AUTOMATED SUNFLOWER SOLAR PANEL

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Abstract—Even the smallest of works require energy or produce energy. There are several forms of energy that we use in our daily lives like Electrical, Thermal, Chemical etc. The most essential source of energy is Electrical energy which is being produced at a high pace and so is its demand. Till now most of the electrical energy is being generated by fossil and nuclear fuels. Since their resources are conventional and therefore limited, we are shifting towards non-conventional resources present on Earth such are wind, water, sunlight etc. In this chapter, we will be looking towards the problems in traditional energy-generating methods and the need for change.

Solar energy is one of the biggest sources of non-conventional energies present on our planet, so why not use it directly and convert its energy into electricity so that every person can avail it at a nominal rate, especially in a developing country like India where people don't get electricity in rural villages, installation of solar panels can be of much use.

Keywords—fossil, conventional, traditional, nominal, Installation

I. INTRODUCTION

The constant use of conventional sources of energy has led it to replenish, leading to the scarcity of resources that people around the world need for their daily tasks, including electricity. The non-conventional sources of energy production have been looked into and executed in the past few decades but their cost has always been a term to be concerned with.

Since we all are aware of the high cost of executing a hydro plant or windmills which can only be placed in places having strong winds, but a solar plant can be placed anywhere and everywhere without the tension of selecting a specific area and even can be used for the production of electricity for a small household cutting the high electricity bill payments, and can result in the wide availability of electricity as a resource to even remote areas.

The project requires proper planning and arrangement of hardware. Implementation of the model can only be done after proper research and continuous tests for the functioning of the model prototype.

II. LITERATURE SURVEY

1) Timeline of Reported Problem:

The history of solar panels stretches back several decades, and key milestones include:

1839: French physicist Alexandre Edmond Becquerel discovers the photovoltaic effect, which describes the conversion of sunlight into electricity in certain materials.

1883: American inventor Charles Fritts creates the first solar cell using selenium, with a low conversion efficiency of less than 1%.

1954: Researchers at Bell Laboratories developed the first silicon solar cell with a conversion efficiency of 6%.

1960s and 1970s: Solar panels are used primarily for space applications, such as powering satellites.

1980s: The cost of solar panels begins to decline, and they become more commonly used in off-grid applications, such as powering remote locations.

1990s: The efficiency of solar panels continues to improve, and they become increasingly used in grid-tied applications, such as generating electricity for homes and businesses.

2000s: Solar panel costs continue to decrease, and new technologies such as thin-film solar panels and concentrator photovoltaics are developed.

2010s: The efficiency of solar panels continues to improve, with some models achieving conversion efficiencies of over 20%. Solar energy becomes more competitive with fossil fuels in terms of cost.

2020s: Solar energy is projected to continue its growth trajectory, and it is expected to become the largest source of electricity globally by 2035, according to the International Energy Agency.

Overall, the timeline of solar panel development has been characterized by steady improvements in efficiency, reductions in cost, and greater adoption in various applications.

2) Existing Solutions:

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Solar panels have been around for several decades, and they have become increasingly efficient and cost-effective over time. One of the challenges with solar panels is that they only produce electricity when they are exposed to sunlight. As a result, their output can be affected by factors such as the angle of the sun, weather Conditions, and time of the day.

To address this issue, various technologies have been developed to optimize the output of solar panels. For example, some solar panels are mounted on tracking systems that allow them to follow the movement of the sun across the sky, maximizing their exposure to sunlight throughout the day. Other systems use mirrors or lenses to concentrate sunlight onto a smaller area of solar cells, increasing their efficiency.

A rotating solar panel that is dependent on sunlight could potentially be used in applications where it is important to maximize the output of solar energy, such as in space exploration or remote locations where traditional power sources are not available.

3) Problem Definition:

An LDR (Light-Dependent Resistor) based solar panel is a system that uses an LDR to measure the intensity of light falling on a solar panel and adjusts its angle to maximize the amount of energy produced.

The problem that this system aims to solve is the sub-optimal energy production of solar panels due to their fixed position and orientation. Traditional solar panels are installed at a fixed angle, and they can only produce optimal energy when the sun's rays are perpendicular to their surface. However, as the sun moves across the sky, the angle of incidence of the sun's rays changes, causing a decrease in energy production. Additionally, factors such as shading and weather conditions can further reduce energy production.

The LDR-based solar panel system seeks to address this problem by continuously measuring the intensity of light falling on the solar panel and adjusting its angle to maximize energy production. The LDR, which is a variable resistor whose resistance varies with the intensity of light, is placed on the surface of the solar panel. The LDR is connected to a microcontroller, which receives the voltage reading from the LDR and determines the optimal angle for the solar panel.

The microcontroller controls the angle of the solar panel using a servo motor, which can rotate the panel to the desired angle. The microcontroller continuously measures the voltage output of the solar panel and adjusts the angle of the panel until it produces maximum voltage output.

The problem of sub-optimal energy production of fixed solar panels is significant, as it limits the amount of energy that can be generated from solar power. The LDR-based solar panel system is an effective solution to this problem, as it can maximize energy production by continuously adjusting the angle of the solar panel to the optimal position.

III. PROPOSED METHODOLOGY

The following steps are taken to implement the Automated Sunflower Solar Panel IOT system:

1. Requirements Gathering: The requirements for the projects are gathered using the features it includes and the work it is designed for, i.e. for IOT implementation PCB, resistors, transistors etc are used while to make the solar panel rotate e have used an LDR.

2. Design: As the name suggests the design is just the same as the inspiration from which its work is planned i.e. of a sunflower. A basic application comes along with the system which includes the battery percentage along with energy production records.

3. Assembling: The IoT system is developed using modern IOT components and the design is 3-D printed to create a sunflower shape of it. All the connections are made on PCB and the breadboard.

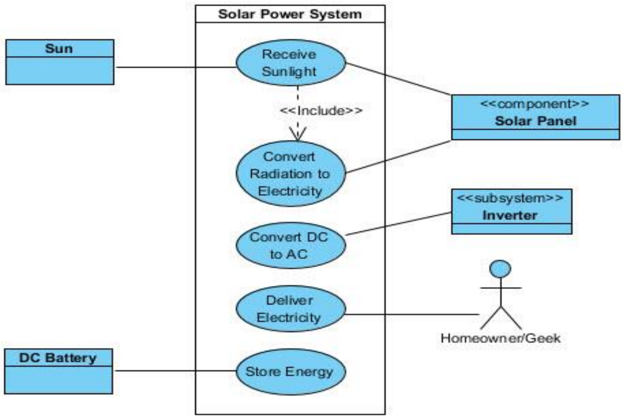

Fig. 1 Working System

4. Testing: The system will be tested after its successful assembly for real-time energy production.

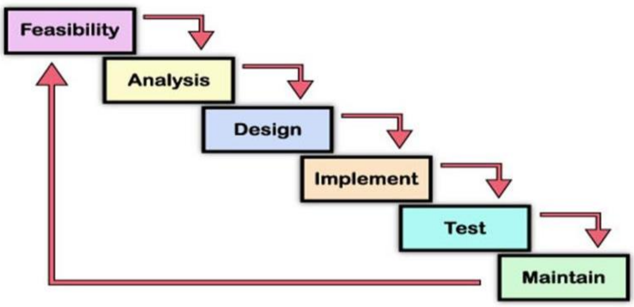

Fig. 2 Implementation Lifecycle

IV. IMPLEMENTATION

The implementation of Automate Sunflower Solar Panel involved the following phases:

A. Hardware Requirements :

1	Solar Panel
2	Li-Ion Battery
3	Arduino Nano
4	ESP-8266 Node MCU
5	L29d Driver
6	7806 Transistor
7	10K Resistor
8	LDRs
9	Servo Motors
10	Male and Female Headers
11	N20 Gear Motors
12	TP4056 Battery Charging Board
13	Voltage Detection Module

Table – I

B. Result Analysis :

- To analyse the result of our IoT system we tested it in the dark where we put light movements over the panels and it was successfully able to move according to the direction changes.
- The solar panels were able to produce energy accordingly with more efficiency than planned in the beginning as the result of the project.
- The IOT application was able to showcase the results in the form of respective units of energy.
- The only problem that occurred was in the opening and closing of the Solar Panels which we will be trying to solve with the progress of this project work.
- To analyse the work further we also circulated a survey form while showcasing the product for the audience reviews, the review about the upgraded design and efficient working were all positive.

C. Validation :

- To validate the work we interviewed the audience for their feedback, they were highly impressed by the easy-to-use mobile application that shows the result of the product along with the fact of how efficient this product was when compared to other solar panels currently in the market.

- The feedback from the audience suggested that this product can be of great use in places with low sunlight and in households.

V. DESIGN FLOW/PROCESS

A. Evaluation & Selection of Specifications/Features:

A1. Key Features and Specifications:

i. **Better Efficiency:** The system provides better efficiency when compared to other models of the same category. It changes direction accordingly to get efficient power capture.

ii. **Automated Technology:** With growing technology, the trend has been set high and since everything is being

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transformed to automatic from being manual, we have brought in an automated system design for a solar panel.

iii. **User-Friendly Application Interface:** The application used to monitor the power efficiency and battery percentage records has a smooth functioning and user-friendly design where users can switch to their dashboards can get access to the data of till past seven days.

iv. **Remote Tracking:** Since it's impossible to be available near the system every time therefore to track the production and working of the IOT device, users get access to their own application Dashboard.

A2. Selection of Specifications:

The selection of specifications and features was based on a careful analysis of the target audience. The people in need of solar panels to generate electricity but the existing system wasn't that efficient.

i. Relevance: Each feature and specification had to be relevant to the target audience and their needs. The features and specifications had to be designed to help users get easy access to all their saved data.

ii. Usability: Each feature and specification had to be easy to use and understand. The application needed to be simple yet effective and fulfilling all the demands.

iii. Effectiveness: The features and specifications had to be effective and contribute in the growth of both the user and producer.

The Automated Sunflower Solar panel IOT System and its respective application have been designed to cater for the needs of people living in areas where the sunlight reach is lesser along with the areas where there is sufficient sunlight but they want more efficient results from their solar panels, without the hassle of turning its direction manually.

B. Design Constraints:

This section will highlight the key design constraints for the system and explain how they have been addressed.

The following are the Key Design Constraints:

i. Accessibility: The application for the IOT system is in such a way which makes it accessible to every user, whether they know the basic mobile operations or not, and whether they are aware of the analysis of visualizations or not.

ii. Performance: The system itself is designed to upgrade the performance of the existing system. It had been fully optimized to increase its productivity.

iii. Compatibility: The application is made in such a way that it is compatible to use as mobile applications as well as web applications as per the user's requirements.

iv. Scalability: The system needs to be produced in such a way that the people in need get to know about its existence hence increasing the scalability.

The design constraints of the Automated Sunflower Solar Panel were carefully considered and addressed during its development process. It was designed keeping in mind that it is accessible, scalable, and compatible when deployed.

C. Design Flow:

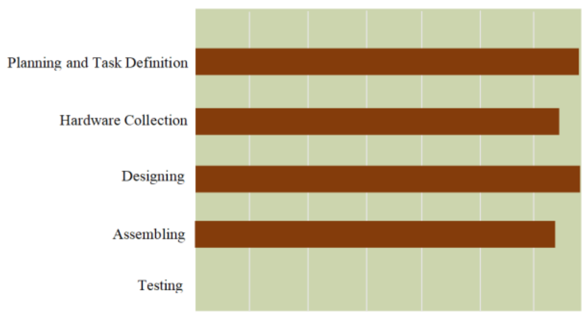

Fig. 3 Gantt Chart

SNO.	Activity	Deadline	Progress	Status
1	Planning and task Definition	10th March'23	100%	Completed
2	Hardware Collection	28th March'23	98%	Ongoing
3	Designing	20th Apr'23	100%	Completed
4	Assembling	05th May'23	98%	Ongoing
5	Testing	3th May'23	95%	Ongoing

Table – II

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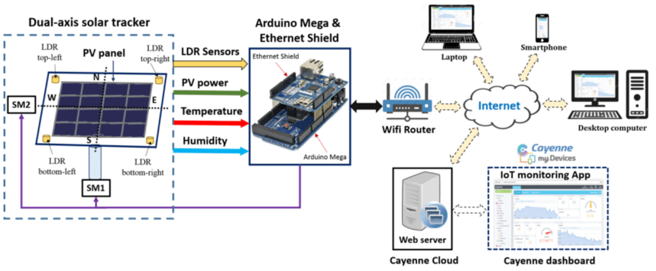

Fig. 4 Design Flow

D. Design Selection:

To create a report on design selection among Use Case, and Gantt Chart, we first need to understand the purpose of each of these design tools and how they can be used in the context of the Automated Sunflower Solar Panel.

i. Gantt Chart: A Gantt chart is a graphical representation of a project schedule that shows the start and finish dates of different tasks. It helps to visualize the progress of a project and identify potential scheduling conflicts.

In the context of our project, a Gantt chart can be used to create a project schedule that shows the different tasks required to complete the project, their start and finish dates, and their dependencies. It can also help to identify potential scheduling conflicts and adjust the project timeline accordingly.

ii. Use Case: A use case is a description of how a user interacts with a system to achieve a specific goal. Use cases help to identify and define the functional requirements of the system and provide a clear understanding of how the system should behave.
In the context of our project, we have two different use case diagrams, the first concerns the solar panel and the second use case diagram is of AMR.

VI. CONCLUSION AND FUTURE WORK

A. Conclusion:

- The LDR-based automated solar panel system with a sunflower-inspired design effectively tracks the movement of the sun throughout the day, maximizing the absorption of solar energy and improving overall energy generation efficiency.
- The sunflower-inspired design of the solar panel system incorporates biomimicry principles, taking inspiration from nature to optimize energy capture by aligning the solar panels with the sun's position.
- The use of Light Dependent Resistors (LDRs) as sensors enables the system to detect changes in light intensity and accurately track the sun's movement, ensuring that the solar panels are always aligned in the optimal position for maximum energy capture.
- The automated tracking system significantly improves the energy generation capacity of solar panels compared to fixed-mount systems, resulting in increased energy output and a higher return on investment.
- The integration of a microcontroller or control system allows for real-time monitoring and adjustment of the solar panel position based on the LDR readings, ensuring continuous optimization of energy capture.
- The sunflower-inspired design not only enhances the functionality of the solar panel system but also adds an aesthetic appeal, making it visually pleasing and potentially more acceptable in various environments.
- The automated solar panel system has the potential for a wide range of applications, including residential, commercial, and utility-scale solar installations, where maximizing energy generation is crucial for economic and environmental sustainability.
- The LDR-based automated solar panel system offers a scalable and cost-effective solution for increasing solar energy utilization and reducing reliance on non-renewable energy sources.
- Further research and development can focus on optimizing the design, enhancing tracking accuracy, and exploring advanced control algorithms to improve the overall performance of the system.

Overall, the LDR-based automated solar panel system with a sunflower-inspired design represents a promising approach to enhance solar energy generation efficiency, making it a viable and sustainable solution for meeting the increasing global energy demand while reducing carbon emissions.

B. Future Work:

- **Improved Tracking Accuracy:** Enhance the accuracy of sun tracking by refining the LDR sensor calibration and incorporating advanced algorithms for real-time adjustment of the solar panel position. This can be achieved by considering factors such as weather conditions, shading, and variations in sunlight intensity throughout the day.
- **Integration of Weather Sensors:** Incorporate weather sensors, such as temperature, humidity, and wind speed sensors, to gather additional environmental data that can be used to optimize the solar panel's performance. This data can be used to make intelligent decisions about panel orientation and tilt angles.
- **Energy Storage and Management:** Explore the integration of energy storage systems, such as batteries or supercapacitors, to store excess energy generated during peak sun hours. Develop an efficient energy management system that allows for the utilization of stored energy during low sunlight periods or during high energy demand.
- **Remote Monitoring and Control:** Implement a remote monitoring and control system that enables real-time monitoring of the solar panel system's performance and allows for remote adjustments and troubleshooting. This can be achieved through wireless communication protocols and a user-friendly interface.
- **Structural Optimization:** Explore ways to optimize the mechanical design of the sunflower-inspired solar panel system, focusing on reducing weight, improving durability, and increasing resistance to environmental factors like wind,

rain, and snow.

- **Cost Reduction Strategies:** Identify cost-effective materials and manufacturing processes to reduce the overall system cost. Conduct a thorough economic analysis considering factors such as installation, maintenance, and operational costs to make the system more financially viable.

By addressing these areas in future research and development, the LDR-based automated solar panel system with a sunflower-inspired design can be further optimized, resulting in enhanced performance, increased energy generation efficiency, and broader applicability.

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