Internet of Things Based Smart Building

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Abstract: The Internet of Things is an extension of the existing connections between people and computers to include digitally-connected "things." IoT encourages the communication between devices, also famously known as Machine-to-Machine communication. Because of this, the physical devices are able to stay connected and hence the total transparency is available with lesser inefficiencies and greater quality. Due to physical objects getting connected and controlled digitally and centrally with wireless infrastructure, there is a large amount of automation and control in the workings. Without human intervention, the machines are able to communicate with each other leading to faster and timely output. Internet of things based smart building makes use of energy consumption. In accordance to 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 biggest advantage of IoT is saving money.

Keywords: **Internet of Things, Smart building, Building Management System, PIC Microcontroller, Webserver**

I. INTRODUCTION

The Internet of things (IoT) is emerging technology in the industrial sector. The concept of "smart city" does not only offer 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 are Energy, water, mobility, buildings and 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 allow us to create smarter performance through data and analytics, allowing for a continual listing and efficiency management of each building or destination.

Commercial buildings have a wide range of monitoring, management and resource optimization requirements. A relevant observation is that energy is a relatively big-ticket item for many industries, including office buildings and corridor. Depending on how you use your smart building technology, it's possible to make your space more energy efficient. Another one aspect about a smart building is, maximizing home security. When you incorporate security and surveillance features in a smart home network, home security can skyrocket.

II. SCOPE OF THE SYSTEM

C.Karlof and D. Wagner[1], mentioned that the Internet of things (IoT) is the network of physical devices, vehicles, home appliances, and other items embedded with electronics, software, sensors, actuators, and connectivity which enables these things to connect, collect and exchange data, creating opportunities for more direct integration of the physical world into computer-based systems, resulting in efficiency improvements, economic benefits, and reduced human exertions. Our focus is on routing security in wireless sensor networks. K. Xu, Y. Qu, and K. Yang [2], proposed that The Internet of Things (IoT) is the network of physical objects embedded with actuators, RFIDs, sensors, software, and connectivity to enable it to interact with manufacturers, operators, and/or other connected devices to reach common goals. S. Ray, Y. Jin, and A. Ray Chowdhury, [3] proposed thatThe scope of impact of computing in this new era is also pervasive. It encompasses individual, enterprise, automotive, and cloud services, and brings together such diverse areas as security, energy efficiency, physical design, analytics, and software development. Q. Wang, W. Wang, and K. Sohraby, [4] studied with the popularity of multimedia sensing at cloud edges and the reducing cost of the Internet of Things (IoTs) fog devices and systems, new challenges have been posed to efficiently deal with the big data multimedia traffic generated from IoT sensing units. Big-volume-of-data (BVD) multimedia communications poses new challenges to the last-mile wireless access, due to the popularity of smart phone-based mobile devices and multimedia sensing capabilities in modern Internet of Things (IoTs). E. Z. Tragoset al., [5] mentioned that the Internet of Things (IoT) has emerged lately as a promising set of technologies for interconnecting effectively and efficiently a large number of heterogeneous smart devices via the Internet. The goal is to create a global virtual network infrastructure where devices could talk one to another without human intervention, providing advanced applications to the end users. IoT applications cover a wide range of sectors from smart agriculture, environmental monitoring, smart transportation, waste management, etc.

III. RESEARCH METHODOLOGY

The system architecture of IoT based smart building is shown in Fig. 1. It consists of a different block explaining the architecture of proposed scheme.

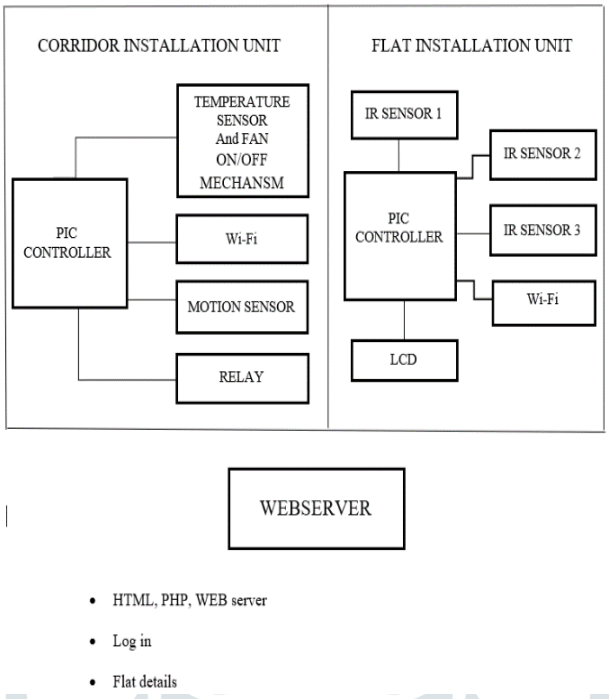

Fig. 1 Block diagram of Internet of Things based Smart Building System.

Fig.1 shows the block diagram of internet of things based smart building system. PIC (Programmable Interface Controller) is main component of the system. It is electronics circuits that can be programmed to carry out a vast range of tasks. In this system, status of devices is sent to PIC microcontrollers then it is uploaded to web pages using Wi-Fi. Here we are using PIR (Passive Infrared Sensor) as a motion sensor. A passive infrared sensor (PIR sensor) is an electronic sensor that measures infrared (IR) light LED dating from object in its field of view. They are most often used in PIR based motion detectors. The term passive in this instance refers to the fact that PIR devices do not generate or radiate energy for detection purposes. They work entirely by detecting infrared radiation emitted by or reflected from objects.

IV. ELEMENTS OF THE SYSTEM

A. *Corridor Installation Unit*

This corridor installation unit contains PIC microcontroller, temperature sensor, motion sensor, Wi-Fi module and relays. This device is placed into the corridor. To reduce the consumption of energy it is placed into corridor. For temperature sensor, threshold temperature is set. So that whenever we required fan should be ON it will get started. Temperature above default temperature sense the sensor then this temperature reading goes to the host computer of building through wi-fi. Then this status updated on a website through Wi-Fi then the fan will start. Also motion sensor will work whenever the motion detected. The light will start only when a person enters into a corridor, which is detected by a motion sensor. Due to this, all devices work efficiently. So, that we achieve energy saving and also ventilation into a corridor.

B. *Flat Installation Unit*

This unit contains PIC microcontroller, IR sensors, Wi-Fi module and LCD. This device is used for the counting of person present inside the flat. IR sensor will detect the person either going inside a flat or outside flat. This count is given to host computer of building through Wi-Fi. Then this count is updated to the website through Wi-Fi. So that we detect all members are present or not. This count is also shown on LCD. This system is for security purpose of the smart building.

C. *WEB Server*

We will develop the website of smart building. On this website we will get the all information about the devices placed into the building. But this website is accessible only those having login ID and password. A Web server is a program that uses HTTP (Hypertext Transfer Protocol) to serve the files that form Web pages to users, in response to their requests, which are forwarded by their computers' HTTP clients.

D. Design Steps

i. Selection of main component of system ARM7 processor for both units.
ii. Here we are using temperature sensor LM35. By detecting temperature fan will start.
iii. This light will not start unless and until motion will detected. For that motion sensor required.
iv. We are using 8266 Wi-Fi module. The status is updated on website through Wi-Fi.
v. In flat installation, IR sensor is used. To detect person going inside or outside.
vi. So that, we can count number of members present inside home.
vii. For this programming code is developed. For that MPLAB software is used.
viii. On the server side, website is developed. For that HTML, PHP languages required.

V. FLOW CHART FOR CORRIDOR INSTALLATION UNIT

This flow chart shows that how it works and controls the devices. Unit installed into corridor is for the purpose of saving energy. In unit one we are using temperature sensor LM35. According to temperature fan will get turn ON and OFF. Also, according to motion sensor light will turn ON and OFF.

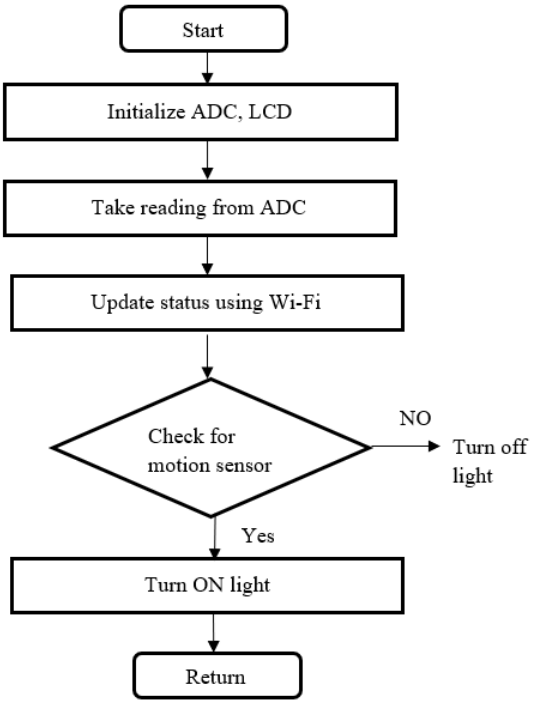

Fig. 2 Flow chart for corridor installation unit

In the above flow chart, working of system present in corridor is shown. First we have to initialize ADC and LCD. Then output of temperature sensor is in analog form. ADC will convert this into digital form. This digital reading is given to computer through wifi and then this status is updated to webserver. If updated temperature is above threshold temperature and if motion detected. Then turn ON light and fan. If motion not detected then turn OFF the light. In this way system present in corridor unit works. In this way we achieve energy saving.

VI. FLOW CHART FOR FLAT INSTALLATION UNIT

This flow chart shows that how this system works and counts the number of people present into the flat. This system is developed for the security purpose.

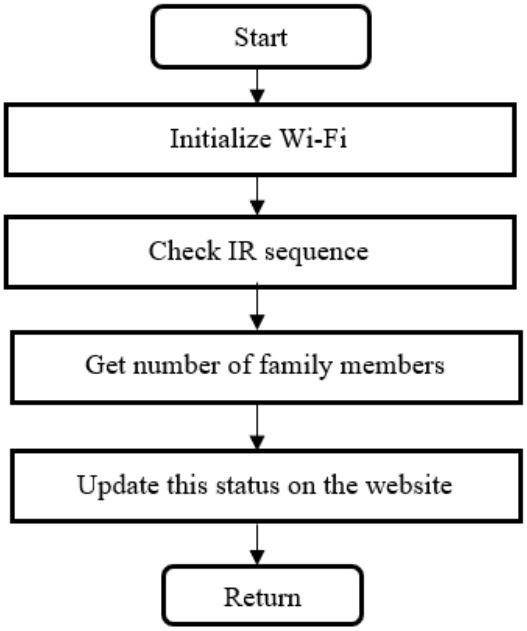

Fig. 3 Flow chart for flat installation unit

In the above flow chart working of system present in flat is shown. In this, initialize Wi-Fi, check IR sensor sequence. According to sequence, we get either person is going outside or inside. This sequence of IR is updated to webserver through wi-fi. So, we get a number of members present into the flat. In this way we can calculate how many people going inside or outside.

VII. SYSTEM IMPLEMENTATION

The steps of implementation are,

1. Completion of the hardware part

i) Selection of PIC controller. Here we are using 16F877A controller. PIC (Programmable Interface Controller) is main component of the system. It is electronics circuits that can be programmed to carry out a vast range of tasks. They can be programmed to be timer or to control a production line and much more. PIC microcontrollers are relatively cheap and can be brought as pre-built circuits or as kits that can be assembled by the user.

ii) Here, LM35 temperature sensor used. LM 35 is device which is device designed specifically to measure the hotness or coldness of an object. The purpose of using LM35 is, the temperature can be measured more accurately than with a thermistor.

iii) A passive infrared sensor (PIR sensor) is an electronic sensor that measures infrared (IR) light LED dating from object in its field of view. They are most often used in PIR based motion detectors. The term passive in this instance refers to the fact that PIR devices do not generate or radiate energy for detection purposes. They work entirely by detecting infrared radiation emitted by or reflected from objects.

iv) The ESP 8266 wifi module is a self-contained SOC with integrated TCP/IP protocol stack that can give any microcontroller access to wifi network. The data sent to the PIC microcontroller is uploaded to the website. This work of uploading is done by the wifi.

2. Coding

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

3. Designing of website

Hypertext Markup Language (HTML) is the standard markup language for creating web pages and web applications. With Cascading Style Sheets (CSS) and JavaScript, it forms a triad of cornerstone technologies for the World Wide Web. Web browsers receive HTML documents from a web server or from local storage and render the documents into multimedia web pages. HTML describes the structure of a web page semantically and originally included cues for the appearance of the document. HTML elements are the building blocks of HTML pages. With HTML constructs, images and other objects such as interactive forms may be embedded into the rendered page. HTML provides a means to create structured documents by denoting structural semantics for text such as headings, paragraphs, lists, links, quotes and other items.

VIII. ROJECT MODULE

A. Corridor Installation Unit

This device is used to reduce the consumption of energy it is placed into corridor.

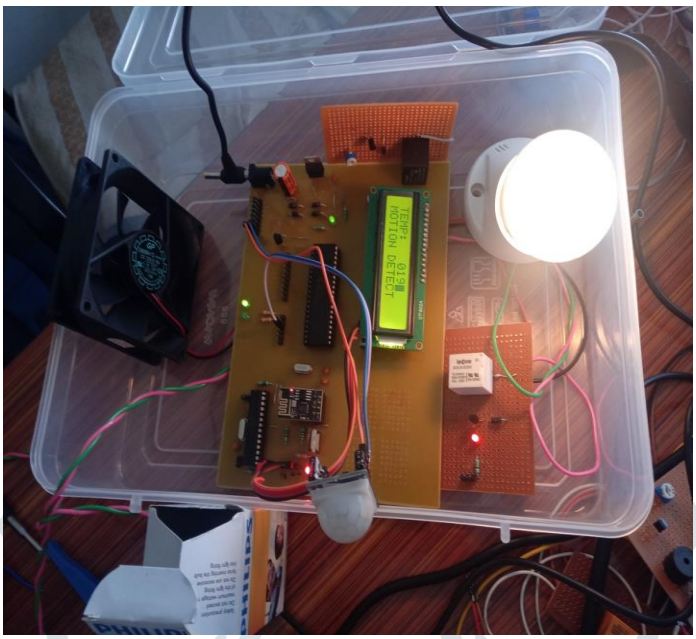

Fig. 4 Project module of corridor installation unit

As we are using temperature sensor to measure the temperature. Here, we set the default temperature. If temperature goes above default temperature then fan will be started. Also, we are using motion sensor, to detect motion. If motion detected then light will be started. This temperature and motion status are shown on to the LCD. Due to this, all devices work efficiently. So, that we achieve energy saving and also ventilation into a corridor. This information is updated to visual studio software through Wi-Fi. and simultaneously updated to the website.

B. Flat Installation Unit

This device is used to count number of members present in the flat. This unit is placed into the corridor.

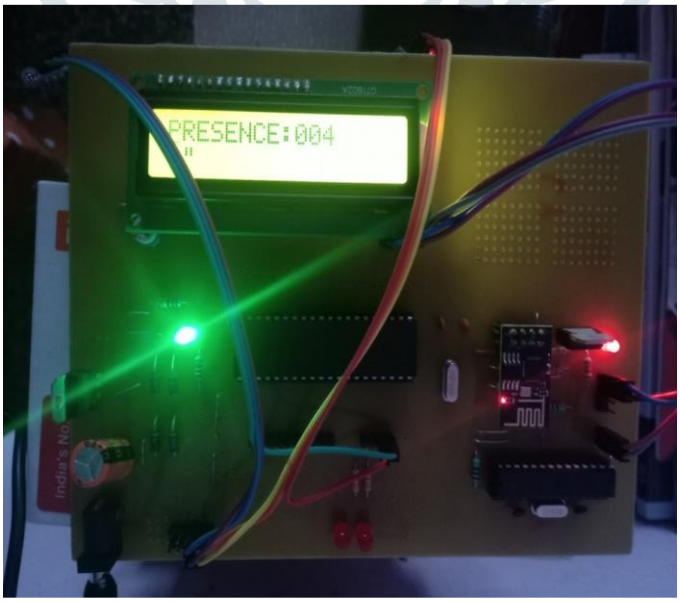

Fig. 5 Project module of flat installation unit

As we are using IR sensor to count the number of members present in the flat. This count is shown on to the LCD. This system is for security purpose of the smart building. This information is updated to visual studio software through Wi-Fi. And simultaneously updated to the website.

IX. RESULTS AND DISCUSSION

A. Visual Studio Application of IoT Based Smart Building

a. Login Page

A login is set of credentials used to authenticate a user. Most often, these consist of a username and password. Logins are used by websites, computer applications, and mobile apps. They are a security measure designed to prevent unauthorized access to confidential data. To access the software, we have to logged in. Only authorised person should log in.

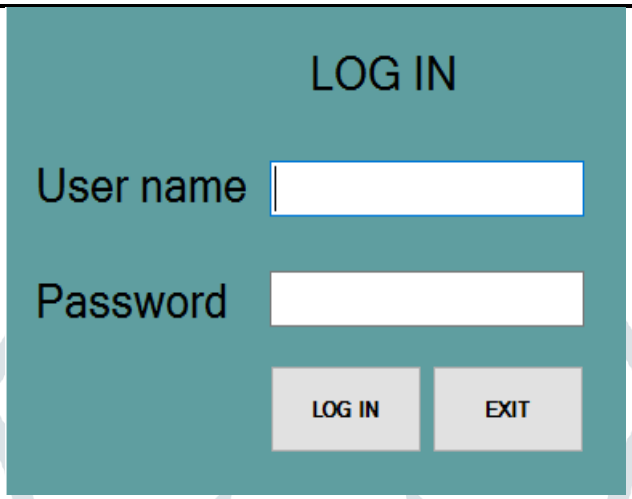

Fig. 6 Application of login page

In above figure to access software we have to enter user name and password. If it fails, we have to enter again user name and password until it successfully logged on. Only to authorised person user name and password given.

b. Connect to Device

To connect the device, addresses of Wi-Fi are different. According to address we connect to device.

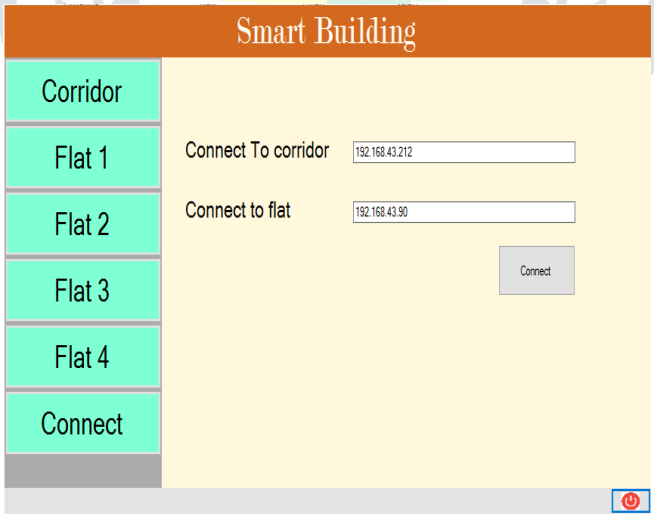

Fig. 7 Application of connection of device

In above figure, we can see that according to addresses corridor and flat unit connected to Wi-Fi.

c. Corridor Status

On this page we can see the status of device. Here, we are using temperature sensor and motion sensor. If temperature is above threshold temperature then fan will turn on. If motion detected then light will turn ON. This status of device uploaded to website.

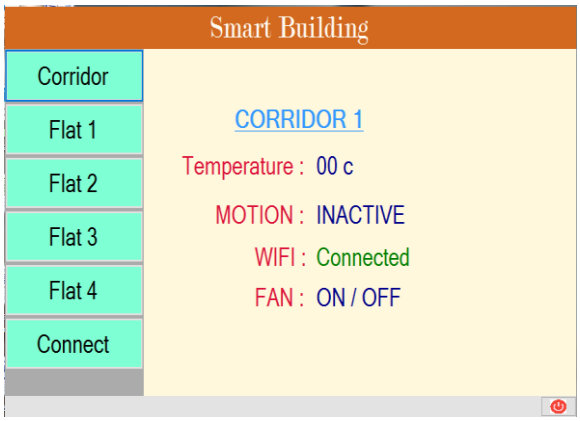

Fig. 8 Application of corridor status

In this figure Wi-Fi is connected. But motion sensor is inactive. So, that fan and light are in OFF position. Due to this we achieve less energy consumption. It is very efficient system.

d. Flat Status

In this to get number of members present in the flat we are using IR sensor. For security purpose we are using this system.

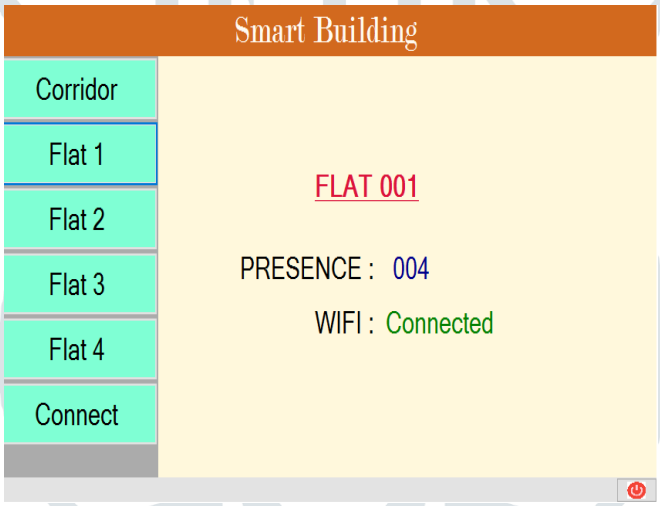

Fig. 9 Application of flat status

In this software we can see that Wi-Fi is connected. And four members are present in the flat. This status of members is updated to website through Wi-Fi.

A. Website Presentation of IoT Based Smart Building

a. Webpage

A login, logging in or logging on is the entering of identifier information into a system by a user in order to access that system (e.g., a computer or a website). It is an integral part of computer security procedures. A login generally requires the user to enter two pieces of information, first a user name and then a password. This information is entered into a login window on a GUI (graphical user interface) or on the command line in a console (i.e., an all-text mode screen), depending on the system and situation. A user name, also referred to as an account name, is a string (i.e., sequence of characters) that uniquely identifies a user. User names can be the same as or related to the real names of users, or they can be completely arbitrary. A password is likewise a string, but it differs from a user name in that it is intended to be kept a secret that is known only to its user and, perhaps, to the system administrator.

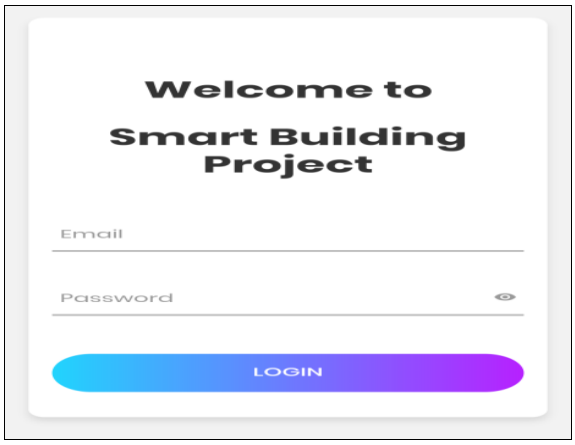

Fig. Fig. 10 Webpage of login

In this above login website login ID is email address and password are given to only authorized person.

b. Corridor Status Webpage

Home automation features also form a system that increases safety whether it is lighting your way when you get home at night or helping monitor an aged loved one with motion sensors. Heating and cooling accounts for more amount of an average home's energy use and costs.

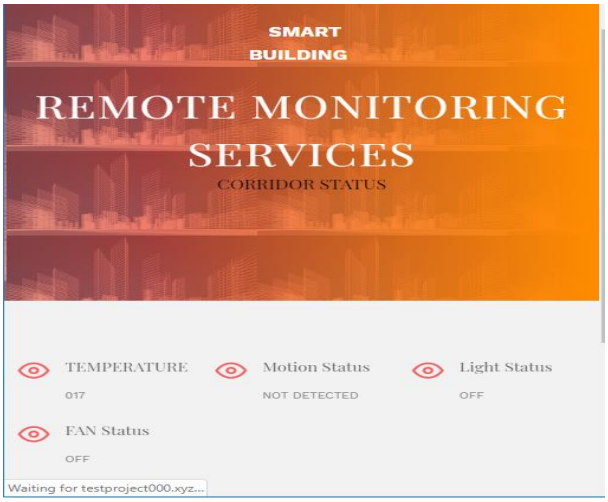

Fig. 11 Website of corridor status webpage

In this website we can monitor the devices placed into the corridor. Here, temperature is 17 C which less than threshold temperature is 30 C. So, that fan is in OFF position. And also, motion is not detected so that light is OFF.

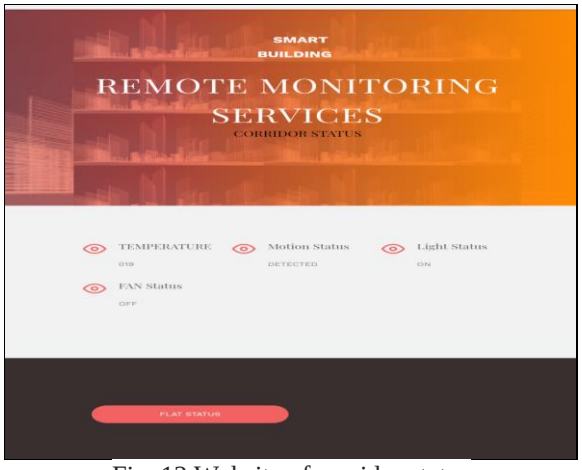

Fig. 12 Website of corridor status

In this website we can see that temperature is 19 C which is less than threshold temperature. So, that fan is in OFF position. Here, motion is detected so that light is turned ON.

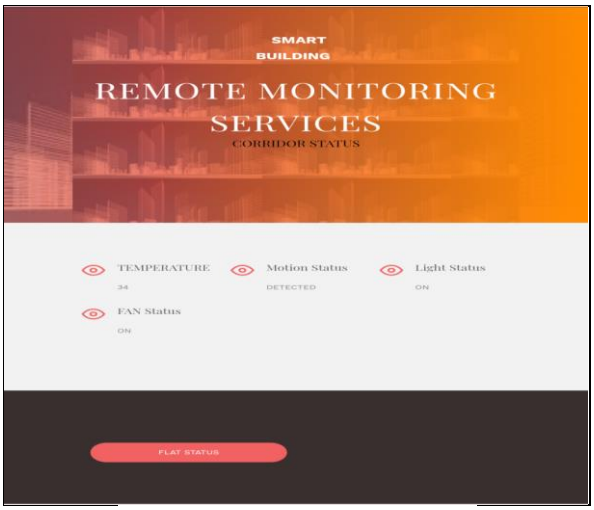

Fig. 13 Website of corridor status

In this website we can see that temperature is 34C so fan will turn ON and motion is detected so light will turn ON.

c. Flat Status Webpage

The purpose of this implemented system is to provide security to building. This purpose is achieved in this IoT based smart building. The use of IR sensor is going to fulfill our purpose.

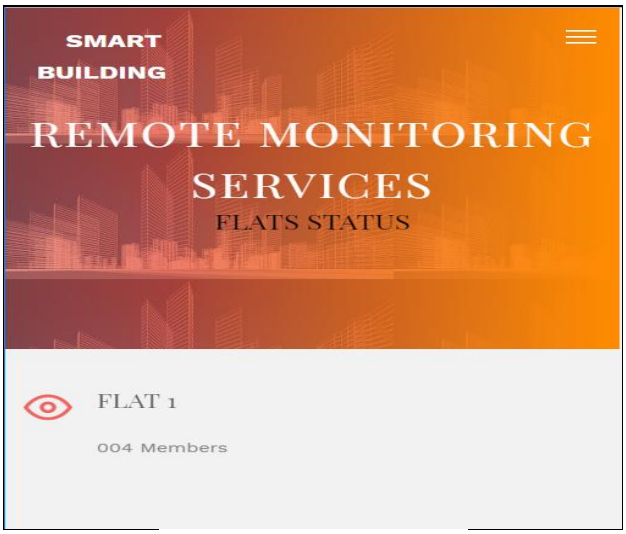

Fig. 14 Website of flat status

In this website we can count the number of members present in the flat. Here, in flat number one, four members are present.

X. CONCLUSION

Internet of things based smart building makes use of energy consumption. In accordance to 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. From result we conclude that, for threshold temperature fan will get automatically turn ON. As motion is detected light will turn ON. The status of devices updated to website of IoT based smart building. In this way we achieve energy saving and security of building. In flat installed unit, we count members present into the flat. Due to this security level of building increases. And from anywhere we can monitor the members present into flat. Smart buildings are a huge system that includes multiple technologies and applications that can be used to provide security and control of the home easily.

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