Managing Energy In Remote Computer Rooms Using IoT

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Abstract - To efficiently save and manage energy in the remote computer rooms, an IOT based strategy is used to maintain the rooms. The fall and rise in the temperature level makes the remote computer rooms to have a proper ventilation system. In order to maintain that proper temperature level, many air conditioners are equipped in the remote computer rooms. The air conditioners which operate all the time to consume more energy. If the temperature and humidity level are not considered properly, then there would be many issues like fire accidents, damage of servers which would result in the loss of data. With minimal investment and power consumption, an IOT based embedded system, sensors, cloud server is established to effectively monitor and maintain the remote computer rooms. To reduce the energy consumption of air conditioners, a fuzzy logic algorithm is used to make decisions and control the load based on the temperature and humidity level. This strategy would definitely help the remote computer rooms to manage energy and protect them.

Keywords—Blink Io Arduino Uno, Remote Computer rooms

I. INTRODUCTION

To manage energy in the remote computer rooms which contains servers for the purpose of storing data. The maintenance of data center is a major issue. The data centers contain lot of servers to process and store large amount of data. The data center maintenance is a critical aspect of ensuring continuous operations and uptime. Many servers are placed and they are kept close with each other. The main reason for the temperature rise in servers is due to the server nodes as they generate more heat. The level of the temperature and humidity are need to be checked frequently to safeguard the data center. The proper maintenance of the data center will surely prevent the remote computer rooms from many problems .IOT can be a powerful tool to aid in data center maintenance. IOT devices can also be used to automate routine maintenance tasks, such as cleaning and visual inspections, freeing up staff time for more complex tasks. Traditional data center monitoring relied on manual checks and reports, which could be infrequent or inaccurate. By using IOT sensors and devices, data center managers can receive alerts and take preventive action before a problem escalates. IOT devices can also detect changes in equipment performance and predict issues before causing failure. With the help of IOT, data centers will be saved from many issues.

II. BASIC CONCEPTS

In this section basic concepts like IOT, remote computer rooms, Energy consumption, characteristics and applications are discussed.

A. INTERNET OF THINGS

The Internet of Things (IOT) refers to the network of physical objects embedded with sensors, software, and technologies that enable data exchange with other devices through the internet. This technology has become increasingly important due to its ability to connect everyday objects and enable seamless communication amongst people, processes, and things .IOT has become increasingly important due to its ability to connect everyday objects and enable seamless communication amongst people, processes, and things. IOT technology is mostly used in smart homes and healthcare systems, but it also has applications in various industries like manufacturing, power grids, logistics, and cities. IOT devices collect, send, and act on data using embedded systems and web-enabled smart devices. Benefits of IOT for businesses include deriving data-driven insights, increasing productivity and efficiency, and creating new revenue streams. The benefits of IOT for businesses are numerous. One of the most significant benefits is the ability to derive data-driven insights from the massive amounts of data generated by IOT devices. This data can be used to improve product design, optimize processes, and create new revenue streams. IOT can also increase productivity and efficiency by automating

routine tasks, reducing errors, and freeing up staff time for more complex tasks. In addition, IOT can help businesses reduce costs by optimizing energy usage, improving supply chain management, and preventing equipment downtime. It is a rapidly growing technology that has the potential to revolutionize the way we live and work .In manufacturing, IOT devices are used to automate processes, monitor equipment health, and optimize production, resulting in increased efficiency and cost savings. IOT devices are becoming increasingly integrated into our daily lives and are being used across a wide range of industries and applications. While IOT offers numerous benefits, such as increased efficiency, productivity, and cost savings .The most important factor for using IOT is energy consumption in easy way. The future potential of IOT is vast, and it is expected to continue to grow and evolve, transforming the way we interact with the world around us.

B. REMOTE COMPUTER ROOMS

Remote computer rooms are data centers that are located off-site, away from an organization's primary location. These data centers are designed to provide businesses with a secure and reliable location to store their IT infrastructure, applications, and data. Remote computer rooms can be a viable option for businesses of all sizes, from small businesses to large corporations.

Figure 1: Remote Computer Rooms

Remote computer rooms also play an important role in disaster recovery and business continuity planning. By backing up critical data and applications in a remote data centre, organizations can ensure that they can recover from disasters such as fires, floods, and cyber-attacks quickly and efficiently. This can help minimize downtime and ensure that business operations can continue even in the face of unexpected events. They generate a lot of heat due to the operation of the computer equipment housed inside. The equipment generates heat as a by-product of the energy it consumes to perform its computing task s .In order to function properly, computer equipment needs to operate within a specific temperature range. If the temperature gets too high, the equipment can become damaged or even fail completely, which can lead to data loss and downtime .To prevent this, remote computer rooms are designed with advanced cooling systems that can maintain a consistent temperature and prevent equipment from overheating. These cooling systems typically use air conditioning, ventilation, or liquid cooling systems to dissipate the heat generated by the equipment.

C. ENERGY CONSUMPTION

IOT technology can significantly impact energy consumption by enabling real-time monitoring and control of energy usage patterns. IOT applications in the energy sector can improve asset and industrial efficiency, enhance revenue generation, and promote effective resource utilization. The use of sensors enables real-time monitoring of room temperatures and remote control over energy consumption patterns, allowing businesses to optimize energy data, make timely decisions, and reduce energy waste. Smart energy solutions using IOT can also help balance energy supply and consumption, reducing energy bills and emissions .By incorporating IOT solutions, the energy industry can improve productivity, reduce waste, and transition towards renewable resources.

III. RELATED WORK

K.C. Chang, K.C. Chu, H.C. Wang, Y.C. Lin, and J.S. Pan [1] developed a model which supports the IOT system of collecting the data. To reduce the energy consumption of network, the base station sleep is analyzed in a dynamic manner in a very short period which accomplish the expected amount of energy saving.

M. I. K. Khalil, I. Ahmad, and A. Almazroi [2] investigated a problem of reducing the overall cost while considering the price of electricity, renewable energy through on-site as well as count of the servers which are active. To rectify this arising issue they have implemented an algorithm called green geographical load balancing for analyzing about workload condition. M. Zhang, B. Li, and S. Yin [3] identified the innovation techniques on saving the energy and focuses on reducing the emission of carbon using several models like linear regression model, mediating effect model and threshold regression mode l .Y. Berezovskaya , C.W. Yang, A. Mosaic, V. Vyatka, and T. B. Mined [4] proposed a toolbox which mode individual elements such like local fans, cooling system, batteries, processors, and servers. The internal parapets of the buildings are properly adjusted. D. Lee and F.P. Tsai [5] the cloud which contains the AI programs can be changed without changing the hardware to get good performance at any time. By increasing the efficiency of the energy the cost of air conditioners are reduced. Y. Zhang, X. Gong, X. Qu, and Y. Tina [6] proposed a model which is a device classifier that depends on the convolution neural network. This is then put into a storage system. F. Xiang, Wang, Wang, and Y. Xu, [7] designed and carried out an intelligent monitoring system for the environment for the purpose of accomplishing the power equipment management automatically. They perform operations such as pre-processing and big data analyzing of real time data obtained from power equipment's like batteries and chillers. C. Yang [8] proposed a system to acquire the utilization of electricity where real time and historical data are examined for giving a precautionary alert and real time alert. The evaluation of carbon reduction and conservation of environment is also carried out in this system. Y. Nakamura, K. Matsuda, and M. Matsuoka [9] proposed a model which estimates the usage of power by using the methodology of machine learning. The estimation helps in determining the operational settings. Y. Ma, S. Asha, W. Miller, and L. Guan [10] investigated the possibility for air conditioning system aided by solar in the medium sized office buildings in the cities of Australian capital. This is done by using the energy plus which is a simulation software for the whole building. D. Marcos-Jorquera, V. Gilart-Iglesias, F. Mora-Gimeno, and J. Gil-Martinez –Abarca [11] proposed a system for data center monitoring which acts as a energy saving systems. Monitoring helps in decision making through the real time information whenever necessary. The system can easily adapt to the dynamic environment. A prototype of the model was implemented in several device and was found that it requires minimum hardware support [14]. H. Shoukourian, T. Wilde, A. Auweter, and A. Bode [12] presented a toolset to estimate the data from HPC data center by all means. The toolset was called Power Data Aggregation Monitor (Power DAM).

IV. MATERIALS AND METHODS

A. PROPOSED METHOD

In a proposed IOT system we use current sensor, temperature sensor, smoke sensor, relay, ESP32 IC, Arduino and solenoid valve. The system mainly designed to manage and monitor the remote computer rooms and data centers. It manages the utilization of energy in air conditioners and monitors the data centers from fire accidents as well as prevent the data centers by opening the fire extinguisher automatically. The DHT11 measure the remote computer room's temperature and humidity. The current sensor measures the amount of current and voltage consumption. The MQ4 gas sensor which detects fire. Then the real information is collected by the hardware. It then delivers the real time data through MQTT protocol to a cloud server. Then the operator can view the real time data by using a cloud server platform called Blink IOT platform. According to the real time data received by Blink IOT platform the data centers are maintained. In case of any variation in temperature and humidity the relay would control the air conditioners accordingly.

B. OBJECTIVE

The system aims at maintain the data center from several issues like server damage, fire accidents and energy wastage. Energy consumption is an important factor for any industry. Data centers utilize large amount of energy in order to protect the servers which in turn results in wastage of energy. But IOT helps in reducing the wastage of energy by real time visualization of data through our mobile phones.

C. BLOCKDIAGRAM

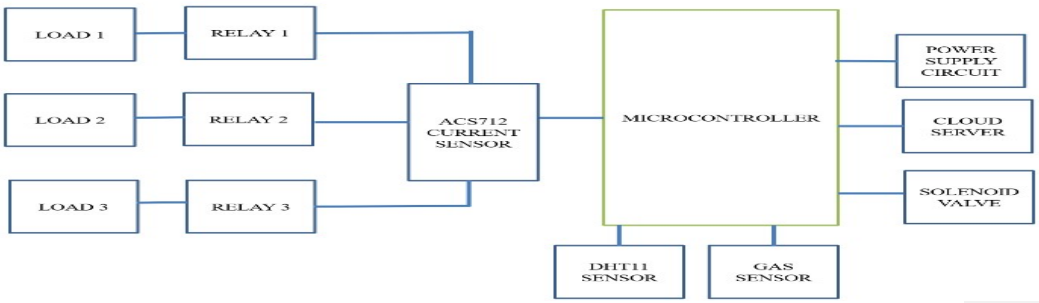

Figure 2: Block diagram

In this block diagram, Microcontroller is used for controlling the air conditioners, IOT module or Node MCU connected to the local internet connectivity by which it can transfer the data to the cloud. The temperature and humidity sensor is used to measure the temperature as well as the humidity level of the data center. The smoke sensor is used to detect in smoke case on any fire accidents. The current sensor will measure the amount of current utilized. The relays will control the air conditioners based on the real time data. In case of any fire accidents, the alarm will give an alert and the solenoid valve is opened automatically. The Blink IOT would show historical data through energy utilization of remote computer rooms can be reduced gradually.

D. ARDUINO UNO

Arduino UNO is conveniently programmable flexible board and an open-source microcontroller. It consists of Atmega328p microcontroller. It contains 14 digital pins, 6 analog I/O pins, USB Port and power jack. It operates at 5V. It is recommended that the input voltage can be between 7V to 12V. The board can be programmed by an IDE called Arduino IDE. The program that is written on the IDE can be exported to the Arduino board through USB cable. The Arduino board contains 3 types of memories inside the ATMEGA328P microcontroller. Static Random Access Memory is of 2KB and stores the data which are temporary. Flash memory of 32KB and stores the program. Electrically Erasable and Programmable Read Only Memory. It is of 1KB and contains the data either the power is on or off.

E. NODE MCU

ESP32 S2 supports WIFI, Bluetooth and Bluetooth Low Energy module. They also contain GPIO, SPI, UART and I2C. A low power coprocessor is also present inside the chip to save the power while doing a task. It operates in the range of 3.0V to 3.6V. It can adopt to different power modes like active mode, modern-sleep mode, light-sleep mode, deep-sleep mode and hibernation mode. It supports a range of peripherals such as UART, SPI, I2C, I2S, PWN, ADC, DAC and more. It has security features such as secure boot and secure storage.

F. ACS712 CURRENT SENSOR

ACS712 IC can identify both the Ac as well as DC current. It senses the current indirectly. The ACS712 Current sensor is a current sensing module that is used to measure the amount of current flow through a conductor. It consists of linear Hall sensor circuit. When the current flows through the hall sensor circuit, with the help of the generation of magnetic field the current is detected. Then the magnetic field produces a voltage proportional to it, which is then used to measure the current. As it is a Hall Effect current sensor designed to measure and monitor AC and DC currents. It is a low-cost and compact alternative to traditional current sensing solutions. It has a linear output that is proportional to the current being measured, and it can be used to measure both AC and DC currents up to 5A. It is suitable for use in a wide range of applications such as motor control, power supplies, and inverters.

G. MQ2 GAS SENSOR

MQ2 gas sensor is used to detect the smoke and gas concentration such as propane, methane, hydrogen, LPG, alcohol, smoke and carbon monoxide. In case of any firing or burning happens in the data center, it would detect the smoke. It provides a binary indication of the presence of combustible gases and an analog representation of their concentration in air. The sensing element has six leads attached to it. The two leads heat the sensing element and the remaining four leads are output signals. The concentration of gas is determined by the voltage values. The operating voltage of this sensor is 5v DC voltage. When the concentration of gas range is between 200 to 10000ppm, the sensor detects the presence of gas.When the gas concentration exceeds a certain threshold, the sensor sends a signal to the Arduino, which alerts the buzzer.

H. DHT11 SENSOR

DHT11 sensor is used to measure the temperature as well as humidity. It measures the humidity using the capacitive humidity sensing element and measure the temperature using the thermistor. The sensor can provide new data once every 2 seconds and comes with a 4.7K or 10K resistor as a pull-up from the data pin to VCC. The sensor can be used to learn about basic temperature and humidity sensors, humidity and temperature logging, making a Wi-Fi-connected weather station, and monitoring temperature and humidity on an LCD display. It can be easily interfaced with any microcontroller like Arduino. It is very accurate and reliable and integrated into variety of applications. The applications of DHT11 sensor include measuring temperature and humidity, local weather station, automatic climate control, and environment monitoring.

I. BLYNK IOT

Blink IOT platform is used in IOS and android smart phones. Through the internet it controls various devices like Arduino, Raspberry Pi and Node MCU. It uses a client-server architecture, where the client is the mobile application and the server is the Blink cloud platform. The Blink cloud platform provides a secure connection between the mobile application and the hardware device, allowing the mobile application to send commands to the hardware device and receive data back from the device. By using this platform, we can view the sensor data and cloud data. The platform which has dashboard that shows the temperature and humidity of the remote computer rooms so that we can control the air conditioners. It also allows users to connect their hardware devices to the cloud and build their own mobile applications for remote control and monitoring. It provides users with an easy-to-use mobile app builder to design their own mobile applications for controlling their hardware devices. We can create our graphical interface by dragging and dropping widgets. The Blink server acts a cloud service that stores and processes the data from the connected devices. It offers a secure, reliable and scalable backend for the IOT application. We can control our device from anywhere in the world and program the hardware with help of the Blink application.

The blink library is designed to use along with blink IOT platform. It provides an easy-to-use API to connect their hardware to the blink cloud. The library provides a set of functions that the developer can use to connect the device to the Blink cloud platform. Once the device is connected to Blink, the developer can use the Blink mobile application to create a custom user interface for controlling the device. The mobile application provides a wide range of widgets, such as buttons, sliders, and graphs that can be used to create a custom user interface. In addition to providing a mobile application for building custom user interfaces, Blink also provides a set of APIs that developers can use to build custom applications that interact with the Blink cloud platform. The APIs allow developers to send commands to their devices, receive data from their devices, and monitor the status of their devices. One of the key features of Blink is its support for a wide range of hardware devices. Blink supports popular hardware platforms such as Arduino, Raspberry Pi, ESP8266, and ESP32, as well as a wide range of sensors and actuators. Another key feature of Blink is its support for a wide range of communication protocols. Blink supports protocols such as Bluetooth, WI-Fi, Ethernet, and GSM, allowing developers to easily connect their devices to the Blink cloud platform using their preferred communication protocol. Blink is also designed to be highly scalable. The Blink cloud platform can handle thousands of simultaneous connections, making it suitable for both small-scale and large-scale IOT projects. In terms of security, Blink uses a number of measures to ensure that data is transmitted securely between the mobile application and the hardware device. Blink uses SSL/TLS encryption to secure data in transit, and devices are authenticated using a secure token-based system.

J. PROGRAMMING

Arduino UNO, supports a language that we call as Arduino Programming Language, or Arduino Language. He Arduino IDE (Integrated Development Environment) is a software application that helps in writing code for the Arduino Uno microcontroller board. It provides an easy-to-use interface for writing, compiling, and uploading code to the board. The Arduino IDE provides an intuitive and user-friendly interface for writing code. It features a code editor with syntax highlighting, auto-completion, and error highlighting to help you write clean and error-free code. The code editor also includes features such as code folding, brace matching, and indentation to help you organize your code. The compiler checks the code for syntax errors and other issues and generates an error message if any errors are found. It includes a serial monitor that allows you to communicate with the Arduino board over a serial connection. This is useful for debugging and testing your code as it allows you to send and receive data to and from the board in real-time. It also comes with a library manager that allows you to easily add and manage third-party libraries. These libraries contain pre-written code that can be used to add functionality to your Arduino projects. The library manager makes it easy to search for and install libraries, and also keeps track

of any dependencies that the libraries may have. The Arduino IDE supports version control systems such as Get and SVN, allowing you to manage your code in a collaborative environment.

The Arduino programming language is a simplified version of C++ programming language. It is designed to make it easier for beginners to get started with programming and electronics. The language is based on a set of libraries that provide high-level functions for interacting with the hardware on the Arduino board. Like C++, the Arduino programming language allows you to declare and use functions and variables. You can define your own functions and variables, or use the built-in functions and variables provided by the Arduino libraries. It includes two special functions called setup () and loop (). The setup () function is called once when the program starts and is used to initialize the hardware and variables. The loop () function is called repeatedly as long as the program is running and is used to execute the main program logic. It provides functions for interacting with the digital pins on the board. The pin Mode () function is used to set the mode of a pin (input or output), and the digital Write () function is used to set the state of a digital output pin (HIGH or LOW). It includes a set of libraries that provide high-level functions for interacting with various hardware components such as sensors, motors, displays, and communication modules. These libraries simplify the programming process and make it easier for beginners to get started with Arduino programming. It provides a function called analog Read () for reading analog values from the analog input pins on the board. The function returns a value between 0 and 1023, representing the voltage level on the pin. It contains functions for serial communication, allowing you to send and receive data between the Arduino board and a computer or other device. The Serial. Begin () function is used to initialize the serial communication, and the Serial. Print () and Serial. Read () functions are used to send and receive data. An Arduino sketch is a program written in the Arduino IDE using a simplified version of the C++ programming language. It is the code that runs on an Arduino board and controls its behavior. This sketch blinks the built-in LED on an Arduino board on and off every second. The setup () function is called once when the board is powered on or reset and is used to initialize any necessary pins or settings. The loop ( ) function is called repeatedly as long as the board is powered on and is used to execute the main program logic.

Comment [s1]:

V. RESULTS

As a result, the energy is managed in the remote computer rooms using this system. The energy consumed by the air conditioners is managed through real time visualization of data. The tremendous energy that is wasted is now saved through this strategy and also the room is monitored.

A. SIMULATION RESULT

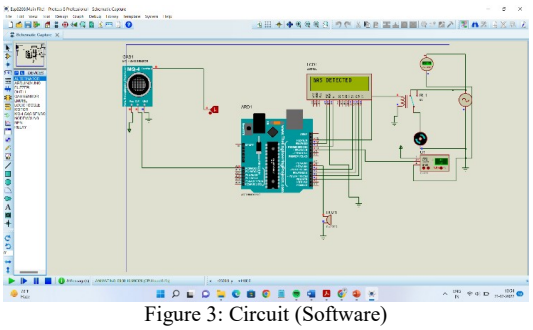

Figure 3: Circuit (Software)

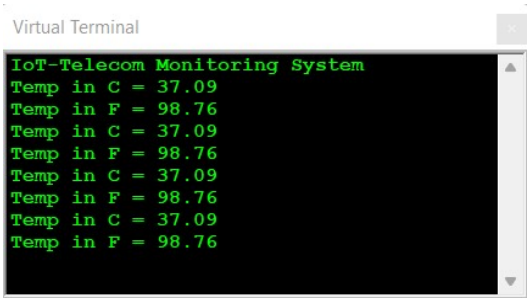

Figure 4: Virtual Terminal (Software)

B. BLYNK IOT

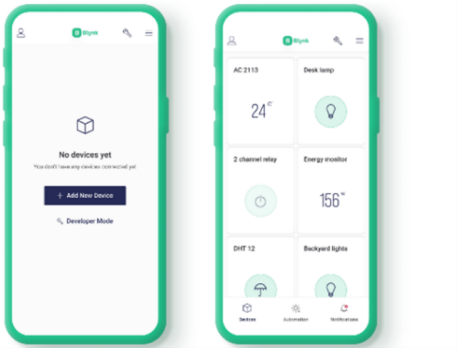

Figure 6: Blink IOT UI and Dashboard

VI. CONCLUSION

This work proposes an IOT based system to prevent, manage and save the energy in remote computer rooms. Temperature sensor (DHT11), Current sensor (ACS712) and relay acts as hardware platform, while BLYNK IOT platform is software platform. Then we use an effective algorithm called fuzzy algorithm. Fuzzy algorithm is used to manipulate the working time and switching frequency of air conditioners, that helps in increasing the efficiency of energy. It proposes an energy saving mechanism in the entire data center rooms and also prevents the room from any type of fire accidents. The proposed system monitors by real time visualization of data and manages the energy by controlling the air conditioners.

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