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"VEHICULAR TRAFFIC BASED ENERGY HARVESTING SYSTEM"

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ABSTRACT:

This paper presents a vehicular traffic-based energy harvesting system designed to convert the mechanical energy from moving vehicles into electrical energy. The system utilizes a mechanical setup integrated with piezoelectric or electromagnetic mechanisms to capture energy from road traffic. It offers a sustainable solution for powering roadside infrastructure and supports green energy initiatives.

INTRODUCTION:

The exponential growth in urbanization, population, and industrialization has led to a dramatic increase in global energy demand. Established energy systems, chiefly reliant on fossil fuels, are rapidly depleting while contributing significantly to environmental degradation, including greenhouse gas emissions and climate change. As a result, there is an urgent need to explore innovative and sustainable energy generation methods that utilize untapped resources in everyday life. One such resource, largely overlooked in urban environments, is the energy generated by vehicular traffic.

Vehicular movement on roadways produces significant mechanical forces, including pressure, vibrations, and kinetic energy. This energy, which is currently dissipated into the environment as waste, represents a unique opportunity for renewable energy generation. A well- designed system to harvest this energy could convert it into electricity for powering urban infrastructure, such as streetlig hts, traffic signals, and sensor networks, without requiring additional space or significant alterations to existing infrastructure.

The implementation of traffic energy harvesting systems not only contributes to the Increasing need for renewable energy while enhancing energy efficiency in smart city infrastructure. By leveraging the energy from vehicle movement—a byproduct of daily transportation—these systems offer a promising solution to enhance urban sustainability without requiring significant changes in behaviour.

LITERATURE SURVEY:

Recent advancements in sustainable energy research have explored the promising field of vehicular traffic-based energy harvesting systems. These systems aim to capture and convert mechanical energy generated by moving vehicles into usable electrical power, includi ng piezoelectric devices, electromagnetic generators, and mechanical compressive systems installed beneath road surfaces. Research by Park et al. (2011) demonstrated embedded in roadways to alter pressure from mooving vehicles into electricity, infrastructure such as traffic lights and sensors. Similarly, Khalid et al. (2018) presented an electromagnetic-based design utilizing speed breakers and road humps, showing significant energy generation capabilities under heavy traffic conditions. Other approaches have investigated mechanical systems such as spring-loaded plates and hydraulic mechanisms, which have shown durability in real-world tests. A review of these technologies emphasizes the importance of selecting appropriate materials, optimizing system design for maximum energy conversion, and ensuring minimal disruption to traffic flow. Furthermore, the integration of energy harvesting systems with smart city infrastructure has become a focal point of recent studies, positioning these technologies as vital components in future sustainable urban development. Overall, vehicular traffic-based energy harvesting presents a viable solution for decentralized, renewable energy generation, although challenges such as cost-effectiveness, maintenance, and large-scale implementation remain key areas for ongoing research.

RESEARCH METHOD:

The research methodology for the vehicular traffic-based energy harvesting system involves a combination of theoretical modeling, experimental design, and performance analysis. Initially, techniques employed in kinetic and energy harvesting from vehicular movement. Based on these insights, a conceptual model was developed, focusing on the integration of mechanical-to-electrical energy conversion devices, such as piezoelectric transducers or mechanical compression systems, into road infrastructures. A prototype energy harvesting module was designed and fabricated, considering factors such as load endurance, material durability, and energy conversion efficiency. Experimental setups were established in controlled environments to simulate vehicular loads, where various parameters like vehicle weight, speed, and frequency of traffic were systematically varied. Dataset compilation systems were deployed to record voltage outputs, energy storage performance, and structural responses under repetitive loading. Analytical models were then validated using the collected experimental data, and Success metricswere compared against theoretical predictions. Additionally, simulations were performed to optimize system design and predict long-term behavior under real-world traffic conditions. This methodological approach ensured a comprehensive analysis of the feasibility, efficiency, and scalability of the vehicular traffic-based energy harvesting system.

APPLICATIONS:

1. **Street Lighting:** Powering roadway and pedestrian lighting systems to reduce dependence on grid electricity..

2. **Traffic Management Systems:** Supplying energy for traffic signals, sensors, and surveillance cameras in remote or high-traffic areas. Priority Charging– Allocate slots based on employee needs.
3. **Smart City Infrastructure:** Enabling self-sustaining IoT devices for real-time monitoring of road conditions, environmental factors, and vehicular movement. Remote Monitoring – Admin dashboard for real-time status.
4. **Electric Vehicle Charging Stations:** Supplementing power sources for strategically placed EV charging points.

CONCLUSION:

In conclusion, vehicular traffic-based energy harvesting systems present a promising solution for addressing The rising need for alternative energy sources to address environmental concerns. By converting the kinetic energy of moving vehicles into electrical energy, these systems offer a novel approach to energy generation that leverages existing infrastructure with minimal environmental impact. With appropriate design and strategic placement, significant energy can be harvested to support roadway lighting, traffic management systems, and even feed into the local grid. While challenges such as system durability, efficiency optimization, and cost-effectiveness remain, continued advancements in materials science and mechanical design are expected to enhance the viability of these technologies. Ultimately, integrating energy harvesting systems into transportation networks can contribute meaningfully to smart city initiatives and the broader goals of energy sustainability and resilience.International Journal of Research Publication and Reviews, Vol (6), Issue (1), January (2025), Page – 2512-2515

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