NTERNET OF THINGS IN SMART GRIDS

[1]MR.S PRAVEEN KUMAR, [2]MR.R.SURESH BABU, [3]R.VATHSALYA, [4]M.SUPRAJ, [5]V.SWAMY,

[1,2]Assistant Professor (EEE), Guru Nanak Institutions Technical Campus, Hyderabad, Telangana

[3,4,5]UG Scholar (EEE), Guru Nanak Institutions Technical Campus, Hyderabad, Telangana

Abstract:- This review paper examines the integration and impact of the Internet of Things (IoT) in smart grid technology, focusing on key implementations across the energy sector. These include advanced metering infrastructure, power transmission and distribution monitoring, and energy theft detection. The paper emphasizes the role of the Ubiquitous Power Internet of Things (UPIoT) in improving grid observability and controllability, and discusses advancements in machine-to-machine communication architectures that optimize metering infrastructure. Additionally, it explores the use of long-range wireless protocols for efficient data transmission within power distribution networks. The challenges and potential solutions for integrating IoT with smart home and building systems are also addressed, highlighting the innovative 'lastmeter' concept for customer-centric smart grid applications. Through case studies and experimental results, the paper provides detailed insights into how IoT technologies can revolutionize smart grid systems, enhancing their efficiency, reliability, and sustainability.

1. INTRODUCTION

1.1 GENERAL

The number of online capable devices surpassed 22 billion worldwide in 2018, and it is forecasted that it will be increased by approx. 38.6 billion by 2025, and 50 billion by 2030 [1] . These devices comprise vehicles, home appliances, and other electronics items connected with software, sensors, and categorized by their connectivity to the cyber world. New possibilities came up with growing technological advancements in the world that could improve our day-to-day life and offer effective services or production methods. Digitalization has allowed ''smart'' [2] to become the epicenter of the current technological developments. A smart system is a system or group of systems that incorporates roles of sensing, actuation [3] , and monitoring to describe or analyze a condition, make judgments based on the existing data, and make smart actions [4] . A smart energy system expects to have better control and use of energy consumption by aligning consumption with energy generation and combining various energy sectors [5] . The Internet of Things (IoT) is a collection of technologies and applications that offer devices and settings to producedistinct information and link them for rapid data evaluation or “quick” action. Nowadays, the internet has become pervasive and is influencing social life in unbelievable ways [6] .IoT is primarily a digital world that meets up with a glut of sensors and actuators [7] , or it can be said that it is a concept in which computing and networking skills are entrenched in some sort of imaginable idea. [8] The research in IoT is in the beginning phase, so there are multiple definitions for IoT defined by researchers. Theoretically, the term IoT comprises everything connected to the internet, but over time it is increasingly being used to define items that "talk" to each other [6][9] . There are numerous benefits of having things linked with each other, such as 1) more information leads to informed choices, 2) the opportunity to keep track of and record events, 3) automating tasks to reduce workload, and 4) lowering the running costs. The industries and enterprises are implementing IoT to automate and streamline their regular activities. Connected devices are being integrated into current and developing business processes. It is being used not just to reduce operating costs but to enhance productivity, improve customer experience, and create extra revenue streams

2. LITERATURE SURVEY

2.1 EXISTING SYSTEM

The current smart grid systems use IoT technologies like sensors, smart meters, and communication networks to monitor and manage the electricity distribution. These devices collect real-time data on energy usage, grid performance, and potential faults, which helps in improving efficiency, reliability, and reducing costs.

2.2 PROPOSED SYSTEM

The proposed system for IoT in smart grids would enhance existing systems by incorporating advanced features and more interconnected devices for better automation and real-time decision-making. It aims to make the grid more resilient, optimize energy distribution, and allow for better integration of renewable energy resources.

3. BLOCK DIAGRAM

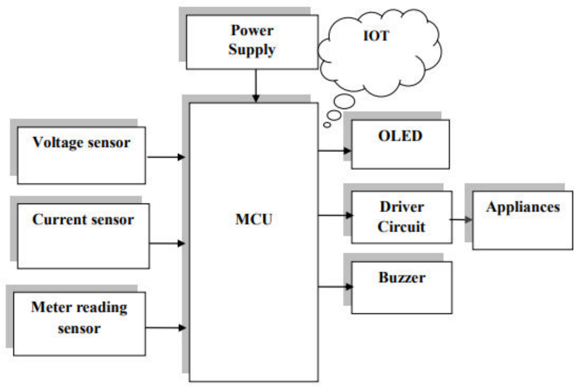

FIG: 1 Block diagram

3.1. HARDWARE COMPONENTS

- Regulated power supply.
- Micro controller.
- Voltage sensor
- Current sensor

3.2. SOFTWARE REQUIREMENTS:

- Embedded C

4. IMPLEMENTATION

The circuit diagram represents a smart energy monitoring and control system designed around the Raspberry Pi Pico W microcontroller (U4). Its primary purpose is to monitor electrical parameters such as voltage and current while also detecting human presence using an IR sensor. The system can intelligently control an electrical appliance through a relay based on the data it receives from sensors. The voltage and current sensors measure the electrical parameters of the connected appliance and feed the data into the Pico W via its analog input pins. Meanwhile, the IR sensor detects motion or presence near the appliance and sends a digital signal to the microcontroller. The power supply section, located at the top-left, uses a step-down transformer (TR1) to convert high-voltage AC mains to a lower AC voltage. This is then rectified by a bridge rectifier (BR1), filtered using capacitors (C1 and C2), and regulated to a steady +5V DC using a 7805 voltage regulator (U2). This 5V powers the Raspberry Pi Pico and oth components. An LED (D1) with a series resistor (R1) acts as a power indicator, signaling that the circuit is receiving power. The system uses an OLED display (LCD1) with I2C communication (connected via SDA and SCL pins) to show real-time readings such as voltage, current, and appliance status. If the system detects abnormal conditions like overcurrent or overvoltage, it triggers a buzzer (BUZ1) to alert the user. The Raspberry Pi Pico also controls a 12V relay (RL1), which switches the appliance ON or OFF depending on the conditions. For example, if the IR sensor detects human presence and the voltage/current levels are within safe limits, the relay is activated to turn on the appliance. If the sensors detect unsafe electrical conditions, the relay is deactivated, and the buzzer may sound to warn the user. Overall, this circuit automates appliance control while ensuring safety and energy efficiency. It continuously monitors electrical conditions and presence, providing feedback to the user through both the OLED display and audible alerts. It is ideal for smart home or industrial automation systems where automated appliance control and real-time monitoring are needed.

5. CIRCUIT DIAGRAM

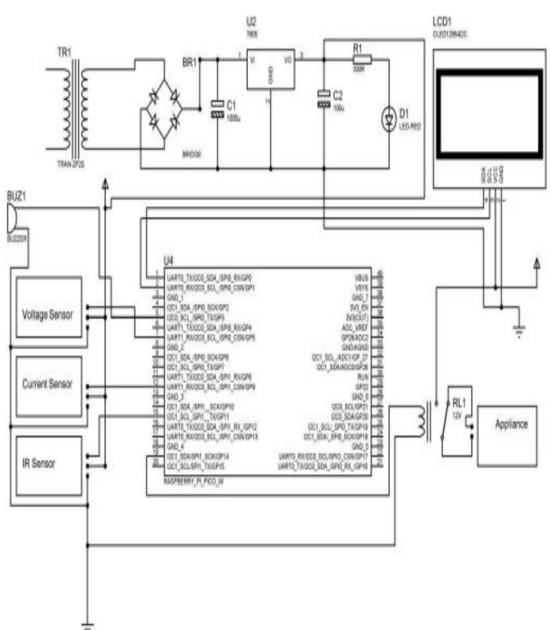

Fig circuit diagram

6. RESULT

This project is well prepared and acting accordingly as per the initia specifications and requirements of our project. Because of the creative nature and design the id of applying this project is very new, the opportunities for this project are immense. The practical representation of an experimental board is shown below:

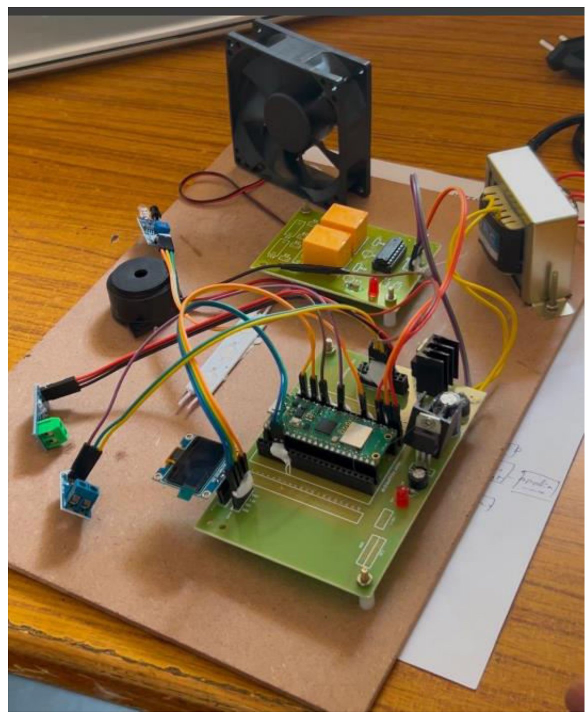

Fig:3. Project Model

6. CONCLUSION

In this digital era, technological possibilities are progressively transforming the economic sector and cultures. Digitalization has facilitated numerous opportunities for technology improvements and effective utilization of limited resources, i.e., Information Technology and the Internet of Things, supporting smart technologies. ‘Energy Digitalization’ is one of the prominent evolving implementation areas of IoT technologies. Healthcare systems might benefit from IoT as well, both in terms of efficiency and cost, which is essential for hospitals. The present COVID-19 epidemic prompted the evaluation of several IoT devices that might aid in efficient monitoring and control, demonstrating the increased value of IoT goods. The transportation sector is also leveraging the benefits of IoT devices in vehicles to control and monitor. In the highly demanding area of autonomous vehicles, significant developments are expected in the coming future. The energy industry is currently one of the most advanced application areas of IoT technology. Smart homes, the creation of smart and adaptable microgrids, and developments in effective demand-side management of power networks are among the solutions being developed. The smart grid is the upcoming grid that explains the challenges of uni-directional data flow, energy waste, rising energy needs, trustworthiness, and safety in the conventional power grid. The IoT helps the smart grid by delivering smart devices (sensors, actuators, and smart meters) for the monitoring, evaluation, and management of the grid, and connectivity, automation, and tracing of such devices. Thus, smart grids are expected to expand rapidly in the energy market. This shows that IoT-aided smart grid networks universally boost multiple network-based operations at higher levels of energy generation and transmission. The convergence of IoT is expected to quickly increase functionality, energy, and economy, amalgamating the complete automation of a smart grid built on the IoT. With the development of IoT-based smart grid systems, a concentrated research effort is needed on addressing the security issues using efficient cybersecurity mechanisms. This also refers to IoT, which can transform our lives and behaviours. The intensive ongoing research and development carried out in IoT technology has enabled devices to work together with one another, collect data, and function as required. IoT has added what we now call smartness to devices, processes, and systems. Smartphones, cities, grids, transport, healthcare, and many other systems have achieved this intelligence. This technological transformation is gradually penetrating lives from a privilege to an essential requirement. Some potential IoT application areas are still unknown or have a lack of strategy for addressing them. This indicates that more intensive research in this difficult area is needed to uncover new and significant societal benefits. The applicability and significance of IoT technologies in forthcoming times are apparent and will play a critical role. This is the time to work towards holistically integrating IoT into our lives to ensure safety, security, and sustainability

7. REFERENCES

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