Smart Electricity Monitoring and Control System Using IoT

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Abstract— In everyday life, electricity is necessary, and appropriate utilization is critical. Over the years, existing systems have been scrutinized in order to improve residential power control. The existing PMAS approach, on the other hand, has a greater error ratio and does not provide a remote monitoring system. This study uses mobile applications to give consumers with a simple system for monitoring and controlling the power consumption of household appliances. The suggested system provides 0.6 percent current errors for the hairdryer appliance, compared to 7.8 percent current errors for the present Power Monitoring and Switching (PMAS) system. The electricity cost is one of the most important operational overheads in many commercial and industrial buildings. The design and development of a Smart Power monitoring device for monitoring the electrical parameters of Wasit university buildings, such as voltage, current, and power. The system includes a smart sensing unit that detects and controls the electrical equipment used in daily activities based on various tariff rates. It has the potential to lower consumer costs while also enhancing grid stability. A constructed model was thoroughly analyzed, with experimental results compared to those obtained using traditional measuring devices. The Arduino-based wireless power meter is a non-invasive existing meter with a WI-FI connection for domiciliary power.

Keywords: Internet of Things; IoT Applications; Energy Efficiency; Energy In Buildings; Smart Energy Systems; Smart Grid; Flexible Demand; Energy Storage

I. INTRODUCTION

Electric power usage has become obvious in all fields at this time. Because modern technology has made numerous electrical appliances and equipment widely available, it has become vital to develop new methods for controlling and monitoring electrical energy consumption[1,2,3]. Wasit University was chosen to implement an Internet of Things project that was designed to monitor Power Consumption wirelessly by relying on IoT applications and a wireless sensor network over a WI-FI connection[4,5,6].A wireless sensor network (WSN) is defined as a collection of sensors that are spatially separated and linked via a radio frequency (RF) connection[7, 8]. Sensors collect sensory data such as temperature, illumination, pressure, and so on, which can then be sent over a wireless link to a base station, which uses the sensor data to acquire the needed information about the setting[9,10,11]. Electricity has the biggest demand in Malaysia, and it is predicted to rise progressively in the next years, owing to the country's increasing urbanization, rapid industrialisation, and growing population. According to statistics, residential sectors consume up to 48 percent of global energy [12,13,14,15]. Commercial and residential buildings account for around 40% of Malaysia's building energy [16].People in the present era make use of household appliances that are equipped with cutting-edge technology. In Malaysia, households use an average of 20 to 30 electrical household appliances [17,18,19]. The great majority of household appliances utilize a lot of energy and electricity. Consumers frequently keep lights, fans, freezers, air conditioners, and other appliances on when they aren't in use, resulting in energy waste [20,21,22]. This disregard for customer behavior can result in excessive power consumption and waste of electrical energy, as well as a reduction in the life duration of household goods like hair dryers and dry irons.

II. LITERATURE REVIEW:

The authors proposed a monitoring system based on IoT technology in [14]. This system employs a triple-level context for providing awareness services intended contextualization, all while using opensource software and hardware. The test was carried out using two scenarios, one of which was a smart home with an IoT-based monitoring system (IMS). The disaster management service notifies the user when certain events occur, such as gas leaks, fires, and break-ins. The second scenario involves a health-care service, such as deep sleep management and home comfort management. Rita T. Tse (2016) created a system that included a WSN and a server to analyze data collected from the network. The (SAKF) Self-adaptive Kalman Filter [26, 27, 28] was used in this system[15]. This WSN system can identify factors in a variety of contexts, collect data from numerous nodes, and visualize the data in real time. Each node is capable of monitoring a variety of variables, including UV Ultraviolet light, atmospheric pressure, PM2.5 particulate matter, humidity, temperature, and geographic position. The node data can be sent to the server and stored in the database utilizing WiFi (Wireless Fidelity) networks. This work's sensor nodes are all ready for personal use. Furthermore, several writers proposed a wireless sensor networking action for solar photovoltaic (PV) planting, dubbed an IoT objective solution for a Monitoring System[16-18].

III. METHODOLOGY:

The monitoring system, control system, IoT implementation, appliances, and basic electrical theory were all discussed in this paper's produced SMACS. Figure 6 depicts the suggested flow diagram, which is made up of five distinct elements that will be discussed further.

A. Monitoring System.

Since the number of user appliances and power consumption [29, 30, 31] in the residential and commercial sectors has expanded, it is critical to monitor and measure the electric system and appliances. The residential sectors, which are the subject of this study, are made up of small energy consumers and users, such as houses and apartments [34]. A power monitoring system can assist users or consumers in conserving energy. Monitoring systems [23, 24] in the

present period must sort data, record, and exploit it to get the intrinsic information displayed in legitimate and novel ways, as well as use the Internet to visualize it everywhere [4].The monitoring system can be thought of as a unified [25, 26] and user-friendly solution for reliable electricity management [5]. By giving real-time feedback, this technology can assist users in changing their habits [6].

B. Control System

The operational status control of electric equipment can reduce building power consumption costs and enhance the electrical energy ratio to a more effective and dependable ratio. Because everything can be managed, the power control system can assist the user in managing their electricity more effectively and efficiently. The remote control device can be used to give orders to this system [5].

C. Implementation of IoT

Thing-speak was used to create an IoT platform that is compatible with the ESP 8266 WiFi module. It can also display, analyze, and calculate the required data before storing it in the cloud, either publicly or privately. Thing-speak is a language for analyzing and storing data from sensor-based IoT.

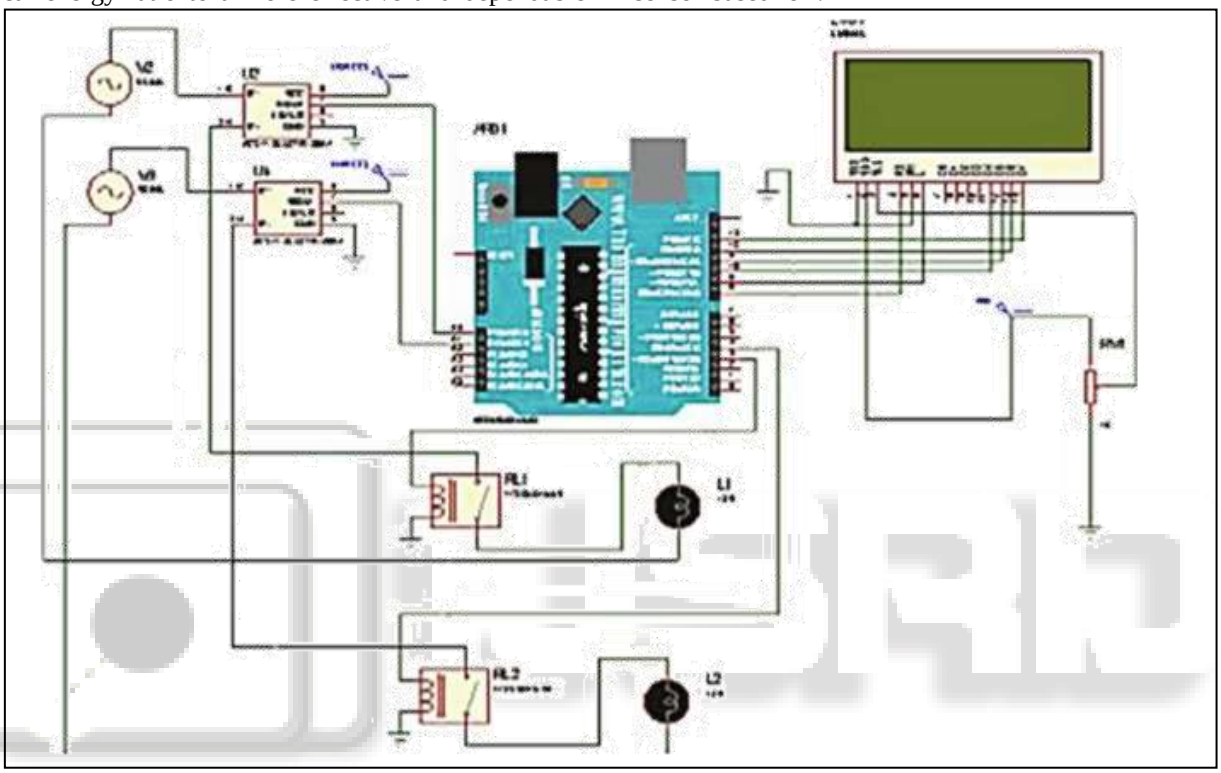

Fig. 1: System design of SMACS

IV. RESULT AND DISCUSSIONS

The Virtuino mobile application was created to remotely and wirelessly monitor consumption. Virtuino was the mobile application used in this. It's a program that can be used as a SMACS monitoring system. The Virtuino web server can be connected to the Thing-speak web server. It receives real-time data from Thing-speak and visualizes it on the mobile app; however, Virtuino does not have the capability to visualize historical data. The data can be read on the mobile app as long as the phone or WiFi is turned on. To determine the correctness of the suggested method, a comparison of several types of household appliances was conducted. A few appliances with varied current values were chosen. The higher the current value, the more accurate the SMACS result is. The bulb has a percentage inaccuracy of 2.5 percent, with the current being the smallest of the appliances considered. The percentage mistake is merely 0.15 percent when compared to the appliance with the highest current value, which is the water heater. The value is getting close to zero, which is regarded correct.

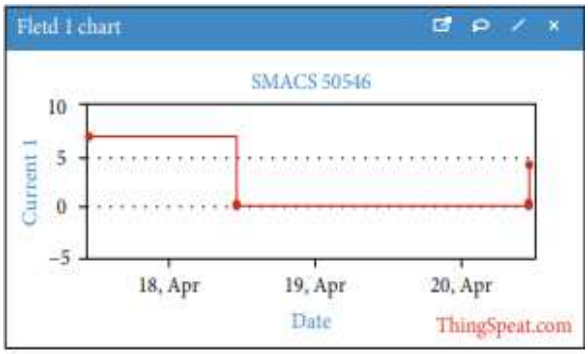

Fig. 2: Chart display from Thing-speak

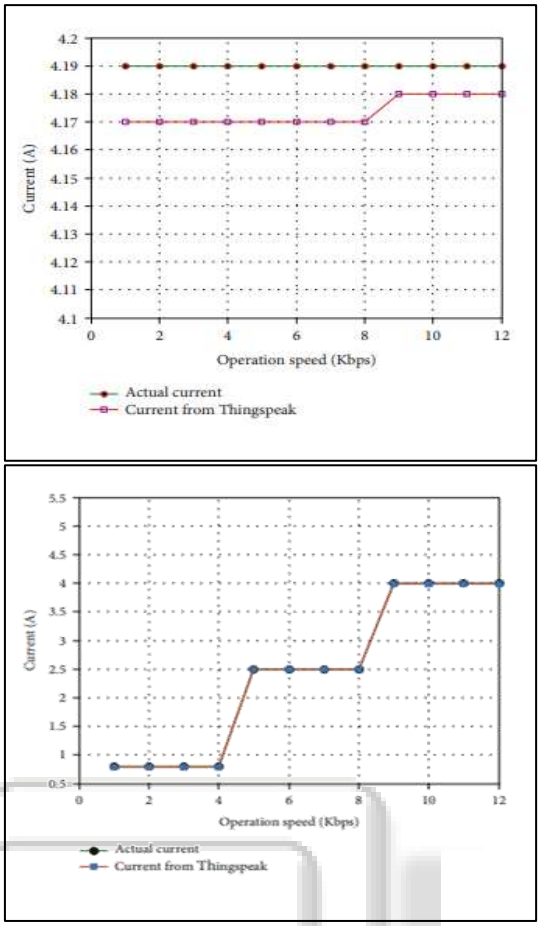

Fig. 2(a): Current test comparison for rice cooker appliance. 2(b): Current test comparison for 100 W lighting appliance.

V. CONCLUSION

This paper proposes a solution for Wasit University's established energy monitoring, which can monitor the electricity of the entire campus in a cost-effective manner by utilizing Internet of Things technology. The following are the important concluding remarks derived from the suggested design and implementation of a network of wireless sensors for IoT applications using a non-IP network:

- In order to monitor systems, the design that was proposed used an unique IoT application.
- The monitoring web-portal is adaptable to any changes required by the customer.
- The suggested system allows the user to view a history log of the power consumed.

This study proposes and develops a smart monitoring and control system for household appliances based on the Internet of Things. The technique and processes were developed to deliver a helpful and critical solution in a monitoring and control system. The proposed system measured and monitored current, voltage, and power usage more accurately. This is because the suggested SMACS took into account the system process design when choosing the ESP8266 WiFi module, ACS712 current sensors, and 5 V relays as hardware.

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