WEATHER MONITORING SYSTEM FOR A PV APPLICATION ON THE IOT PLATFORM

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Abstract: *Currently, the use of photovoltaic (PV) systems on roofs is increasing due to incentives from governments, leading to the need to monitor system parameters as well as weather factors affecting the PV system. This paper describes the deployment build weather monitoring systems including ambient temperature, surface temperature of photovoltaic panels and intensity of solar radiation on the Internet of Things (IoT) platform. The main device of the monitoring system is the NodeMcu WiFi module based on the ESP8266 microcontroller, all the signals read from the sensor will be transmitted via Wi-Fi by the ESP8266 and uploaded to the Thingspeak IoT platform where the data is Data will be stored, processed and used for monitoring.*

Keywords: PV system; IOT; ESP8266; Weather Monitoring.

1. INTRODUCTION

Currently, the use of solar PV panels on rooftops is increasing due to incentives from governments [1], leading to the need to monitor the electrical parameters of the system as well as the weather factors affecting the electrical system. The main weather parameters that affect the photovoltaic system are intensity of solar radiation, ambient temperature and panel surface temperature and some other factors [2].

As modern devices and sensors continue to increase power and functionality and reduce costs, IoT is becoming a broad platform and service for consumer electronics. IoT refers to the concept of embedding electronic devices, connecting to the Internet and other types of devices (sensors) [3].

Observing the weather factors that affect the photovoltaic system is an important IoT application, which includes monitoring the ambient temperature, the photovoltaic panel surface temperature and the intensity of solar radiation as well as the calculation. This data provides effective short-term measures such as remote device control and long-term data analysis and measurement.

The results of the paper explain real-time monitoring of radiation intensity and temperature levels from around the world and its statistical analysis. It also shows how weather factors affect the PV system. The system can be expanded to provide remote device control based on sensor data.

2. DESCRIPTION OF THE PROPOSED SYSTEM

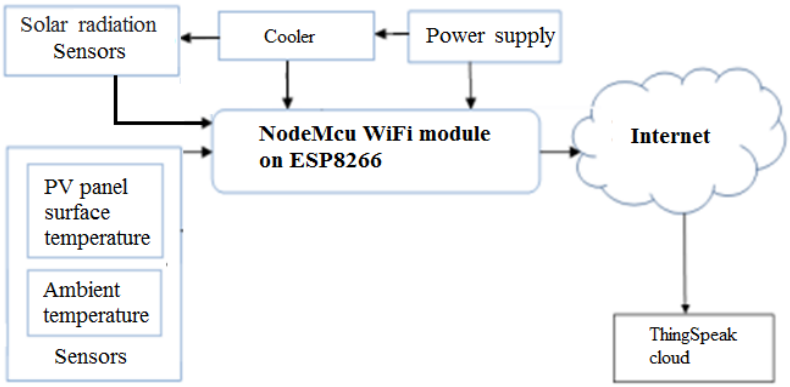


Figure 1. *System block diagram.*

The system mainly consists of a NodeMcu WiFi module based on an ESP8266

microcontroller, two temperature sensors, a sunlight sensor, a cooler, a sensor housing and a power supply. Figure 1 shows the system function flow where the NodeMcu WiFi module directly reads the temperature and light intensity and transmits data over the Internet to the ThingSpeak cloud. All data passed from these sensors is stored in the ThingSpeak database, where it is analyzed and tracked for future feedback. System block diagram is shown in figure 1.

2.1. NodeMcu WiFi module based on ESP8266 microcontroller

ESP8266 is a Wi-Fi microcontroller from the Chinese manufacturer Espressif Systems. The processor chip has 16 GPIO lines, and some of them are used to communicate with other SoC components such as flash memory.

The NodeMCU is a development board based on the ESP8266 chip (ESP12E version), which is an ultra low power UART-WiFi module. The chip itself was designed for the Internet of Things, and this board allows you to simplify development, since it already has a USB connection, a power supply voltage regulator is installed, and all the chip leads are routed to combs with a standard pitch of 2.54 mm, which allows you to insert it into a breadboard and create a prototype without even turning on a soldering iron. In addition, NodeMcu also allows programming with the Arduino IDE, an open source software.

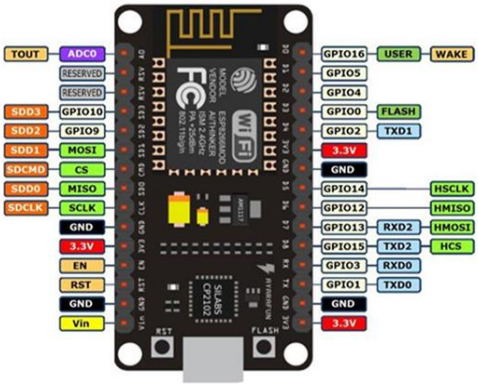


Figure 2. *NodeMcu WiFi module based on ESP8266 microcontroller.*

2.2. Temperature sensor

DS18B20 is a digital temperature meter with 9 - 12-bit conversion resolution and temperature monitoring alarm function. The DS18B20 communicates with the microcontroller over a single-wire communication line using the 1-Wire interface protocol.

In this study two DS18B20 sealed temperature sensor are used as a temperature sensor. Its characteristics are as follows: The temperature range measured is within -55,... + 125 °C; Accuracy of ± 0.5 °C (within -10,... + 85 °C); Data collection time: 750 ms at 12-bit resolution; 94 ms at 9-bit resolution; Supply voltage: 3-5.5 V; No-load current: 750 nA; Current consumption in probe: 1 mA.



Figure 3. *Sealed temperature sensor DS18B20.*

2.3. Solar radiation sensor

The light sensor on the MAX44009 microcircuit (GY-49) is designed to measure the level of ambient light close to the sensitivity of the human eye. The module has a digital output via an I2C interface. The presence on the board of a voltage regulator and a level converter of the I2C interface allows the module to be used with microcontrollers with both 5 V and 3.3 V logic. Illumination range within 0.045 - 188000 Lux and operating temperature within - 40 to +85 ℃.



Figure 4. *Light sensor on the MAX44009 chip.*

Pyranometers is often used to measure solar radiation intensity. However, it does come at a pretty high price, so the use of an alternative ambient light sensor is a possibility. In this study the light sensor on the MAX44009 chip (GY-49) is used as a sensor for the intensity of sunlight. According to the document [4], the intensity of sunlight 1000 (W/m^2) is equivalent to approximately the illumination of 120.000 Lux, from here we give the conversion formula 1 Lux = 0.0083 (W/m^2)

3. DEPLOYMENT ON SOFTWARE

ThingSpeak is an Internet of Things (IoT) platform that collects and stores sensor data in the cloud and develops IoT applications. The ThingSpeak IoT platform provides applications that allow you to analyze and visualize data in MATLAB and then act on it. Sensor data can be sent to ThingSpeak from the NodeMCU ESP8266 Wi-Fi module. This article discusses weather parameters such as light intensity, ambient temperature, and PV panel temperature that are displayed in ThingSpeak.

Software an important role in hardware integration and design. The Arduino IDE is used to program the data received from the sensor and the data sent to the cloud. After checking the individual hardware components, they integrate it into the board and place it in the sensor housing. Then, source program is uploaded for esp8266.

The esp8266 source program is written as follows. After reading and receiving data from sensors, checking data, calculating parameters, the program will check Internet connection and send necessary data to Thingspeak platform.

4. EXPERIMENT AND RESULTS



Figure 5. *Sample for the experiment.*

The experiment was conducted from January to March 2021 and a typical day was selected as evidence. In figure 5 shows the position of the metering setup and the photovoltaic system. The monitoring system's sensor housing is positioned so that the surface of the solar radiation sensor coincides with the surface of the PV panel, PV surface temperature sensor is in contact with the back surface of PV panels.

Figure 6 shows the monitoring results on the Thingspeak site, where we can adjust the coordinate axes, average the values, or calculate them using the apps available on the website.

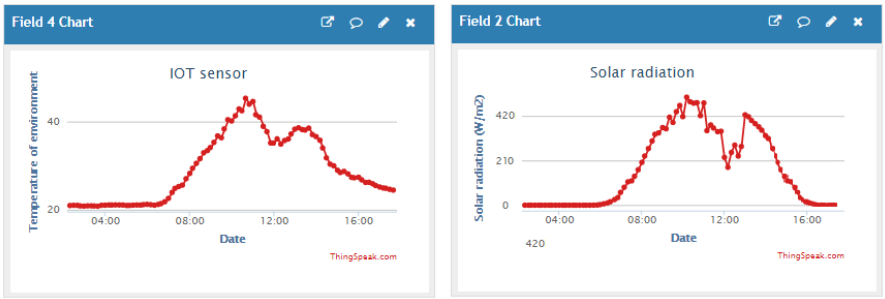


Figure 6. *Charts obtained with Thingspeak.*

Figure 7 shows the generating power of a 1.3 kWp PV system, which received from the software included with the grid inverter of the photovoltaic system. Looking at the graph, we can see the correlation between the measured radiation and the generated power. From this we can conclude that the sensor reads and returns a value that can be used for monitoring. This is all the more obvious when looking at figure 8, the power of the PV system is almost linearly proportional to solar radiation.



Figure 7. *The generating power of a photovoltaic system.*

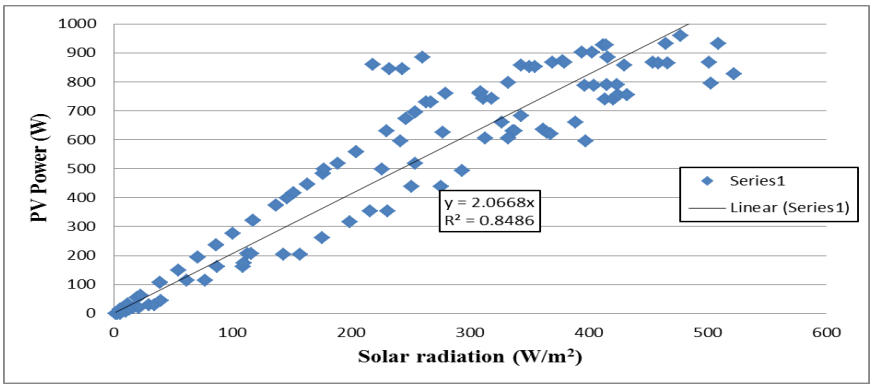


Figure 8. *Dependence of PV power on solar radiation.*

5. CONCLUSIONS

The article presents a hardware and software description of a system for monitoring temperature and intensity of solar radiation for PV systems on the Thingspeak IoT platform.

Experimental results also showed that the proposed system works well and quickly monitors environmental parameters such as temperature and light intensity. These parameters can be used to calculate performance ratio for the increasingly popular PV systems.

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TÓM TẮT

HỆ THỐNG GIÁM SÁT THỜI TIẾT CHO ỨNG DỤNG QUANG ĐIỆN TRÊN NỀN TẢNG IoT

Hiện nay, việc sử dụng hệ thống quang điện mái nhà ngày càng tăng do các chính phủ khuyến khích, dẫn đến nhu cầu giám sát các thông số của hệ thống cũng như các yếu tố thời tiết ảnh hưởng đến hệ thống quang điện. Bài báo này mô tả việc triển khai xây dựng hệ thống giám sát thời tiết bao gồm nhiệt độ môi trường xung quanh, nhiệt độ bề mặt của các tấm quang điện và cường độ bức xạ mặt trời trên nền tảng Internet of Things (IoT). Thiết bị chính của hệ thống giám sát là mô-đun WiFi NodeMcu dựa trên vi điều khiển ESP8266, tất cả các tín hiệu đọc được từ cảm biến sẽ được ESP8266 truyền qua Wi-Fi và tải lên nền tảng Thingspeak IoT nơi dữ liệu sẽ được lưu trữ, được xử lý và sử dụng để giám sát.

Từ khóa: Hệ thống PV; IOT; ESP8266; Giám sát thời tiết.

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