Nano Tree Based Charging System Using IoT

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Abstract: This Nano tree design based on biomimetic technology is offering new creative ideas to capture the environmental energies, like solar energy, wind and convert them into electricity. The artificial tree will exploit all the possible thin-film deposition, thermophotovoltaic materials to maximize energy conversion; with its 3D texture of the surface of the leaf, the Nano tree captures solar radiation efficiently. Energy conversion is, therefore, much more efficient than in traditional solar panels. Additionally, we introduce a type of pollution detection system using an MQ gas sensor and Arduino embedded in the artificial tree to monitor harmful gases and absorb CO2 through carbon paper. For the urban traffic congestion problem, we proposed a density-based dynamic traffic signal management system. IR sensors and Arduino control the signal, adjusting the time according to the real-time traffic density in order to optimize traffic flow. We address key global issues such as innovations in renewable energy, pollution-free life, and overcoming traffic congestion through ecologically friendly solutions, efficiency, and adaptability.

1 INTRODUCTION

This is the Intelligent Nano Tree-Based Charging System for Smart Traffic Management using IoT-the innovative solution that will come to solve problems of urbanization and transportation. Renewable energy harvesting, IoT technology, and smart traffic management all are involved in building this sustainable, efficient, and intelligent method. The key challenge is to optimize the utilization of energy, decongest the traffic, and work toward improving public safety through the use of renewable sources of energy, such as solar and wind power; monitor generation and usage of energy through IoT; smart traffic management through the usage of IR sensors; and optimize the streetlight by employing LDR and IR sensors.

Key constituents of the system include harvesting of renewable energies using solar panels as well as wind turbines, an IoT-based platform for monitoring and control, Thing Speak, in addition to IR sensor inputs in intelligent traffic management based on real-time density perception and optimization in the signalling timings along with automated street lighting through LDR sensors detecting daylight and IR sensors that detect objects. It provides several advantages: from energy efficiency to the reduction of congestion, improved public safety, sustainability with respect to the environment, and even real-time data analytics.

Touching applications of sustainability of nature, public safety, urban planning, and transport management, the project thus introduces a revolution into the urban infrastructure as eco-friendly, efficient, and intelligent transport systems of the modern city. Its success will lead to model urban development and place it as a highly important initiative for creating sustainable and liveable cities.

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2 LITERATURE REVIEW

Adaptive Control of Streetlights Using Optimization of Energy Muhammad Asif, Sarmad Shams, Samreen Hussain, Jawad Ali Bhatti, Munal Rashid MDPI 2022. In this paper the proposed system. s to develop a adaptive control system of street light and decreases energy resources. Many researchers have proposed a number of methodologies and ideas to reduce the energy wastage of the street lights and also highlighted the ways to make them smarter.".

"Hybrid Powerplant Using Solar and Wind Energy Ahmad Sahru Romadhon and Tri Widyaningrum, ICST 2022. In this paper, the technology uses both solar and wind energy as a hybrid solar energy system, the utilization of solar energy which utilizes cell and utilization of wind energy is utilizes for generating the electricity.".

"Automatic Traffic Management Scheme" This is the most widely automatic system. It adopts a very simple time-based system that's work on the time interval basis, which is currently inefficient for random and non-uniform traffic, but time. interval Basis is very time wasting it is a fast process.

P. Sinhmar in his paper has suggested solution to reduce the number of traffic jams with the use of IR transmission and micro controller. Counting of passing vehicles is done through IR transmitter, and receiver, the decision to change the traffic delay is made by microcontroller based on the collected information. Such a system helps in getting accurate statistics and thus helps in designing better traffic signal lights.

K.M. Yousef et al (Yousef et al., 12010) in his paper has developed an adaptive traffic control system based on a traffic infrastructure using wireless sensor network to control the flow of traffic. He also developed an intelligent traffic controller to control the operation of the traffic infrastructure supported by WSN. It senses the traffic and dynamically changes the traffic lights through wireless transmission. It only adds convenience to already existing traffic light system and not safety.

Wen in his paper has come out with a framework for dynamic and automatic traffic light control system. They fix RFID tags to the cars and make a note of that number of cars, average speed, etc. through RFID refers and store in the database by passing the information wirelessly. That database later acts as an input for control of the traffic signal lights, which helps in reduction of the traffic congestion.

Simple Traffic Management Scheme

Traffic is managed by one man only. If there are four roads where vehicles are coming, then the man needs to control the traffic. He has to release one by one. The scheme uses very little manpower, and it is not difficult to handle when there is more traffic.

3 GAPS IDENTIFIED

This project addresses a critical gap in existing research by focusing on efficient energy utilization, real-time implementation, and sustainable production. Our innovative approach harnesses electricity from a nano tree using solar panels and wind energy, providing a sustainable power source.

The generated energy powers:

1. Intelligent street lighting systems with monitoring capabilities
2. Automated traffic management systems based on real-time tracking
3. Pollution control measures using carbon paper

This integrated approach demonstrates a holistic strategy for sustainable energy production and utilization, paving the way for smarter, environmentally conscious urban infrastructure.

4 METHODOLOGY

This The Nano Tree-based Charging System harnesses solar and wind energy, utilizing IoT technology to optimize traffic management, street lighting, and pollution monitoring. Solar panels which extract the sunlight from the sun and wind turbines which extract the wind from the environment to generate electricity and stored in a battery and monitored in real-time on ThingSpeak. The system adjusts traffic signal timings based on vehicle density detected by IR sensors on two roads.

1. Intelligent street lighting systems with monitoring capabilities
2. Automated traffic management systems based on real-time tracking
3. Pollution control measures using carbon paper

For street lighting, an LDR sensor monitors daylight intensity, automatically turning lights off during the day and on at night. Additionally, an object detection sensor adjusts street light intensity according to street activity.

A carbon paper pollution detector measures pollution levels, displaying data on an LCD display. This comprehensive system integrates renewable

energy, IoT automation, and sustainable solutions for urban development.

Key features include:

- Renewable energy harvesting
- IoT-based automation
- Real-time traffic management
- Intelligent street lighting
- Pollution monitoring and control
- Energy efficiency
- Data-driven decision making
- A microcontroller uses this data to adjust traffic lights dynamically, giving priority to the road with more vehicles and ensuring smoother traffic flow.

The system also optimizes street lighting. During the day, an LDR sensor keeps the lights off, while at night, it turns them on automatically. Additionally, IR sensors detect movement, ensuring that lights are only activated when needed, conserving energy. To address air pollution, a carbon paper-based sensor measures pollutants like carbon monoxide or particulate matter, with the results displayed on an LCD screen for easy monitoring. IoT connects all these components, allowing for centralized control and real-time updates. This project presents an innovative approach to tackling urban challenges while promoting energy efficiency and sustainability.

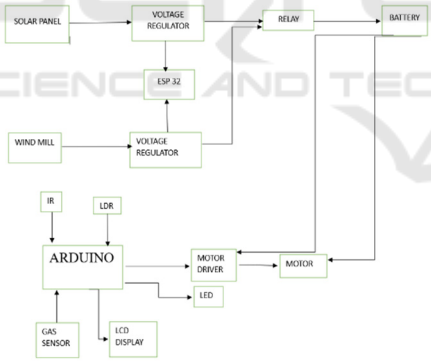

Figure 1: Block diagram

5 APPLICATIONS

Nano Tree-Based Charging System: The IoT-enabled innovation integrates renewable energy from both solar panels and wind turbines. Energy so harvested is employed to power intelligent traffic management, ensuring that signal timings are adjusted according to vehicle density sensed through IR sensors. LDR-based brightness of street light is optimized for daylight detection. It can have applications in fields such as Intelligent Transportation Systems, Environmental Monitoring, Public Safety, Energy Efficiency, and Disaster Management. Industries that will benefit from it are industries in Transportation, Energy, Construction, Government, and Urban Planning. Real-world implementations include city-wide traffic management, smart highways, and street light energy efficiency. This sustainable solution is transforming urban landscapes, enabling enhanced sustainability, and improving quality of life toward a smarter and greener future.

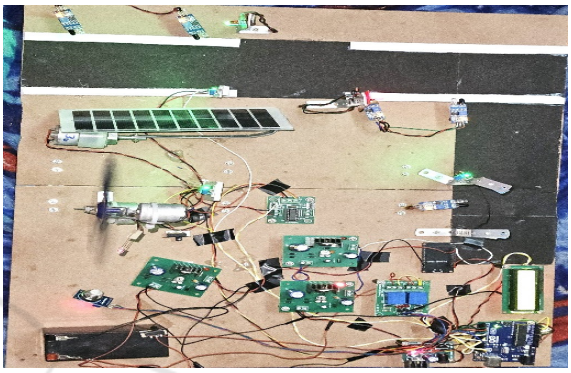

Figure 2: Prototype

6 RESULTS

The proposed systems demonstrated significant energy efficiency through the integration of renewable energy sources and IoT-enabled adaptive lighting, optimizing power consumption to meet real-time requirements. The intelligent street lighting system exhibited excellent adaptability to varying climatic conditions, ensuring consistent and reliable performance. Furthermore, the Arduino and IR sensor-based traffic control system effectively enhanced traffic management by improving flow and reducing congestion through dynamic, real-time adjustments. These results confirm the potential of the systems to address energy and traffic challenges, offering sustainable and intelligent solutions for urban and remote infrastructure development.

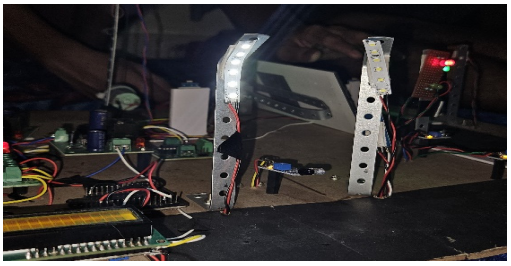

Figure 3: Streetlights

Street lights are always in off mode during the day, but at night, they are dim. Whenever the IR Sensor senses a person or object near the lights, they blow brighter.

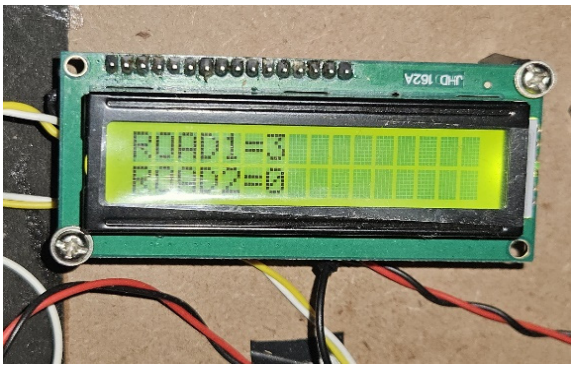

Figure 4: Traffic monitor

Depending on the density of vehicles on both roads, the traffic signals operate accordingly.

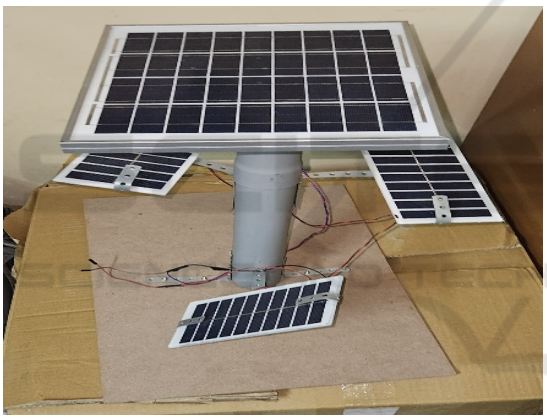

Figure 5: Solar panels artificial tree

An artificial tree uses solar panels, from which most of the electricity is generated for the overall objectives. The electricity generated from the artificial tree will be supplied to the traffic system, street lights, and also to the overall monitoring of the system.

7 CONCLUSION

Nano This paper presents a comprehensive study on an intelligent street lighting system integrated with IoT and nano tree-based energy harvesting technology, demonstrating its potential for energy conservation, easy of maintenance, and improved operational efficiency. The proposed system is particularly well-suited on deployment in both urban and remote areas with low traffic density, offering significant energy savings and addressing critical issues such as power theft. Furthermore, its ability to adapt to unprecedented climatic changes ensures uninterrupted functionality and reliability.

Additionally, a traffic light optimization system using Arduino and IR sensors was designed and developed to enhance urban traffic management. This system effectively integrates hardware and software components, enabling real-time traffic control and paving the way for efficient road planning. In conclusion, the implementation of IoT-enabled nano tree-based charging systems, coupled with optimized traffic control mechanisms, provides a sustainable and intelligent approach to addressing energy, environmental, and urban traffic challenges.

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