Energy efficient lightning strategies in buildings based on raspberry pi controller

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Abstract : Electricity is that the Minimum demand of a community for better lifestyle. Energy consumption graph is increasing day by day whereas the resources of energy are decreasing parallelly. Usage of power is growing drastically paving the style for parallelly. Consumption of power is growing drastically paving the style for energy economical technologies and excavation for renewable energy sources. At present, reducing energy demand within the residential, industrial and in any commercial places may be a nice challenge. The renewable energy is quenching really and demand for electricity is increasing very quickly. Therefore, this paper proposes a system for continuous observance of electrical appliances. The planned system will facilitate in reducing the energy wastage by unendingly perceptive the electrical appliances supported utterly totally different sensors input.

IndexTerms **- Sensors, wireless technology, WSN, Raspberry Pi**

I. INTRODUCTION

The energy efficiency, Energy saving and environment awareness is a recent and most popular topic now a days in current research. Electricity consumption devices and lightning systems are one of the major energy wastage sources in all over the world. In Asia, the quantity of electricity consumption employed in lightning buildings is approximately about 50% in which the energy wastage is about 10-15%. This energy wastage is due to the irresponsibility of the humans because they are unaware of how much amount of energy has been wasted in a day. And therefore now, in current years Asian government has started promoting the awareness campaigns towards energy saving and energy consumption. The foregoing research based on energy efficiency and industrial projects shows that simple lightning can be controlled by PIR sensor (PyorelectricInfraRed sensor) which is known for its motion detection. These sensors are terribly effective in saving the electricity that are used for lightning building however currently there are such a big amount of new advanced analysis happen which are far more effective in energy saving than before. These advanced devices have better lightning control strategies, great potential and better flexibility, offer many more benefits over straightforward on/off systems. Some advanced management ways, such as day lightning or load shedding are available but they need much more system-oriented approach, and therefore they are not so successful. When these lightning control components are specified as a system then they often do not work well together specially in dimming applications. This wiring is so complex and hence more complicated to work in the field, resulting in poor performance. To overcome these types of problems, the best approach is to slowly convert analog operative world into digital one with WSN technology based- ICT (Information and Communication Technology).

Many researches divulge that there are some wired systems available which are helpful in controlling lightning systems. These wired systems also appraise the artificial and day light radiance by the utilization of sensors to control the light intensity and thus its energy consumption is achieved. But due to existence of number of wires and cables for communication and transmission that wired system is not so much reliable and complicated to handle. Therefore maintainability of these wired systems have become a great challenge to the user. To overcome these wired related problems recent studies introduce wireless sensor network i.e. WSN technology. The WSN technology is more reliable and more popular in the demand side. This technology is way higher and really straightforward to put in and maintain. When this WSN technology-based ICT is combined with DC powered lightning system, this package provides advantageous options for energy efficiency [5].

This paper proposes a smart control system which is built and distributed into the testbed area. This smart control system is connected to the dc powered lightning system: i) to gather the sensors data from indoor surroundings for quality observance, , ii) For controlling and adjusting lightning system , a real time analysis is performed. iii) For Optimization and reduction in the energy consumption Raspberry Pi is used.

iv) Upload the real time data on the cloud. v) Controlling the premises environment by bluetooth terminal app. The overall purpose of designing this dynamic system is to reduce the undesired wastage of energy consumption and to help the user to vigil the premises for real time analysis in different clouds i.e., in the web [10].

RELEATED WORK

Maintaining electricity consumption is incredibly vital to save lots of electricity for our coming generations There are numerous researches that already gave their best in this field however these researches are applicable solely on little scale. Because of hyperbolic consumption of electricity day by day some advanced analysis ought to be taken place that's applicable on giant scale. Although to urge the data and to understand wherever and the way abundant strategies may be enforced. Numerous literatures are surveyed and are conferred below:

M. Mango et al. (2013). In this paper, author proposes a low cost, easy to install, flexible, wireless smart LED lightning system which automatically adjust the radiance of light to reduce electricity. By using Zigbee communication with the help of motion sensors and light sensors consumer can easily control the energy consumption [1].

D. Caicedo et al. (2013). In this paper, author proposes an algorithm which solves the problem of large energy consumption of LED. By using this algorithm light intensity will be automatically controlled and hence energy saving is increased [2].

Y. K.Tan, et al. (2013). This paper provides the information about the uses of smart sensors to maintain the dc powered LED lightning. By using smart sensors the intensity of light is same as in conventional method but the energy saving by this method is 44% [3].

J. Love et al. (2011). In this paper, the author performs field experiment by taking two rooms side by side. Then author investigates the impact of various configurations of manually-operated venetian blinds system on the comparison of commercial photocontrolled continuous dimming lighting control system. This method gives energy efficiency upto 5 to 45% when the sky is cleared [4].

Researches associated with monitor, control, energy saving, and energy potency are highly regarded and plenty of researches are performed associated with this[5].IOT connected researches provide several techniques and solutions that are terribly price effective and economical [6].The two main technologies used in above researches are wired and wireless technology. Wired technology works on the principle in which sensors measure the artificial and daylight illumination in a particular network area to improve the light intensity and energy efficiency. But due to the presence of huge number of wires and cables, the devices are not so much economical, especially at the time of installation and maintenance. Consequently these large numbers of wires produce a lot of handling problems [7]. So, to overcome all this types of issues wireless systems are used, which become more popular than wired system for monitoring and controlling. WSN is used to regulate the energy in buildings and offices and its way more economical to handle and make no different issues. WSN is being used for sensing parameters like temperature, humidity and gas in buildings and unfriendly environments conjointly [14][15].WSN uses different protocols to communicate with different sensors [12].

Recently, WSN is employed in energy efficiency applications, such as one of the present project, Bluetooth based energy efficient system, which is one among the necessary arduino project [16].Arduino based energy efficient system using bluetooth module helps the user to manage electronic devices and also helps in controlling electricity using Bluetooth terminal app on their android smart phone [17]. The Bluetooth terminal app sends commands to the arduino through wireless communication i.e. from bluetooth. The arduino is connected to main system which has few relays that are further connected to different electronic devices.

In voice recognition based home automation the wireless communication between smart phone and arduino Uno is done through bluetooth technology. This will be advantageous for handicapped and aged people who want to control appliances by speaking voice command. The communication between user and voice recognition tool depends on signal to noise ratio(SNR) [13].If noise signal is noisy then communication can highly effect and system will fail to show accuracy. All these systems are arduino based mostly, that facilitate in energy efficiency, controlling and observing the buildings however these arduino don't seem to be most correct, economical and versatile To overcome this problem Raspberry Pi controllers are used [19].

Raspberry Pi models are recently launched models. They can be considered as mini computers with several features [18].The comparisons between arduino and raspberry Pi2 model are shown below in table 1.

TABLE I
A COMPARISON BETWEEN RASPBERRY PI AND ARDUINO UNO

	Arduino Uno	Raspberry pi2
Price	Rs 300-1500	Rs 2635
Size	7.6x1.9x6.4cm	8.6x5.4x1.7cm
Memory	4MB	512MB
Clock Speed	16MHZ	700MHZ
Operating system	None	Linux Distributions
Input voltage	7to12v	5v
Flash	32kb	SD card (2 to 16GB)
USB	One, input only	Two peripherals
Multitasking	No	Yes
Time to market	minimum	maximum
Latency	poor	Better
Maintainability	poor	Better

The table shows that the Raspberry Pi2 has several advanced options than arduino Uno. However Raspberry Pi also has some disadvantages i.e. it is tough to handle, maintain and to control. Moreover its initial price is additionally higher than arduino UNO. So the decision to choose controller depends upon the need of the system.

METHODOLOGY

Till currently there are such a lot of researches that are performed. However there are totally different issues conferred with the i.e. lack in security, flexibility, efficiency, saving electricity in accordance with the user desires. So as to beat the drawbacks of various strategies, this paper proposes an energy efficient smart building automation system which is designed for building lightning and automation [8].This interactive energy efficiency system can be prepared by taking Raspberry Pi2 as a processing unit. Sensors are used for Data collection units. Based on Sensor values, this system can automatically control the devices and provide energy efficiency. We are using PIR sensor for recognizing the persons. Temperature, LDR sensors are monitoring the Room parameters. All information is then analyzed in Raspberry Pi2, which controls the FAN and Bulbs. After analyzing, this information is then used to alert gas leakage by using gas sensor and provide alert with the help of Buzzer. All these information are monitored in the Web server by using GPRS module. And Bluetooth Module is then used for Monitoring Sensor values locally which also controls the devices according to the Sensor values. The proposed system of given methodology is shown in below figure3.

BLOCKDIAGRAM:

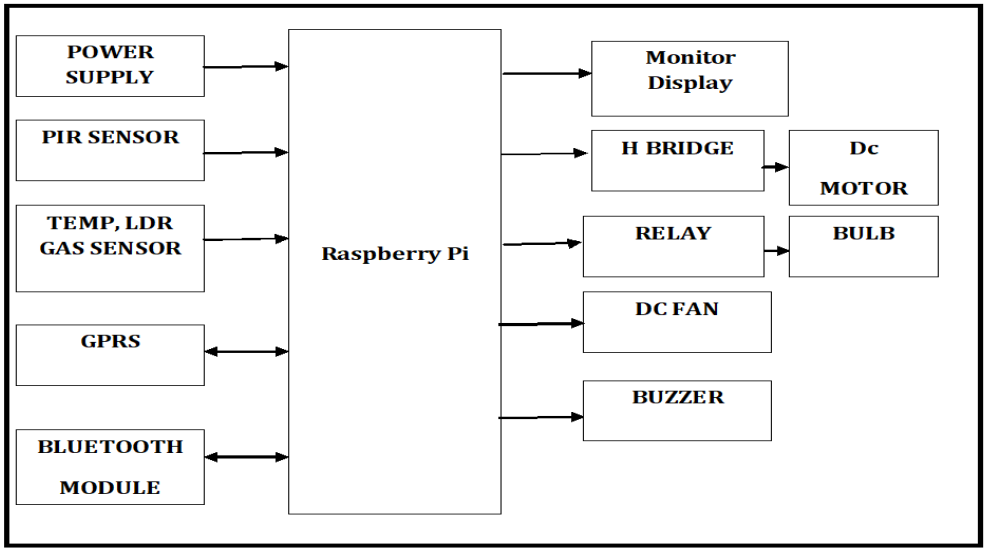

Figure3: System block diagram

3.1 Microcontroller Section:

This is the main unit of the entire system. This basically consists of a Microcontroller (Raspberry pi) with its related circuits like Crystal with capacitors, Reset circuits, resistors (if required) and many more. The microcontroller is the core of the research because it manages all the devices to work according to the program coded. In this we use the Raspberry pi as microcontroller. The Raspberry pi is a mini computer board with debit cardsize which will be used for several functions as any pc will as a result of it keeps its software system, documents and package programs, it works as a traditional pc at low price server to handle net traffic. It has two peripherals which is very beneficial by using these peripherals many sensors are used at a time with the help of WSN. These controllers are very portable and have a very low cost. The Raspberry pi has two models in it and they are model A and model B. The important difference between these two models is presence of USB peripherals. Model A board will take less power but doesn't have Ethernet port while model B includes an Ethernet port. So, decision of choosing the models depends upon the need, however in this smart control system model B is used. .

3.2 Power Supply:

This section provides power to all the various parts of the proposed system. It generally consists of a Transformer to step down the 230V ac to 12V ac using diodes. Here diodes are used as a rectifier which converts the ac power to dc. The output of the rectifier is obtained as rippled dc which is filtered by capacitor. Then voltage regulator is used to regulate the obtained dc voltage.

3.3 C. PIR sensor:

A PIR sensor stands for Passive Infra-Red sensor which is an electronic device that detects infrared (IR) light radiation from objects in its surrounding area. PIR sensors are basically motion detectors. The motion is detected when an infrared light radiation with one temperature, such as a human, passes in front of an infrared light radiation with another temperature, such as a door.

3.4 Temperature sensor:

Thermistors are a temperature sensing device. In this research work thermistor operates on the value of temperature of the testbed.

3.5 LDR:

LDR stands for light dependent resistor which is basically used to measure the light intensity.

3.6 Humidity sensor:

Humidity sensor is an electronic device that measures the relative humidity of a surrounding area. A humidity sensor can be operate in both indoors and outdoors places. They are also available in both analog and digital forms.

3.7 GPRS:

This consists of a GPRS modem. The GPRS modem will communicate with raspberry pi using serial communication. The modem is interfaced to microcontroller using MAX 232, a serial driver. The GPRS stands for Global Packet Radio Service is a TDMA based digital wireless network technology which is used for the internet connection. GPRS module will be used to post data in the web page directly.

3.8 . Bluetooth:

AUBTM-22 is a Bluetooth v1.2 module with SPP profiles. The Bluetooth module is meant to be integrated into another host system which needs Bluetooth functions. The HOST system will send commands to AUBTM-22 through a UART.AUBTM-22 can analyze the commands and execute correct functions, e.g.to set the maximum transmit power, to vary the name of the module Later, the module can transmit the data receive from the UART with SPP profiles.

3.9 . DC Motor:

DC motor is used as an output for this proposed system. DC motor is connected to raspberry pi. And this motor is controlled by the raspberry pi with the appropriate inputs given by consumer. Its speed will be change according to the speed set by the switches

3.10. DC Fan:

Dc fan is also an output section which needs dc supply. So consumers can directly add the dc motor to raspberry pi with suitable transistor logic.

3.11 Relay Section:

This relay section consists of associate interfacing circuit to switch ON / OFF the system whenever any unhealthy conditions i.e. overload and faults, are detected. This electronic equipment primarily consists of a Relay, transistor and a protection diode. A relay is also used to operate the Ac (230V) devices.

3.12 Buzzer Section:

This consists of a Buzzer. The buzzer is used to alert / indicate the presence of fault. It is sometimes used to indicate the start of the embedded system by alerting during start-up.

HARDWARE DESIGN AND EXPERIMENTAL RESULTS

4.1 Smart automated hardware

The actual smart building automated systems hardware is shown below in figure4.

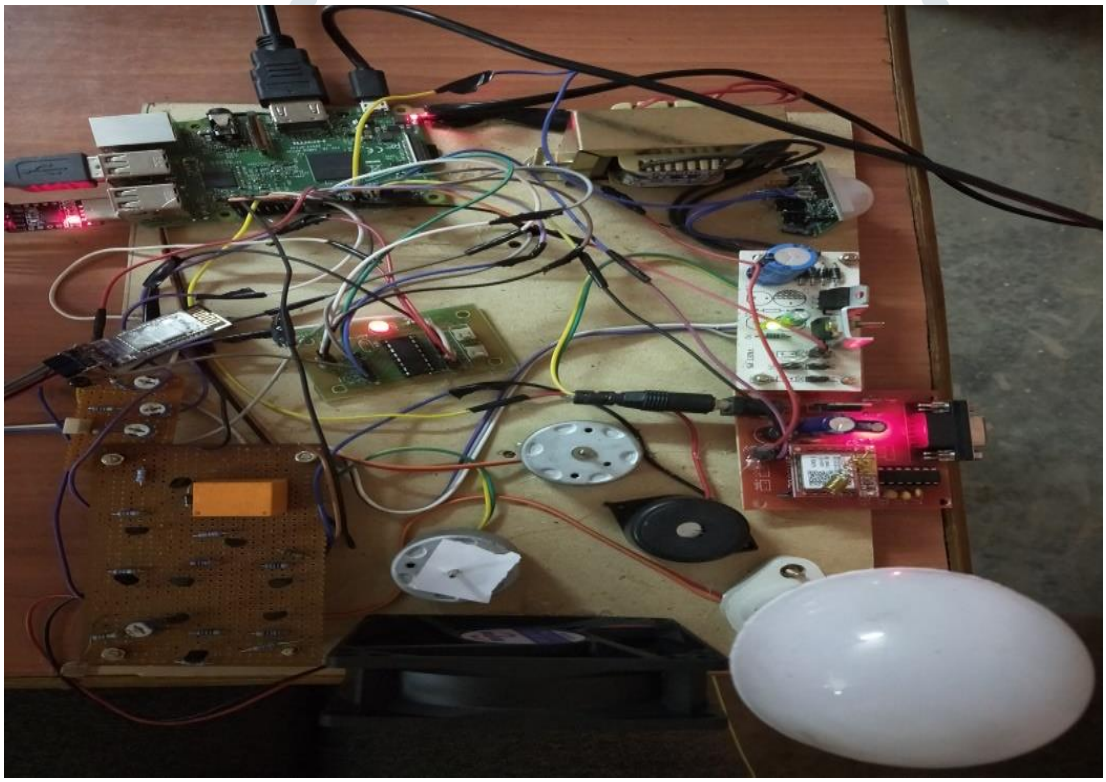

Figure 4: Connection Diagram

An architecture implemented on energy efficient DC/AC lightening grid is proposed. This proposal has many advantages such as better flexibility, easy handling, better energy efficiency and many more. All these great advantages are only possible by using Raspberry pi with WSN technology.

4.2 Controlling of whole equipment

With the help of bluetooth Beacon communication module [11] consumer can control the entire system, simply by giving the command “MANUAL” .In this manual mode the entire system works according to consumer needs by giving various commands. If consumer wants to perform entire system automatically, then by giving command “AUTO” the system will work automatically. This whole controlling process can be done using “Bluetooth Terminal APP” in consumer’s mobile phones and this will be shown in below figure5:

Figure 5: Bluetooth terminal App

The immediate consequence of this procedure is that the ability to benefit from an integrated wired and wireless solution that may facilitate to attain significant energy saving reduced operational price, perform risk management and enhance worker productivity. Furthermore, the IoT flexibility permits the straightforward upgradation of system at affordable prices. The IoT platform permits fast development within the market of innovative IoT applications, at an reasonable value, at intervals fraction of the time compared to alternative approaches [20]. This result is arises because of the mixing of a mostly distributed network engineered on the lighting infrastructure, with IoT devices, and to the synergies between energy management and IoT systems. The most infrastructures are prepared and simply obtainable, facilitating speedy application of intelligent solutions.

4.3 Displaying information

The results of the experiment done using Raspberry Pi is shown in figure 6. The result's showing the various readings which are taken by the different sensors through Bluetooth device which are displayed on the RaspberryPi desktop page.

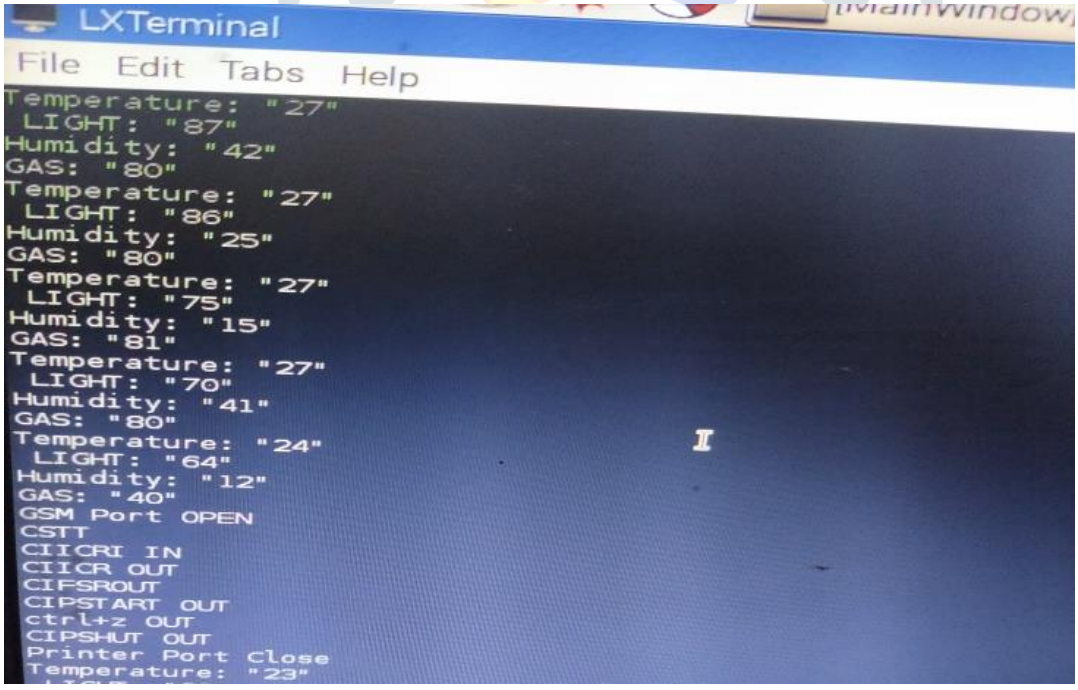

Figure 6: Result in Raspberry Pi desktop

and another figure7 and figure 8 shows the results which are uploaded in the different clouds so that users can easily see their real time data any time from any place in the web.

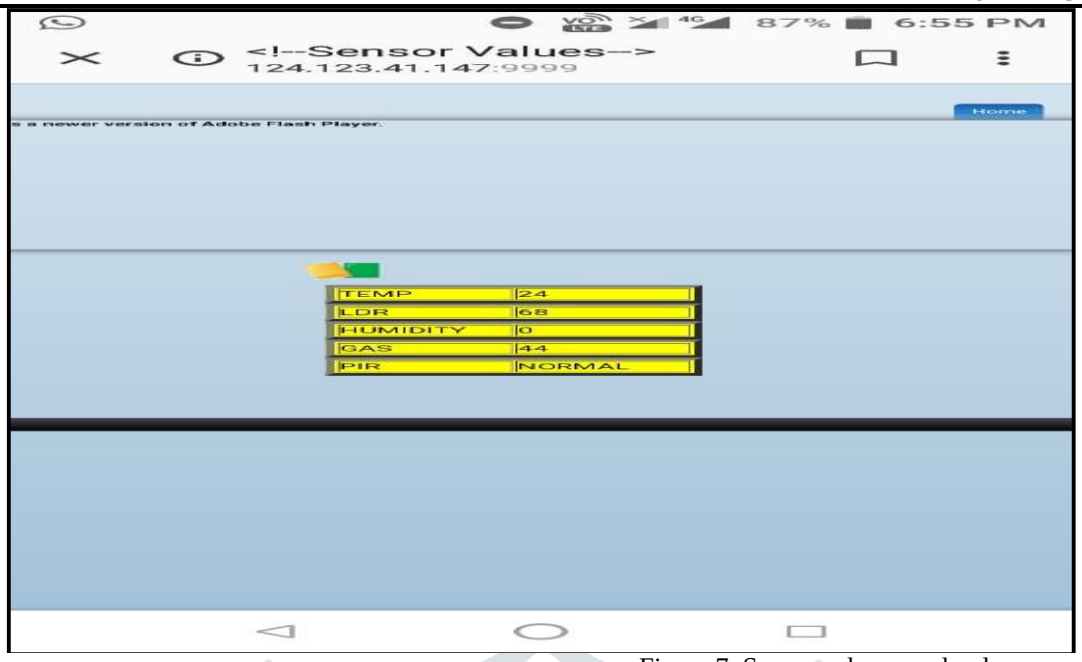

Figure 7: Sensor values on cloud

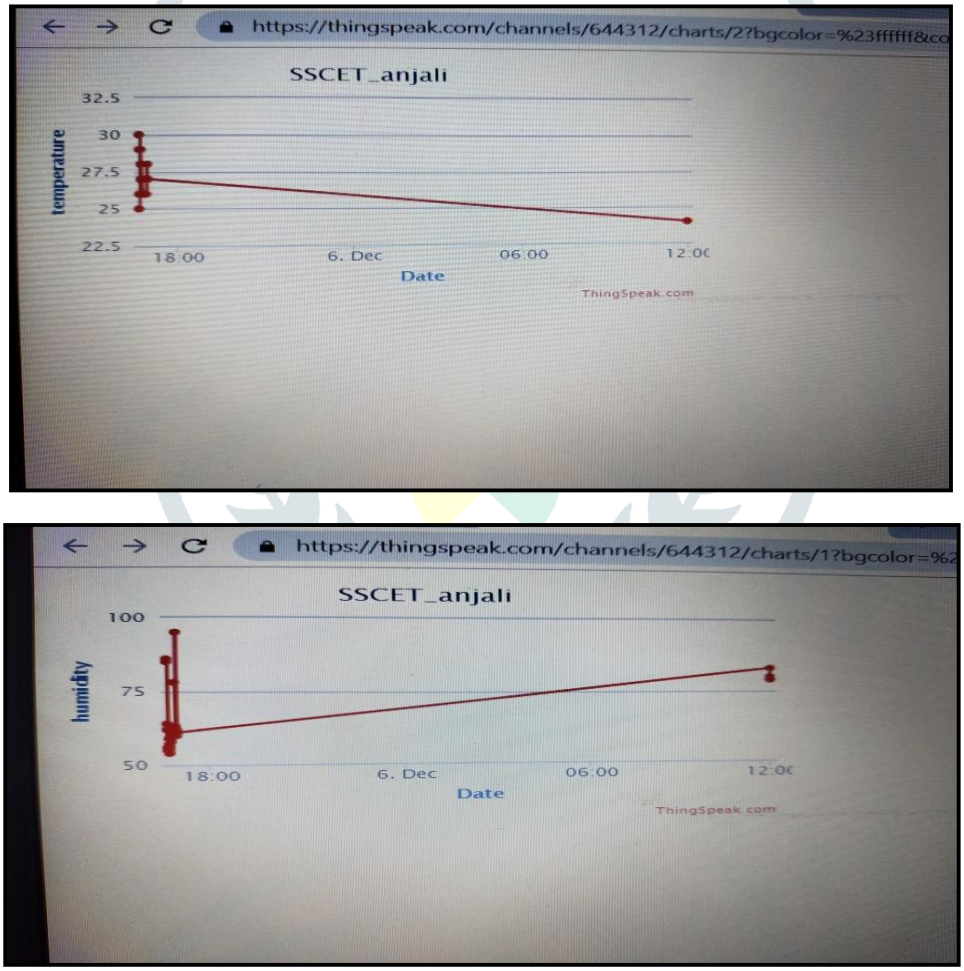

Figure 8: sensor values on another cloud

4.4 Power Saving evaluation

To demonstrate the planned system in terms of power efficiency a room is employed as a testbed and different readings are determined that is shown in below table2 [9].

TABLE 2
POWER EFFICIENCY MEASUREMENT DURING 5DAYS

Group	Day1	Day2	Day3	Day4	Day5
Room1	43% energy saving	32% energy saving	58% energy saving	18% energy saving	25% energy saving
Room2	38% energy saving	55% energy saving	32% energy saving	66% energy saving	11% energy saving

Total average power saving	44%

. V. CONCLUSION

This paper proposes smart building automation system that operates on numerous operations very efficiently. Integrating features of all the hardware components are used very effectively in this smart control system. Presence of every module has been reasoned out and placed cautiously thus contributing to the best working of the unit. Secondly, using highly advanced IC's and with the help of growing technology proposed research work becomes very flexible than existing system. Compared with several existing wire system, this technique wants no wires which supplies larger flexibility and efficiency. Also users will easily participate within the network with their sensible devices like mobiles that have BLE embedded therein which doesn't need any wires.

Application of this system had been demonstrated in two ways first in "AUTO" mode and second in "MANUAL" mode. In AUTO mode different sensors and hardwares are working automatically after applying power supply to them whereas in MANUAL mode the system can be controlled through bluetooth terminal app as per consumers need.

The data will be conjointly seen within the website that's updated in very few minutes by the GPRS module. Since it facilitates users know their data from any places.

APPENDIX

Appendix A

Data sheet of Raspberry pi 2 model B

TABLE III
DATA SHEET OF RASPERRY PI2 MODEL B

	SPECIFICATIONS
CHIP	Broadcom BCM2836 SoC
CORE ARCHITECTURE	Quad-core ARM Cortex-A7
CPU	900 MHz
GPU	Dual Core VideoCore IV® Multimedia Co-Processor Provides Open GL ES 2.0, hardware-accelerated OpenVG, and 1080p30 H.264 high-profile decode Capable of 1Gpixel/s, 1.5Gtexel/s or 24GFLOPs with texture filtering and DMA infrastructure
MEMORY	1GB LPDDR2
OPERATING SYSTEM	Boots from Micro SD card, running a version of the Linux operating system
DIMENSIONS	85 x 56 x 17mm
POWER	Micro USB socket 5V, 2A

Appendix B

Data sheet of AUBTM-22 (Bluetooth Module)

Key specification of Bluetooth module AUBTM-22 is shown below :-

- Bluetooth core V2.0 compliant
- SPP support
- Support UART,USB,PCM,I2C interface to host system

Electrical specifications :-

TABLE IV
ELECTRICAL SPECIFICATION OF AUBTM-22

CHARACTERISTICS	MIN.	MAX.	UNIT
OUTPUT POWER	-11	14	DBm
OPERATION CURRENT	-	170	Ma
SENSITIVITY	-	-70	dBm
SUPPLY VOLTAGE	2.7	3.7	V
RESOLUTION	-	8	Bits
OFFSET	-1	1	LSB
GAIN ERROR	-0.8	0.8	%
SAMPLE RATE		700	Samples/s

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