JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

WHEEL HUB DYNAMO FOR EV CYCLE

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Abstract : In today's world, vehicles require electrical energy to operate different components such as lights, indicators, sensors and other electrical systems. This project focuses on generating electrical energy from the rotation of vehicle wheels using a wheel hub dynamo. When the vehicle moves, the rotating wheels drive the dynamo, which converts mechanical energy into electrical energy. The electricity generated by the dynamo is in AC form, so a rectifier is used to convert it into DC power. A voltage regulator is then used to maintain a stable voltage suitable for the vehicle's electrical system. The generated power can be used to charge the main battery and supply auxiliary electrical loads. The main aim of this project is to make better use of the energy produced during vehicle movement and reduce the dependence on external charging sources. This system provides a simple and practical approach to energy recovery, improves energy utilization and supports the development of more energy-efficient vehicles. Overall, this project demonstrates how the rotational movement of vehicle wheels can be converted into useful electrical energy for practical applications.

IndexTerms **- Wheel Hub Dynamo, Renewable Energy, Energy Harvesting, Vehicle Wheel Rotation, Mechanical Energy, Electrical Energy Generation, AC to DC Conversion, Rectifier, Voltage Regulator, Battery Charging, Main Battery, Auxiliary Loads, Energy Efficiency, Power Generation System.**

I. INTRODUCTION

Nowadays, vehicles depend on electrical energy to operate many important components, such as headlights, indicators, sensors and other electrical devices. As the use of electrical systems in vehicles increases, finding better ways to generate and use electricity has become important. This project introduces a simple method of generating electricity from the rotation of vehicle wheels using a wheel hub dynamo.The working principle is simple. When a vehicle moves, its wheels rotate and drive the dynamo, which produces electrical energy. The generated AC power is converted into DC using a rectifier. After that, a voltage regulator maintains a stable voltage so that the power can be used for charging the main battery and operating other electrical loads.This project also includes a battery monitoring system that checks the battery percentage. When the battery level falls below 20%, the system allows the generated power to be transferred to the main battery. The main purpose of this project is to make use of wheel rotation to generate useful electrical energy instead of allowing that mechanical movement to go unused. Through this project, we aim to demonstrate a simple and practical approach to energy generation that can help improve the overall energy utilization of vehicles.

II. LITERATURE SURVEY

J. Enayati and P. Asef (2022), [1] “Review and Analysis of Magnetic Energy Harvesters: A Case Study for Vehicular Applications”. Summary: This paper discusses the use of magnetic energy harvesting technology in vehicles. The authors explain how mechanical movement can be converted into electrical energy using electromagnetic systems. The study highlights the importance of energy harvesting in improving vehicle energy efficiency.

Y. J. Wang, C. D. Chen, and C. K. Sung (2013), [2] “System Design of a Weighted-Pendulum-Type Electromagnetic Generator for Harvesting Energy from a Rotating Wheel”. Summary: This research focuses on designing an electromagnetic generator that produces electricity from rotating vehicle wheels. The system uses magnets and coils to convert mechanical energy into electrical energy. The results demonstrate the possibility of generating power through wheel rotation.

S. M. Hosseini et al. (2023), [3] “Energy Recovery and Energy Harvesting in Electric and Fuel Cell Vehicles: A Review of Recent Advances”. Summary: This paper reviews different energy recovery techniques used in electric and fuel cell vehicles. The authors discuss regenerative braking, mechanical energy recovery and other harvesting methods. The study explains how recovered energy can improve vehicle efficiency.

Z. Zhao and T. Wang (2019), [4] "Energy Harvesting from Vehicle Suspension System by Piezoelectric Harvester". Summary: This research explains how electrical energy can be generated from vehicle suspension vibrations using piezoelectric materials. The authors study the conversion of mechanical vibrations into electrical power. The findings show that vehicle movement can be used as an energy source.

H. Taghavifar and S. Rakheja (2019), [5] "Parametric Analysis of the Potential of Energy Harvesting from Commercial Vehicle Suspension System". Summary: This paper investigates the possibility of generating electrical energy from vehicle suspension movements. The authors analyze the effects of vehicle speed, road conditions and suspension parameters on energy generation. The study highlights the potential of recovering unused mechanical energy.

F. Khoshnoud et al. (2015), [6] "Energy Regeneration from Suspension Dynamic Modes and Self-Powered Actuation". Summary: This research focuses on recovering energy from different vehicle suspension movements, such as bouncing and vibrations. The authors explain how mechanical energy can be converted into useful electrical energy. The study supports the development of energy-efficient vehicle systems.

Author details to be verified, (2016), [7] "A Bidirectional Boost Converter with Application to a Regenerative Suspension System". Summary: This paper discusses the use of bidirectional converters in regenerative suspension systems. It explains how electrical energy can be controlled and transferred efficiently. The study is useful for understanding voltage regulation and power management in vehicle applications.

B. Zhu et al. (2017), [8] "Practical Design of an Energy Harvester Considering Wheel Rotation for Powering Intelligent Tire Systems". Summary: This research presents an energy harvesting system designed for vehicle wheels. The authors explain how wheel rotation can generate electricity to operate intelligent tire monitoring devices. The study demonstrates the practical use of rotational energy for small electrical applications.

H. Zhang et al. (2019), [9] "Cylinder-Based Hybrid Rotary Nanogenerator for Harvesting Rotational Energy from Axles and Self-Powered Tire Pressure Monitoring". Summary: This paper introduces a hybrid rotary energy harvesting system that collects energy from rotating vehicle axles. The generated electricity is used to operate tire pressure monitoring systems. The research highlights the importance of self-powered monitoring devices in vehicles.

G. Miao et al. (2022), [10] "A Low-Frequency Rotational Electromagnetic Energy Harvester Using a Magnetic Plucking Mechanism". Summary: This study focuses on generating electrical energy from low-frequency rotational movements. The authors use an electromagnetic mechanism to improve energy harvesting performance. The research provides useful information for designing generators that operate with rotating mechanical components.

Author details to be verified, (2010), [11] "Energy Harvesting from an Exercise Bike Using a Switch-Mode Converter Controlled Generator". Summary: This paper explains how mechanical energy produced by a rotating exercise bicycle can be converted into electrical energy using a generator. It also discusses the use of electronic converters to regulate the generated power. The study demonstrates the practical application of mechanical energy conversion.

Author details to be verified, (2024), [12] "Enhance Energy Efficiency Based Automobile Wheels by Using Piezoelectric Energy Harvesting Technology and Sustainable Power Generation". Summary: This research explores the use of piezoelectric technology in automobile wheels to generate electricity. The authors explain how pressure and mechanical movement can be converted into electrical energy. The study focuses on improving energy efficiency through alternative power generation methods.

Author details to be verified, (2017), [14] "Energy Conversion Mechanism and Regenerative Potential of Vehicle Suspensions". Summary: This paper studies the possibility of recovering energy from vehicle suspension systems. It explains how mechanical energy that is normally lost through vibrations can be converted into useful electrical energy. The research highlights the importance of energy recovery in automobiles.

Y. Fu, X. Gu, and P. Cao (2025), [14] "Evaluating the Potential of Multitype Energy Harvesting in New Energy Vehicles: A Systematic Review and Quantitative Analysis". Summary: This research reviews different energy harvesting technologies used in modern vehicles. The authors discuss mechanical, solar and other energy recovery methods. The study explains how combining different energy sources can improve vehicle energy utilization.

E. M. Szumska (2025), [15] "Regenerative Braking Systems in Electric Vehicles: A Comprehensive Review of Design, Control Strategies, and Efficiency Challenges". Summary: This paper discusses regenerative braking systems used in electric vehicles. The authors explain how energy produced during braking can be recovered and stored in batteries. The research highlights the importance of battery charging and energy management systems.

G. Rausa et al. (2025), [16] "Mechanical, Thermal, and Environmental Energy Harvesting Solutions in Fully Electric and Hybrid Vehicles: Innovative Approaches and Commercial Systems". Summary: This research explains different methods of recovering energy from electric and hybrid vehicles. The authors discuss mechanical, thermal and environmental energy harvesting techniques. The study highlights the importance of utilizing available energy to improve vehicle performance.

Author details to be verified, (2023), [17] "A Rotating Auxetic Energy Harvester for Vehicle Wheels". Summary: This paper presents an energy harvesting system designed for rotating vehicle wheels. The study focuses on converting mechanical movement into electrical energy. It provides useful information about alternative energy harvesting techniques for automobile applications.

C. Shu et al. (2024), [18] "Energy Recovery in Automotive Systems: A Review of Regenerative Braking, Flywheel, Thermoelectric, Rankine Cycle and Electric Turbo Compound". Summary: This paper reviews various energy recovery methods used in automobile systems. The authors explain how braking energy, mechanical energy and heat can be recovered and reused. The study aims to improve overall vehicle energy efficiency.

A. S. Mhatre and P. Shukla (2026), [19] "A Comprehensive Review of Energy Harvesting Technologies for Sustainable Electric Vehicles". Summary: This research discusses different energy harvesting technologies used in electric vehicles. The authors focus on recovering unused energy through various techniques. The study highlights the importance of sustainable energy generation for future transportation.

Author details to be verified, (2026), [20] "Recent Progress in Mechanical Energy Harvesters for Smart Mobility". Summary: This paper reviews recent developments in mechanical energy harvesting technologies for transportation systems. It discusses electromagnetic and piezoelectric generators that convert mechanical movement into electrical energy. The study highlights the future potential of energy harvesting in smart vehicles.

III. SUMMARY OF LITERATURE SURVEY

After reviewing the 20 research papers, we understood that many researchers have explored different ways to generate electricity from vehicle movement. Some studies focus on electromagnetic generators, while others use piezoelectric materials, regenerative braking and suspension vibrations to produce electrical energy.

From these studies, we learned that the rotation of vehicle wheels can be used as a source of electrical energy. An electromagnetic generator is one of the suitable methods for converting this mechanical movement into electricity. The generated power can be converted and regulated using suitable electronic circuits before being used in the vehicle.

However, existing methods also have some challenges, such as power losses, voltage fluctuations and variations in power generation depending on vehicle speed. These problems show the need for a simple and reliable system.

Based on the information collected from these research papers, our project uses a wheel hub dynamo to generate electricity when the vehicle moves. The generated AC power is converted into DC using a rectifier and maintained at a suitable voltage using a voltage regulator. The electrical power can then be used to charge the main battery and supply auxiliary loads.

Overall, this project is an attempt to make better use of the energy produced during vehicle movement. It demonstrates a simple way of generating useful electrical power from wheel rotation and improving energy utilization in vehicles.

IV. PROBLEM IDENTIFICATION

In modern vehicles, electrical energy is required to operate various components such as headlights, indicators, sensors and other auxiliary systems. These components mainly depend on the vehicle's main battery for their operation. During vehicle usage, the battery continuously supplies power, which may lead to increased charging requirements.

At the same time, the rotational movement of vehicle wheels provides an opportunity to generate additional electrical energy. However, this mechanical energy is not commonly utilized for direct electrical power generation in conventional vehicles.

Therefore, the main problem identified in this project is the lack of an effective system to utilize wheel rotation for generating additional electrical energy. To address this problem, a wheel hub dynamo is proposed to convert mechanical energy into electrical energy, which can be converted, regulated and used for charging the main battery and supplying auxiliary loads.

V. OBJECTIVES

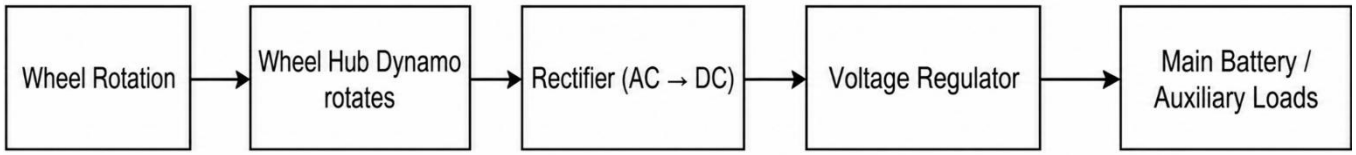
- The main objective of this project is to generate electrical energy from the rotation of vehicle wheels using a wheel hub dynamo. When the vehicle moves, the rotating wheels drive the dynamo, which converts mechanical energy into electrical energy.
- The generated AC power is converted into DC using a rectifier and regulated to maintain a stable voltage.
- The system also monitors the battery percentage and controls the power transfer when the battery level falls below 20%.
- The generated electrical energy is then used to charge the main battery and supply auxiliary loads such as lights, indicators and other electrical components.

- Through this project, we aim to make better use of the energy produced during vehicle movement instead of allowing it to go unused.
- We also aim to develop a simple, cost-effective and practical system that improves energy utilization, reduces dependence on external charging sources and demonstrates an alternative method of electrical power generation for vehicles.

VI. METHODOLGY

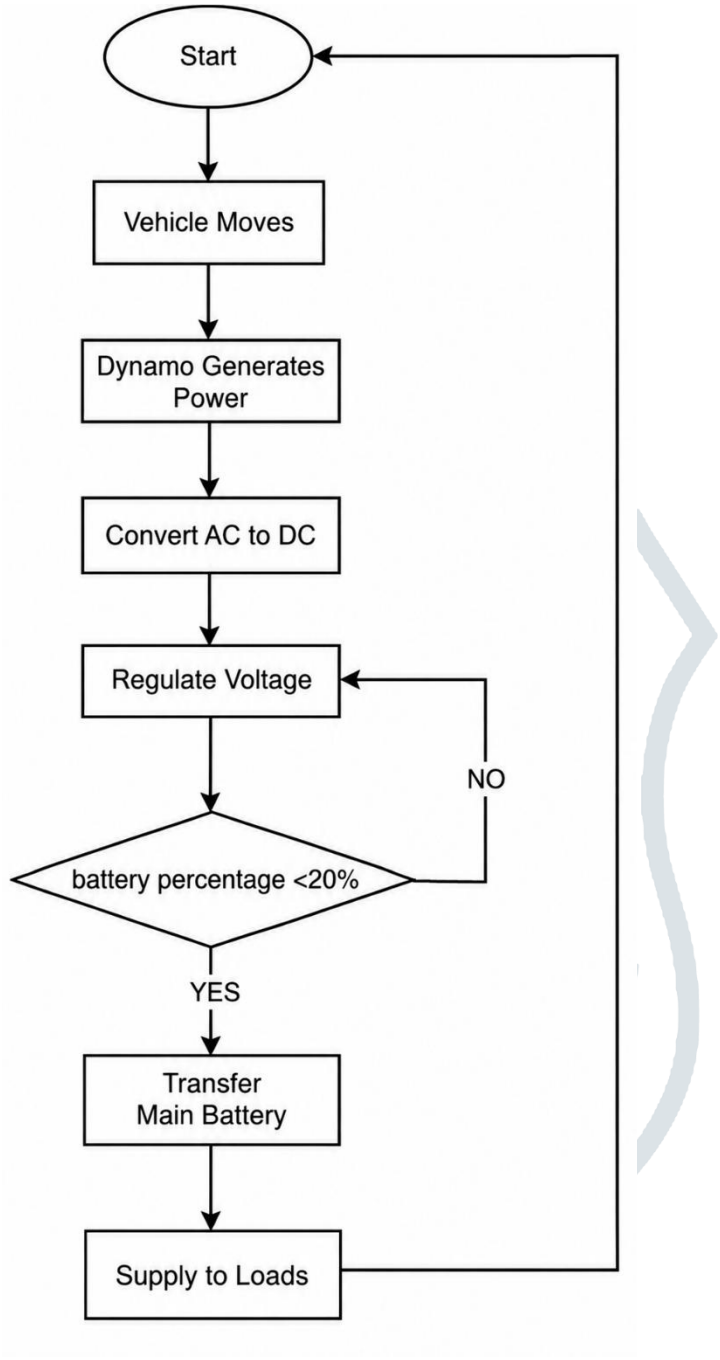
The methodology of this project is based on generating electrical energy from the rotation of vehicle wheels using a wheel hub dynamo. When the vehicle starts moving, the wheels begin to rotate, which also drives the dynamo. The dynamo converts the mechanical energy produced by wheel rotation into electrical energy in the form of AC. Since the generated AC power cannot be directly used for battery charging, it is passed through a rectifier to convert it into DC power. After conversion, a voltage regulator is used to maintain a stable output voltage and avoid unwanted voltage fluctuations. Finally, the regulated DC power is supplied to the main battery for charging and can also be used to operate auxiliary electrical loads such as lights, indicators and other vehicle components. In this way, the project demonstrates how the rotational movement of vehicle wheels can be used to generate useful electrical energy.

VII. BLOCK DIAGRAM



- The block diagram explains the complete working process of the proposed wheel hub dynamo-based power generation system.
- The main aim of this project is to generate electrical energy from the rotation of vehicle wheels and use the generated power for charging the main battery and operating auxiliary electrical loads.
- The system works in different stages, starting from wheel rotation and ending with the supply of regulated electrical power.
- The process starts when the vehicle moves and its wheels begin to rotate.
- This rotation produces mechanical energy, which is used to drive the wheel hub dynamo.
- The dynamo rotates along with the wheel and converts mechanical energy into electrical energy through electromagnetic induction.
- The electricity generated by the dynamo is in the form of AC (Alternating Current). The amount of electricity generated mainly depends on the speed of the vehicle and the working capacity of the dynamo.
- The generated AC power is then passed through a rectifier, which converts AC into DC (Direct Current). This conversion is necessary because vehicle batteries and most electrical components require DC power to operate. The rectifier allows the current to flow in one direction and provides DC power for the next stage.
- After this, the converted DC power is passed through a voltage regulator. Since the output voltage may vary depending on the speed of the vehicle, the voltage regulator helps maintain a stable voltage and protects the battery and other connected electrical components from unwanted voltage fluctuations.
- Finally, the regulated DC power is supplied to the main battery for charging and can also be used to operate auxiliary electrical loads. These loads include headlights, indicators, sensors and other electrical components used in the vehicle.
- In this way, the system provides an additional method of generating electrical power by using wheel rotation.
- Overall, the project demonstrates how mechanical energy from vehicle movement can be converted into useful electrical energy and utilized for different vehicle applications.

VIII. FLOW CHART



- The flowchart explains the step-by-step working of the proposed wheel hub dynamo-based power generation system. The process starts when the vehicle begins to move and its wheels start rotating.
- This rotation drives the dynamo, which generates electrical energy in the form of AC (Alternating Current). The generated AC power is then converted into DC (Direct Current) using a rectifier.
- After that, the DC power passes through a voltage regulator to maintain a stable output voltage and protect the connected electrical components.
- Once the voltage is regulated, the system checks the battery percentage to determine whether charging is required. If the battery percentage is below 20%, the generated electrical power is transferred to the main battery for charging.
- After that, the stored electrical energy is supplied to the vehicle's auxiliary loads, such as headlights, indicators and other electrical components.
- If the battery percentage is above 20%, the system does not transfer power for battery charging and continues to regulate the generated voltage. This process repeats as the vehicle keeps moving, allowing the system to continuously monitor the battery level and manage the generated electrical power.
- Overall, the flowchart shows how wheel rotation is used to generate electricity and how the generated power is controlled and utilized in the vehicle.

IX. RESULTS





The image shows the working prototype of the proposed Wheel Hub Dynamo-Based Power Generation System. The project has been developed using a bicycle to demonstrate how electrical energy can be generated from the rotation of a wheel. The wheel hub dynamo is fitted near the rear wheel and is connected to the rotating mechanism. When the bicycle wheel rotates, the dynamo converts the mechanical energy into electrical energy.

The generated electrical power is collected and supplied to the connected electrical circuit. A battery setup is placed on the rear carrier to demonstrate the storage and utilization of the generated power. The system is designed to convert the generated AC power into DC using a rectifier and maintain a suitable output voltage using a voltage regulator before supplying it to the battery and electrical loads.

The prototype provides a practical demonstration of the project concept and shows how a bicycle can be used as a testing platform for wheel-based energy generation. The setup helps us understand the relationship between wheel rotation and power generation. It also provides a way to test the dynamo output and study how the generated electricity can be used for battery charging and other electrical applications.

Overall, the developed prototype demonstrates the basic design and implementation of the proposed system. It shows the possibility of converting mechanical energy from wheel rotation into electrical energy and utilizing it for useful purposes. Further testing can be carried out to measure the output voltage, current and charging performance at different wheel speeds.

X. FUTURE SCOPE

The proposed wheel hub dynamo-based power generation system has good potential for further development and improvement. In the future, the system can be designed with a more efficient dynamo to generate better electrical output at different vehicle speeds. Advanced voltage regulators and battery management systems can be added to improve charging performance and protect the battery from overcharging. The system can also be integrated with microcontrollers and IoT technology to monitor voltage, current, battery percentage and power generation in real time. Further improvements can be made by reducing the size and weight of the setup and developing a compact design suitable for different types of vehicles. The generated power can also be utilized to support additional electrical components and low-power devices. With proper design and testing, this project can be developed into a more reliable and efficient energy harvesting system for future vehicle applications**.**

XI. APPLICATIONS

- Electric Vehicles: Can be explored as an additional source of electrical power for supporting low-power vehicle systems.
- Two-Wheelers: Can be used in bicycles, electric bicycles and motorcycles for generating electricity from wheel rotation.
- Battery Charging: The generated electrical energy can be used to provide supplementary charging to suitable batteries through a proper charging circuit.
- Auxiliary Lighting: Can supply power to headlights, indicators, tail lights and other lighting systems.
- IoT-Based Monitoring: Can support low-power sensors and monitoring devices used in vehicles.
- Rural Transportation: Can be explored in bicycles and small vehicles where additional electrical power is useful.
- Educational Projects: Can be used as a practical demonstration of electromagnetic induction, energy conversion and power management.

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