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IoT for Smart Building

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***Abstract*—** Smart buildings promise to improve efficiency by reducing operating costs and increase the safety, productivity and quality of life of those who work and live inside their walls. Although the capital costs associated with smart buildings are higher than those for conventional ones, the life-cycle costs of smart buildings are lower and payback happens quicker. Smart buildings have been shown to save energy, streamline building management and prevent expensive equipment failures. Although they are more expensive to build, over the long run, they actually cost less than conventional buildings over time as a result of how efficiently they run. The added benefits of increased safety and a higher quality of life for those inside make smart buildings a good style of living for the future.

Keywords- *Internet of things, PIC controller, smart building, Wi-Fi module, web server.*

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I. INTRODUCTION

The Internet of things is emerging technology in the industrial sector. The concept of "smart city" does not offer only improvements in the quality of life of the inhabitants but also greatly improves efficiency regarding asset management. The term smart cities industry spans five key areas, 1) Energy 2) Water 3) Mobility 4) Buildings and 5) Government. The next granular evolution of the smart city is the application of these concepts in a more confined physical space of commercial building environments. In fact, nearly all the applications for smart cities have comparable applicability to building management. The aim of a smart building is to improve occupants comfort to achieve energy savings, avoid or reduce damages by sending warnings and increase security compared to the traditional system etc. This aim is completed by technical solutions incorporated in building management systems (BMSs), which are increasingly based on IoT principles. Inexpensive sensors are emerging and user friendly applications are becoming available. These developments are now driving the deployment of the IoT in building applications. A BMS is a comprehensive platform employed to monitor and control a building's mechanical and electrical equipment. Through the integration of IoT and building systems, our smart building can understand user journeys, data and space utilization, allowing for asset decisions and savings to be driven by real data. By connecting temperature control, power management, lighting and spaces it can allows us to create smarter performance through data and analytics, allowing for a continual listing and efficiency management of each building or destination.

II. SCOPE OF THE SYSTEM

Daniel Minoli, Kazem Sohraby, and Benedict Occhiogrosso [1], mentioned that a related and cost effective user level IoT application is the support of IoT enabled smart buildings. Commercial space has substantial requirements in terms of comfort, usability, security and energy management. Joy Dutta and Sarbani Roy [2], presented a prototype of a smart building using newly surfacing technologies like IoT (Internet of Things), fog and cloud for the smart city. The aim is to improve the standard of living in a home and in an office with newly improved working facilities where the whole system will be automatic, efficient and will be under the control of the user via his/her smart phone or computer within the budget of a common man. Magno, T. Polonelli, L. Benini, E. Popovici, Senior Member [3], mentioned that a novel system to control LED lighting with a low cost and low power wireless sensor network has been proposed. The method requires the deployment of complementary sensors with ZigBee radio that generate a PWM signal to control existing commercial LED drivers which can significantly reduce the power consumption of the LED lighting.. Kanae MATSUI [4], mentioned that Home Energy Management System (HEMS) is one of the main compartments of a "smart city", is conceived as utilizing IoT, and should be implemented widely to achieve energy conservation. An information provision system using sensory data could contribute to creating a low-cost information-based home energy management system.

Kaustubh Joshi and Theophilus Benson [5], studied a new application of using network function virtualization (NFV) to integrate multiple access network (wireless and optical) functions and consolidate them in an "edge cloud computing" site close to the consumers. Consolidation of traditional edge functions such as routing, Dynamic Host Configuration Protocol (DHCP), quality of service (QoS), and traditional central office (CO) functions like telephony and video services into the edge site, a system can achieve dual objectives. Consolidating functions that runs inside each home into the cloud improves the ability for operators to manage and update these functions. On the other hand, by moving traditional CO functions to run closer to end users, more fine grained control such as per user energy management can be achieved.

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III. RESEARCH METHODOLOGY

Existing in building management system operates manually. In the manual system, there is a possibility of wastage of energy. Proposed system operates automatically. It increases accuracy, low energy consumption and user comfort. The main objective of this project is to improve occupants comfort and efficient utilization of energy.

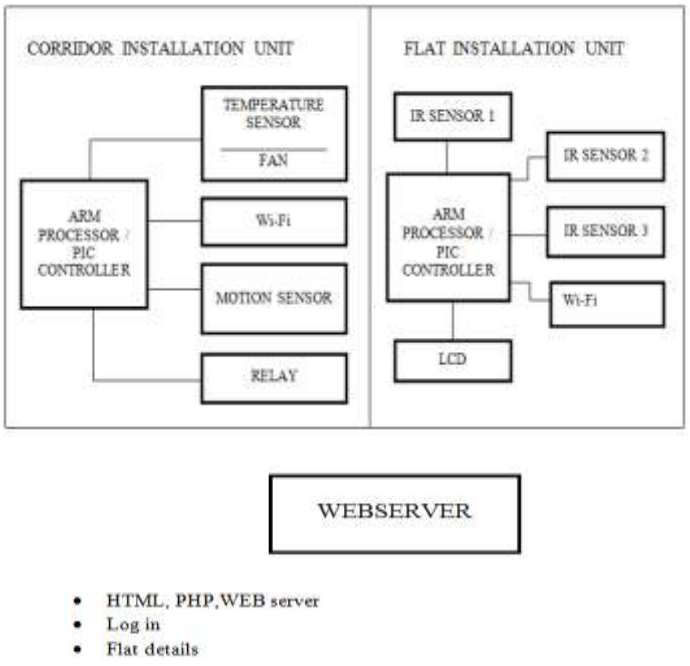

Figure 1. Block diagram of Smart Building System

A. *Elements of the system*

1. Corridor installation unit:
   - This unit is placed in the corridor.
   - Set default temperature.
   - Temperature above default temperature sense the sensor then this status updated on a website through Wi-Fi then the fan will start.
   - The light will start only when a person enters into a corridor, which is detected by a motion sensor.
   - So, that we achieve energy saving and also ventilation into a corridor.

2. Flat installation unit:
   - IR sensor will detect the person either going inside a flat or outside flat.
   - This information is updated on to a website.
   - So that we detect all members are present or not.
   - This count is shown on LCD.
   - This system is for security purpose of the smart building.

3. WEB server
   - User ID and password is provided.
   - On the website, we see details of flat members.

B. *Design steps*

i. Selection of the main component of system i.e. ARM processor/PIC controller for both units.
ii. Here we are using the temperature sensor. By detecting temperature fan will start.
iii. This light will not start unless and until motion is detected. For that motion sensor is to be used.
iv. We are using 8266 Wi-Fi module. The status is updated on a website through Wi-Fi.
v. In a flat installation, use IR sensor. To detect person going inside or outside so that, we can count a number of members present inside a home.
vi. Develop code using Keil software.
vii. On the server side, develop a website. For that HTML, PHP languages are required.

C. *Flow Chart*

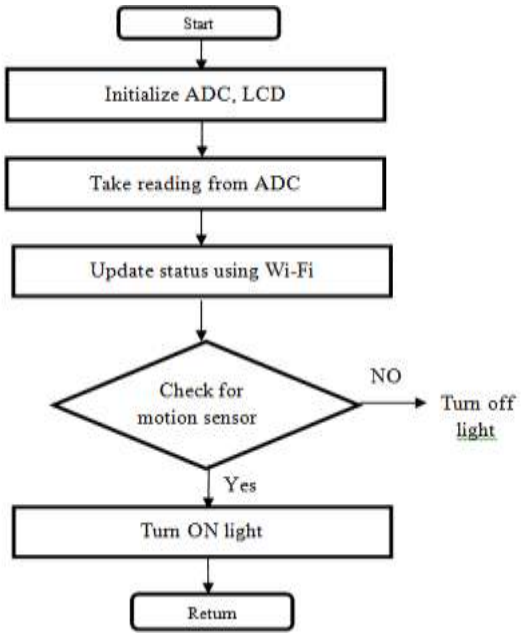

Figure 2. Flow chart of corridor installation unit

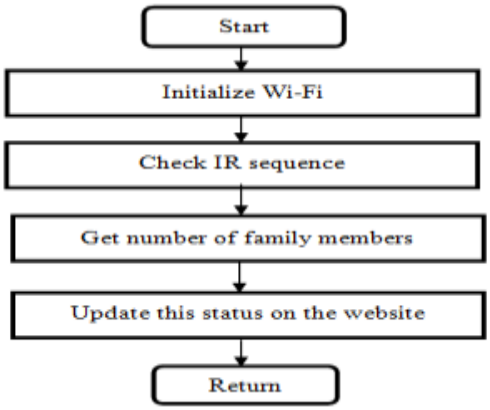

Figure 3. Flow chart of flat installation unit

As shown in Figure 2, when we start the system, initialize ADC and LCD. Update this status on a website using Wi-Fi. According to reading fan will start. Then, check for the motion sensor. If motion is detected then turn on a light, otherwise light will off. To achieve energy saving.

As shown in Figure 3, in a flat installation, initialize Wi-Fi, check IR sensor sequence. According to sequence, we get

either person is going outside or inside. So we get a number of members present into the flat. Update this status on the website.

D. System Implementation

The steps of implementation are:

1. Completion of the hardware part

i. In this system main component is PIC microcontroller 16F877A. This powerful (200 nanosecond instruction execution) yet easy-to-program (only 35 single word instructions) CMOS FLASH-based 8-bit microcontroller packs Microchip's powerful PIC® architecture into an 40 pin package.

ii. Temperature sensor is LM35. The LM35 series are precision integrated-circuit temperature devices with an output voltage linearly-proportional to the Centigrade temperature. The LM35 device has an advantage over linear temperature sensors calibrated in Kelvin, as the user is not required to subtract a large constant voltage from the output to obtain convenient Centigrade scaling.

iii. Wi-fi module used is 8266. The ESP8266 is a low cost Wi-Fi microchip. The chip first came to the attention of western makers in August 2014 with the ESP-01 module, made by a third-party manufacturer, Ai-Thinker. This small module allows microcontrollers to connect to a Wi-Fi network and make simple TCP/IP connections using Hayes-style commands. However, at the time there was almost no English-language documentation on the chip and the commands it accepted. The very low price and the fact that there were very few external components on the module which suggested that it could eventually be very inexpensive in volume, attracted many hackers to explore the module, chip, and the software on it, as well as to translate the Chinese documentation.

iv. An infrared sensor is an electronic device that emits in order to sense some aspects of the surroundings. An IR sensor can measure the heat of an object as well as detects the motion. These types of sensors measures only infrared radiation, rather than emitting it that is called as a passive IR sensor. Usually in the infrared spectrum, all the objects radiate some form of thermal radiations. These types of radiations are invisible to our eyes, that can be detected by an infrared sensor. The emitter is simply an IR LED (Light Emitting Diode) and the detector is simply an IR photodiode which is sensitive to IR light of the same wavelength as that emitted by the IR LED. When IR light falls on the photodiode, The resistances and these output voltages, change in proportion to the magnitude of the IR light received.

2. Coding

Using C compiler we construct the instruction and using MPLAB software we can execute the code.

3. Designing of website

Using PHP and HTML languages we design the website. PHP is an acronym for "PHP, Hypertext Preprocessor". PHP is a widely-used, open source scripting language. PHP scripts are executed on the server. Hypertext Markup Language (HTML) is the standard markup language for creating web pages and web applications.

4. Testing of an overall system

System testing of software or hardware is testing conducted on a complete, integrated system to evaluate the system's compliance with its specified requirements.

E. Effectiveness of the system

Existing in building management system operates manually. In the manual system, there is a possibility of wastage of energy. Proposed system operates automatically. It increases accuracy, low energy consumption and user comfort.

F. Future scope

Smart buildings based on IoT concepts are expected to evolve rapidly in the next five years. The confluence of IoT is expected to enhance the functionality, capabilities, energy efficiency and cost effectiveness of buildings. In recent years, governments and regulatory agencies around the world have increased their focus on commercial buildings, given the fact that buildings are large consumers of energy.

IV. CONCLUSION

A BMS is a comprehensive platform employed to monitor and control a building's mechanical and electrical equipment. Through the integration of IoT and building systems, our smart building can understand user journeys, data and space utilization, allowing for asset decisions and savings to be driven by real data. The concept of smart cities is emerging in multiple continents, where enhanced street lighting controls, infrastructure monitoring, public safety and surveillance, physical security, gunshot detection, meter reading, and transportation analysis and optimization systems are being deployed on a city wide scale.

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