Mechanical engineering, NS Raju Institute of Technology(A),Visakhapatnam, 531173.
[2]Student, Department of Mechanical engineering, NS Raju Institute of Technology(A),Visakhapatnam, 531173.
[3]Student, Department of Mechanical engineering, NS Raju Institute of Technology(A),Visakhapatnam, 531173.
[4]Student, Department of Mechanical engineering, NS Raju Institute of Technology(A),Visakhapatnam, 531173.
[5]Student, Department of Mechanical engineering, NS Raju Institute of Technology(A),Visakhapatnam, 531173.
[6] Assistant Professor, Department of Mechanical engineering, NS Raju Institute of Technology(A),Visakhapatnam, 531173

ABSTRACT

The increasing urban population and growing environmental concerns have necessitated the development of sustainable transportation alternatives. This paper presents the conceptualization, design, and implementation of a Multi-Driven Electric Bicycle (MDEB) that integrates human pedaling, electric motor assistance, and solar energy to deliver a versatile, eco-friendly mobility solution. The MDEB is designed to operate in three distinct modes—Manual, Electric, and Hybrid—each tailored for specific riding conditions and user preferences. A modular control system managed by an Arduino-based unit ensures seamless transitions between modes and optimal power utilization. Performance testing of the prototype shows promising results in terms of speed, energy efficiency, user comfort, and environmental benefits. The study concludes with discussions on future scope, potential challenges, and the MDEB's role in shaping next-generation personal transportation systems.T

1. Introduction

Urbanization, increased vehicular congestion, and escalating fuel prices are driving the need for innovative and sustainable transportation systems. Electric bicycles (e-bikes) have emerged as an efficient and environmentally friendly mode of transport. However, current e-bike models are predominantly powered by batteries, which limits their range and applicability. The Multi-Driven Electric Bicycle aims to overcome these limitations by incorporating multiple energy sources: human pedaling, electric motor propulsion, and solar energy.

➢ Background

The history of electric bicycles dates back to the 19th century, with modern adoption gaining traction due to advancements in battery and motor technologies. With global concerns about carbon emissions and fuel consumption, there has been renewed interest in hybrid and electric mobility systems. Electric bicycles have evolved significantly, transitioning from simple battery-assisted cycles to more complex multi-mode vehicles integrating smart technologies.

➢ Problem Statement

Traditional e-bikes, while effective, are limited by battery capacity and often do not provide adaptive assistance in real-time. The lack of integration between manual and electric drives and the absence of energy recovery mechanisms reduces overall efficiency. Furthermore, range anxiety, infrastructure limitations for charging, and poor adaptability to different terrains further hinder the adoption of e-bikes. The project addresses these issues through a hybridized solution that enhances range, performance, and user experience.

➢ Objectives

• To design and fabricate a multi-driven electric bicycle with Manual, Electric, and Hybrid modes.

• To integrate solar charging capabilities for enhanced sustainability.

- To develop a smart control system for efficient energy management.
- To evaluate system performance in real-world scenarios.
- To promote the use of green transportation among the general public.

➢ **Scope of the Study**

- The research encompasses system design, component selection, mechanical fabrication, control logic programming, and performance testing. Emphasis is placed on safety, rider comfort, sustainability, and cost-effectiveness. The study includes the development of a prototype that can later be adapted for mass production.

2.Evolution of Electric Bicycles

➢ Electric bicycles have been in conceptual development since the 1800s, but only in the past two decades have they become viable consumer products. Key developments such as lithium-ion battery technology, brushless DC motors, and embedded control systems have greatly improved efficiency and performance. Studies have confirmed the health, environmental, and economic benefits of e-bikes, especially in urban transportation systems.

2.1Multi-Driven Systems

➢ Research into hybrid propulsion systems reveals that combining human and electric power increases range and reduces energy consumption. Solar integration adds an additional layer of sustainability. Regenerative braking has been successfully tested in reducing net energy usage by up to 15% in some systems.

2.2 Limitations in Current Designs

Despite progress, challenges remain in developing cost-effective, lightweight, and reliable hybrid electric systems. Battery degradation, lack of standardization in components, and complexity in control systems are major barriers to wider adoption. These issues underscore the need for more user-centric and adaptive designs.

3 Methodology

3.1 Design Approach

➢ A modular approach was adopted for easier integration, maintenance, and potential future scalability. The bicycle's chassis was selected to be lightweight yet strong enough to support additional components. A systems engineering process was followed to ensure all components interact efficiently.

3.2 Implementation Steps

Market and literature research

Requirement analysis and functional design

CAD modeling using SolidWorks

Component procurement

Frame modification and subsystem installation

Control system programming and sensor calibration

Field testing and feedback collection

3.3 Tools Used

- CAD software: SolidWorks
- Microcontroller IDE: Arduino IDE
- Testing equipment: Multimeters, oscilloscopes, GPS trackers

- Mechanical tools: Welding machines, crimpers, cutters

3.4 Materials

Frame: 6061 Aluminum alloy for strength-to-weight efficiency

Motor: 36V BLDC hub motor

Battery: 36V, 10Ah lithium-ion

Control unit: Arduino Due with L298N motor driver

Additional: Regenerative braking unit, Hall effect speed sensor, brake switch

4. System Design and Components

➢ Frame Design

➢ The frame was chosen for its geometry and compatibility with mountain biking standards, allowing space for battery and control units. The frame was reinforced with brackets and mounts to secure electrical components.

➢ Propulsion System

➢ The propulsion system includes a 250W hub motor located at the rear wheel. It is designed for mid-speed urban commuting and offers adequate torque for inclines. It is connected to a throttle and regulated through the control system.

➢ Battery and Power System
➢ A 10Ah battery offers a 40–45 km range under hybrid operation. The BMS ensures safe voltage and temperature ranges during use. Battery placement was designed for center-of-gravity balance.

➢ Control System
➢ Using the Arduino Due, the control system reads data from sensors and user inputs. It adjusts power delivery using Pulse Width Modulation (PWM) and integrates safety features like overload shutdown and regenerative braking logic.

➢ Sensor Integration
➢ Sensors include:

- Speed sensor: Hall-effect based

- Braking sensor: Mechanical switch interrupt

- Cadence sensor: Determines rider input for hybrid modulation

5. Operational Modes

➢ Manual Mode
➢ In this mode, the electric system is completely disengaged. The bicycle operates like a traditional cycle. It is useful during exercise, low battery conditions, or system faults.
➢ Electric Mode

➢ The motor handles all propulsion. Throttle input or preset cruise settings can be used. This is ideal for urban commuting, especially over long distances or in hot climates.

➢ Hybrid Mode
➢ The most innovative mode, where sensors detect rider input and supplement it with electric assistance. Control algorithms dynamically adjust motor power to optimize energy usage.

➢ Safety and Redundancy
➢ Redundant systems allow users to revert to Manual mode during faults. Visual and audio alerts notify users of issues like overheating, low battery, or sensor errors.

VOLUME: 09 ISSUE: 04 | APRIL - 2025 SJIF RATING: 8.586 ISSN: 2582-3930

6. Results and Evaluation

➢ Speed and Performance
➢ Performance trials indicated:

- Manual: 12–18 km/h
- Electric: Stable 22–25 km/h
- Hybrid: 18–23 km/h with enhanced battery conservation

➢ Battery Metrics
➢ 36V, 10Ah battery lasted ~45 km in Hybrid mode
➢ Full recharge in 3.5 hours
➢ Regenerative braking added ~10% back to battery in downhill tests

➢ User Feedback

- Users appreciated smooth transitions between modes, lightweight frame, and the ergonomic handlebar controls. Riders reported reduced fatigue and improved satisfaction over long-distance travel.
- Terrain Versatility
- The bicycle was successfully tested on paved roads, gravel paths, and mild inclines. Hybrid and Electric modes improved performance on hilly terrain.

7. Discussion

The results affirm that multi-driven e-bikes are both technically viable and functionally beneficial. The control logic provides intuitive performance while optimizing energy use. While battery weight and component cost remain concerns, the advantages outweigh the limitations. The bicycle supports smart mobility goals for urban planning and has potential for broader implementation.

8. Applications

- Urban Commuting: Solves last-mile connectivity and reduces vehicular congestion.
- Institutional Use: Ideal for universities, corporate campuses, and hospitals.
- Recreational Use: Encourages healthy lifestyle without overexertion.
- Logistics and Delivery: Useful for lightweight urban deliveries.
- Tourism: Enhances experience in scenic areas without fatigue.

9. Challenges and Limitations

- High Initial Cost: Quality motors and batteries are expensive.
- System Complexity: Requires advanced understanding for troubleshooting.
- Weight Addition: Electrical components increase overall weight.
- Maintenance: Requires specialized tools and knowledge.

VOLUME: 09 ISSUE: 04 | APRIL - 2025 SJIF RATING: 8.586 ISSN: 2582-3930

10. Future Scope

- Solar Charging: Flexible panels integrated into the frame.

- AI Assistance: Real-time adjustment based on traffic and user behavior.

- Material Innovation: Lighter frames with composites.

- Smart Features: GPS, anti-theft, mobile apps.

- Custom Models: For delivery services, elderly riders, and rural mobility.

11. Conclusion

- The Multi-Driven Electric Bicycle represents a step forward in sustainable transportation. By incorporating manual pedaling, electric drive, and intelligent control, the system delivers efficiency and flexibility. It addresses urban mobility issues, promotes environmental conservation, and provides a platform for future enhancements. With refinement, the MDEB can significantly influence how personal and micro-transportation evolve globally.

12. References

[1] Dr. A. Sudhakara et al. (2014). “Hybrid electric bicycle using PMDC motor controller and pedaling machine.”

[2] Nishant Patel & Karan Gagnani (2018). “Multi-Powered Hybrid Two-wheeler.”

[3] Ali Ramadhan & Rizky Dinata (2021). “Development of electric bicycle and its impact on the environment.”

[4] Diana Segura-Velandia et al. (2021). “Electric bicycles, next generation low carbon transport systems.”

[5] Ninad Yadav et al. (2024). “Electric Bicycle using Pedal Assist System.”

[6] Riccardo Mandriota et al. (2025). “A Pedaling Torque Observation Approach for Sensorless Electric Bicycles.”

[7] Li, Z., Wang, W., & Chen, L. (2015). “Human-electric hybrid bicycle with energy regeneration.” IEEE Transactions on Industrial Electronics.

[8] Kumar, P., Gupta, R. K., & Kumar, N. (2017). “Solar-powered electric bicycle: A review.” Journal of Solar Energy Engineering.

[9] Cherry, C. R., Weinert, J. X., & Weinert, J. (2009). “The environmental impacts of electric bicycles.” Journal of Transportation Engineering.

[10] Fishman, E., & Cherry, C. (2016). “Electric bicycles in urban transport: A review of survey-based findings.” Transport Reviews.