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Development of Building Energy Management and Solar System

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Abstract

A building management system (BMS) is a computer-based control system that regulates and monitors mechanical and electrical equipment in a building, such as ventilation, lighting, power systems, fire systems, and security systems. The goal is to create a building's solar system for energy management. The amount of energy used within and outside the building is being tracked. It can automate the control of electric equipment like air conditioning and lighting. The research is now being conducted using the waterfall approach. The Waterfall Method was widely utilized in Software Engineering to ensure project success. The "Waterfall" method separates the software development process into several stages. There are six steps: planning, analysis, design, implementation, testing, and maintenance, which are all essential aspects of any project. Findings and discussion are critical components in evaluating the project's outcomes. This project's hardware and software include a current sensor, temperature sensor, battery, IoT circuit, and Arduino IDE software. These steps must go through technical testing before becoming a functional system. The prototype's results, as well as the coding, will be discussed. The project for Building Energy Management with Solar System has been improved. Solar energy and the Internet of Things (IoT) are used in this novel design. An Automatic Transfer Switch (ATS) is used to switch the supply input automatically. Because the system has a solar backup power supply, it will not shut down if there is a blackout.

Keywords: - Building Management System (BMS); Energy-efficient Cognitive Autonomous Building Automation (ECABA); Heating Ventilation and Air Conditioning (HVAC); Internet of Things (IoT); Smart Grid Building Energy Management System (SG-BMS); Real-Time Monitoring&Control (RTM-C)

1. Introduction

Nowadays, Technologies are developing, and many new advancements use automatic systems, or so-called intelligent systems, to monitor energy entering the building and turn on/off electrical equipment (Huey et al., 2022). Building an energy management system is the device's name (BMS). This project's development aims to reduce electricity waste and prevent short circuits from triggering building fires. This concept is inspired by an incident on December 24 at Tun Aminah Hospital in Johor Bahru, where damage to the lamp's capacitors was discovered to be the principal cause of the fire that took six lives. This suggests that in the October 25 event, damage to the lamp capacitors triggered a short circuit, resulting in heat generation from electricity and sparks and flames spreading throughout the ICU ward, including the storage of dangerous materials. Short circuits can happen, and the public should be aware of this. It can be triggered in various ways and conditions, one of which is

by turning on a light switch that is not lit or damaged. Why should governments invest in programmers that allow them to monitor and regulate building systems to prevent such incidents (Shamsudin et al., 2015 and Hammim, 2016).

Building energy management with a solar power system is a project that functions similarly to a building management system (BMS), also known as a building automation system (BAS). It is a computer-based control system that controls and monitors mechanical and electrical equipment in a building, such as ventilation, lighting, power systems, fire systems, and security systems (King & Perry, 2017). This project is being developed to make it more dependable, as when the building experiences a blackout, all of the devices that use electricity will shut down. However, because this project is a building energy management solar system, it will not shut down because it uses green energy, making it easier to monitor where there is a trip or low energy consumption (Said, Basir & Abdullah, 2021 and Said, Abdullah & Basir, 2022).

Since the construction and building business requires a limitless quantity of resources, Efforts to attain sustainability should prioritize addressing the needs of current generations without jeopardizing future generations' capacity to meet their own. Sustainability in construction is described as "creating a healthy built environment via the implementation of resource-efficient, environmentally sound approaches." As a result, it encompasses the management of a building's serviceability throughout its life and its final deconstruction and material recycling to minimize the waste stream associated with demolition.

According to the Organization for Economic Cooperation and Development (OECD), sustainable buildings have the fewest adverse effects on the built and natural environments, both within the buildings and their immediate surroundings, as well as in their broader regional and global contexts. Today's building automation systems are rigid in regulating numerous components, most notably their energy management systems. Efficiency targets are built into the system and deeply ingrained in the control mechanisms; they have not been achieved automatically but during the design phase. Compared to programmable control systems, cognitive systems acquire information through data interaction and reprogram their behaviour in response to changing situations. As part of the ECABA (Energy-efficient Cognitive Autonomous Building Automation) project, a building automation system capable of pursuing goals autonomously and adapting to changes in the surrounding environment will be built (Kumara, Waidyasekara & Weerasinghe, 2016). Since there is no project prototype, there is no previous research to draw upon for Building Energy Management with Solar Systems.

2. Methodology of Building Energy Management & Solar system

The method implemented for building energy management with solar is SDLC Model to be widely utilized in Software Engineering to ensure project success. The entire software development process is separated into several phases in "The Waterfall" technique. Typically, the output of one phase serves as the input for the following phase in this Waterfall. There are six phases: planning, analysis, design, implementation, testing, and maintenance. SDLC stands for Software Development Life Cycle Process, and it outlines the many stages of software development to generate a high-quality outcome. From conception to retirement, the SDLC stages cover the entire life cycle of a software product.

During the development of this building energy management with solar system project, some hardware and software are employed to meet the project's goals and plans. The following is a list of the hardware and software that will be involved during the project. A list of the project's components includes the current sensor module ACS712, Inverter, Solar power supply, Automatic transfer switch (ATS), Temperature sensor LM35, Liquid crystal display (LCD) 2x16, and Arduino UNO.

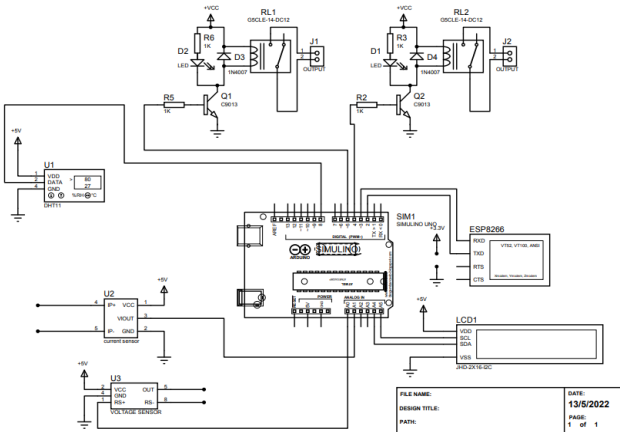


Fig. 1. The schematic circuit of the proposed system

Fig. 1 illustrates a circuit for developing a project's building energy management system (BMS). The system was controlled by an Arduino Uno based on the circuit. The prototype used two current sensors and one temperature sensor to check Real Time Monitoring & Control (RTM-C) for the data shown in Fig. 4(a) Additionally, it uses the ESP8266 to operate the system through the Internet of Things (IoT). The system can be viewed on an application and controlled by the application. For the standard display, an LCD 2x16I2C was used. This project will be designed and developed using Proteus. The development of this project will depend on the building's electricity-powered power source & solar power will be used as a backup source of energy in the event of a power outage.

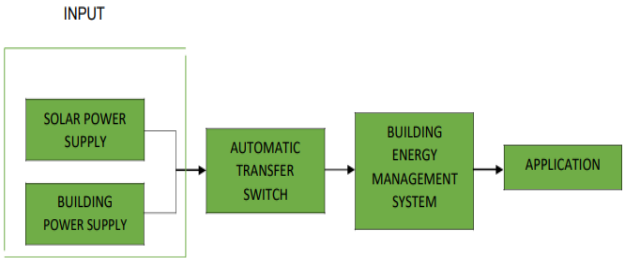


Fig. 2. Block diagram of the proposed system

The suggested system's block diagram is displayed in Fig. 2. Inputs for a building energy management system are shown in the figure as solar energy and building power supply. The system's purpose is to monitor Real Time Monitor & Control (RTM-C), which gathers information from the building and displays it on an LCD screen for normal viewing or via the Internet of Things about the electric consumption entering and leaving the building. It also has an automated transfer switch (ATS), whose purpose is to move the supply input from the building supply to the solar supply during a blackout, so the system won't shut down.

3. Result and Discussion

The prototype of the proposed design is shown in Fig. 3. The project's outcome, as shown in the diagram below, is that once the systems are connected via IoT, they can be monitored in Real Time Monitor and controlled by an application called Blink App. The current, voltage, temperature, and switches to regulate the light are listed in the app, as shown in Fig. 4(a). It would be easy to control or monitor the system from anywhere if it is used by the application.

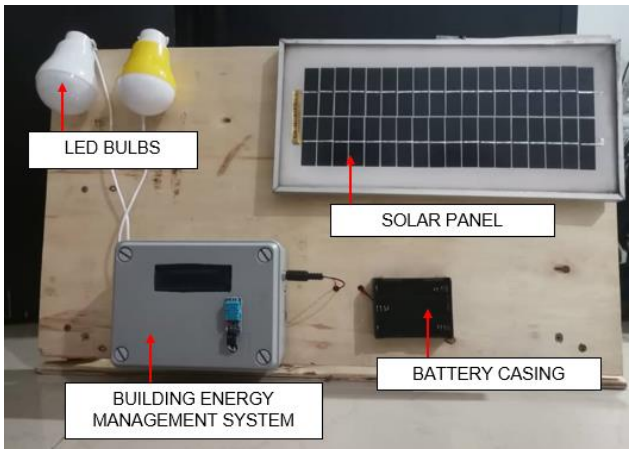
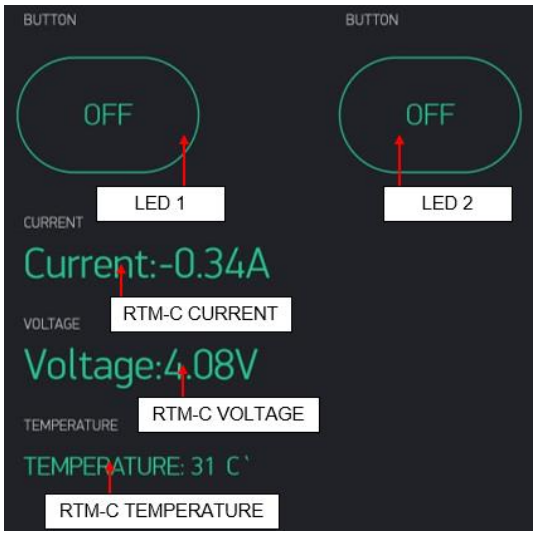
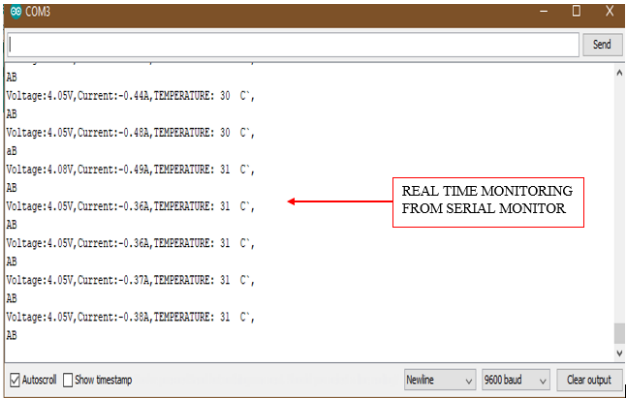


Fig. 3. The overall prototype of the proposed system

As for Fig. 4(a), it was the display that was utilizing the Blink Application, which meant that the system was online and that the data that was displayed was Real Time Monitor occasionally as for the outcome. By using the app, it is also possible to operate security, lighting, HVAC, etc. For the prototype, the only control will be over the output of the light. The Arduino's programming can be noticed in the serial monitor's appendix. Concerning the two bulbs, there will be states like current, voltage, temperature, and the keywords (a, b). The keywords will be capitalized (A, B) and periodically read if the light is on, as seen in Fig. 4(b).



(a)



(b)

Fig. 4. The (a) output listed in the Blink app and (b) output from the serial monitor of the proposed system

4. Conclusion

In conclusion, the project of Building Energy Management with Solar Systems is had been improved from the Building Energy Management System (BEMS) successfully proposed. The innovation of the proposed project is acquired to use the solar power supply and the Internet of Things (IoT). The problem in the past project was that whenever the building experience blackout, the system would shut down on its own. The advantage of this project is that this problem is resolved in the newly designed system using two power supplies direct from the building and the solar. If ever the system experience a blackout situation, the system will not shut down because there had backup power supply solar. The system will automatically use an Automatic transfer switch (ATS) to

switch the supply input. The second part of the improvement that has been made from the project is its use of the Internet of Things (IoT) to monitor, and it can be controlled from anywhere as long the system is connected to the WIFI it will make the user easier to monitor and control the system.

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