Design and Implementation of Sunlight Tracking Based on the Internet of Things

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Abstract. In this article, for smart management and control of the solar pursuing device, an archetype is designed to evaluate or verify administration system and control. The newly-built prototype is designed for several applications to be a powerful platform for understanding the smart solar energy method. The Internet of Stuff integrates ordinary items using the Internet to enter the physical world. The IoT technology is facilitated to track solar PV (photovoltaic) power generation that can improve plant upkeep, tracking, and efficiency. This would include monitoring the solar panel and pointing it into the sunlight. It's all feasible to utilize LDR sensors. The IoT automatically preserves track of the voltage supply the solar panel detects the towards of sunlight. The suggested system demonstrates the online utilization of solar PV power.

Keywords: ESP32, LDR, SOLAR PANEL, VOLTAGE SENSOR, IOT.

1. Introduction
Electricity considers one of the most important devices which are used in everyone's life. The consumption of energy is increasing daily dramatically while energy resources are decreasing. To equilibrium the shortage of electricity, many sources are used to produce the electricity[1]. There are two methods to generate electricity: the first method is the traditional method and the other is the unconventional method. In addition, fossil and nuclear fuels are used to generate the electrical energy, but they are not unconventional[2]. Sustainable energy sources can be attained by using solar energy as a source. Solar energy is widely available throughout the world. The sun light has been used to produce energy for billions of years. Sunlight can act as an significant source of electricity the produced by transforming it into electrical energy[3]. This application is known as solar thermal energy, and it is conservative. Many ecological sources are presented such as wind, rain, tides, geothermal energy, natural biofuels, and traditional biomass. Solar energy has enormous advantages. Nowadays, frequent power outages are very communal in Iraq. So, it is essential to investigate renewable energy. The Rapid growth of renewable energy requests has been enabled by the steep reduction in cost over the preceding decades and specialized change in its stable productivity, quality, and life[4, 5]. Iraq is one of the countries that has a very hot climate in the summer and it needs continuous energy to overcome the high
temperatures. The operating capacity of the electrical stations is about 25GW, but the actual need is about 35GW. Therefore, Iraq suffers from a severe shortage of electricity supplies. Some institutions, factories, and agricultural fields have used solar cells to avoid the shutdown. The Internet of Things simply means the network of physical things. The tracking of sunlight can be used to increase the efficiency of generating the electricity by using the Internet of Things. The collection of the sun’s radiation that falls on the ground surface is not constant because it changes depending on the location, time, and climatic conditions. The solar panel can be checked by using the Internet of Things. Solar power is much more effective than any other green energy, and harmless to the environment. To achieve more productivity from the solar panel, various techniques have been studied, and one of them is a solar tracking device, which regulates the system by straiting it with the light, rendering the solar tracking important to improve efficiency[6]. Tracking systems were chosen that depend on the Earth's physical features, efficacious and easy to use. In[7-9], the development of a highly efficient dual-axis tracker in solar panel tracking is discussed. The researcher used a light-dependent resistor (LDR), two controlling motors to move the panel directly toward sunlight. The tracker panel showed better performance and efficiency than a fixed panel. In[10], the authors suggested using a single-axis solar tracker to fill the deficit in the production of electrical energy in a city in Egypt. In[11-13], conventional solar energy systems can be classified into two main groups, Active and passive. Active solar tracking systems use electric motors and gears to increase the power of solar panels, while a passive tracking system is used to compress gas with high boiling point gases. This work was carried out by Khatoon and Kumar who created a prototype to realize and manage the system, keeping pace with modern applications and making it a smart system based on the technology of the Internet of things, thus achieving supervision of solar photovoltaic energy[14-17]. The researchers used LDR sensors with an Arduino microcontroller. Vinod Kumar and John, suggested solar tracker setup which prepared from mechanical and electrical construction system. The mechanical structure is used to control the Azimuth and Elevation motor of the solar follower depend on the angle collected from the website, while electrical structure used for control motor and evaluation the device data[18]. The Internet of things is considered as a bridge between two construction, which let all scheme completely automatic and make solar tracker precise, cheap[19, 20]. Diggavi, Thula, et al., suggested a mechanism to show the maximum power generation using a solar tracking system, display its results and monitor using the thing speak platform. The LDR sensor is connected to a Node MCU microcontroller and compares the display results and output of the solar panel in dual-axis condition[21]. In[22], A solar tracking system based on Arduino was proposed to track the maximum radiation incident on the surface of the board and could be obtained at any time during the days year.

2. The Requirements of the Proposed Work

2.1. LDR SENSOR

This is a kind of passive element, such as a resistor with resistance variation by the intensity of light. A photo resistor is a device that alters the conductivity of photo responsive materials. The electrical resistance of the photo resistor is lowered. The number of electrons is proportional to the photon frequency.
2.2. Microcontroller ESP32S
The ESP32 is a powerful, integrated Wi-Fi, a full TCP/IP stack, and Bluetooth 4.2. Due to the low cost, great power, and connectivity, the ESP32 is ideal for Internet of Things development. This chip was chosen because it decreases the charge of the checking system with high treating performances. ESP32 board based on Tensilica 32-bit LX56 microprocessor, CPU Xtensa with 2-core[23].

2.3. HTTP/HTTPS (Hypertext Transfer Protocol)
HTTP is a request and comeback protocol between a customer and a server. By using the HTTP server, devices can communicate with the Ask Sensors server. GET is one of the most commonly-used HTTP requests to request data from a specified resource and it enables you to write data to or read data from the Ask Sensors IoT platform.

2.4. L298N Motor Driver
Several techniques can be used to control a DC motor. We will use the L298N motor driver which can provide up to 3A of current at 35V. Additionally, it allows to run of two DC motors simultaneously and build a robot. The L298N integrated motor driver is shown in the following figure 4[24-26].
2.5. **Voltage Sensor**
A voltage sensor is used to monitor the voltage in an item. Voltage sensors can detect both AC voltage or DC voltage. The input of this sensor can be a voltage signal and the output is an electrical switch.

![Figure 3. L298N DRIVER](image)

2.6. **Solar panel**
Solar energy is a group of photovoltaic cells that generate electricity from sunlight and convert light into electricity from the sun in an industrial area, domestic and street lights, they are wide applications of solar panels.
2.7. **DC Motor Electric Gear Box (Gearbox 12V – 2A)**

Table 1. Summary Specification of DC gearbox motor[27]

|                |               |
|----------------|---------------|
| speed          | 260 rpm       |
| Brand          | chines        |
| Voltage        | 12vdc         |
| Current        | 2A            |
| mounted        | 37mm          |

**Figure 6. Gearbox motor device**

2.8. **Ask sensor IOT Cloud Platform**

It is an IOT platform designed to be easy in the practical application of various IoT system projects, gather and envision your devices data simply, controller your actuators distantly, and achieve linked strategies in real-time, allowing users to communicate, visualize and analyse data coming from their sensors via the cloud. You can connect various controllers like Arduino, ESP32, or any other device in few minutes and start developing IoT applications[28-31].

3. **Experiment Setup**

This experiment can be used for monitoring the system tracking the output of the solar panel using ESP32S technologies, to optimize the system. It is done by using a 10W prototype shown in figure
3.1 Flowchart

The flowchart of the PV tracker system is assumed in the procedure of the steps below as shown in figure (8).

![Flowchart Image](image)

**Figure 7.** prototypes of the sunlight tracker system

**Figure 8.** The flow chart of proposed work

The performance of solar panels has been monitored by using IoT. The sensor of the system using in the project, LDR & voltage sensor for detecting the sun location and transmit the data to Node MCU.
ESP32. After the microcontroller progression the information from a sensor, L298N motor driver that hold PV, it moves toward the sun. The PV gathers the energy from the sun and send value to ESP32, and ESP32 sends data via the router to IOT shown in the figure 9.

![Connection Map of Proposed Circuit Diagram](image)

**Figure 9.** The connection map of the proposed circuit diagram

### 3.2 Results

After completing and connecting the experiment, the resulting curves are monitored by the cloud, and the 4LDR values are compared with the voltage sensor during real-time. Figure (10,11,12,13,14) show the curves of LDRs values of voltages VS time. Measuring from the solar panel, the parameter may be monitored from the serial monitor in Arduino IDE. The stream data made and saved in the Ask sensor platform.

![LDR1 vs Time](image)

**Figure 10.** LDR1 vs Time
Figure 11. LDR2 vs Time

Figure 12. LDR3 vs Time

Figure 13. LDR4 vs Time
Solar tracker has been successfully developing, and monitoring systems are equipped with a Node MCU ESP32 unit to transfer and read information from the solar panel to the IOT. There are two motors and are classified into two parts, horizontal and vertical, and each of them uses two motors to define the system’s functions. Experimented with the real-time reading of the LDR values and compared to the voltages coming out of the solar panel. Finally, the solar tracker is the best choice in producing solar cells, in addition to being environmentally friendly.

4. Conclusion

Solar tracker has been successfully developing, and monitoring systems are equipped with a Node MCU ESP32 unit to transfer and read information from the solar panel to the IOT. There are two motors and are classified into two parts, horizontal and vertical, and each of them uses two motors to define the system's functions. Experimented with the real-time reading of the LDR values and compared to the voltages coming out of the solar panel. Finally, the solar tracker is the best choice in producing solar cells, in addition to being environmentally friendly.

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