Optimization of day and night seamless solar energy tracking system

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Abstract: *This idea suggests installing a solar energy tracking system that is active during the day and night in order to maximize energy use and encourage sustainability in metropolitan areas. The device integrates solar panels to create electricity, thereby leveraging the underutilized potential of vehicle lighting during nighttime. Then, by using the energy produced to run vital urban infrastructure like traffic lights, carbon emissions are decreased and traditional power sources are used less frequently.The main innovative feature of the concept is its capacity to switch between utilizing solar energy from natural sources during the day and artificial energy sources like car headlights at night. This is accomplished by putting in place an advanced tracking system that dynamically modifies the solar panels' orientation to modifies the solar panels' orientation to maximize the efficiency of energy capture.The project also highlights how crucial it is to track and evaluate energy consumption from IoT devices in order to guarantee best practices in resource allocation and performance. Real-time data on energy generation, consumption, and system efficiency may be gathered and evaluated by utilizing IoT technology, facilitating educated decision-making and ongoing development.*

Keywords: *solar panel, vehicle, headlight, tools, energy, design thinking, thingspeak, traffic light.*

I. INTRODUCTION

Using solar electricity stands up as a promising approach in the search for sustainable energy. The idea of a day-and-night solar energy tracking system offers a cutting-edge strategy to optimize solar energy use continuously. Through the smooth integration of solar panels with pre-existing infrastructure, such traffic signals and car lighting, we can completely transform urban sustainability and energy conservation.In this study, we investigate the novel concept of using car headlights as nighttime solar energy sources. By carefully arranging solar panels on cars, we can harness light energy and turn it into electrical power, utilizing a hitherto unexplored resource. Then, a variety of systems, such as traffic lights and other urban monitoring tools, can be powered by this energy. Additionally, the use of an advanced tracking system guarantees the best possible energy capture all day long. We can dramatically increase the efficiency of energy generation by dynamically altering the orientation of solar panels to track the movement of the sun. By taking a proactive stance, the environmental effect of conventional energy sources is reduced while energy output is maximized.In addition, the incorporation of renewable energy sources into urban infrastructure fosters self-sufficiency and resilience. Communities can lessen their reliance on conventional power grids and thereby lower their risk of power shortages and outages. Furthermore, we enable local communities to take control of their energy needs and contribute to a more sustainable future by decentralizing the generation of energy.

II. LITERATURE SURVEY

Based on a dual-axis solar tracker, the design is a self-orienting solar tracking system for mobile applications and camping gear that can be installed anywhere in the world. The tracking system included two orientation sensors, a mathematical model, and a GPS module that gives the information needed to determine the sun's local position based on solar time. A microelectromechanical system (MEMS) gyroscope and compass provide the reference orientation on which the tracking elevation and azimuth angles are calculated. These sensors are mated with an 8-bit micro power µC and a smart control program allowing for very efficient system operation resulting in a reduced power budget of the tracking system and automate PV panel-based power generation system installation. The results demonstrated the robustness of the proposed model[1].

The three biggest issues facing the world's population are traffic jams, energy waste, and traffic monitoring. When one lane has substantially more traffic than the others, the conventional roadway management approach is unable to regulate the flow of traffic. Furthermore, there is some power loss because the current street light controller employs lights that are switched on in the late afternoon before the sun sets and that are not turned off in the morning even if it is sufficiently bright outside. To provide a standardized method of resolving this problem, the suggested solution will include an intelligent street lighting system and an advanced smart traffic management system. To achieve the increased smart traffic control system, the timings of the signals are adjusted by comparing of the densities on all roadways, meaning that a particular lane is changed to a green light for a predetermined period of time when its density is significantly higher than that of the other lanes[2].

The researchers have shown how to develop and construct a 3D printed single-axis solar tracking PV (photovoltaic) system that tracks the sun's movement to boost solar panel efficiency. The system is made up of an Arduino microcontroller-based control system and a 3D printed support structure with a single axis tracking mechanism. SolidWorks was used in the design of the support structure, and a load simulation was carried out to guarantee structural stability. Because of its superior mechanical and thermal capabilities, 3D printing was done using Acrylonitrile Butadiene Styrene (ABS) material. Throughout, the solar panel rotated on a single axis, tracking with the motion of the sun thanks to the tracking mechanism's servo motor. Two light sensors' output data were used by the control system to calculate the sun's location, and the servo motor was then controlled appropriately. The prototype of the system was tested outdoors, and the results showed that the solar tracking system can increase the energy output of the solar panel by up to 19.4% compared to a fixed solar panel[3].

One of the main loads on the electricity grid is the massive quantity of electrical power that streetlights consume. Street lights powered by solar energy offer a clean substitute for nonrenewable energy sources while also lowering the electrical demand on the power grid. Nonetheless, while building and operating the street light system, the majority of implementations typically do not take the battery's state of charge (SoC) or health into account. By monitoring road traffic and modifying the street lamp's brightness according on the SoC and traffic, this work suggests a method for maximizing the use of the solar energy stored in the battery while simultaneously preserving its health[4].

In [14], the researchers use the MATLAB/SIMULINK program with the Arduino serving as the primary control unit to improve the overall output and stability of the solar system through Single-Axis Solar Tracking (SAST) and Dual-Axis Solar Tracking (DAST). This combination increases the system's power, preserves the panel, and raises solar power output or productivity. Because tracking forces the panel to follow the sun wherever it goes, it produces its maximum power throughout the day. Depending on the type of tracking system, the voltage and power collected from the panel will be higher than the generation of stationary position.Following completion of the task, it was found that the output of the stationary position had been enhanced by 2.6% and 3.3%, respectively, by the single- and dual-axis solar tracking systems. Because our study is a system that controls the cell rather than an actual improvement to the cell, the low output percentage can be attributed to the use of an inaccurate experimental cell.

The suggested system, which tracks the sun using a light-dependent resistor, alters its orientation in two axes (azimuth and elevation) by sensing the difference between the sun's position and the panel's position. To evaluate the system's efficacious tracking of the sun's location, a hardware experimental configuration on a testbed is used. Ultimately, the Android app is used to display real-time data, and a GSM/WiFi module is used to relay weather data to the app. The results of this research, which enhances the current system, demonstrated a relative improvement in power generation of up to 52%. The quality of service generated by the current system is enhanced by combining the QoS algorithm with intelligent artificial intelligence techniques[3].

Renewable energy could be the answer to this issue. Solar energy conversion to electrical energy has become more common in recent years because to the use of solar panels. It is inexpensive and virtually safe for the environment. It emits the electromagnetic radiation needed to create electricity. The main objective is to create a functional, autonomous solar tracking system that can move the solar panel and keep it always pointed in the direction of the sun. A photoresistor will serve as the sensor in this setup. On the dual axis solar panel, the horizontal and vertical axes are rotated to boost the device's efficiency. Therefore, the dual axis offers accurate control over the planet's elevation with respect to the sun. This will Sufficient energy has given.

This endeavor has offered a this research proposes an intelligent method for adjusting the direction of continuous sun tracking sensors on cloudy days. Direct sunlight is more important for weather conditions than diffuse radiation from a clear sky. The panel is therefore constantly facing the sun. The solar beam is almost zero when the sky is cloudy, and the panel is oriented horizontally to collect the most scattered energy. The panel needs to be pointed at the source within the sky dome that is generating the greatest amount of solar energy when it is partially covered. Therefore, the concept behind our method is to examine pictures captured by a sky camera system mounted on the ground to determine the Thus, the concept underlying our method is to determine the area of the sky dome that is believed to be the best source of energy in cloudy conditions by analyzing photos captured by a ground-based sky camera system. The experimental setup constructed at Mansoura city in north Egypt is used to implement the suggested strategy. When compared to conventional continuous sun tracking systems, the intelligent technique produced efficiency gains of up to 9%, and the results were pretty good under overcast conditions[5].

III. COMPONENTS REQUIRED

a) *Thingspeak*

An open-source platform for Internet of Things (IoT) analytics called ThingSpeak enables users to interact with and collect data from internet-enabled devices. In addition to supporting interaction with the MATLAB numerical computing program for data analysis and visualization, it offers an API for data access, retrieval, and logging. IoT applications like home automation, industrial monitoring, health monitoring, environmental monitoring, and fleet vehicle monitoring frequently employ ThingSpeak. It can send and receive data using a variety of protocols, such as MATLAB, REST API, MQTT, and third-party programs. The platform allows users to prototype and develop Internet of Things (IoT) devices that need analytics, as well as store and analyze data in real-time. With up to eight fields of data per field, the platform is free to use and open-source.

b) IFTT

Using an internet platform called IFTTT (If This Then That), users may build automatic workflows, or "applets," connecting various web services and devices, including social networking, productivity tools, and Internet of Things (IoT) devices.Users can easily develop custom applets that link to different channels (services and devices) and define actions based on triggers and circumstances with the help of the IFTTT platform. Usually, the user specifies one or more actions to be carried out in response to a trigger, which is a specific occurrence or condition on a given channel.One may, for instance, develop an applet that sends out an email alert each time a new post is made on a specific blog, or that automatically turns

c) Applications

i)Traffic light and urban infrastructure

The generated solar energy is used to power traffic lights, streetlights, and other essential urban infrastructure.By integrating solar-powered components into the urban infrastructure, the system reduces dependency on the grid and lowers energy costs while promoting sustainability.

IV. PROPOSED METHOD

The strategically positioned to capture light energy during both day and night. During the day, solar panels capture sunlight and convert it into electrical energy through photovoltaic cells. Similarly, during the night, solar panels capture light energy from vehicle headlights. A sophisticated solar tracking system continuously adjusts the orientation of the solar panels to maximize energy capture. During the day, the system tracks the movement of the sun, while at night, it aligns with the direction of vehicle headlights. The captured solar energy is converted from DC to AC using inverters for compatibility with standard electrical systems. Excess energy is stored in batteries or supercapacitors for use during periods of low sunlight or high demand.The generated solar energy is distributed to power traffic lights and other urban infrastructure. This reduces dependency on the grid and ensures uninterrupted operation, even during power outages. Internet of Things (IoT) devices are deployed to monitor energy generation, consumption, and system efficiency in real-time.

Data collected from sensors are transmitted to a central control unit for analysis and optimization.Operators have access to a centralized control interface, allowing them to remotely monitor system performance and make adjustments as needed. This enables proactive maintenance and ensures optimal operation of the system.In this we can monitor the values through thingspeak and displays the values in led.In addition we used the harnessing energy in the applications like traffic light.

A device can be connected to the traffic light system to measure the current and communicate the data to the Thingspeak platform in order to monitor the current generated from the vehicle's headlamp utilizing the stored energy for traffic light systems. The apparatus may consist of a microcontroller, like an Arduino or a Raspberry Pi, that is configured to detect current and transmit the information to the Thingspeak platform via its application programming interface. The data can then be visualized and analyzed in real-time using the Thingspeak platform.

Create a traffic signal system that can use the energy produced when a car's headlights are on.Install a device that measures the current produced by the traffic light system, such as a microcontroller.Utilizing the Thingspeak platform's API, program the microcontroller to transmit the data to the platform.Create a Thingspeak channel in order to collect and display the data.Examine the data to learn more about how well the traffic signal system operates and how much energy the car's headlights produce.

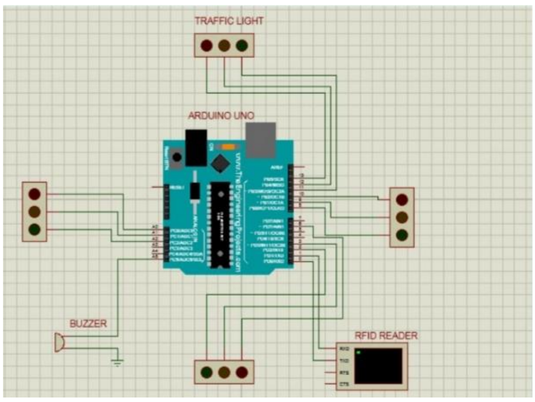

Figure 1. Block diagram of proposed method

V. RESULTS AND DISCUSSION

The implementation of the day and night solar energy tracking system has yielded promising results, showcasing its potential to revolutionize urban sustainability and energy efficiency. Through the integration of solar panels with vehicles, the system successfully generates electricity from both natural sunlight during the day and vehicle headlights during the night. The sophisticated solar tracking mechanism ensures optimal orientation of the solar panels, maximizing energy capture efficiency throughout the day and night. The generated solar energy is effectively utilized to power traffic lights and other essential urban infrastructure, reducing dependency on traditional power sources and lowering carbon emissions. By leveraging renewable energy sources, the system enhances the resilience and self-sufficiency of urban infrastructure, mitigating the risks of power outages and disruptions. Additionally, the adoption of solar energy for powering urban infrastructure contributes to reducing greenhouse gas emissions and mitigating environmental degradation associated with conventional energy sources. Integration with IoT devices enables real-time monitoring of energy generation, consumption, and system performance, providing valuable insights for optimizing energy usage and facilitating proactive maintenance.

Moreover, by harnessing solar energy from both natural and artificial sources, the system reduces energy costs and reliance on the grid, leading to long-term cost savings for municipalities and urban communities. Continued research, innovation, and collaboration are crucial for realizing the full potential of this transformative technology.

By these we can also monitoring the values which was generated current by the solar panel through thingspeak.We also get the output values in graph format.

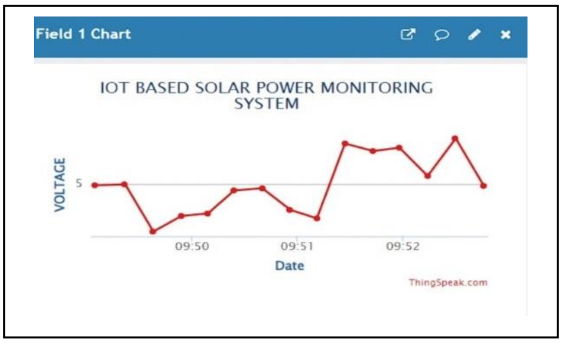

Figure 2. Result

By using the stored current from the battery we can use this current for the streetlights and traffic signals etc.

The way we produce and consume solar energy might be completely changed by putting in place a day-and-night solar energy tracking system with energy storage and monitoring via Thingspeak. This device offers a creative and intriguing approach to sustainable traffic control by using car headlights as a power source.

VI. CONCLUSION AND FUTURE WORKS

Reducing dependency on conventional energy sources and improving urban sustainability are two potential goals of the day-and-night solar energy tracking system. Traffic lights and other vital urban infrastructure can be efficiently powered by the system's ability to harvest solar power from both ambient sunshine and car headlights. By combining solar panels with cutting-edge tracking systems and automobiles, the technology reduces carbon emissions and increases energy capture efficiency while encouraging environmental stewardship. IoT monitoring also makes it possible to analyze data in real-time to optimize energy use and improve system efficiency. All things considered, the day-and-night solar energy tracking system provides a scalable and affordable way to handle energy issues in metropolitan settings while achieving sustainability goals.

To further improve the efficiency, scalability, and reliability of the day-and-night solar energy tracking system, more research and development are required.investigation of cutting-edge solar panel materials and technologies to increase the robustness and efficiency of energy capture.investigating the integration of smart grid technology for grid management and energy distribution that is seamless.For improved energy storage efficiency and capacity, research is being done on cutting-edge energy storage technologies as supercapacitors and next-generation batteries.the system's expansion to include more urban infrastructure, like security cameras, lamps, and public transit.Urban field testing and pilot projects are carried out to verify system performance, collect empirical data, and pinpoint areas in need of improvement.Working together with regulators and legislators to create incentives and laws that will encourage the broad use of renewable energy sources in urban infrastructure.

REFERENCES

[1] Y. R. Al-Saadi, M. S. Tapou, A. A. Badi, S. Abdulla and M. Diykh, "Developing Smart Self Orienting Solar Tracker for Mobile PV Power Generation Systems," in IEEE Access, vol. 10, pp. 79090-79099, 202 2,doi: 10.1109/ACCESS.2022.3194026.

[2] Sakthevel T C, D. Sharmiladevi, D. Sugumar, Syed Ibad Ali, T. Anita Jones Mary, Suresh Kumar, "Using a Smart Wearable Devices Monitoring the Social Distance in Smart Cities", 2023 International Conference on Research Methodologies in Knowledge Management, Artificial Intelligence and Telecommunication Engineering (RMKMATE), pp.1-5, 2023.

[3] D. Arulselvam, J. Abishek, K. Sivasankari and M. Aarthi, "Precised and Efficient Mobile Solar Tracking System with amicable power consumption," 2022 International Conference on Power, Energy, Control and Transmission Systems (ICPECTS), Chennai, India, 2022, pp. 1-4, doi: 10.1109/ICPECTS56089.2022.10047179.

[4] Ruchi Gautam, Harpreet Kaur Channi, "Energy Consumption by Solar LED Streetlights in Domestic Application", Renewable Energy Optimization, Planning and Control, pp.213, 2023.

[5] W. R. Babu, N. Pushpalatha, L. Catherine, K. Janani, S. S. Kanase and P. Patil, "Review and Comparison on Types of Solar Trac king using PNT Systems," 2023 7th International Conference on Intelligent Computing and Control Systems (ICICCS), Madurai, India, 2023, pp. 1697-1701, doi:10.1109/ICICCS56967.2023.10142648.

[6] K. Charafeddine and S. Tsyruk, "Automatic Sun-Tracking System," 2020 International Russian Automation Conference (RusAutoCon), Sochi, Russia, 2020, pp. 191-195, doi: 10.1109/RusAutoCon49822.2020.9208086.

[7] W. X. García-Quilachamin, J. Evangelina Sánchez-Cano, F. Ulloa, E. VelesacaZambrano and J. Herrera-Tapia, "Analysis of the parameters of a solar tracker system, based on movements of a power generation system," 2021 16th Iberian Conference on Information Systems and Technologies (CISTI), Chaves, Portugal, 2021, pp. 1-6, doi: 10.23919/CISTI52073.2021.9476478.

[8] S. Guduru, P. CH, A. P. M and K. Vijayan, "Smart Solar Tracking System for Optimal Power Generation Using Three LDR's," 2023 International Conference on Recent Advances in Electrical, Electronics, Ubiquitous Communication, and Computational Intelligence (RAEEUCCI), Chennai, India, 2023, pp. 1-5.

[9] P. Gupta, V. Gupta, M. Sharma, R. K. Pachauri and J. Akhtar, "Design and Performance Analysis of Three axis Solar Tracking System," 2022 7th Asia Conference on Power and Electrical Engineering (ACPEE), Hangzhou, China, 2022, pp. 1876-1880, doi: 10.1109/ACPEE53904.2022.9783762.

[10] D. Hou, S. Yang and Y. Lian, "Design of Tracking System Based on Embedded Solar Panel," 2021 China Automation Congress (CAC), Beijing, China, 2021, pp. 6367- 6370, doi: 10.1109/CAC53003.2021.9727825.

[11] M. R. Haider, A. Shufian, M. N. Alam, M. I. Hossain, R. Islam and M. A. Azim, "Design and Implementation of Three-Axis Solar Tracking System with High Efficiency," 2021 International Conference on Information and Communication Technology for Sustainable Development (ICICT4SD), Dhaka, Bangladesh, 2021.

[12] L. H. Jiao and K. Shrestha, "Design and Build A 3D Printed Single-Axis Solar Tracking Photovoltaic System," 2023 5th Global Power, Energy and Communication Conference (GPECOM), Nevsehir, Turkiye, 2023, pp. 352-357.

[13] Kanwal, Tabassum, Saif Ur Rehman, Tariq Ali, Khalid Mahmood, Santos Gracia Villar, Luis Alonso Dzul Lopez, and Imran Ashraf. "An intelligent dual-axis solar tracking system for remote weather monitoring in the agricultural field." Agriculture 13.

[14]]M. Karthik, R. Vishnu, M. Vigneshwar and M. Logaeshwar, "Arduino based Dual Axis Smart Solar Tracking System," 2023 Third International Conference on Artificial Intelligence and Smart Energy (ICAIS), Coimbatore, India, 2023, pp. 169-174.

[15]] A. Karthika1, S. Jayanthi1, G. Deivamani2,"Dual Axis Solar Tracking System Using Arduino",International Research Journal of Engineering and Technology (IRJET).

[16] M. A. Khandekar, S. Muthyala, S. Agashe and P. Walunj, "Development of an Intelligent Sun Tracking System for Solar PV Panel," 2023 IEEE IAS Global Conference on Emerging Technologies (GlobConET), London, United Kingdom.

[17] Nader Behdad,Sunil Kumar, Solar Tracking System Using pixel identification algorithm, Journal of Artificial Intelligence and Metaheuristics, Vol. 3 , No. 1 , (2023) : 31-41.

[18] S. I. Palomino-Resendiz, F. A. Ortiz-Martínez, I. V. Paramo-Ortega, J. M. GonzálezLira and D. A. Flores-Hernández, "Optimal Selection of the Control Strategy for Dual-Axis Solar Tracking Systems," in IEEE Access, vol. 11, pp. 56561-56573, 2023.

[19] K. Ramaneti, P. Kakani and S. Prakash, "Improving Solar Panel Efficiency by Solar Tracking and Tilt Angle Optimization with Deep Learning," 2021 5th International Conference on Smart Grid and Smart Cities (ICSGSC), Tokyo, Japan, 2021, pp. 102- 106.

[20] M. N. Reza, M. S. Hossain, N. Mondol and M. A. Kabir, "Design and Implementation of an Automatic Single Axis Solar Tracking System to Enhance the Performance of a Solar Photovoltaic Panel," 2021 International Conference on Science & Contemporary Technologies (ICSCT), Dhaka, Bangladesh, 2021, pp. 1-6

[21] M. T. Taha, E. O. Mohamed, A. M. Abdolsalam and A. B. Taha, "Control of SingleAxis and Dual-Axis Solar Tracking System," 2020 International Conference on 57 Computer, Control, Electrical, and Electronics Engineering (ICCCEEE)..

[22] M. S, R. K, R. P, H. P. S M, G. S and B. M, "Automatic Solar Tracking System," 2022 International Conference on Power, Energy, Control and Transmission Systems (ICPECTS), Chennai, India, 2022, pp. 1-6.

[23] D. P. V and K. Sathiyasekar, "Design and Analysis of an Effective Solar Tracking System Using Intelligent Controller," 2023 Eighth International Conference on Science Technology Engineering and Mathematics (ICONSTEM), Chennai, India, 2023, pp. 1-5.

[24] S. İ. Ulutekin, B. Şahin, G. Kolcubaşı, O. Alıç and A. Zirek, "Performance Comparison of Fixed and Dual Axis Solar Tracking Systems," 2023 12th International Conference on Power Science and Engineering (ICPSE), Eskisehir, Turkiye, 2023, pp. 51-54.

[25] N. Waldron, S. Smith and V. Karthik, "Solar Tracking System Utilizing Internet of Things Technologies for Enhanced Power Generation," 2023 12th International Conference on Renewable Energy Research and Applications (ICRERA), Oshawa, ON, Canada, 2023, pp. 269-272.

[26] K. Vidanapathirana, K. Kumarapeli, M. Marasinghe, D. Amarasinghe and J. Lucas, "Performance Evaluation of a Hybrid Dual-Axis Solar Tracking System," 2021 3rd International Conference on Electrical Engineering (EECon), Colombo, Sri Lanka, 2021, pp. 50-55.