Substation Monitoring and Controlling Using GSM

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Keywords: PZEM-004T, Arduino Mega 2560, GSM Modem, NodeMCU, Power Supply.

Abstract: The "Substation Monitoring and Controlling utilizing GSM" project aims to coordinate the use of sensors as well as Arduino technology for tracking and regulating critical electrical characteristics in substations, including current, voltage, as well as temperature. Dallas temperature sensors (DS18B20), together with voltage and current sensors, allow the system to keep tabs on information in real time. There are also 100W and 200W lights that show when anything is wrong, which is an excess or underload, plus a buzzer that goes out when something very serious is going on. Also, in the event of unusual readings, the GSM chip notifies the appropriate people via instant messaging, and data goes over to the cloud platform Thing Speak enabling remote analysis as well as monitoring. The system's capacity to identify problems early and provide remote control over the mobile phone network known as improves substation safety and efficiency.

1 INTRODUCTION

When it comes to contemporary power networks, substations are vital for controlling the flow of energy and making sure that distribution is stable and efficient. In order to keep the power supply reliable and avoid breakdowns that might cause power outages or equipment damage, it is vital to monitor such substations. Conventional methods of inspection and control have depended on human intervention, which is labor-intensive and error-prone. There is an increasing demand for computers which can monitor voltage, current, and temperature, as well as react quickly to unexpected situations, considering the complexity and need for real-time data.

By incorporating smart technology into substations, real-time monitoring, remote control, and information management are all made possible. Substation management becomes more alert as a result, enabling early identification of problems like overloads, underloads, or temperature anomalies. Improving the power network's efficiency and security by allowing for remote alerting or system control further lessens the likelihood of catastrophic outages. These solutions provide a smarter and more dependable method of power infrastructure maintenance via cloud-based analysis and continuous data recording.

2 LITERATURE SURVEY

1 Title: RFID-Based Automatic Fare Collection for Public Transport
Authors: John Smith, Jane Doe
Abstract: This study delves at the idea of replacing traditional ticketing with an RFID-based fare collecting device for public transit. The technology automates the collecting of fares by use of a central server which keeps track of each journey and makes use of radio frequency identification cards for recognizing passengers. There has been less fare evasion and faster, more accurate transactions, according to the authors. They do, however, talk about possible privacy issues with passenger monitoring, as well as scalability & installation costs. Public transit systems may benefit greatly from RFID technology, according to the research, although the technology has to be fine-tuned before it can be widely used.
2 Title: Design and Implementation of a Smart Card Ticketing System for Urban Buses
Authors: Michael Turner, Emma Collins
Abstract: In this article, we lay out the blueprints for an improved urban transit ticketing system that uses smart cards. A more convenient and secure alternative to paper tickets, this system uses rechargeable smart cards to collect fares. Integrating with additional urban transit systems, remote charging capabilities, plus real-time balance updates

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are key aspects. The authors show that operational expenses and passenger boarding times decrease substantially when comparing the smart card system to conventional cash-based fee mechanisms. In order to promote broad adoption, the research highlights the need of reliable systems and user-friendly interfaces.

3 Title: Automated Fare Collection Using Smart Cards and GSM for Bus Transit

Authors: Sarah Johnson, David Miller

Abstract: To enhance operational efficiency & customer comfort, the authors of this paper suggest a smart card fare collecting system for public buses which is based upon GSM technology. The technology keeps tabs on how many stops a passenger takes, and then automatically deducts the correct price from the card's stored amount. Operators may get comprehensive information on passenger movement and income thanks to this system's integration of GSM technology, which transmits data in real-time through a central server. Concerns about data security & network dependability are among the issues highlighted through the paper's description of the system architecture. Public transportation fare collection may be modernized within a scalable way by integrating smart card as well as GSM technology, according to the authors.

3 EXISTING METHOD

Operators used to come to the location on a regular basis to check the equipment, measure voltage, monitor temperature, and spot abnormalities by visual inspections and manual meter readings preceding the implementation of manual inspection & control. When problems arose, like voltage fluctuations or heating up, the equipment was either adjusted by hand or cooled down manually. Lacking real-time warnings or remote monitoring, the procedure was labor-intensive, time-consuming, and susceptible to human mistake. Routine checks or reports have been utilized to identify defects, particularly ground faults. Delays in responding to problems or dangerous situations were possible outcomes of that less efficient approach.

4 PROPOSED METHOD

In order to improve both safety and effectiveness, the suggested "Substation Control and Monitoring System Utilizing GSM" uses cutting-edge communication and sensor technologies to provide a real-time, automated solution overall substation management. The device utilizes an Arduino Mega 2560 microcontroller to include a number of sensors, such as a voltage sensor, a temperature sensor for detecting instances of overheating, the a PZEM-004T to track energy, current, and power factor. When the system detects that the temperature has risen too high, a relay is used to start an exhaust fan immediately. To avoid harm, loads are deactivated when voltage fluctuations occur; a buzzer notifies operators, as well as a GSM module notifies users in real-time. Efficient problem detection is made possible by push-button switches. The appliance transmits all operational information to Thing Speak via NodeMCU, allowing the continuous remote oversight and analysis. This allows enabling proactive management with prompt reaction to any potential concerns. Figure 1 shows IoT-Based Smart Energy Monitoring and Control System using Arduino Mega.

5 BLOCK DIAGRAM

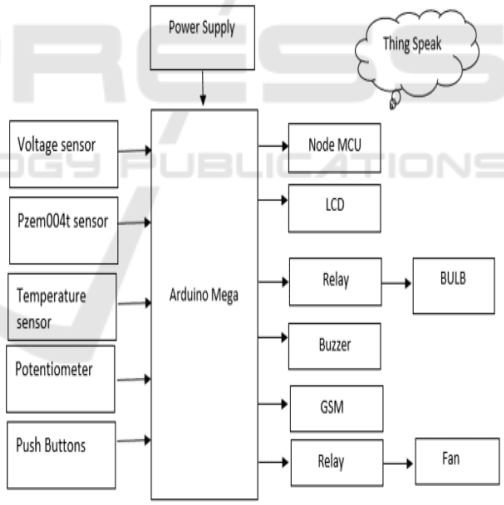

Figure 1: IoT-Based Smart Energy Monitoring and Control System Using Arduino Mega.

6 HARDWARE REQUIREMENTS

6.1 Arduino

After the hardware requirements have been evaluated, the next step was to deal with the program prerequisites. You can code, compile, and debug

using a variety of software alternatives available for different microcontrollers. Therefore, critical to follow the specifications while developing the source code that the proposed system, and then use the selected software to compile and debug the source code. After the needs for hardware as well as software have been met, the system cannot run without integrating the two. This entails connecting every one of the inputs and output modules according to the system's requirements and transferring the source code into the microcontroller. Equipped to include a USB interface, 14 digital I/O pins, 6 analog pins, including an Atmega328 microcontroller, The Arduino Uno proved that it is an invaluable tool in electronics. It has Tx and Rx pins that allow for serial connection. There are a number of other Arduino boards available, including the Due, Leonardo, and Mega, but the Uno and Mega continue to be the most popular. Among the many affordable, user-friendly, and highly successful options for digital electronics, embedded systems, robotics, and Internet of Things (IoT) applications, Arduino Uno commands special attention.

6.2 Voltage Sensor

The supply of voltage may be measured, computed, and identified with the help of this sensor. You can find out the voltage level for either AC or DC using this sensor. The voltage may serve as an input for this sensor, and the switches, analog voltage signal, current signal, audio signal, etc. While some sensors just produce sine waves or pulse waves, others can produce outputs such as AM, PWM, or FM modulation. A voltage divider may be required for these sensors' measurements. Figure 2 shows Voltage Sensor Module.

Figure 2: Voltage Sensor Module.

The sensor has two inputs and two outputs. Positive and negative pins make up the majority of the input side. You may hook up the device's two pins onto the sensor's positive and negative terminals. You may link the device's positive and negative pins with the sensors positive and negative pins. This sensor primarily produces voltage (Vcc), ground (GND), and analog o/p data as its output.

6.3 Temperature Sensor

A digital temperature sensor, including the DS18B20, can detect temperatures within a +-5% accuracy range ranging from -67oF to +257oF (or -55oC to +125oC), and it uses a single wire protocol. Information received across a single wire may have a bit range ranging from 9 to 12 bits. This sensor is capable of being controlled by using one pin with a microcontroller, since it uses the single wire protocol. A 64-bit serial code may be provided for each sensor under this high-level protocol, allowing for the operation of several sensors from a single microcontroller pin. An introduction to the DS18B20 sense of temperature will be given in figure 3.

Figure 3: DS18b20 Temperature Sensor.

6.4 GSM

The abbreviation "GSM" refers to a series of mobile communication modems. The concept of GSM originated in 1970 at Bell Laboratories. All throughout the globe, people are using this mobile communication method. Mobile voice and data services run across 850MHz, 900MHz, 1800MHz, and 1900MHz band frequencies using GSM, a free fully digital cellular technology.

To facilitate digital communication, the GSM system was established utilizing the time division multiple access (TDMA) method. A GSM processes the data by digitizing and compressing it before sending it down a channel alongside two other streams of client data, each operating in an individually specific time slot. The digital technology may support data speeds ranging from 64 kbps to 120 Mbps.

Macroscopic, microscopic, pico, and umbrella cells were all part of a GSM system. The way something works determines the variation of each cell. Within a GSM network, you may find macro, micro, pico, and umbrella cells, among five distinct sizes. determined by the implementation environment, the coverage region covered by each cell differs.

6.5 Relay

To regulate several circuits with a single signal or change one circuit either on or off with a low power signal, a magnetic switch called a relay may be used. Relays are essential to the efficient operation of most high-end industrial application equipment. Resistors are basic switches that may be turned on and off physically or electrically. An electromagnet and several contacts make up a relay. A magnetic field facilitates the switching process. Its operation is also guided by other concepts. Their uses, however, make them distinct. The majority of these gadgets rely on relays. Figure 4 shows 5V Single-Channel Relay Module.

Figure 4: 5V Single-Channel Relay Module.

6.6 Pin Diagram

The figure 5 shows SPDT Relay Pinout Diagram.

Figure 5: SPDT Relay Pinout Diagram.

6.7 LCD

Scratch pad displays and other smaller personal computers use LCD technology. Similar to gas-plasma, as well as light-producing diode (LED) technologies, liquid crystal display (LCD) technology allows displays to be far thinner than cathode beam tube (CRT) technology. LCD use less electricity than gas and LED displays because they function by reflecting light instead of emitting it.

An involved lattice and a showcase network, which allows for dynamic framework display, are the two main components of an LCD. The active Matrix LCD is also known as a thin film transistor (TFT) display. At each pixel crossing within the associated LCD lattice, there is a matrix containing conductors. To adjust the brightness of each individual pixel, a current is sent via two lattice conductors. To reduce the amount of current needed to adjust the brightness within a pixel, a functional framework places a transistor at each pixel crossing point.

While the initial invention only used a single sweep through the matrix, some distant network LCDs utilize double filtering, indicating that they inspect the matrix twice using current simultaneously. However, dynamic lattice continues to be a superior invention.

6.8 Buzzer

Mechanical, electromechanical, or piezoelectric variants of the buzzer or beeper are all used as auditory signaling devices. Buzzer is primarily a beeper, it is often used in alarm systems, timers, and to provide feedback to users when they do things like click the mouse or press the key. Computers, printers, copiers, alarms, electronic toys, automobile electronics, telephones, timers, as well as a host of other gadgets that need audio signaling capabilities

often make use of buzzers, which are integrated structures consisting of electronic transducers as well as a DC power source. Connecting directly with the active buzzer which has a 5V rating will result in an ongoing audible output. The Figure 6 shows DC Piezoelectric Buzzer Module. This part allows for an easy circuit design, encouraging "plug and play" capabilities when paired with a specialized sensor expansion module along with the matching board.

Figure 6: DC Piezoelectric Buzzer Module.

6.9 Push Button Switch

- A push-button switch was a kind of switch that uses compressed air switch or basic electric mechanism for turning on or off an electrical device.
- Their operational modes could be momentary or latching, according to the type.
- The material used to make the button, which is either metal or plastic, is often sturdy and long-lasting. You may get push button switches with many different sizes and styles. Today at Herga, we offer a variety of push button switches.
- Recognizable in ordinary life as well as in medical and industrial settings, push-button switches were ubiquitous.

6.10 Introduction to NodeMCU

To build your own Internet of Things (IoT) device with only a few lines of Lua script, you'll need NodeMCU, an open-source firmware as well as growth kit.

You may connect the circuit board to external peripherals via its several general-purpose input/output (GPIO) pins, which can provide PWM, I2C, SPI, and UART serial communications.

The firmware, or software, runs upon the ESP8266 Wi-Fi system on a chip, and the actual hardware depends on this ESP-12 module; these two components make up the module's interface.

Based on the widely popular scripting language Lua, which is easy to pick up and use, the firmware provides a straightforward environment for programming while also linking yourself to a large and active community of developers.

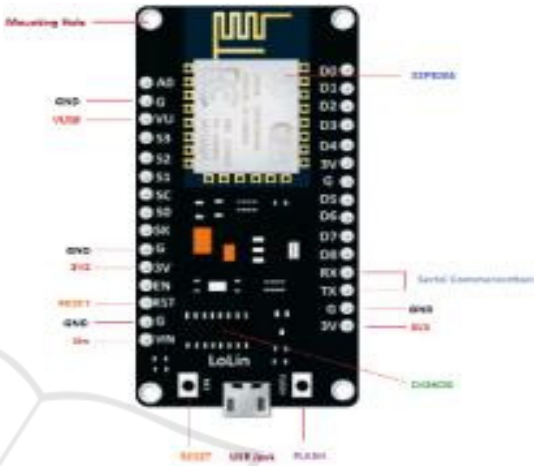

Figure 7: NodeMCU ESP8266 Pinout Diagram.

Additionally, with open-source firmware, you're given the freedom to alter, tweak, and reassemble the current module while continuously customizing the whole user interface to meet your specific needs. Figure 7 shows NodeMCU ESP8266 Pinout Diagram (LoLin V3).

7 RESULT

The connections are given as per the circuit diagram. diagram. power supply is given to the circuit by Ac supply. The power supply beard contains rectifier, capacitor and voltage regulator. rectifier converts AC Supply to the DC supply. capacitor serves as a Temporary Battery for storing purpose. From the power supply board. Every component receives the power supply to the work. Every Component in the project connected to the Arduino as per the code wrote in Arduino Software Platform (Arduino IDE). GSM, Temperature sensor, PZEM sensor, potentiometer, voltage sensor, buzzer is supplied by the AC Supply with the help of Power Supply Board.

The following figure 8 shows the prototype of the Equipment.

Figure 8: IoT-Based Smart Energy Monitoring and Control Prototype.

The following figure 9 shows the digital output of fault (or) Abnormal condition in the LCD display.

Figure 9: LCD Display Showing High Voltage Alert in IoT Monitoring System.

The Figure 10 shows the Alert message received by the receiver with help of Global system for mobile communication (GSM).
The figure 11 shows the graphical representation of the Voltage, Current and the temperature along with the time and date. All the data can be uploaded to the think Speak with help of NodeMCU. This Page accessed by any person who has username and password of the account.

Figure 10: Global System for Mobile Communication (GSM).

Figure 11: Thingspeak Dashboard for Substation Monitoring.

8 CONCLUSIONS

Finally, the substation management and monitoring system improves the reliability and security of electrical substations through providing information on critical parameters like temperature, voltage, as well as current within real-time. Timely action is guaranteed by the system's capacity to identify abnormal circumstances and transmit alarms, lowering the chance of damage or failures. More operational supervision is provided by the system's integration with cloud-based remote monitoring and

control, which makes it a dependable option for contemporary substation management and helps to avoid power distribution problems.

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