Smart System: IoT for University

Dr. Kamlesh sharma
Associate Professor, Computer science department
Lingaya‘s University
Faridabad, India
Kamlesh0581@gmail.com

Dr. T. Suryakanthi
Faculty of Computing
Botho University
Gaborone, Botswana
suryakanthi.tangirala@bothouniversity.ac.bw

Abstract—

The paper proposes an IoT (Internet of things) for the University campus. It discusses the development of a Smart System for a big campus, that will analyze the usage of all electrical and electronic devices and optimize the power consumption. The proposed system is developed using a combination of IoT, Wireless Sensors, Network Security, Green IT, Big Data Analysis. Special IoT sensors will be installed with every Electrical and Electronic device which will send the data to the cloud. The Whole network is monitored by computer expert system which will immediately notify the operation and maintenance team to take appropriate action on time. Using BIG data analysis, it is possible to optimize the usage of all device and power consumption. It will also help to improve the response time of operation by the maintenance team. As the system is designed to optimize the power consumption, so automatically it will reduce the cost and help us to go green.

Keywords—RFID; IoT;Wi-Fi; Green IT; Big Data

I. INTRODUCTION

The world is witnessing a new era of computing where different components interact in automated environment with least human interference. The interaction is among machine, infrastructure and environment work together to create a network through association of Radio Frequency Identification (RFID) and sensor network technologies. This combination will gradually adapt to meet new challenges leading to information and communication systems being invisibly embedded in the environment around.

The term Internet of Things was pioneered by Kevin Ashton in 1999 in the context of supply chain management [1]. However, in the last decade, the term has been applied more comprehensively to cover wide range of applications i.e. automation to be used domestic environment, organizational automation, healthcare, utilities, and transport are among a few to mention. [2]. The innovative improvements in technology has given a new meaning to ‗Things‘ as ‗some logical mechanism‘ to enable the computer to sense information almost independently or without manual support. The objects and identified logical mechanisms (things) interact with the physical world by open wireless technology including Bluetooth, radio frequency identification (RFID), Wi-Fi, and telephonic data services as well as embedded sensor and actuator nodes, IoT has grown significantly and is revolutionizing the business operations and its own traditional definitions [3].

The report of Cisco IBSG © 2011 Cisco and/or its affiliates provides meaningful analysis in support of Internet of Things. It was found that in the year 2003, approximately 6.3 billion people worldwide and 500 million devices were connected to the Internet. When the number of connected devices were divided by the world population, the ratio emerged to be less than one (0.08) device per person. Based on this report the concept it is interpreted that IoT didn‘t exist in 2003 due to relatively negligible number of internet connected things.

However, tremendous growth in mobile and smartphone technology, tablet PCs, I-pads etc. lead to the number of internet connected devices to 12.5 billion in 2010 against the world‘s human population of 6.8 billion. These facts made the ratio of connected devices per person to approximately 1.84 and created a history for future analysis as shown in table 1. Analyzing the implication of this analysis reveals that term IoT would have emerged sometime in the year 2008 or 2009 realistically.

Realizing the greater business potential, the present research effort is made to explore the areas of cost reduction through power management with the help of IoT concept in a University. Similary the concept can be applied almost in every sphere wherever the logical flow of information can be automated utilizing the suitable technological tools.

Year	World Population	Connected devices	Connected devices per person
2003	6.3	500	0.08
2010	6.8	12.5	1.84
2015	7.2	25	3.47
2020	7.6	50	6.58

Table 1. Growth estimation of IoT by Cisco IBSG

More logical thinking is required to understand the relationship between type of input required to generate the desired output. The reverse thinking process has to emerge from wanted results. In fact, the process should start by identifying the different processes, mechanical movements, images or verbal signals that will act as input to the data processing technologies viz. Radio Frequency Identification, Optical and sensor network technology to achieve a desired output.

Figure 1 .IoT smart phone implementation for a house

II. PROPOSED PROBLEM DEFINATION

The present paper deals with implementing the concept of IoT in university campus to optimize the utilization of power. In the present world the power consumption is very high in every organization.

The proposed system is a Centralized Power Consumption Monitoring System, whose primary objective is to optimize the use of power using the big data analysis. It acts like a Smart alert system to alarm for wastage of power. Here in the University the system is connected with University ERP (Roaster/ Time Table) to monitor the proper use of all electrical devices. The Smart System special feature is easier maintenance and fast servicing and access from anywhere anytime.

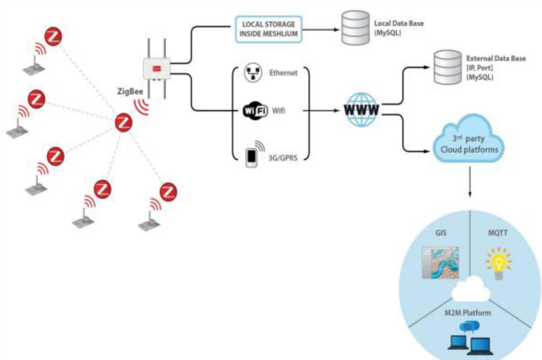

Figure 2 .Sketch of proposed system

Connected devices: These are electrical devices that are intelligent due to connection to the Internet and sensors. These devices know or are able to anticipate what a user needs.

Internet of Things: IoT is the fast growing computing technology which helps a university to operate more efficiently. With a combination of sensors, smarts systems, IoT connects everyday objects to a network, enabling those objects to complete tasks and communicate with each other, without user intervention.

Where all electrical devices of te university‘s like ACs, fans, lights etc. are connected to a central system that automates those devices based on user input.

III. Scenario in University

Generally it is found that when a lecture comes to end, and students have to change the location for next class, lecture, lab or lunch generally the electrical appliances remain operational even when there is no-one physically present in the classroom. The appliances are to be switched All students exit from the class and many times we noticed that they left the electrical and electronic devices remain switched on until and unless a security guard or other person check it and switch off the equipment/ device. And if the guard is lazy and do not switch off the equipment[14]. If the guard forgets to switch off any device or may be he is lazy then it waste a lot of power. Also A lot of man power is needed to monitor these activities which could be overcome by using IOT, Big Data analysis and Green IT[13].

The cameras can install in all rooms and galleries and in whole campus, but again need to monitor the all cameras which again time and man power wasting.

In proposed system all electrical and electronic devices will send real time data to the cloud. MEMS based sensors will monitor the power consumption, room temperature, humidity and light. There will be predefined raster/ time table entered into the system. If there is no class or attendee for the room and the devices are running systems in the room, the system automatically intimate the centralize control room that there is no class or attendee in the room means and power is consuming [15]. So the user can switch off the device from any location in the campus and out of the campus. It can monitor and analysis the power consumption by all devices and can find out when and where the electricity wastes. The basis of that analysis, it can arrange/ adjust the roaster/ time table to optimize the resources usage and save more electricity and man power[6][7]. Even it can improve the maintenance and services in case of equipment failure.

IV. DESIGN

The system is designed by integrating the IOT sensors (e.g Zigbee Sensors and Gateway) with every electrical and electronic device, this sensors will sense and communicate with smart network as shown in figure 2. The smart Network system interconnects all sensors as shown in figure

3 and figure 4. The proposed system is a centralized monitoring with auto notification feature. With the help of big data analysis, optimization of the usage of all devices and power was possible.

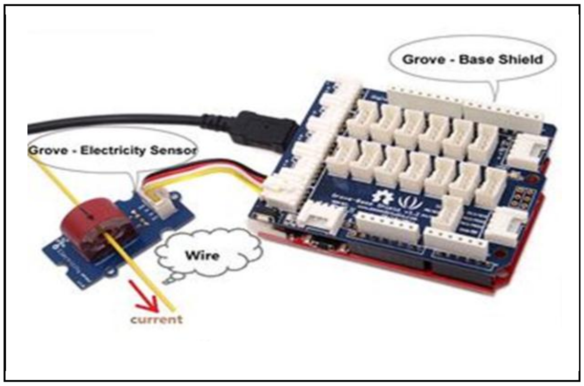

Figure 3. Zigbee Sensors

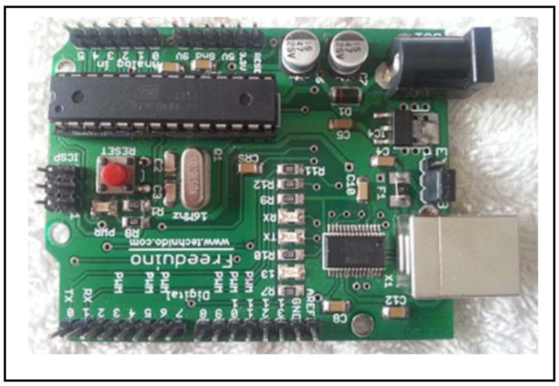

Figure 4. Zigbee Sensors on board

V. IMPLEMENTATION

Special IOT sensors will be installed on every device which will send the real time data to the cloud. Network system will ensure the connectivity of all sensors and provides the necessary security for the communication between all devices and internet. Network plays a critical role as the connectivity platform for control systems, operational systems, sensors, machines, and devices[12]. It must provide a secure infrastructure that can support billions of context-aware devices, people, processes, and data. Centralized monitoring system will notify the operation & maintenances team for down time and out of order devices. Intelligence reporting system and Big Data analysis will help to optimize the power consumption and usage of devices[4]. System can be controlled anywhere anytime with smart phones or tablets [5].

The system takes the input to help of sensors and then check it with the smart university controlled system which is connected with university ERP(Roaster/ Time Table) to monitor the proper use of all electrical devices. The system worked accordingly as shown in figure 5. It acts like a Smart, alert system when there is wasting of power. The Smart System special feature is easier maintenance and fast servicing and access from anywhere anytime [8][9].

Smart University Features

Feature	**Description**
Wireless connectivity	A hub that is Wi-Fi enabled doesn't need to be physically connected to router.
Expansion capability	The better , The higher the number of products/devices it can support
Protocol compatibility	A hub that can communicate with the major university automation protocols—Zigbee, Z-Wave, Wi-Fi and Bluetooth LE—is important, but what's more important is making sure it communicates with the devices that is already check for compatibility[10].
Scheduling /Automation System	The hub's software should be able to set up schedules for devices and create actions to connect different devices, such as an action that turns electricity off when not required according to university controlled system.
Alerts/Messaging	The software should be able to send alerts when chosen actions are completed, such as an alert when error is rectified or equipments required maintenance etc[11].

VI. TECHNOLOGY DETAILS

The Technology details of the system is listed in Table 2.

Sr. No	**Devices/ Systems**	**Use\ Specification\ Remarks**
1.	IOT Sensors and Gateway	Many IOT Sensors and Gateway sensors are available in the market which could interact with the electrical and mechanical devices and sends their data to cloud/ Server.
2.	Wireless/Wired	A Smart Network will be designed to interconnect all

	Network	wireless or wired devices and the with the Internet and Cloud system. GPRS, 3G, Wi-Fi, RJ 45, LAN, RFID, RF, Internet etc.
3.	Centralized Server / Cloud/ DATABASE	A Cloud/ server with Centralized DATABASE will be setup to store all data received from all devices and available the data any time anywhere.
4.	Application/ GUI/ Monitoring system	An Application will be designed to Monitor all devices. Application must send alert and notification of failure/ over usage / On-OFF. A Mobile app could be provided to relative user to control/ monitor the devices.
5.	Data Mining/ Intelligence Reports/ Optimization	With the help of data mining/ Intelligence reports/ Big Data analysis. We will be able to analyze the usage of power e.g peak hours, average usage, and optimize the power consumption by

Table 2. Technology Detail of System

VII. POWER CONSUMPTION CHART

Statistics of power consumption for devices in a university are shown in table 3. Average Power Units consumed by a CEILING FAN (75 WATTS) in 10 hours per day are 23Unit. If we use the same FAN for 8 Hours per day then the consumed units are 18 units which are 5 units lesser than the previous case. So if we have 100 no of FANS and we calculate the total units that could be saved in a month (we take 20 days except Saturday, Sunday and Holidays)

20 * 100 * 5 = 10000 Units of Power per month, which means, with this saved power we can run extra 27 no of FANs 8 Hours per day for 20 days.

Equipment Device Name	**Capacity (Watt)**	**Avg. Units Consumed in 30 Days (10 hours per day)**	**Avg. Units Consumed in 30 Days (8 hours per day)**	**Phases**
Shelling Fan	75	23	18	Phase 1
Lighting Tube/Bulb	50/ 100	16/ 30	12/ 24	
Air Conditioner (1/1.5 TON)	1400/ 2100	420/ 630	336/ 504	
Air Cooler and Blower	250/ 400	75/ 120	60/ 96	
PCs and UPS in Computer Labs	300	90	72	Phase 2
Electrical, Mechanical, Electronic Devices in Labs and Workshop	250 to 2500	75/ 650	50 to 500	
Other Misc Utilities (Exhaust Fan,Water Pump, Display TV, etc)	250 to 750	75/ 113	60 to 90	

Table 3. Power consumption

VIII. BENEFITS OF SMART NETWORK

- **Leads to Savings:** The usage of connected electrical devices of routine operations can be optimized leading to higher saving.
- **Facilitates Control:** The automated control of the machines through mobile technology, internet and sensor technology results in easy control of multiple devices from remote location.
- **Convenience to user:** Without moving to location, devices can be controlled through a center point.
- **Ensures Security:** It provides more effective monitoring of the existing security systems. The review

cycles could be fixed through sms alerts or e-mails etc and can be controlled round the clock even while being away from site.

- **Minimizes Supervision requirements:** Alarms and audible alert systems are integral part of IoT to provide system generated automated checks. This facilitates easy identification in case of any system failure and minimizes the need of direct human supervision.

IX Conclusion

The design of sensors with the special embedded system, network system and cloud system are critical part of the proposed system. The Sensor system will provide the real time data, The network system ensures connectivity & security and The cloud system will handle the overall big data. This system is proposed for the university campus later on it can be extended to other sectors like corporate offices, hospitals, hotels, and other huge power consumption industries.

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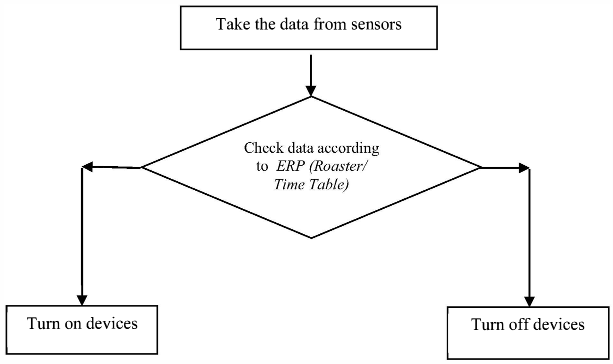

Figure 5: Flow chart of controlling the devices with the help of ERP(Roaster/Time Table)

Sample Code Measuring the Alternative Current for Arduino Sketch

```
#define ELECTRICITY_SENSOR A0 // Analog input pin that sensor is attached to

floatamplitude_current;          //amplitude current
floateffective_value;     //effective current

void setup()
{
        Serial.begin(9600);
        pins_init();
}
void loop()
{
        intsensor_max;
        sensor_max = getMaxValue();
        Serial.print("sensor_max = ");
        Serial.println(sensor_max);
        //the VCC on the Grove interface of the sensor is 5v
        amplitude_current=(float)sensor_max/1024*5/800*2000000;
        effective_value=amplitude_current/1.414;//minimum_current=1/1024*5/800*2000000/1.414=8.6(mA)
                                                   //Only for sinusoidal alternating current
        Serial.println("The amplitude of the current is(in mA)");
        Serial.println(amplitude_current,1);//Only one number after the decimal point
        Serial.println("The effective value of the current is(in mA)");
        Serial.println(effective_value,1);
}
voidpins_init()
{
        pinMode(ELECTRICITY_SENSOR, INPUT);
}
/*Function: Sample for 1000ms and get the maximum value from the SIG pin*/
intgetMaxValue()
{
        intsensorValue;         //value read from the sensor
        intsensorMax = 0;
        uint32_t start_time = millis();
        while((millis()-start_time) < 1000)//sample for 1000ms
        {
                sensorValue = analogRead(ELECTRICITY_SENSOR);
                if (sensorValue>sensorMax)
                {
                        /*record the maximum sensor value*/
                        sensorMax = sensorValue;
                }
        }
        returnsensorMax;
}
```

Sample output of the above program

```
sensor_max = 25
The amplitude of the current is(in mA)
305.2
The effective value of the current is(in mA)
215.8
sensor_max = 25
The amplitude of the current is(in mA)
305.2
The effective value of the current is(in mA)
215.8
sensor_max = 25
The amplitude of the current is(in mA)
305.2
The effective value of the current is(in mA)
215.8
sensor_max = 25
The amplitude of the current is(in mA)
305.2
```