IoT Based Solar Tree Project with Integrated Inverter System

Shubham Gedam[1], Mohasin Sheikh[2], Aditya Gurnule[3], Avinash Haldar[4], Tina Rahate[5], Durga Kokude[6], Kiran Kimmatakr[7], Mamta Runge[8]

[1,2,3,4,5,6]Students of Electrical Engineering Department in Vidarbha Institute of Technology, Nagpur
[7,8]Professor of Electrical Engineering Department in Vidarbha Institute of Technology, Nagpur

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Abstract – The Solar Tree Project with Integrated Inverter System aims to address the growing demand for renewable energy and the need for sustainable and aesthetically pleasing urban infrastructure. This innovative project combines the concept of solar trees and an integrated inverter system to maximize solar energy generation and provide efficient power conversion. Solar trees are constructions with many branches or solar-powered panels that resemble genuine trees in both form and function. These buildings are perfect for urban settings with little rooftop space since they are thoughtfully constructed to optimize sunlight absorption. Solar trees may produce large amounts of renewable energy while taking up little area by utilizing vertical space and incorporating cutting-edge photovoltaic technology. This proposal includes an integrated inverter system to improve the usage and utility of solar trees. An inverter is a piece of technology that transforms solar energy's direct current (DC) into alternating current (AC), which can power a variety of appliances and gadgets and is compatible with the electrical grid. The generated solar electricity can be efficiently converted and sent directly to the electrical grid or local loads by integrating the inverter directly into the solar tree structure [1].

For the generation of electricity in cities, the Solar Tree Project with Integrated Inverter System offers a creative and environmentally friendly alternative. Solar trees can considerably reduce carbon emissions, encourage the use of renewable energy sources, and improve the visual appeal of urban landscapes by utilizing the power of the sun and cutting-edge power conversion technology.

Keywords: Solar tree, integrated inverter system, renewable energy, solar power, power conversion.

1. INTRODUCTION

Renewable energy source competes with fossil fuels in a number of ways. Hydropower is the term for the energy that flowing water generates. Nearly all of the renewable energy produced in the US is produced there. In order to produce electricity, hydroelectric power plants don't use other sources of energy or contaminate the environment. Even if solar panels take up a tiny amount of area, we can still plant a solar tree to get over this issue. Solar energy is typically regarded as the easiest and cleanest way to harness renewable energy because it is abundant and relatively pure. The direct conversion of solar energy into a form that may be used includes the following processes: solar thermal, solar photovoltaic, and solar architecture. The primary problem with using solar energy is that it requires a lot of area to construct big solar collectors. Even though solar panels take up very little area, we can construct a solar tree to prevent this issue.

As is well known, trees exist in nature and have the ability to create their own nourishment through a process known as PHOTOSYNTHESIS. It is a process through which a green plant harnesses the energy of the sun and the water in the soil during the day to make its own nourishment. Because we rely on green plants for food, either directly or indirectly, they are indirectly supplying nourishment to society as a whole. Here, we're using an example to help us grasp the solar tree. In this tree, the stems that are joined serve as the branches and the solar panels serve as the leaves. The same way that green leaves produce food for people, they also generate energy for the community [3].

The designs for the solar trees are an attempt in the same approach. A creative way to arrange photovoltaic (PV) panels is the solar tree. A solar cell, or more broadly, a photo voltaic cell, is a single converter cell. A solar module or solar array is a collection of such cells intended to boost the output of electrical power. Compared to fossil fuel energy sources, solar energy creates significantly fewer hazardous emissions. By turning light photons into electrons, they produce electricity. Direct current is produced by solar cells. Using an inverter, this DC current is changed to alternating current [2].

2. LITRATURE REVIEW

"Solar Tree: A Solution for Power Crisis" by N. Yaseen et al. This research paper highlights the role of solar trees as a potential solution for addressing power crisis issues. It discusses the design, construction, and installation of solar trees, along with their advantages and challenges. The study emphasizes the economic viability and sustainability of solar trees in areas where traditional energy sources are scarce or unreliable.

"Optimization of Solar Trees for Urban Energy Harvesting" by Yasmin Assef and Ulas Yaman (2020) The paper presents an optimization study on solar trees for urban energy harvesting. It discusses the optimization techniques used to maximize the energy output of solar trees, considering factors such as solar panel orientation, inclination angles, and shading effects. The research provides insights into the efficiency improvement potential of solar trees and their integration into smart grids for enhanced energy management [5].

"Design and Development of Solar Tree for Smart Cities" by Pawan Whig et al. (2021) This study focuses on the design and development of solar trees for smart cities. It discusses the

integration of solar trees with advanced technologies such as Internet of Things (IoT), sensors, and data analytics to create intelligent and sustainable urban environments. The research highlights the potential applications of solar trees in smart city infrastructure, including energy generation, environmental monitoring, and smart lighting systems [6].

"A Review on Solar Tree Technology for Power Generation" by Seema Shinde and Praveen V. (2021) This review paper provides an overview of solar tree technology for power generation. It discusses the design principles, components, and applications of solar trees. The study also reviews the advancements and challenges in solar tree technology, including the integration of inverters and storage systems, as well as the potential for scalability and commercialization.

3. PROPOSED METHODOLOGY

Solar tree is a decorative means of producing solar energy and also electricity. It uses multiple number of solar panels which forms the shape of a tree. The panels are arranged in a tree fashion in a tall tower/pole.

TREE stands for

- T= TREE GENERATING
- R=RENEWABLE
- E=ENERGY and
- E=ELECTRICITY

This is like a tree in structure and the panels are like leaves of the tree which produces energy.

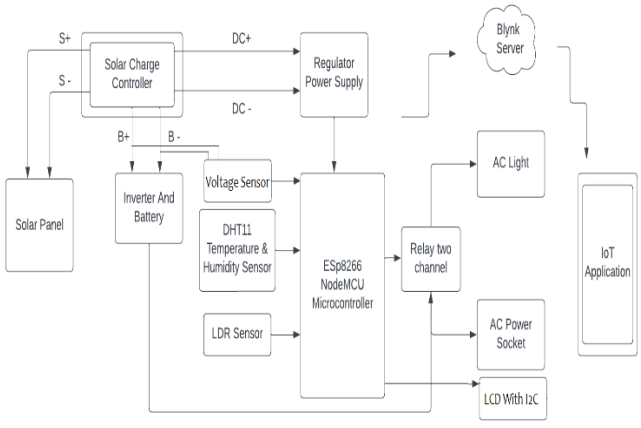

Fig -1: Block Diagram

A solar cell, also known as a photovoltaic or photoelectric cell, is a solid-state electrical device that uses the photovoltaic effect to convert light energy directly into electricity. Photons, which are tiny packets or light quanta, carry the energy of light. Electromagnetic fields store electrical energy, which can then cause an electron current to flow. Solar modules, which are used to harvest energy from sunshine, are constructed from assemblies of solar cells [7]. A solar panel is the integrated collection of modules that results from the assembly of many modules, all of which are positioned in the same plane. An example of solar energy is the electrical energy produced by solar panels. Though term is frequently used to refer particularly to the production of energy from sunshine, photovoltaic is the branch of science and research concerned with the practical application of photovoltaic cells in creating power from light. When there is light coming from a source other than the sun, the cells are referred to as photovoltaic cells. These are utilized for the measurement of

light intensity or the detection of light or other electromagnetic radiation in the visible range, such as infrared detectors.

4. COMPONENT DETAILS

ESP8266 NodeMCU Controller

The NodeMCU (Node Microcontroller Unit) is an open-source software and hardware development environment built around an inexpensive System-on-a-Chip (SoC) called the ESP8266. The ESP8266, designed and manufactured by Espressif Systems, contains the crucial elements of a computer: CPU, RAM, networking (Wi-Fi), and even a modern operating system and SDK. That makes it an excellent choice for Internet of Things (IoT) projects of all kinds.
Also challenging to utilize and access is ESP8266. For the simplest operations, like turning it on or sending a keystroke to the "computer" on the chip, you must solder wires with the necessary analogue voltage to its pins. Additionally, you need to programmer it in low-level machine instructions that the chip hardware can understand. Using the ESP8266 as an embedded controller chip in mass-produced devices is not problematic at this degree of integration. For amateurs, hackers, or students who want to test it out in their own IoT projects, it is a significant burden.

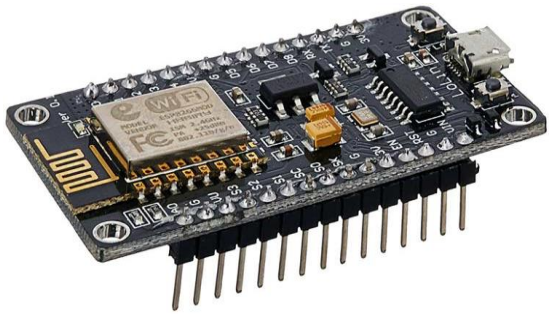

Fig -2: ESP8266 NodeMCU Controller

Solar Panel

Fig - 3: Solar Panel

A solar panel is a device that converts sunlight into electricity by using photovoltaic (PV) cells. PV cells are made of materials that generate electrons when exposed to light. The electrons flow through a circuit and produce direct current (DC) electricity, which can be used to power various devices or be stored in batteries. Solar panels are also known as solar cell panels, solar electric panels, or PV modules.

LCD

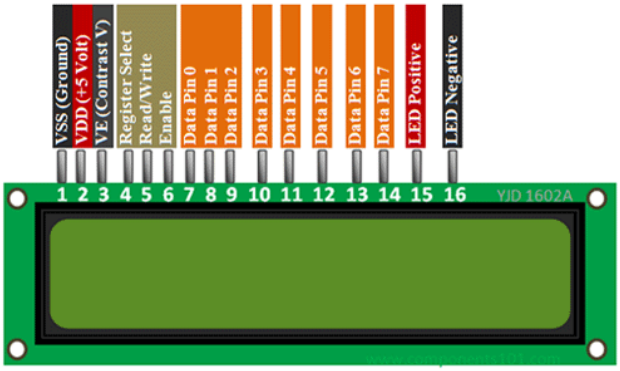

Fig -4: LCD 16x2

A 16x2 LCD means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. The 16 x 2 intelligent alphanumeric dot matrix display is capable of displaying 224 different characters and symbols. This LCD has two registers, namely, Command and Data. The term LCD stands for liquid crystal display. It is one kind of electronic display module used in an extensive range of applications like various circuits & devices like mobile phones, calculators, computers, TV sets, etc. These displays are mainly preferred for multi-segment light-emitting diodes and seven segments. The main benefits of using this module are inexpensive; simply programmable,

LDR Sensor

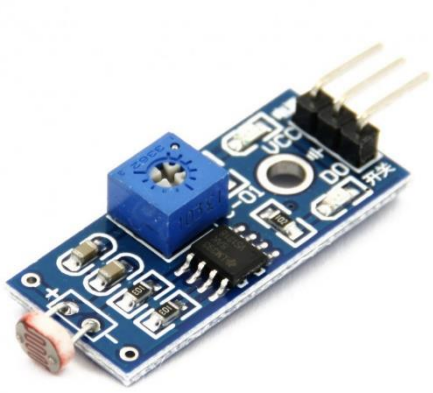

Fig -5: Soil Moisture Sensor

An LDR or light dependent resistor is also known as photo resistor, photocell, photoconductor. It is a one type of resistor whose resistance varies depending on the amount of light falling on its surface. When the light falls on the resistor, then the resistance changes. These resistors are often used in many circuits where it is required to sense the presence of light. These resistors have a variety of functions and resistance. For instance, when the LDR is in darkness, then it can be used to turn ON a light or to turn OFF a light when it is in the light.
An LDR is a component that has a (variable) resistance that changes with the light intensity that falls upon it. This allows them to be used in light sensing circuits.

Voltage Sensor

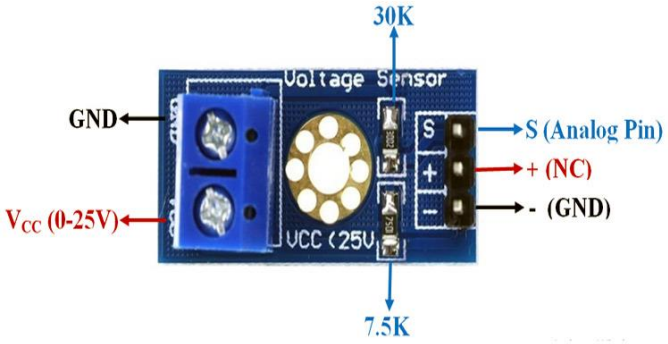

Fig -6: Voltage Sensor

A voltage sensor is a device that measures voltage. Voltage sensors can measure the voltage in various ways, from measuring high voltages to detecting low current levels. These devices are essential for many applications, including industrial controls and power systems. A voltage sensor is a device that measures the voltage of an electrical circuit. Voltage sensors are used in many applications, including monitoring and controlling equipment and machinery.

DHT11 Temperature & Humidity Sensor

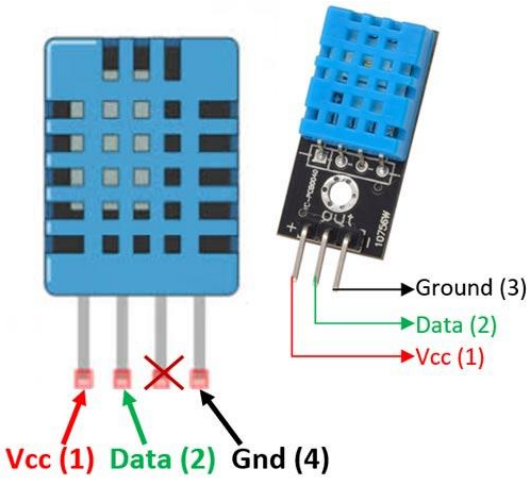

Fig -7: DHT11 Temperature & Humidity Sensor

The DHT11 is a basic, ultra low-cost digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air and spits out a digital signal on the data pin (no analog input pins needed). It's fairly simple to use but requires careful timing to grab data. The only real downside of this sensor is you can only get new data from it once every 2 seconds, so when using our library, sensor readings can be up to 2 seconds old.

Relay

Fig - 8: Relay

The 2 Channels Relay Module is a convenient board which can be used to control high voltage, high current load such as motor, solenoid valves, lamps and AC load. It is designed to interface with microcontroller such as Arduino, PIC and etc. The relays terminal (COM, NO and NC) is being brought out with screw terminal. It also comes with a LED to indicate the status of relay.

Battery

Fig - 9: Battery

A battery can be defined as an electrochemical device (consisting of one or more electrochemical cells) which can be charged with an electric current and discharged whenever required. Batteries are usually devices that are made up of multiple electrochemical cells that are connected to external inputs and outputs. Batteries are widely employed in order to power small electric devices such as mobile phones, remotes, and flashlights. Historically, the 'term' battery has always been used in order to refer to the combination of two or more electrochemical cells. However, the modern definition of the term 'battery' is believed to accommodate devices that only feature a single cell.

Inverter

Fig - 10: Inverter

A UPS Inverter is composed of sophisticated circuitry. It includes an inverter and a charge controller (usually referred to as the rectifier). The inverter switches the DC power from the battery into AC. The rectifier converts the AC utility into DC and also controls the charging parameters.

5. RESULT

The integration of IoT devices and sensors can enable real-time monitoring of solar panel performance, allowing for early detection of issues such as shading or malfunctioning panels. This can lead to improved energy generation and overall system efficiency. Real-time data collection and analysis can provide insights into energy consumption patterns, allowing for optimized energy management strategies. This can result in better utilization of generated energy and potential cost savings. IoT connectivity enables remote monitoring and control of the solar tree system. This allows for real-time tracking of energy generation, system performance, and maintenance needs. Remote control capabilities can also facilitate adjustments to maximize energy production based on weather conditions and demand.

6. CONCLUSION

The IoT-based Solar Tree project with an integrated inverter system offers significant potential for enhancing the efficiency and management of solar energy systems. The IoT-based Solar Tree project with an integrated inverter system offers significant potential for enhancing the efficiency and management of solar energy systems. Through a comprehensive literature review, we have examined the benefits, challenges, and future prospects of this technology. The integration of IoT devices and sensors in solar tree systems enables real-time data collection, remote monitoring, and control. IoT-based Solar Tree project with an integrated inverter system represents a significant advancement in renewable energy technology. It offers numerous benefits, including improved energy management, enhanced efficiency, and remote monitoring capabilities. However, challenges related to data security, scalability, and reliability must be addressed. With further research and development, this technology has the potential to revolutionize the solar energy industry and contribute to a more sustainable future.

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