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Smart Energy Management System for Office Environment

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Abstract: *The innovative smart grid concept is not only reshaping the electricity grid infrastructure, but also encouraging a shift towards more environmentally responsible energy consumption. "green" solutions for homes and businesses have been explored in an effort to accelerate the spread of renewable energy sources and lessen the impact of their energy consumption on the environment. However, the "Smart Building" paradigm proposes to integrate distributed generation plants, storage capabilities, and electrical loads to deal with the challenges posed by the unpredictability of the overall power availability brought on by renewables (such as solar and wind energy). Each Smart Building has its own control system and may work off the grid or in conjunction with the main power grid. The former scenario involves a Smart Building's ability to either draw electricity from or provide power to the grid. The latter entails the Smart Building's inability to draw power from the grid in the event of a shortage, or to inject power surpluses into the grid in the event of a surplus of production. Instead, the Smart Building must rely solely on local generation and storage to meet the power demand of the electrical loads.*

Keywords: Smart Office Building; Real-time Load Scheduling; Photovoltaic Generation; Battery Storage..

I. INTRODUCTION

Most individuals nowadays spend a considerable amount of time at their workplaces. Because of its direct impact on workers' productivity, the workplace setting should be relaxed in order to bring out everyone's best work. Therefore, it is essential to have a comfortable workplace. A fax machine and an electronic typewriter were examples of cutting-edge technology in previous decades; now, an iPad coupled to a cloud solution represents state-of-the-art innovation. A smart workplace streamlines processes for both workers and clients, boosting morale and encouraging more frequent interaction. The utilisation of innovative technology and a variety of tools and solutions is used to this end. As previously insurmountable barriers are broken down, a world that prizes originality and complexity is emerging. Intelligent development zones are emerging all over the globe, making smart offices an urgent need. A smart workplace is one that makes full and efficient use of its available information technology and other hardware. To put it another way, modern workplaces are robotic thanks to advances in IT. There must be openness and honesty in the presence of cutting-edge technology. Because of this, office automation has the potential to have a far-reaching effect on the efficiency of the industrial sector and corporate operations generally by making systems more accessible and encouraging the free flow of information. Companies, organisations, and businesses of all sizes may benefit from the widespread use of modern means of communication and automation. One benefit of a smart workplace is that it allows for more flexible working hours by eliminating the need for individual employees to record their arrival and departure times. Improving how the members of a team talk to one another may have a positive impact on their overall output. The goal of every well-thought-out workplace layout must be to help workers reach their greatest potential. It's not magic; it's simply creative problem solving and cutting-edge innovation tailored to the requirements of real people. Automation in the workplace allows for streamlined record-keeping and instantaneous communication. The construction industry is a major consumer of energy worldwide. Almost a third of the world's energy goes towards powering it. The efficiency, comfort, and security of a smart building can be maximised in the same way as a smart home's can via the intelligent collection and analysis of sensor data. Mechanical devices, control systems, and other modern building amenities all work together to make workplaces safer and more productive for its inhabitants. A smart

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building is essentially a super system made up of many smaller linked systems. For a building to be considered "smart," all of its components must be able to communicate with one another. It aids in the visualisation of data, allowing for quicker and more accurate decision making by building managers. There are a number of approaches that may be used to create the smart building. A building's many subsystems, such as its lighting, HVAC, and other systems, may be controlled automatically and centralised via a building automation or building management system. The goals of a building automation system are to increase the efficiency of the building's systems, enhance the comfort of the building's occupants, reduce the building's energy consumption and running expenses, and lengthen the utility infrastructure's useful lifespan. Energy use during construction of buildings is rather high. Electricity usage in business buildings may be significantly reduced with proper management. The emergence of the Smart workplace idea may be attributed to these problems. The energy-saving design principles of the "smart office" may be extended across the whole structure, creating the "smart office building." Safety is an important part of modern living. Users are compelled to implement stringent safety measures due to the rapid development of technology. Optimal system security is essential. ATM and other intelligent cards, user password-based systems, and many more fall under the umbrella of identification technologies. However, these systems are insecure because they are vulnerable to hacking, theft, and forgotten passwords. RFID has also found use in the realm of security. However, RFID has the drawback of being easily duplicated or stolen, allowing unauthorised individuals access. This is a very risky move. Despite these drawbacks and malfunctions, biometric or fingerprint authentication based identification remains the most effective and reliable solution for security. In this system, a concentrated smart office lighting, heating, security, and alarm system is designed to save energy while simultaneously increasing employee satisfaction. Smart Energy Solutions takes a holistic approach to reducing energy use by using Behavioural economics. This solution, by acknowledging the centrality of people, demonstrates how to minimise energy usage once and for all.

II. LITERATURE REVIEW

CH. Madhuri Devi et.al [1] have submitted a study that provides a comprehensive analysis of current power management practises. Using an FM transmitter and an FM receiver, data on energy statistics can be wirelessly transmitted to a central monitoring station.

A Lachi Reddy et.al [2] have suggested a state-of-the-art Energy Management System based on Web Server and Smart Metre technology. There are three parts to this project: the microcontroller, the Ethernet chip, and the electricity metre (with its cutting-edge voltage sensors).

Madhu M S et.al [3] have presented an Intelligent Energy-Saving System for Smart Houses. They demonstrated that energy usage may be decreased by using a computerised system to regulate household appliances.

Grenville J. Croll [4] have advocated using computer and associated technology solutions to enhance the system's energy efficiency. The components of the study relate to the most significant users of electricity in the economy: the maritime industry, industry, commerce, and households.

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III. SYSTEM ARCHITECTURE

Block Diagram

The step-by-step procedure for Office automation system is showed in the Block diagram.

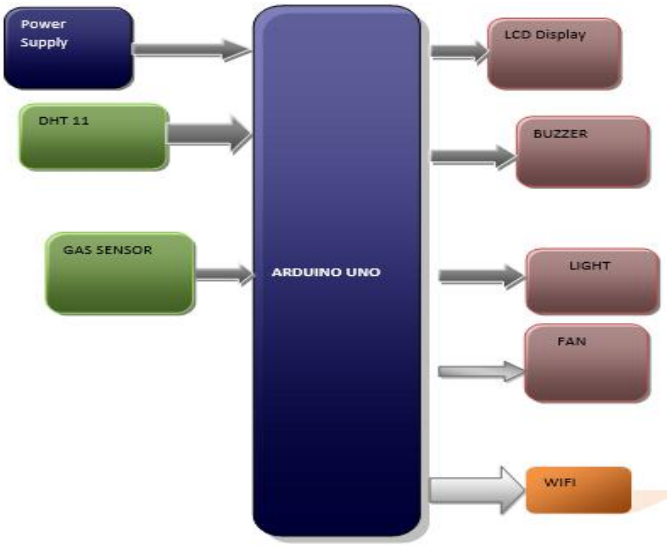

Fig1. Block Diagram

Description of the Components

ARDUINO

The ATmega328 (datasheet) provides the foundation for the Arduino Uno, a microcontroller board. It has a 16 MHz ceramic resonator, a USB port, a power connection, an ICSP header, a reset button, and six analogue inputs. Six of the digital I/O pins may be utilised as PWM outputs. All you need to get started is a USB cable, an AC-to-DC converter, or batteries; everything else is included.

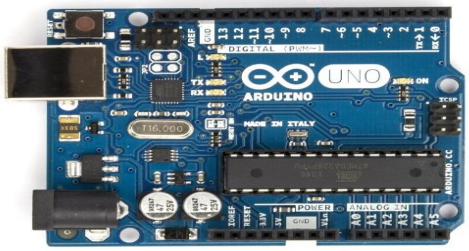

Fig2: Arduino

DHT11

The DHT11 is a digital temperature and humidity monitor that is both easy to use and very inexpensive. Taking readings from a thermocouple and capacitive humidity sensor, it then transmits a digital signal over the data port to provide an accurate representation of the ambient environment. Forget about using analogue input pins.

Fig 3.DHT11

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GAS

Gas sensors are instruments that help us learn about the amount of gas in the air and its natural circulation patterns. The levels of gas in a room may be seen using gas monitors.

Fig4.Gas sensor

LCD Display

There are several uses for LCD (Liquid crystal display) screens, which are electrical display modules. When referring to an LCD display, the term "16x2" indicates that there are two lines, each of which may show 16 characters (for example, 808F and C0CF). This LCD displays each letter as a 5x7 pixel matrix.

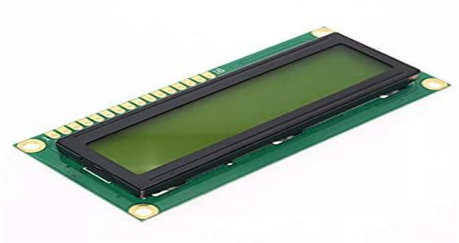


Fig5.LCD Display

Wi-Fi module

WiFi modules (wireless fidelity) also known as WLAN modules (wireless local area network) are electronic components used in many products to achieve a wireless connection to the internet.

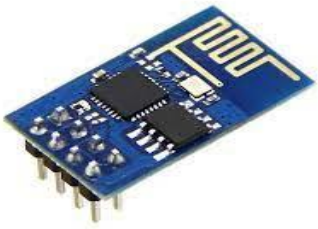
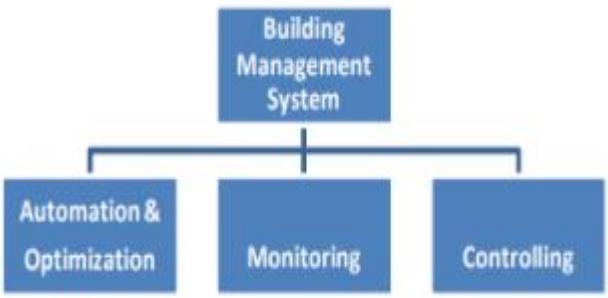


Fig6.WIFI Module

IV. BASIC FUNCTION AND WORKING MODEL OF BMS



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Numerous automated systems have been installed to make indoor life for humans as pleasant as possible, improving nearly every function with negligible financial investment. To improve safety, DC motors, controllers, sensors, and electronic circuits are embedded in the structure's skeleton. The necessary hardware and sensors are now in place. Door/gate/gate/fire/light control are all part of this idea. Since automated systems have been installed within buildings, lighting regulation has become a necessity. Here, fully automatic system introductions are made with consideration for all factors.

Building automation systems

The primary goals of commercial building automation systems are to maximise comfort and safety for tenants at the lowest possible cost to the building's technical infrastructure. Indoor heat parameters, air quality (CO2 and humidity), and lighting features in the workplace and common areas should be optimised for maximum comfort. Security mechanisms to monitor occupancy, restrict access to restricted areas, and sound the I&HAS (Intruder & Holdup Alarm System) in the event of an intrusion.

Smoke alarm system:

Smoke evacuation systems are crucial to the well-being of your building's residents and visitors. Once smoke was contained, an alarm was sent out by the system. The MQ3 sensor may help find fires or smoke earlier. A smoke evacuation system can pinpoint the origin of smoke and direct it away from exits and other protected areas. If smoke or fire is detected within that time, an alarm will go off.

Light model:

This module helps cut down on energy waste. In this method, the mechanism that regulates the light is responsive to the availability of the people involved. When someone walks out of the hallway, the light will automatically turn on or off. Infrared (IR) sensors are used to detect motion or objects in public spaces illuminated by LEDs or other bright lights.

V. RESULTS

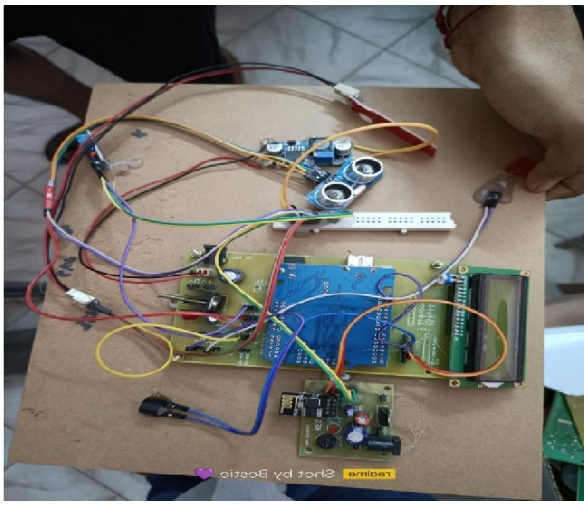

Fig7.Hardware structure

The whole of the proposed system's hardware architecture is seen in Fig. 7. That have implemented Temperature, Smoke, PIR, and LDR sensors; use an Arduino UNO; use a Buzzer; use a relay; use a transformer; use an LCD display; use fans; use LED lamps.One computer and a mobile phone are required to see the system's output. By bringing them together, they were able to create a whole new application for smart automation in the workplace. The sensor data is displayed on an LCD screen and is continually monitored on the PC's Wamp server. The first thing we see when we turn on the system is the project's name displayed on an LCD panel.

VI. CONCLUSION

In this paper, we present a real-time energy management system for a Smart Office, which integrates forecasting algorithms for predicting production/consumption trends with an optimizer to plan Smart Building operations in light of these predictions and actuals, as well as current energy prices. We conclude that our suggested system's integration is a

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legitimate support for reaching almost optimum schedules of the Smart Building's operating mode, which in turn guarantees considerable cost savings, based on the data supplied.

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