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IoT based Smart Hospital Electrical Hazardous Free System

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***Abstract*—The Internet of Things' (IoT) rapid advancement has opened up new avenues for creative solutions in a variety of industries, with the healthcare industry being one of those that has benefited most. Within this framework, the implementation of a state-of-the-art Smart Hospital Electricity Energy Meter that makes use of the ESP32 microcontroller and makes use of Blynk 2.0's capabilities stands out as a revolutionary step. The goal of this project is to improve energy management procedures in hospital settings by promoting economy, sustainability, and efficiency. The selected system utilizes the capabilities of the ESP32 microcontroller, which is widely recognized for its exceptional low-power consumption and smooth Wi-Fi connectivity, making it an ideal option for complex Internet of Things applications. Acting as a versatile interface, Blynk 2.0 plays a pivotal role in the monitoring and regulation of energy consumption across various devices within the expansive confines of a hospital. The harmonious integration of these technological components not only facilitates real-time data acquisition but also empowers the realization of remote monitoring capabilities, thereby fostering a paradigm of efficient energy utilization within the smart hospital environment.**

I. INTRODUCTION

We will develop an Internet of Things (IoT)-based smart hospital electrical hazardous free system as well as the recently updated Blynk 2.0 software in this project. We had previously used the outdated Blynk application to build an IoT-based smart hospital electrical hazardous free system, an IoT-based AC energy meter, and a GSM prepaid energy meter. However, with the latest Blynk platform change, it was also required to modify our Energy Meter project. Our goal is to streamline the monitoring of power use by automating the process.
Manual meter readings are the traditional method of keeping an eye on power use, but they may be tedious and cumbersome. Time and money may be saved by automating remote data collecting, which is made possible by the Internet of Things. Since the idea of a smart energy meter has been increasingly popular around the globe in recent years, this is a great chance for us to develop our own Internet of Things-based electrical energy meter.
We will use the latest Blynk 2.0 program and an ESP32 to develop an Internet of Things (IoT) Smart Electricity Energy Meter. The voltage, current, power, and total energy spent in kWh may all be measured with the best current sensor (SCT-013) and voltage sensor (ZMPT101B). The measurements will be transmitted to the Blynk 2.0 software and shown on a dashboard that can be accessed from any place. The ESP32's EEPROM will store the energy meter data in the event of a power failure, guaranteeing ongoing readings. Let's get started on the

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automated monitoring of power use project.

The hospitals' electrical safety checklist is a set of standard operating procedures designed to protect hospital patients and healthcare staff. One of the most crucial concerns in hospitals is electrical safety. since the majority of equipment and other appliances used in hospitals run on electricity. Furthermore, a minor problem or neglect of care can turn into a major concern for patients and medical staff alike. Hospital electrical safety is ensured by many international standards because of its paramount relevance.

Electrical safety at hospitals is challenging because in addition to a wide variety of staff members, nurses, physicians, cleaners, and other service workers, hospitals also receive a large number of visitors and patients. Hospitals also hire outside laborers to maintain a variety of equipment and systems, including air conditioning, heating, oxygen, and water supplies. since of all of this, it becomes challenging to maintain electrical safety since we are unable to hire and teach everyone. While they are within the facility, we won't be able to confirm that they follow electrical safety regulations.. Furthermore, since practically every equipment in hospitals runs on electricity, there is a risk of power leakage in virtually every part of the facilities. Electrical safety in hospitals is difficult yet necessary due to the crucial nature of the facility and its security.

II. Electrical Hazardous in Hospital

Electrical energy risks are present practically everywhere! this is due to the fact that electricity plays a major role in the operation of equipment and gadgets. Naturally, medical equipment need electricity to function. Compared to residences and construction sites, hospitals are not as dangerous when it comes to electrical hazards. Yes, it has typical components.Let’s see what is an electrical hazard in hospitals:

- Insulation damage. Cable insulation and cords should always be in good condition. Electrical shock or even a short circuit might result from any damaged or fractured insulating components.
- A power failure. In hospitals, this is one of the biggest concerns for electrical hazards. Hospitals are not allowed to have power outages. Having a backup power supply that is not connected to the national grid is crucial.
- A spike in electrical power. Due to their sensitivity to electricity, medical instruments might be harmed by surges. A strong protection program can greatly aid in the avoidance of this risk.
- Dim illumination resulting in low visibility. Strong illumination is essential for healthcare personnel. Good illumination makes their work easier and more accurate.
- Electrical panels with rust. The entering panels are the source of electrical risk. If rust creates a contact between phase and neutral, it can result in poor openings and possibly a short circuit..
- Insufficient anchoring. Every metallic component near an electrical source has to be grounded.
- A subpar program for electrical device maintenance. Inadequate upkeep may result in electrical malfunctions that halt the device or provide inaccurate patient status measures. Remember that many medical equipment need to be calibrated on a regular basis.
- Lack of an emergency protocol for any associated electrical crisis. Effective disaster preparedness can save lives. Everyone ought to be aware of exactly what they should be doing and practice it frequently.
- Electrical fires caused by overloaded outlets can occur as temperatures rise. Circuits that are overloaded produce heat.

A. Hospital Electrical Safety Organization Standards

IEEE **-** Electric systems in healthcare facilities, IEC 60601 AAMI / NFPA99, and many more are examples of common worldwide standards. National standards are subject to the International Electro-technical Commission (IEC) and the International Organization for Standardization (ISO). Electrical safety is crucial. Let's talk about a comprehensive hospital electrical safety checklist now.

B. Hospital Electrical Safety Checklist

Wearing the appropriate PPE for your health is the first thing you should do. Make sure the hospital administration is informed about the area that will be inspected by getting in touch with them.

- Examine the backup power supply. Verify that it is prepared for an automated start. After testing it, note how quickly it responds.
- Make that preventative maintenance is performed on the hospital's emergency electrical generator in accordance with manufacturer guidelines.
- Vital equipment that needs constant power should be equipped with a UPS that can power them during a blackout until an alternate power source is available.

- Verify that every metallic and electrical component is properly grounded. Examine the most recent ground resistance measurement records.
- Examine the state of the grounding conductor. Verify that the copper is insulated.
- Ascertain that every patient bed has two independent power sources. One originates from a regular source, whereas the other does so from an emergency source..
- Verify that there are adequate containers next to each patient bed for electrical medical equipment.
- At least one or more containers from the emergency source should be present in every critical care area next to the patient's bed.
- Verify that ground fault circuit interrupters (GFCIs) are used in damp areas..
- Power outlets for charging any charged gadgets in the ambulance should be available in the ambulance parking area.
- Verify that there is adequate illumination distributed throughout.
- Verify that every lighting fixture is operational and has a routine maintenance schedule.
- Verify that loads do not exceed the electrical system's design.
- There should be a good distribution of emergency lights fixtures in the area. Give these lighting fixtures a test.

C. Hospital Electrical Equipment

In hospitals, several kinds of equipment are used on a regular basis. And many individuals go about their business. The majority of them are ignorant of the associated risks. A list of hospital electrical devices and safe usage procedures is required for safety reasons. Let's use an illustration. Generators are crucial equipment for providing backup power in the event of a blackout. It is necessary to run the generator outside. However, using it in close quarters would cause carbon monoxide to build up, which will have a negative impact on human health. In addition, during refilling and handling, great caution and appropriate ventilation are required.

D. Hospital Electrical Installations Putting Patients at Risk of Fire

We discussed the many sorts of workplaces' fire threats in the last post. But the risks of a hospital fire are higher. Workers have enough PPE, training, and other strategies to cope with fire incidents, much like in the workplace. But hospital patients cannot defend themselves in the event of a fire; they require assistance to perform their everyday chores.

- It's critical to totally remove and minimize electrical risks that might start a fire.
- Avoid using electrical wires or extensions for extended periods of time or heavy machinery.
- Verify the functionality of safety equipment such as fuses and breakers.
- Correctly install heat sensors, smoke detectors, and fire alarms.
- Hospital electrical safety checklists consider protective equipment like circuit breakers and fuses to be essential.

III. EXISTING METHODOLOGY

Clearly state the objectives of putting the Smart Hospital Electricity Energy Meter into practice, including cost savings, increased sustainability, and improved energy efficiency. Determine the important parties: Ascertain which departments or individuals are engaged, such as IT personnel, hospital administrators, and energy management teams.

Hardware Setup: Get hold of ESP32 microcontrollers: Get the ESP32 development boards you'll need dependent on how many devices you plan to watch. Determine the sensors used for energy monitoring: For precise measurements of energy usage, choose sensors that are compatible with the ESP32, such as voltage and current sensors. Attach sensors to the ESP32: Create a circuit that link sensors to the ESP32 microcontrollers so that precise data collection is possible. Software Engineering: Install the Arduino IDE: To build ESP32s, install and set up the Arduino Integrated Development Environment (IDE).Develop firmware: To allow the ESP32 to read data from energy sensors and send it to the Blynk 2.0 platform, write the firmware code. Link the Blynk library in: To link the ESP32 to the Blynk 2.0 platform, incorporate the Blynk library into the firmware. Configuration of Blynk 2.0: Make an account on Blynk: Create a new project for the Smart Hospital Electricity Energy Meter after creating an account on Blynk. Create an authentication token: To enable secure connection, get an authentication token from Blynk and include it into the ESP32 firmware. Blynk dashboard design: You may add control interfaces, historical trends, and real-time energy usage statistics to the Blynk dashboard. Testing and

Debugging: Update the ESP32's firmware: Flash the ESP32 microcontrollers with the produced firmware. Check that the ESP32 devices are successfully transmitting energy usage data to the Blynk 2.0 platform by monitoring data transfer. Debugging and optimizing: Find and fix any problems with the firmware, hardware connections, or Blynk setup. Analyze and visualize data using Blynk analytics: Utilize the analytics tools of Blynk 2.0 to learn more about the trends and patterns of energy consumptionSet up threshold alerts on the Blynk platform to inform stakeholders of unusual energy use or possible problems.Deployment and Implementation: Expand the deployment: For each device and region you want to monitor in the hospital, duplicate the software and hardware configuration. Cooperate with hospital employees: To ensure a smooth integration of the system into the current infrastructure, carefully collaborate with hospital administrators and employees. Instruction and Record-Keeping: Organize instruction sessions: Provide instruction to the appropriate staff on how to utilize and analyze data from the smart hospital energy meter. Record the system:For future reference and troubleshooting, provide thorough documentation outlining the firmware code, hardware setup, and Blynk configurations. Maintenance and Monitoring: To guarantee the system's continuous operation, set up monitoring procedures and conduct routine inspections. Continue to assist the client: Assist hospital employees and take care of any problems or adjustments needed for long-term performanceAssessment and Improvement: Obtain input: Get input from interested parties to assess how well the system is accomplishing its goals. Optimize system: To continuously enhance hospital energy management, make the required changes in response to input and continuing data analysis. This approach will help you deploy the IoT Smart Hospital Electricity Energy Meter methodically and guarantee a reliable and efficient energy management system for healthcare institutions.

IV. PROPOSED SYSTEM

Updated version of the Blynk 2.0 program. We had previously developed an ESP32-based IoT energy meter, a GSM prepaid energy meter, and an IoT DC energy meter using the outdated Blynk application. However, with the latest Blynk platform change, we also had to modernize our Energy Meter project. Our goal is to streamline the monitoring of power use by automating the process.

Manual meter readings are the traditional method of keeping an eye on power use, but they may be tedious and cumbersome. Time and money may be saved by automating remote data collecting, which is made possible by the Internet of Things. Since the idea of a smart energy meter has been increasingly popular around the globe in recent years, this is a great chance for us to develop our own Internet of Things-based electrical energy meter.

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Just one live or neutral wire has to be placed within the clip portion of the Current Sensor. It is also possible to utilize an optional 20x4 I2C LCD display, although it needs extra connections. Attach the LCD display's VCC, GND, SDA, and SCL to the ESP32's 5V, GND, GPIO21, and GPIO22, respectively. A 10K potentiometer located behind the LCD contrast is changed using the I2C Module. Alternatively, without attaching the LCD display, the data from the ESP32/SCT-013/ZMPT101B Energy Meter may be tracked via the Blynk Application.

A non-invasive split-core clamp meter sensor that can measure AC current up to 100 amps is called the SCT-013. This kind of current sensor is used to measure the alternating current in a building and is sometimes referred to as a current transformer (CT). The SCT-013 is simple to use since it doesn't require any high-voltage electrical work to be connected to the live or neutral wire.

The transformer shell encloses a secondary winding made up of several twists of thin wire, in addition to the main winding and magnetic core of the sensor.

Specifications

1. Input Current: 0-30A AC

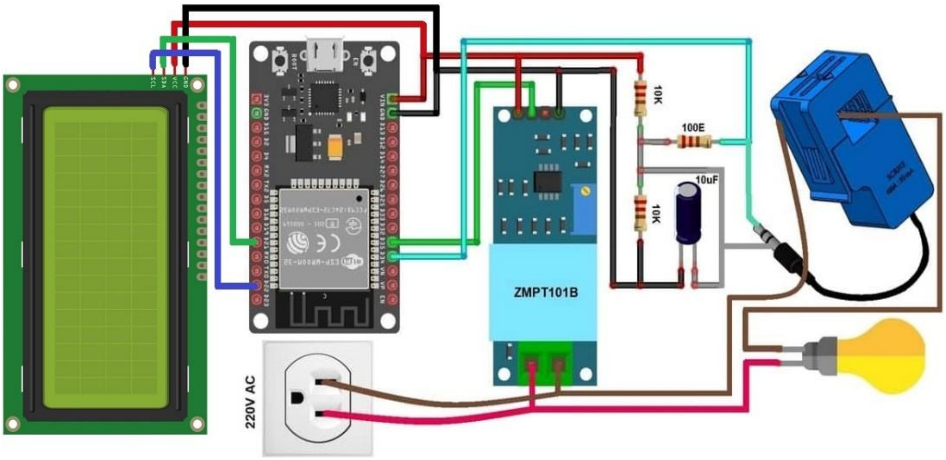

Figure 1. Block diagram

Figure 2. SCT-013 Current Sensor

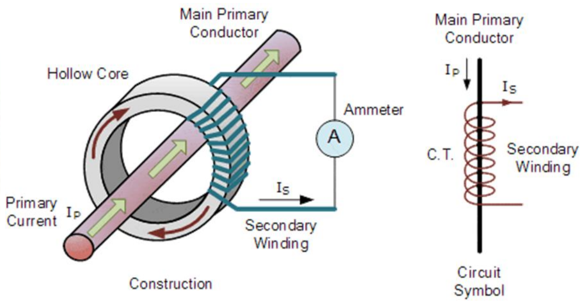

Figure 3. SCT-013 Current Sensor diagram

2. Output Signal: DC 0-1 V
3. Non-linearity: 2-3 %
4. Build-in sampling resistance (RL): 62 Ω
5. Turn Ratio: 1800:1
6. Resistance Grade: Grade B
7. Work Temperature: -25 °C~+70 °C
8. Dielectric Strength (between shell and output): 1000 V AC / 1 min 5 mA

A. ZMPT101B AC Single Phase Voltage Sensor

Figure 4. ZMPT101B AC Single Phase Voltage Sensor

Based on the ZMPT101B voltage transformer, the ZMPT101B AC Single Phase Voltage Sensor Module is a high-precision device. This makes it the perfect option for using an ESP32 or Arduino to measure correct AC voltage.
The module has an adjustable analog output and can measure AC voltage within a 250V range. With a multi-turn trim potentiometer to calibrate and tune the ADC output, it is simple to operate.
Specifications
1. Voltage up to 250 volts can be measured
2. Lightweight with on-board micro-precision voltage transformer
3. High precision on-board op-amp circuit
4. Operating temperature : 40ºC ~ + 70ºC
5. Supply voltage 5 volts to 30 volts

V. Results and Discussion

Following the deployment of the ESP32 and Blynk 2.0 IoT Smart Hospital Electricity Energy Meter, the system showed noteworthy improvements in the healthcare facility's energy management. The following discussion and results emphasize important discoveries, obstacles faced, and possible areas for more optimization. The technology was effective in providing real-time monitoring of the amount of power used by different hospital departments. Hospital administrators were empowered to make well-informed decisions on resource allocation and energy conservation initiatives due to the capacity to get instantaneous data, which facilitated the fast identification of energy-intensive areas. Efficiency & Remote Control: Blynk 2.0's remote control capabilities allowed employees to switch off non-essential equipment when there was little activity, which improved energy efficiency. Talk about how the hospital's sustainability goals were met by taking the proactive step of lowering needless power use by implementing remote-control capabilities. Talk about how the hospital's sustainability goals were met by taking the proactive step of lowering needless power use by implementing remote-control capabilities. Strategic decision-making was made easier by the data-driven approach, which enabled hospital management to efficiently allocate resources, streamline operating schedules, and put energy-saving measures into place. Threshold Alerts and Proactive Management: The Blynk platform's threshold alerts efficiently informed stakeholders of anomalous energy use or possible problems. Threshold alerts enabled proactive management that guaranteed prompt actions, avoiding energy waste and the chance of equipment breakdowns brought on by anomalies. User Interface and Stakeholder Satisfaction: Hospital employees and administrators found the Blynk 2.0 dashboard to have an easy-to-use interface. A key factor in the system's successful adoption was user happiness. A favorable user experience was further enhanced by training sessions and documentation, which guaranteed efficient usage of the energy management solution. Hardware Compatibility: Careful calibration and testing were necessary to ensure that the ESP32 microcontrollers and energy sensors were compatible. This presented some initial issues.Connectivity Problems: Debugging and optimization were required due to intermittent connectivity problems that occurred between the ESP32 devices and the Blynk 2.0 platform.

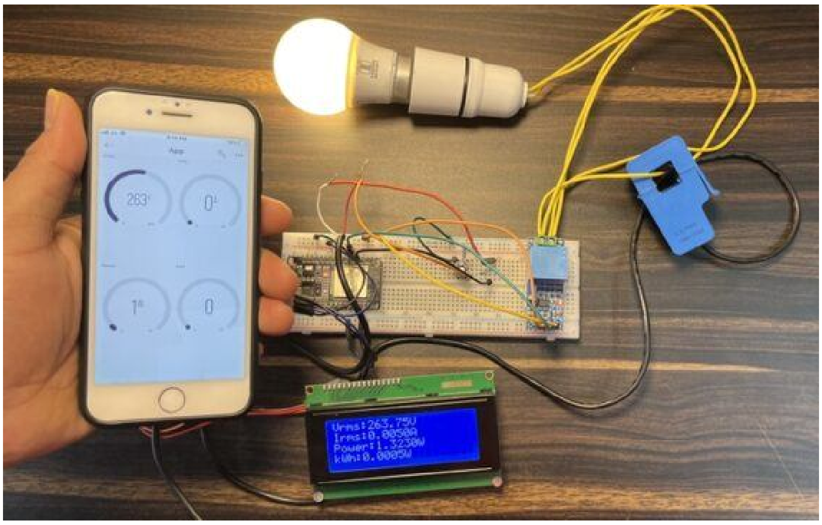

Figure 5. Connection

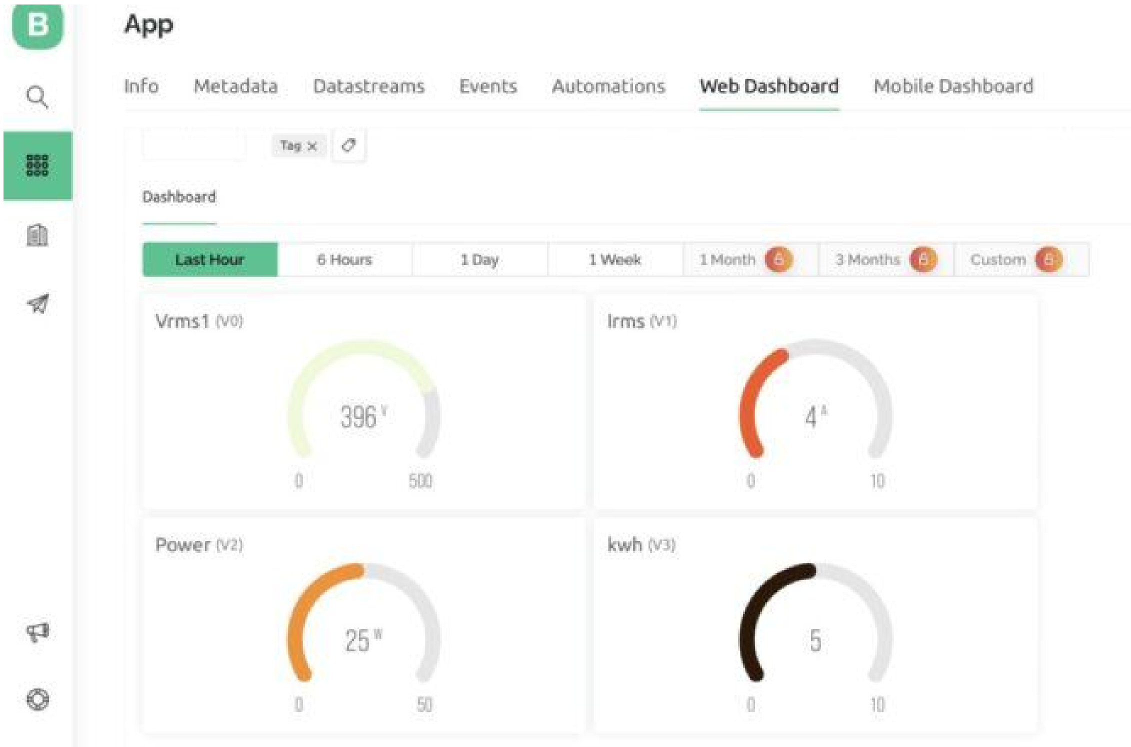

Figure 6. Final Interface

VI. Conclusion

The outcomes show that energy management in the medical institution has oved after the IoT Smart Hospital Electricity Energy Meter was installed. The hospital's entire energy usage is made more efficient and sustainable via proactive management, energy analytics, remote control capabilities, and real-time monitoring. The obstacles encountered during the deployment phase offer significant insights for subsequent undertakings, and the recognized prospects for enhancement facilitate continuous advancements in the energy management system. All things considered, the system shows itself to be a useful tool for encouraging economical and ecologically friendly procedures in the context of smart hospitals.

Future Work

Sophisticated Machine Learning Integration: To improve the accuracy of energy consumption patterns predictions, future implementations could make use of sophisticated machine learning methods. This may result in automatic and even more proactive energy management systems. Integration of 5G technology: This might lead to quicker and more dependable connection, improving device-to-device communication and real-time monitoring in a smart hospital setting. Blockchain for Data Security: As a means of guaranteeing the integrity and confidentiality of sensitive data, blockchain technology may be used more often in the healthcare IoT ecosystem to secure and validate data. Expansion to Wearable Devices: Adding wearables to an IoT network in a smart hospital might give more patient monitoring data points and make the system a more complete healthcare administration tool. Energy Harvesting Technologies: To fuel IoT devices without exclusively depending on conventional power sources, future implementations may investigate energy harvesting technologies, such as turning ambient energy sources (such light or vibrations) into electrical energy.

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