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Smart Energy Management: IoT-based Electricity Minimization Strategies

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Abstract

This paper presents an innovative approach to address the growing concerns of energy consumption by introducing smart energy management techniques based on the Internet of Things (IoT). With the rise in connected devices and the integration of IoT technologies, this research focuses on the development and implementation of strategies aimed at minimizing electricity usage in various contexts. The proposed system utilizes IoT sensors and data analytics to monitor, analyze, and optimize energy consumption patterns in real-time. Through intelligent automation and informed decision-making, the system identifies opportunities for energy savings, reduces wastage, and contributes to a more sustainable and cost-effective electricity management framework. This research not only explores the potential of IoT in energy minimization but also provides valuable insights into the future of smart energy management.

Keywords:- *Smart Energy Management, Internet of Things (IoT), Electricity Minimization, Energy Efficiency, Connected Devices, Data Analytics, Sustainable Technology, Automation, Energy Consumption Patterns, IoT Sensors*

INTRODUCTION

Colleges of the 21st century will become more and more self-controlled and automated due to the comfort it provides, especially when employed in a classroom and laboratories. A college automation system is a means that allow users to control electrical appliances of varying

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kind. Many existing, well-established college automation systems are based on wired communication. This doesn't pose a problem until the system is planned well in advance and installed during the physical construction of the building. But for existing buildings the implementation cost goes very high.

In contrast, Wireless systems can help for automation systems. With the advancement of wireless technologies such as Wi-Fi, cloud networks in the recent past, wireless systems are used every day & everywhere. IOT coverage is very wide and includes a variety of objects like Arduino and sensors. Once all these devices are connected to each other, they enable more and more smart processes and services that support our basic needs, economies, etc. Such a huge number of devices connected to the internet providers many kinds of services and produce huge amount of data and information.

The provision for the user to automate college is the main target of this system. There was a need to automate classrooms and laboratories so that users can take advantage of the technological advancement in such a way that a person can send a control signal to the college control center when he forgets to turn off devices such as fans, tube lights, computers instead of switching manually. Therefore, this system allows users to control college appliances from wherever he is and whenever he wishes.

College system may include centralized control of lighting, appliances, computers to provide improved convenience, comfort, and energy efficiency. The Popularity College Automation system has been increasing greatly in recent years due to much higher affordability and simplicity through internet connectivity. The concept of the "Internet of Things" is closely associated with the commercialization of Domestic/Industrial automation. As the number of controllable devices in the College rises, interconnection and communication between the devices becomes difficult.

The College Automation system can also provide a remote interface to Domestic/Industrial appliances or the system itself, via wireless transmission or the internet, to provide control and monitoring via a Web Application on the server. An example of Automation, this system could be triggered when a LDR sensor detects Low Light Intensity then it will automatically switch on the lights automatically.

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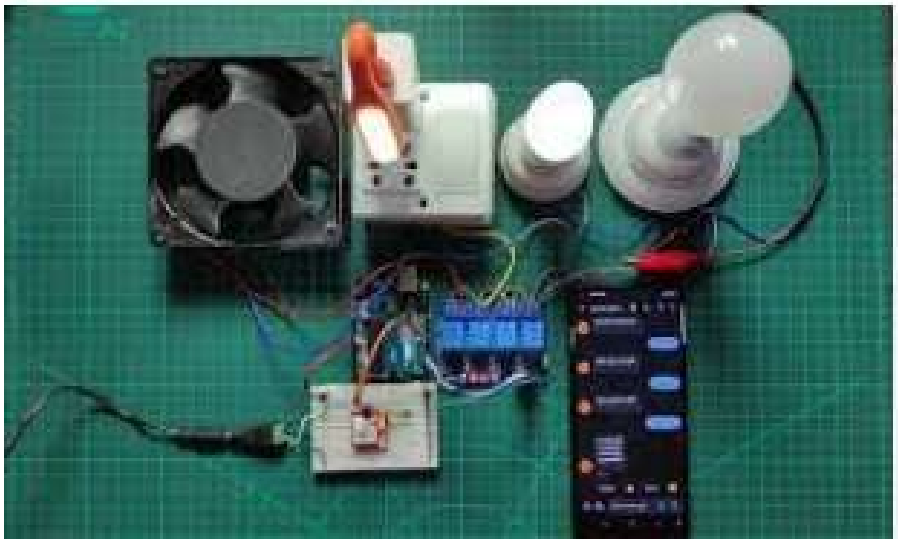
LITERATURE SURVEY

Existing system

GSM based Home Automation System:

The GSM network, the Internet and through speech the real time monitoring has been an important feature that can be used in the home automation systems. As a change in the status of the devices occurs, the user can be informed in real time. The user commands are transferred to a server which is usually done by a PC. The server processes the user commands and sends them to the relevant units. This can help control the appliances. GSM is used as a communication medium to help establish connection in places where there may not be proper internet connectivity. The server uses AT commands to communicate with the GSM modem. The mobile interface is developed using J2ME. The server has 4 engines running – the web server, database, main control program and speech recognition program. The system can be controlled using SMS.



Phone Based Home Automation:

A hardware based remote controller for power point control has been described [12]. The function of this remote controller is to control the power supplied to devices at a remote location. The system uses the telephone line for transmitting the commands. The controller is a logic system built entirely of hardware. It eliminates the cost incurred with microcontrollers. It uses a DTMF transceiver which is interfaced with a solid state relay to control the power supply. It could also be implemented experimentally with infra-red signals and AC power line carrier technology.

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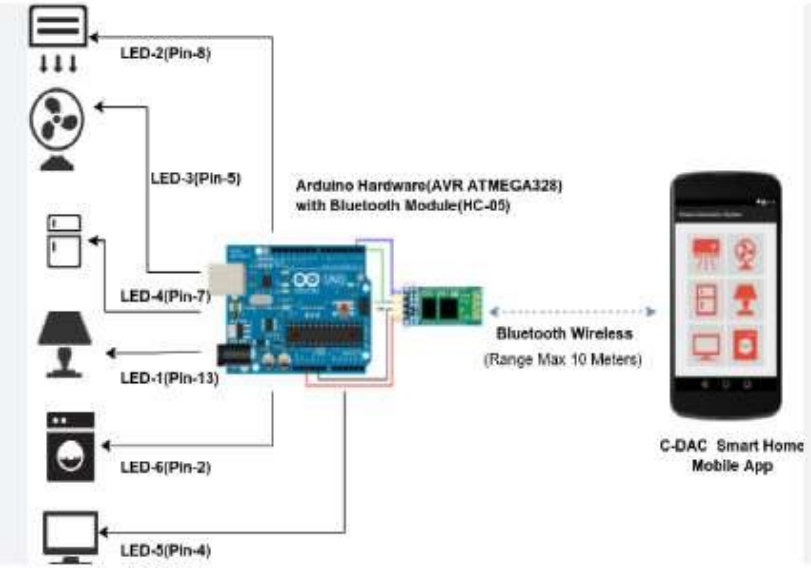

ARCHITECTURE DESIGN

Arduino

Arduino is an open-source electronics platform based on easy to use hardware & software. Arduino boards are able to read inputs, light on a sensor, a finger on a button, or a Twitter message and turn it into an output as activating a motor, turning on an LED, publishing something online. You can tell your board what to do by sending instructions to the microcontroller on the board. To those things you use the Arduino programming language (based on Wiring), and the Arduino Software (IDE), based on Processing.

Over the years Arduino have been the brain of thousands of projects, from everyday objects to complex scientific instruments. A worldwide community of makers - students, hobbyists, artists, programmers, and professionals - has gathered around this open-source platform, their contributions have added up to a huge amount of accessible knowledge that can be of great help to novices and experts in the same way.

Arduino was made at the Ivrea Interaction Design Institute as an easy tool for fast prototyping, aimed at students without a background in electronics and programming. As soon as it reached a wider community, the Arduino board started changing to adapt to new needs & challenges, differentiating its offer from simple 8-bit boards to products for IoT applications, 3D printing, and wearable and embedded environments. All Arduino boards are completely open source, empowering users to build them independently and eventually adapt

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them to their particular requirements. The software is also open source, and it is growing through the contributions of users worldwide.

It's simple and accessible user experience; Arduino has been used in thousands of different projects and applications. The Arduino software is easy to use for beginners, yet adaptable enough for advanced users. It runs on Mac, Windows, and Linux. Teachers and students use it to make low cost scientific instruments, to prove chemistry and physics principles, or to get started with programming and robotics.

Designers and architects build interactive models, musicians and artists use it for installations and to experiment with new musical instruments. Makers, of course, use it to make many of the projects exhibited at the Maker Faire, for example. Arduino is a key tool to learn new things. Anyone - children, hobbyists, artists, programmers - can start tinkering just following the step by step instructions of a kit, or sharing ideas online with other members of the Arduino community.

SENSORS

Motion Detection Sensor-

This is a Pyroelectric sensor (PIR) module which developed for human body detection. It is also called Motion Sensor. A PIR detector combined with a Fresnel lens is mounted on a compact size PCB together with an analog IC, & limited components to form the module. It detects the motion by detecting the changes in the IR levels emitted from the object. It can be used as a motion detector for security systems and robotics. It works from 3.3 V to5V DC and gives a TTL output, which can be directly given to a microcontroller or to relay through a transistor.

Figure:-1 Motion sensor

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Light Sensor (LDR)-

The Light Sensor generates an output signal indicating the intensity of light by measuring the radiant energy that exists in a very narrow range of frequencies basically called“light”, and which ranges in frequency from “Infra-red” to “Visible” up to “Ultraviolet” light spectrum**.** ***(Figure:-2)***

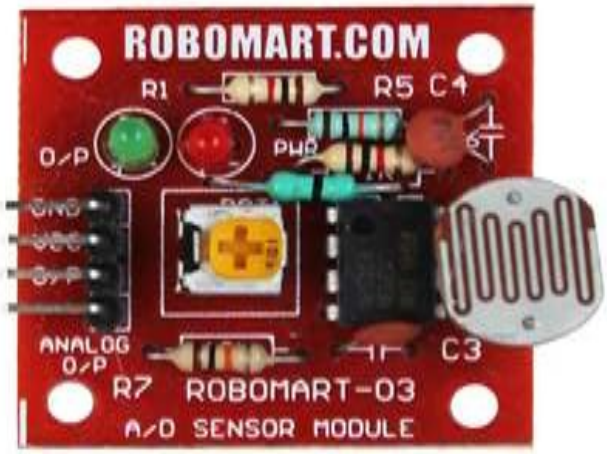

Figure:-2 LDR sensor

Flame Sensor-

It can detect the flame or wavelength at 760 nm to 760 nm range of light, the lighter the test flame distance is 80 cm, on the flame, the greater the distance test. The detection Angle of 60 degreesis specifically sensitive to the flame spectrum. The sensitivity adjustable digital potentiometer to adjust the comparator output, signal clean, good waveform, driving capability is strong, for more than 15 ma With adjustable precision potentiometer sensitivity adjustment. The working voltage of 3.3 Volt to 5 Volt Output form: digital switch output (0 & 1). Has a fixed bolt hole, convenient installation. Small board PCB size is 3.2 cm x 1.4 cm. Use the LM393 wide voltage comparator.

Module USES:

1. It isvery sensitive to the flame. Flame sensor also responds to ordinary light, generally used for fire alarm purposes.

2. The small plate output interface can be directly connected to a microcontroller IO port

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3. Sensor and fire to keep a certain distance, to avoid the damage of high temperature sensors, distance of the test flame for lighter is 80 cm, on the flame, the greater the distance test.***(Figure:-3)***

Figure:-3Flame sensor

DHT11 Temperature & Humidity Sensor features a temperature & humidity sensor complex with a calibrated digital signal output. By using the exclusive digital-signal-acquisition technique and temperature & humidity sensing technology, it ensures high reliability and excellent long-term stability. This sensor includes a resistive-type humidity measurement component and an NTC temperature measurement component, and connects to a high performance 8-bit microcontroller, offering excellent quality, fast response, anti-interference ability and cost-effectiveness.

Figure:-4 DHT11 sensor

CONCLUSION

Electricity Minimization is undeniably a resource which can make a classroom and labs automated. People can control their electrical devices via this system and set up the controlling actions in the computer. This product will have high potential for marketing in the

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future. At the moment the components are a bit too high to be able to produce these devices for an interesting price. This project work is complete on its own in remotely and automatically switching on and off of any electrical appliance not limited to household appliances, and sends a feedback message indicating the new present state of the appliance. It does not implement control of multiple appliances or automatic detection of faults in the controlled appliance.

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