AI Based Turbine Generator

Chellam. P and Janani.

G.S UG Student, Department AI&DS

Arunachala College of Engineering for Women, Tamil Nadu, India

Abstract

The increasing demand for fuel-efficient and environmentally friendly vehicles has motivated the development of systems that can recover otherwise wasted energy. This project presents an AI-based turbine generator system designed to capture waste energy from a vehicle's braking, exhaust gases, and coasting/downhill motion. The system uses a turbine connected to a generator to convert mechanical energy into electrical energy, which is then stabilized by power electronics and stored in a battery. An AI controller monitors vehicle conditions, such as speed, braking, exhaust flow, and battery charge, to intelligently switch the generator ON or OFF and optimally distribute the recovered energy to the battery, motor, or vehicle accessories. By efficiently harnessing wasted energy, this system reduces fuel consumption, enhances battery utilization, and improves overall energy efficiency, providing a practical solution for modern hybrid and conventional vehicles.

INTRODUCTION

Vehicles lose a lot of energy as heat during braking, exhaust gases, or while coasting. This project proposes an AI-based turbine generator system that captures this wasted energy and converts it into electricity. A turbine connected to a generator produces electrical energy, which is stored in a battery or used to assist the motor and run vehicle accessories. An AI controller monitors driving conditions and decides when to engage the generator, maximizing energy recovery and improving overall vehicle efficiency while reducing fuel consumption.

NEED OF THE STUDY

The growing demand for fuel efficiency and sustainable transportation highlights the importance of recovering wasted energy in vehicles. A large portion of energy in conventional vehicles is lost through braking, exhaust gases, and coasting, leading to reduced performance and higher fuel consumption. By developing an AI-based turbine generator system, this wasted energy can be effectively harnessed and reused. Such a system not only improves overall vehicle efficiency but also supports reduced emissions, lower operating costs, and longer battery life. Therefore, the study is essential to promote eco-friendly innovations that address energy losses in modern vehicles.

3.1 Limitations of turbine generator

The proposed AI-based turbine generator system, while innovative, faces certain limitations in practical implementation. Energy conversion losses reduce the overall efficiency, and the additional components may increase both the weight and cost of the vehicle. Space constraints inside vehicles further complicate the integration of the turbine and generator. Moreover, the system requires regular maintenance due to moving parts, and battery capacity can restrict the storage of recovered energy. At low speeds or during short trips, the energy recovery potential is minimal, reducing effectiveness. Finally, the AI-based switching process demands advanced sensors and control mechanisms, which add complexity to the system.

3.2 Real -Time Alert

The AI-based turbine generator can be enhanced with a real-time alert system to monitor the performance, efficiency, and health of the components. Sensors such as temperature, vibration, and voltage detectors continuously track the turbine, generator, and battery conditions. The collected data is processed by the AI controller, which immediately alerts the driver or system operator in case of abnormalities like overheating, overcharging, mechanical faults, or low efficiency. Alerts can be displayed on the vehicle dashboard, sent to a mobile app, or integrated with the vehicle's onboard diagnostics. This ensures early detection of issues, reduces maintenance costs, improves safety, and guarantees reliable energy recovery operation.

3.3 Need of Visual Proof Instruction

In modern intelligent vehicle systems, providing visual proof instructions to users is essential for safe and effective operation. Clear visual displays, such as dashboard indicators, mobile notifications, or sensor-based alerts, help drivers understand the real-time status of the turbine generator, battery, and energy recovery process. Such proof ensures transparency by showing when energy is being harvested, stored, or switched by the AI controller. It also supports timely decision-making by alerting users about issues like overheating, overcharging, or system inefficiency. By offering visible confirmation, visual proof instructions increase user confidence, improve safety, and ensure the reliability of the energy recovery system.

RESEARCH METHODOLOGY

The research methodology for the proposed AI-based turbine generator system involves both theoretical analysis and practical validation. Initially, a detailed literature review is carried out to study existing energy recovery mechanisms and AI- based control strategies. Based on this, the system design is developed, consisting of a turbine for harnessing wasted mechanical energy, a generator for electrical conversion, and an AI-based controller for intelligent switching between power sources. Sensors such as speed, temperature, voltage, and vibration detectors are integrated to provide real-time data for monitoring and alerts.

Simulation tools are then used to model the energy conversion process, optimize turbine performance, and evaluate efficiency under different driving conditions. A prototype setup is built to test energy recovery during braking and coasting, where recovered energy is stored in a battery or supercapacitor. Finally, system performance is analysed through experimental results, focusing on efficiency, reliability, and cost-effectiveness, ensuring that the design meets the objectives of sustainable and intelligent vehicle energy management.

3.3 Related Technologies and Supporting Systems

This section highlights the key technologies that support the proposed AI-based turbine generator system. It includes intelligent energy recovery mechanisms, turbine-based power generation, AI-driven energy management, battery storage systems, and real-time monitoring technologies. Together, these supporting systems enable efficient utilization of waste energy, ensure safe operation, and improve overall vehicle performance. The integration of these technologies forms the foundation for sustainable and intelligent energy recovery in modern transportation systems.

3.4 Tools and Statistics Measures Tools used

1. Simulation Software (MATLAB/Simulink)
Used to model and analyse energy flow and system performance.

2. Microcontroller (Arduino/ESP32)
Controls switching, processes sensor data, and runs AI logic.

3. Sensors (Speed, Voltage, Temperature)
Monitor vehicle condition, energy generation, and system safety.

4. Turbine & DC Generator
Convert wasted mechanical energy into electrical energy.

5. Battery / Supercapacitor
Store recovered energy for later use.

6. Display / Alert System:
Provides real-time status and warnings to the user.

Statistical Measures:

1. Energy Recovered
Amount of useful energy captured from waste sources.

2. Battery Charging Efficiency (%)
Effectiveness of storing generated energy.

3. Power Output (W)
Electrical power produced by the generator.

4. Fuel/Energy Savings (%)
Reduction in fuel or battery consumption.

5. System Response Time
Speed of AI-based switching and alerts.

3.4.3 Statistical Measures of Automation

The performance of the automated AI-based turbine generator system is evaluated using statistical measures such as automation accuracy, response time, energy recovery rate, and system reliability. Automation accuracy represents the correctness of AI-controlled switching decisions without human intervention, while response time measures the speed at which the system reacts to changing vehicle conditions. The energy recovery rate quantifies the amount of electrical energy automatically harvested and stored during operation. Efficiency improvement is used to assess the impact of automation on overall system performance, and error rate analysis ensures safe and reliable operation under varying driving conditions. These statistical measures collectively validate the effectiveness and robustness of the proposed automation system.

Financial Status and Budget Justification

The proposed AI-based turbine generator project is planned as a cost-effective prototype with an estimated total budget of approximately ₹14,000–₹15,000. The major expenditure is allocated to the turbine and generator unit, which forms the core of the energy recovery system. Additional costs include a microcontroller for AI-based switching control, sensors for monitoring speed, voltage, and temperature, and power electronic components such as rectifiers and DC–DC converters for safe energy regulation. Energy storage elements, including a battery or supercapacitor, and a basic display or alert module for user interaction are also included in the budget. Minor expenses are associated with software tools and simulation platforms used for system modelling, and performance analysis. The proposed budget is justified by the system's ability to recover wasted energy, reduce fuel consumption, and improve overall vehicle efficiency, making the financial investment reasonable and sustainable for future implementation.

Conclusion

This AI-based turbine generator system designed to recover and utilize waste energy in vehicles. By converting mechanical energy from braking, exhaust gases, and coasting into electrical energy, the system improves overall energy efficiency and reduces fuel consumption. The integration of AI-based switching ensures intelligent energy management, safe operation, and real-time user alerts. Although certain limitations exist, the proposed system demonstrates strong potential as a sustainable and cost-effective solution for modern vehicles. Future enhancements and real-time implementation can further improve performance and contribute to environmentally friendly transportation.

REFERENCES

1. **AI-Based Energy Recovery Systems in Vehicles**
Systems designed to recover waste mechanical energy and convert it into usable electrical power using intelligent control techniques.

2. **Turbine Generator Applications in Automobiles**
Use of compact turbine generators to harness airflow, braking, and exhaust-related energy in vehicles.

3. **Intelligent Energy Management Using Artificial Intelligence**
AI techniques used for efficient switching, monitoring, and decision-making in hybrid energy systems.

4. **Regenerative Energy Storage and Battery Charging Systems**
Methods for storing recovered electrical energy safely in batteries and managing charging efficiency.

5. **Real-Time Monitoring and Alert Systems in Vehicles**
Sensor-based systems that provide real-time alerts and performance data to users for safety and efficiency.

6. **Sustainable and Green Transportation Technologies**
Technologies aimed at reducing fuel consumption and environmental impact through energy recovery.