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SMART ENERGY MONITORING SYSTEM FOR ELECTRICAL APPLIANCES USING THINGSPEAK

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Abstract - Energy monitoring and management is especially important for organizations that use a lot of energy, such as manufacturing facilities, data centers, and large office buildings. By implementing energy monitoring and management strategies, these organizations can significantly reduce energy costs and improve their overall sustainability Energy monitoring involves the use of energy meters and sensors to collect data on energy consumption in real-time. This data is then analyzed using energy management software to identify patterns and trends in energy usage. This information can be used to make informed decisions on how to optimize energy usage and reduce waste.This paper introduces an IoT-based smart energy monitoring and conservation system using Arduino to solve the existing issue. The primary goal of proposed system is to reduce energy consumption and costs, as well as increase the overall efficiency of electrical equipment. By utilizing real-time data collected by sensors, these systems can optimize the performance of electrical equipment based on specific usage patterns and environmental factors.

Index Terms: IOT, Energy Monitoring, Energy conservation, sensors.

I. Introduction

The Internet of Things (IoT) is becoming more popular in recent years. An IoT device is a piece of hardware that enables connections between machines and the cloud. Using the available network, this technique allows for data sharing between linked devices[1]. It is a web-enabled ecosystem made up of gadgets that communicate with one another via CPUs, sensors, and other communication hardware. In addition to the automotive industry, logistics, healthcare, the smart grid, and smart cities, IoT is used in many different fields. Due to a growing population and improved economic conditions, recent significant increases in electric energy consumption have led to a substantial need for a significantly enlarged energy supply in the upcoming decades. In the existing system, electrical meters are read for electricity usage and billing by human workers who travel to homes and other facilities to obtain these readings[2].

The enormous burden of gathering accurate meter readings calls for significant human resources and labor hours in a nation like India, with many densely populated (residential housing and industrial buildings). The operation costs of the energy provider eventually rise, increasing consumers' electricity rates. The paper offers a remedy for the issues that customers and distribution businesses. With the increased availability of inexpensive sensors, research on novel transmission techniques introducing longer ranges, and improved connectivity, the IoT economy is expanding in many sectors[3].

In the existing system, the customer only receives feedback from the current system regarding monthly power consumption as a bill. Consumer has no method to monitor their energy usage more frequently. The number of consumers is increasing exponentially, and the strain on the power-providing sectors is rising quickly[4].

The central controller for the proposed method is an Arduino board to which all the sensors, including PZEM, DHT11, MQ135, and PIR sensors, are connected. PZEM sensors are used to track data on voltage and current. The air quality, including temperature, humidity, and gas concentrations, is monitored using DHT11 and MQ135 sensors. PIR sensors are used to identify human activity or presence. Nodemcu will be used to upload the sensor data to the server.

This system uses internet-connected sensors and gadgets to gather information about equipment use, such as power usage, operation times, and temperature. Following transmission to a central control system, this data is then analyzed by computers to spot chances for energy savings and produce warnings for potential problems.

The control system can then automatically modify the functioning of the apparatus to reduce energy consumption, such as by lowering power consumption during off-peak hours or turning the instrument off when not in use.

This article describes a sophisticated Internet of Things-based system for energy conservation of electrical equipment. The system overloads the platform's remote energy meter for energy analysis.

II. LITERATURE

Automatic meter reading (AMR), advanced metering infrastructure (AMI), or smart energy meters with real-time energy information reports have all been put in place at the household level in several industrialized countries. Customers will therefore be able to view their usage in real-time, eventually motivating them to use less energy to save money. A group of battery-powered sensors connected to a System on Chip interface makes up the sensors that supply ambient data to the unique energy management system[5].

These sensors gather information about the surroundings, including motion, temperature, humidity, luminosity, and air quality. The platform has data visualization templates that produce an overall dashboard and let management find actions that result in savings utilizing a list of pre-defined actions or even a manual mode if they choose[6].

We develop and deploy a low-cost IoT energy monitoring system for various applications, including smart grid energy management, home automation, and electricity billing systems. The concept is based on a low-cost PZEM-004T. It uses non-intrusive CT sensors, an SD3004 electric energy measurement chip, and an ESP8266 WeMo D1 small microcontroller to get data from sensor nodes and communicate data to a server via the internet[7].

The experiment results showed that the system for monitoring energy could accurately record voltage, current, active power, and cumulative power consumption. The system includes power monitoring nodes that employ the Peace fair PZEM-004T. This cheap power meter uses a non-intrusive CT (modern transformer) sensor, the SD3004 power size chip, and a microcontroller to measure voltage, cutting-edge, energetic strength, and cumulative strength intake[8].

An energy audit can convert from a simple survey to a stage that involves several steps. These categories include simple research, followed by energy monitoring consumption in the field services and then analyzing the model of the sector's performance through computer simulation. Remote sensor monitoring in various fields, equipment, energy, or electrical panels are highly sought-after products, and many organizations are working on them[9].

III. HARDWARE

This section describes the model's intended layout and design. The following section provides an in-depth look at the model and its constituent parts.

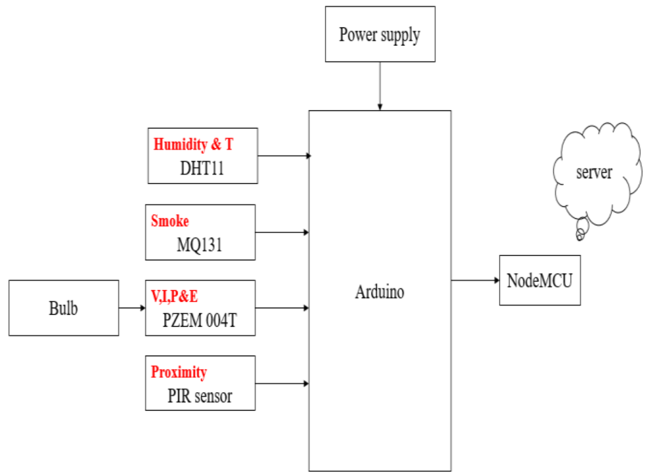

Fig.1. Block Diagram of smart energy monitoring system.

This system uses internet-connected sensors and devices to gather information about equipment utilization, including power consumption, running times, and temperature. The control system can adjust the equipment's operation automatically to save energy, for instance, by cutting back on power during off-peak hours or turning off the device when not in use.

A. Arduino UNO-328

The Arduino firm produced the microcontroller included on the Arduino Uno board. The primary source of inspiration for this free and open-source microcontroller platform for electrical applications was the AVR Atmega328. Six analog input pins and 14 digital I/O ports are included in the Arduino Uno board's most recent iteration, which also has a USB connector.

Connecting the board to various electrical circuits is made possible via these ports. Six of the I/O ports, out of 14, may produce PWM output. This board has every component required to operate the controller, and a USB cable can connect it immediately to a computer.

Also, it possesses every feature necessary for the controller to function effectively. The IDE software, created specifically for use with Arduino, sends code from the computer to the controller. This software was created primarily to allow for Arduino programming.

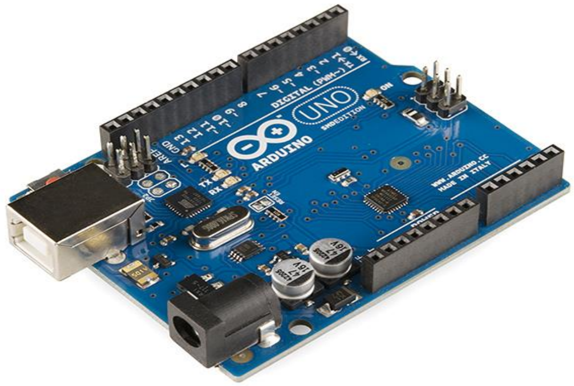

Fig.2. Arduino UNO board.

The code for the IDE is written during the development process using languages like C and C++. The Arduino Uno is the model that is thought viewed as being the most official. It already has a 32KB RAM module and an Atmega328 8-bit AVR Atmel Processor.

B. DHT11

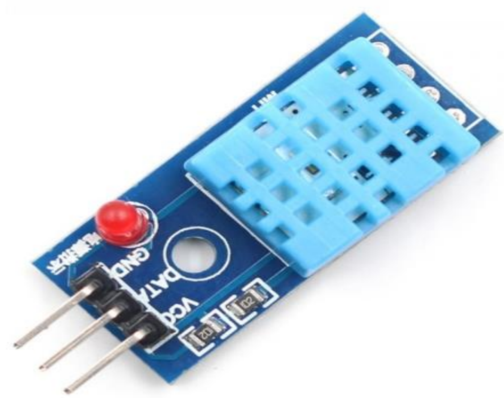

Fig.3. DHT11 Module.

A primary, affordable digital temperature and humidity sensor is the DHT11. It measures the ambient air using a capacitive humidity sensor and a thermistor and outputs a digital signal on the data pin. Although it is pretty simple to use, data collection requires precise timing. The only real downside of this sensor is you can only get new data from it once every 2 seconds.

C. PIR sensor

Fig.4. PIR Sensor

Infrared radiation, or thermal radiation, is emitted by all living things with body temperatures greater than 0 degrees Celsius. To human sight, this radiation is invisible. With a PIR sensor that is intended for this purpose, these impulses can be detected.

D. MQ131 Sensor

Fig.5. MQ131 Sensor.

The MQ131 gas sensor's sensitive component is WO3, which has reduced conductivity in clean air. The sensor's conductivity decreases as the gas concentration increases when ozone gas is detected. Users can transform the conductivity change to a signal corresponding to the gas concentration using a short circuit. The MQ131 ozone gas sensor offers high ozone and strong oxide sensitivity, including cl2, NO2, and others. Organic interference gases react differently.

E. Node MCU

Fig.6. Node MCU

A part of the Node MCU WiFi microcontroller is an embedded WiFi module. The board is built on an Arduino microcontroller with an ESP8266 WiFi Module. A self-contained system-on-a-chip (SoC) called the ESP8266 WiFi Module can connect to your WiFi network and has an inbuilt TCP/IP protocol stack (or as an access point itself). The Uno WiFi board's ability to handle over-the-air (OTA) programming is one of its most crucial features. To transfer WiFi firmware or Arduino sketches, use this method.

F. PZEM 004T

Fig.7. PZEM 004T

Projects that measure electrical usage are very popularly using this peace fair PZEM-004T multi-function AC power monitor. It can measure four interconnected electrical variables: voltage, current, power, and energy. Great for measuring ac (RMS) voltage, present, and power is the small poem-004 t circuit (single-phase).

G. Transformer

Fig.8. Transformer

An electrical device that exchanges control between at least two circuits is known as a transformer. One transformer curl experiences an attractive changing motion due to a fluctuating current, and this causes a second loop that is twisted about the same center to experience a different electromotive force.

H. Arduino software

The Arduino Software (IDE), or the Arduino Integrated Development Environment (IDE), contains a code editor, a message area, a text terminal, a toolbar with simple action buttons, and a menu system. It establishes a connection with the Arduino hardware and downloads programs.

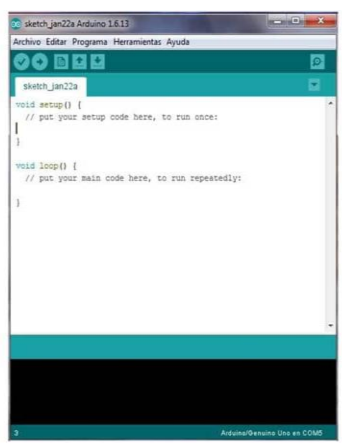

Fig.9. ARDUINO SOFTWARE

I. Think speak

An open-source Internet of things (IoT) application called ThingSpeak (API) allows users to save and receive data from devices that use the Hypertext Transfer Protocol (HTTP) protocol across a local area network or the Internet (LAN). The ability to create sensor logging applications using ThingSpeak, a social network of items with status updates and location monitoring. The ThingSpeak API is utilized in this work to log in the data and graphical representation.

IV. WORKING

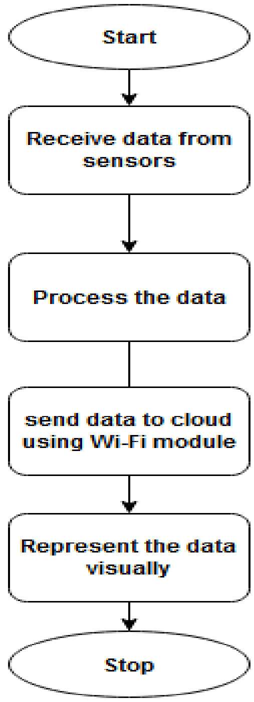

Fig. 10. Figure showing the flow of data.

V. RESULTS

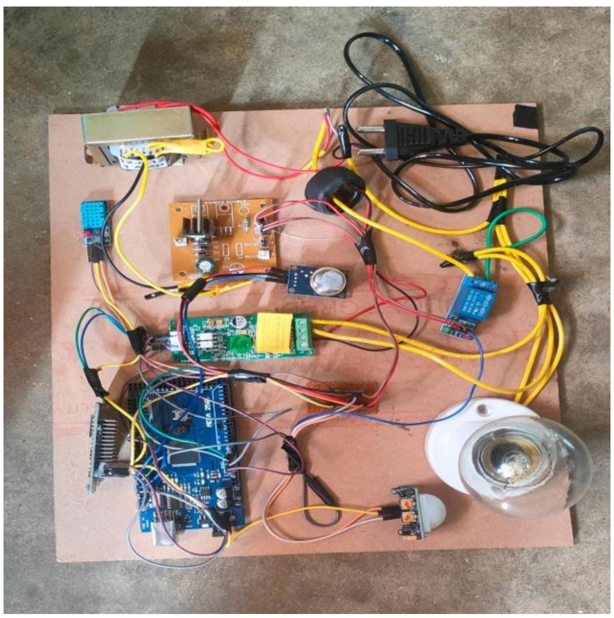

Fig. 11. Figure showing the proposed system.

The proposed IoT-based system for monitoring energy conservation is seen here, and when it is connected to the internet, the IoT cloud app allows users to examine the data remotely. Our project incorporates an Arduino UNO, PIR Sensor module, PZEM 004 module, and Node MCU. First, sensors were connected to the Arduino Uno and Wi-Fi module. The sensors communicated data effectively.IoT-based smart monitoring and energy conservation systems for electrical equipment operate on the guiding idea of optimizing energy use and reducing waste through real-time monitoring and management. This system uses internet-connected sensors and devices to gather information about equipment utilization, including power consumption, running times, and temperature. Following transmission to a central control system, this data is then analyzed by computers to spot chances for energy savings and produce warnings for potential problems. The control system can then automatically modify the functioning of the apparatus to reduce energy consumption, such as by lowering power consumption during off-peak hours or turning the device off when not in use. The system may also deliver detailed data and insights on energy usage patterns to assist facility managers in making wise choices regarding energy management and conservation.

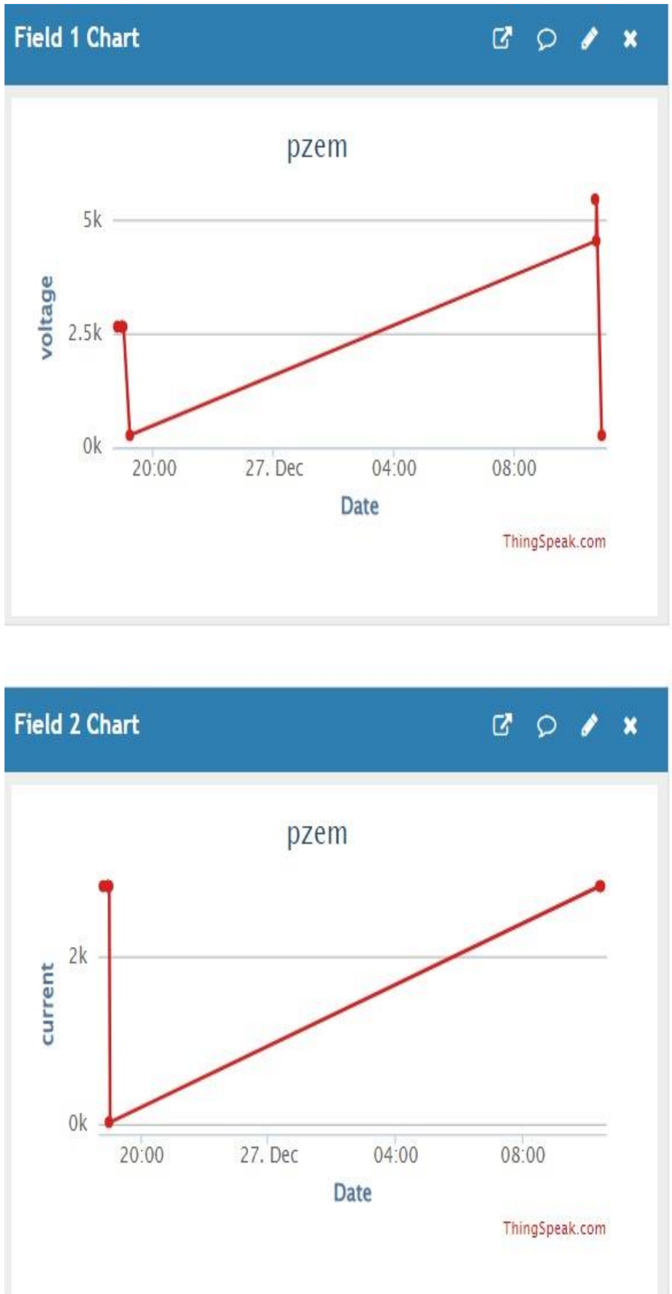

Fig .12.Data Visualization of voltage and current Using ThinkSpeak

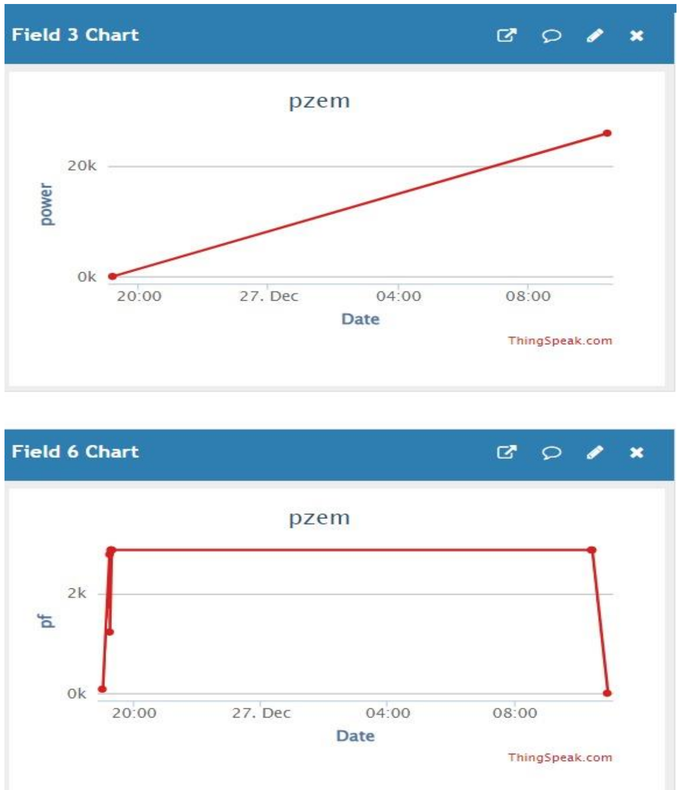

Fig .10.Data Visualization of power Using ThinkSpeak

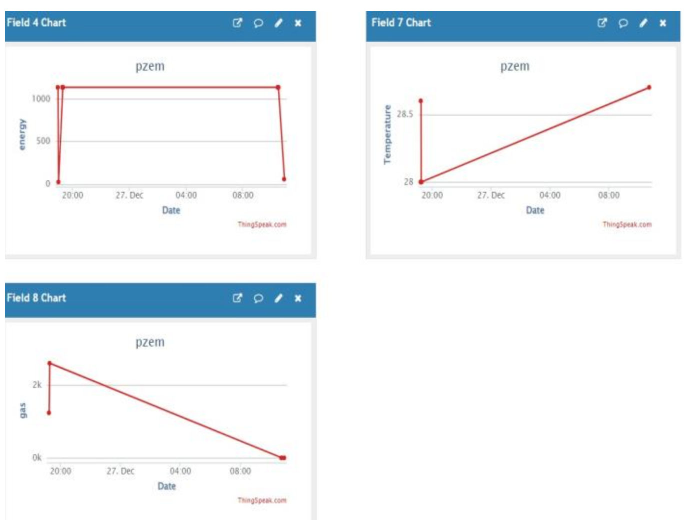

Fig .11.Data Visualization of Temperature,gas and energy Using ThinkSpeak

VI. CONCLUSION

Overall, IoT-based smart monitoring and energy conservation systems offer a range of benefits for businesses and organizations, including cost savings, increased efficiency, and reduced environmental impact. As such, these systems are becoming increasingly popular and are likely to become even more prevalent in the future.The experiment's outcomes: The most up-to-date energy monitoring system can display voltage, current time, energetic strength, and cumulative power use. After presenting a unified framework for IoT in constructing clever novice houses, energy control in creative homes will be used to develop a green and sustainable intelligent village. To achieve our goal, a neural community-based fully Q-studying set of rules is presented to reduce the height load needed of a typical Canadian home while minimizing user inconvenience and improving the device's resilience. A low-cost IoT strength monitoring device design is presented. The proposed device is suitable for programs that measure and monitor physical performance.

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