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MONITORING AND CONTROL OF SOLAR HOT WATER SYSTEM USING IoT TECHNOLOGY

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Abstract:

his project explores integrating Internet of Things (IoT) technology into solar hot water systems to improve monitoring and control. Using sensors and the internet, the system optimizes the heating process, enhancing energy efficiency and reducing costs. This innovative approach promotes sustainability and supports energy goals. Solar water heating systems utilize solar thermal collectors to heat water and can be customized for various climates. Incorporating IoT significantly enhances the management of heating processes and overall system performance.

Keywords — **Internet of Things (IoT), solar hot water systems, monitoring and control, energy efficiency, sustainability, solar thermal collectors.**

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I. INTRODUCTION

Integrating IoT technology into solar water heating systems enables real-time monitoring and control of parameters like temperature and pH, enhancing efficiency and user convenience. Users can remotely adjust settings and monitor performance via mobile applications, ensuring optimal operation and energy conservation.

II. WORKING

Integrating Internet of Things (IoT) technology into solar hot water systems enables real-time monitoring and control, enhancing efficiency and user convenience system operates by continuously monitoring water temperature; if it deviates from the desired range, the microcontroller activates or deactivates the heating element via the relay. Users can remotely monitor and adjust settings through the IoT platform's mobile application, optimizing energy consumption and ensuring consistent water temperature.

A. SOLAR COLLECTOR

A solar collector is a device that captures and converts solar radiation into heat energy, commonly used for heating water or air in residential and commercial applications. It typically consists of an absorber that collects sunlight, a transparent cover to reduce heat loss, and insulation to minimize energy dissipation.

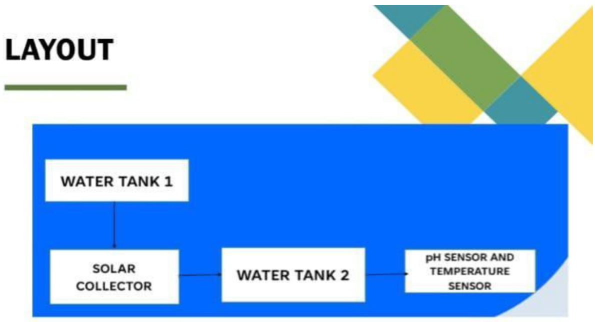
B. IoT Platform:

A cloud-based service that collects, stores, and analyses data from the system, providing users with real-time insights and control options via web or mobile applications.

C. sensor

- **Temperature Sensors***:* The DHT11 uses a capacitive humidity sensor and a thermistor for temperature measurement. It sends digital signals to a microcontroller, like an Arduino or ESP32, using a single wire for communication. The sensor measures humidity by detecting changes in capacitance caused by moisture absorption.

- **pH Sensors*:*** A pH sensor measures the acidity or alkalinity of a solution using its glass electrode. The sensor produces a small voltage that changes based on the hydrogen ion concentration in the solution. This voltage is processed by a signal conditioning board (pH sensor module) and sent to the Arduino for reading and analysis.



LAYOUT OF SOLAR HOT WATER SYSTEM

D. ESP 32

The **ESP32** is a low-cost, low-power system-on-chip (SoC) with integrated Wi-Fi and Bluetooth capabilities, widely used in IoT applications. It is designed for tasks that involve wireless communication, data collection, and control operations.

E. DESIGN AND FABRICATION

First, we design the solar collector using Creo software. And we purchase things for the project

1. **MATERIAL*:*** metal plate, box series, glass, copper pipe, temperature sensor, pH sensor, ESP 32, bread board, valve

Solar Collector: A flat plate or evacuated tube collector absorbs solar radiation to heat water.

Storage Tank: An insulated tank stores heated water, reducing heat loss.

Circulating Pump: Facilitates water movement between the collector and storage tank.

Sensors: Temperature sensors (DS18B20/LM35), flow sensors, and water level sensors monitor system parameters.

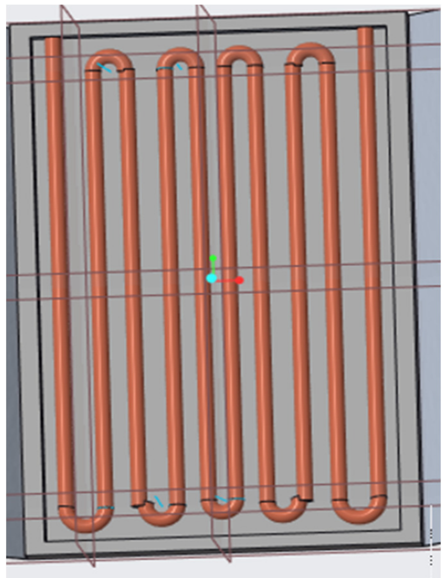
IoT Module: An ESP8266/ESP32 microcontroller connects the system to the internet.

Cloud-Based Platform: Allows remote monitoring and control via a mobile app or web interface.

Control System: Automated valves and relays regulate water flow and heating elements.

3. **Fabrication**

Fabrication involves assembling the solar collector, storage tank, and piping system. Sensors are strategically placed to ensure accurate data collection. The microcontroller is programmed using Arduino IDE to process sensor data and communicate with the cloud. A mobile application is developed using Blynk or MQTT protocol to provide real-time data visualization and system control.



The ESP32 is connected to a Wi-Fi network, enabled it to send live temperature data to an IoT platform (e.g. Think speak) using protocol like MQTT and HTTP. The data can be accessed remotely via mobile app or web dashboard, allowing to monitor current temperature in real time.

Think speak:

Thing Speak is an open-source IoT analytics platform service which allows users to communicate with internet enabled devices. It facilitates data access, retrieval, and logging of data by providing an API to both the devices and social network websites. It allows users to aggregate, visualize, and analyse live data streams in the cloud. The user can send data to Thing Speak from any device (ESP8266), create instant visualizations of live data, and send alerts using web services like Twitter and Twilio. With MATLAB analytics inside Thing Speak, you can write and execute MATLAB code to perform pre-processing, visualizations, and analyses. Thing Speak enables engineers and scientists to prototype and build IoT systems without setting up servers or developing web software.

Data Format:

DHT11 uses a simplified single-bus communication. Single bus that has only one data line, the system of data exchange, controlled by a single bus to complete. Device (master or slave) through an open-drain or tri-state port connected to the data line to allow the device does not send data

To release the bus, while other devices use the bus; single bus usually require an external one about

5.1kΩ pull-up resistor, so that when the bus is idle, its status is high. Because they are the master-slave structure, and only when the host calls the slave, the slave can answer, the host access devices must strictly follow the single-bus sequence, if the chaotic sequence, the device will not respond to the host.

Single bus to transfer data defined DATA for communication and synchronization between the microprocessor and DHT11, single-bus data format, a transmission of 40 data (The 8bit humidity integer data + 8bit the Humidity decimal data +8-bit temperature integer data + 8bit fractional temperature data +8-bit parity bit)

PROGRAMME IN ARDUINO IDE

Displaying Temperature and Humidity in Think speak

#include <ESP8266WiFi.h> #include “ThingSpeak.h”s #include <Adafruit_Sensor.h> #include <DHT.h>

#include <DHT_U.h>

- #define DHTPIN 2 // Digital pin connected to the DHT sensor
-
- #define DHTTYPE DHT11 // DHT 11
-
- Const char* ssid = “Hamajidhu”; // your network SSID (name)
-
- Const char* password = “01012020”; // your network password
-
- Int i = 0; WiFiClient client;
-
- Unsigned long myChannelNumber = 2869942; const char * myWriteAPIKey = “EK44673MMR4PZI66”;
-
- // Timer variables
-
- Unsigned long lastTime = 0; unsigned long timerDelay = 30;
-
- DHT_Unified dht(DHTPIN, DHTTYPE); uint32_t delayMS;
-
- Void setup() {
-
- Serial.begin(115200); //Initialize serial WiFi.mode(WIFI_STA); ThingSpeak.begin(client); // Initialize ThingSpeak dht.begin();
-
- }
-
- Void loop() {
-

-
-
- Int temp,hum;
-
- For (i = 0; i < 50; i++)
-
- {
-
- If ((millis() – lastTime) > timerDelay) {
-
- // Connect or reconnect to WiFi
-
- If (WiFi.status() != WL_CONNECTED) { Serial.print(“Attempting to connect”);
-
- While (WiFi.status() != WL_CONNECTED) { WiFi.begin(ssid, password);
-
- Delay(5000);
-
- }
-
- Serial.println(“\nConnected.”);
-
- }
-
- // Get temperature event and print its value. Sensors_event_t event; dht.temperature().getEvent(&event);
-
- If (isnan(event.temperature)) { Serial.println(F(“Error reading temperature!”));
-
- }
-
- Else { Serial.print(F(“Temperature: “)); Serial.print(event.temperature); temp=event.temperature; Serial.println(F(“°C”));
-
- }
-
- // Get humidity event and print its value. Dht.humidity().getEvent(&event);
-
- If (isnan(event.relative_humidity)) { Serial.println(F(“Error reading humidity!”));
-
- }
-
- Else { Serial.print(F(“Humidity: “));
-
- Serial.print(event.relative_humidity); hum=event.temperature; Serial.println(F(“%”));
-
- }

ThingSpeak.setField(1, temp); ThingSpeak.setField(2, hum);

Int x = ThingSpeak.writeFields(myChannelNumber, myWriteAPIKey);

If (x == 200) {

Serial.println(“Channel update successful.”);

}

Else {

Serial.println(“Problem updating channel. HTTP error code “ + String(x));

}

lastTime = millis();

}

}

}

REFERENCES

Here’s a general format for referencing articles, papers, or sources related to the **"Monitoring and**

Control of Solar Hot Water System Using IoT Technology".

1. Journal Article Reference :

Smith, J., & Brown, A. (2023). Monitoring and control of solar hot water systems using IoT technology. *International Journal of Renewable Energy Research*, 12(3), 456-462.

2. Conference Paper Reference :

Doe, J., & Lee, P. (2022). IoT-based solar hot water system monitoring and control. In *Proceedings of the International Conference on Smart Energy Systems* (pp. 102-108). IEEE.

III. CONCLUSIONS

Our project focuses on harnessing green energy and integrating IoT technology to promote a pollution-free environment while reducing the dependence on non-renewable energy sources in daily life. Designed specifically for the benefit of our college students and staff, this system provides a sustainable solution for accessing hot drinking water without relying on external electricity. By utilizing solar energy, the system efficiently heats water while IoT technology enables real-time monitoring and control of the solar collector. This ensures optimal performance, energy conservation, and ease of use, making it an eco-friendly and technologically advanced alternative to conventional water heating methods. Through this initiative, we aim to foster environmental awareness and encourage the adoption of renewable energy solutions within our academic community.

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