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Hybrid Solar electric bicycle

Automated Solar Bicycle for Sustainable Urban Mobility: An Experimental Research Study.

Abstract This paper presents the design, implementation, and experimental validation of an automated solar-powered electric bicycle aimed at promoting sustainable and eco-friendly urban mobility. The prototype integrates solar energy harvesting with advanced sensor networks, embedded electronics, and cloud connectivity. The system not only enhances rider safety and energy efficiency but also contributes to smart mobility through real-time monitoring, control, and predictive maintenance capabilities.

Index Terms—Solar bicycle, renewable energy, urban mobility, embedded systems, IoT, BMS, sustainable transport.

Introduction

The adoption of sustainable transportation is critical to combating urban pollution, reducing dependency on fossil fuels, and enhancing the quality of life. Solar-powered bicycles offer an innovative solution by combining the benefits of traditional cycling with renewable energy. This research focuses on a novel prototype that leverages solar panels, lithium-ion batteries, smart controllers, and cloud integration to deliver a high-performance, low-emission mobility solution.

II. System Specifications

- **Dimensions**: Custom chassis design with compact, ergonomic geometry
- **Motor**: 350W, 36V DC hub motor
- **Battery**: 36V 10Ah lithium-ion, 1200 charge cycles
- **Top Speed**: 30 km/h
- **Range**: 40 km per charge in sunlight
- **Charging Time**: 4 hours (AC)
- **Suspension**: Front and rear shocks for off-road capability
- **Payload Capacity**: 150 kg
- **Solar Panel**: 3 x 20W flexible solar modules
- **Safety**: IP65 water resistance, Gorilla Glass dashboard, Doppler radar, brake sensors, and proximity detection

III. Proposed Model

The model enhances the conventional solar bicycle with:

- Impact attenuators

- Real-time cloud-connected dashboard (Blynk + SparkPhoton)

- GPS, pulse, and obstacle proximity sensors
- Data analytics via Tableau integration for battery/motor status, power consumption, and speed

IV. Methodology

A. Components:

1. Solar Panels – Mounted on frame or coat
2. Battery – Lithium-ion, 10Ah, monitored with BMS
3. Charge Controller – 42V/2A, prevents overcharge
4. Motor – 350W hub motor with controller
5. Microcontroller – ARM-based TDA with embedded C/C++
6. Dashboard – Cloud integrated, real-time monitoring

B. Software Stack:

- Embedded C, C++ (microcontroller logic)
- Android App + Blynk for mobile dashboard
- Tableau for visualization

- Spring Boot for server-side integration

V. Sensor Network

The system includes:

- Speed, tilt, torque, and GPS sensors
- Solar irradiance sensor
- Brake and proximity sensors
- Load sensor (alarm-triggered)
- Battery temperature, voltage, current monitoring

VI. Safety and Durability Enhancements

- **IP65 Waterproofing**: Ensures durability in rain and humidity
- **Gorilla Glass**: Scratch-resistant, impact-resistant dashboard
- **EMF Safety**: Low radiation design, regulatory compliance

VII. Cloud Integration

Using SparkPhoton and Blynk:

- Device registered with secure ID
- Real-time data upload via WiFi
- Dashboard visualizations (Tableau + REST APIs)
- Mobile monitoring and control

VIII. Applications of ARM-Based TDA

- Real-time solar activity modeling and visualization
- Driver health tracking
- Smart energy optimization
- Predictive maintenance and fault detection

IX. Limitations

- Solar charging depends on weather
- Limited range per charge
- Weight management with additional components

X. Conclusion

The automated solar bicycle prototype provides a promising step toward zero-emission, smart urban mobility. With future improvements in solar panel efficiency, battery density, and lightweight materials, this model can be scaled for widespread adoption in smart cities and rural transport systems alike.

References

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Acknowledgments

I would like to thank the Department of R&D, KIIT University, for the support and funding provided throughout this project.