IoT based Power Efficient System Design using Automation for Classrooms

Anisha Gupta[1], Punit Gupta[2], Jasmeet Chhabra[3]
[1, 2]Department of Computer Science Engineering,
Jaypee University of Information Technology, Himachal Pradesh, India
[3]Department of Electronics & Communication Engineering,
Jaypee University of Information Technology, Himachal Pradesh, India
[1]anishaa.20g@gmail.com, [2]punitg07@gmail.com, [3]jsc04.chhabra@gmail.com

***Abstract* - The paper presents the design and implementation of an Ethernet-based intelligent automated system for conserving electrical energy using a INTEL GALILEO 2ND generation development board, which can be used in large organizations like a University or an office. The proposed system works on automation, so that the electrical devices and switches can be remotely controlled and monitored without any human intervention. It uses the available infrastructure in a classroom that includes surveillance camera and Ethernet connectivity so as to minimize the cost criteria. It is monitored and controlled remotely from a web server located at the control room using the Internet or the Intranet connectivity. The proposed outcome of the project aims as multiple benefits, saving on electricity bills of the University or any other organization it is deployed in, eliminating human involvement and manpower which is often required to manually toggle the lights and electrical device on/off, and last but most importantly, conserve the precious natural resources by reducing electrical energy consumption.**

Keywords- Internet of thing (IoT), Power consumption smart devices, Home automation.

I. INTRODUCTION

Communication of the devices connected to an internet enabled network constitutes what is called 'Internet of Things'.The activity of sensing, communicating, networking and producing new information are the basic key features of Internet of Things(IOT). It is the state of ever-growing network of physical objects which features internet connectivity over IP address, and the communication that occurs between these objects and other network connected devices and systems.

The Internet of Things conceptually embodies intelligent visions of automating the day to day activities. Ideally, IoT will optimize our future routines with intelligent and robust systems that will make our life not only easily but also fast based upon our preferences and priorities like morning alarms, coffee timing, medicine uptake etc. Its vast applications will make our travel arrangements intelligently, by giving frequent updates on- minute and weather data. Our workflows will be smooth and refined, tasks will be prioritized based upon what is happening throughout our organization. It will help us maintain our appliances and vehicles, by notifying us about their maintenance and cleaning or – in the case of our lighting controls – automatic shutdown (based upon the usage and real time presence). It will enable our vehicles to communicate with other vehicles so as to maintain proper synchronization of traffic and tracking solutions. It will regulate our heaters, AC, and other home appliances and devices, to intelligently take decisions as we enter and exit rooms and based upon our usage level.

In short, IoT has the power to meet our every need before we even need realize what we want and will need. Interconnectedness and automation is the real power of IOT solutions. IoT has not only made our lives easier but also has lots of potential to drive economic value and social change. But still, 85% of things still are unconnected and a security threat pervasive, for which industry has yet to conquer the real potential of IoT. Automation is defined as "the creation and usage of technology to inspect and control the production and distribution of products and services."

Using our definition, the automation profession includes "everyone involved in the creation and usage of technology to inspect and control the production and distribution of products and services"; and the automation professional is "any individual involved in the creation and usage of technology to inspect and control the production and distribution of products and services."

In basic words, automation is the use of technologies to intelligently optimize productivity in the production of goods and services. Automation is applied in order to to increase quality, and/or productivity beyond the limitations of human labor levels in order to increase economies of scale, and/or realize predictable quality levels. Various control systems are involved for operating equipment such as machinery, processes in factories and industries, cooling refrigerators, telephonic switching networks, steering and robustness of ships, aircraft and other applications with minimal or reduced human

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intervention. Automation provides robust and efficient solutions to automate various processes.

Automation helps us in saving human labor, as well as used to increase the product quality, accuracy and precision. It also helps us in saving energy by using efficient and intelligent methods.

Maintaining comfortability in your office or building, while keeping a check on your energy bills is what we would wish for. Forgetting to turn off your classroom lights and office appliances for a period of long time can really add up on your electricity bills. **Reducing energy costs** by **controlling the lighting and temperature** based upon the real time occupancy and predicted schedule is an efficient way. A **smart and intelligent system** to maintain your routine chores is not only an efficient but **a robust way** to automate your heating and lighting systems. The system automatically set the setting as per the schedule or the real time occupancy which also allows to manually controlling the main settings with easy controls – Touchscreens.

Intelligent building efficiency is not just limited to offices but also to homes and institutes. The efficiency of home automation systems is improving and features are adding up which will prove to be a smart investment and easy on the pockets.

This paper proposes an IoT based autonomous power control system is proposed to minimize the power consumption and maximize utilization of resource by allocation room to request by timetable autonomously. Power based scheduling lead to efficient power computation.

II. RELATED WORK

Cloud Computation is a new domain and need more research to offer a low barrier to entry for system administration, providing a

Similarly research is going on for the advancement of iot and various products and services based on them, pertaining to one or more domains among those of Automation, Artificial Intelligence and Intelligent systems for energy conservation, Green Technology, and the likes.

Z-HOME

ZHOME [1] is a home automation Indian solution based on Z-Wave Home Automation technology which offers the best wireless solutions in terms of Security and Comfortability.

- Retrofit - Use existing switches, No Re-wiring
- Cost - 1/3 of solutions even from far east
- Complete - Integrates security, Lighting, AV Control and HVAC all in one
- Specialties - Home Automation, Lighting Controls, AV Automation, Building Management System
- Industry - Consumer Electronics

Z-Wave [2] is a wireless communication that helps you to talk to other devices wirelessly protocol.

- Long Distance control in residential and commercial environments
- Based upon low-power RF radio signals that are embedded into electronic devices and systems, such as music players, remote controls, RF watches and various other household appliances.
- has many applications in home automation
- Capabilities being demonstrated even in the roughest & most remote environments like from top of the Himalayas

ZHOME allows customers to start small and expand on the go. They offer custom packages priced low especially for direct customers. They provide a starter kit to start experiencing your home automation today. The kits are classified based upon their user need as 3BHK, 4BHK and Villas. They have basic kits and premium kits where the latter provides more additional features other than security and lighting solutions like curtain control, AV integration and advanced security features with push notifications on iOS devices.

Basic Starter Kit

• 21 Lighting Control

• 1 Home Controller

• 1 WiFi Surveillance camera

• 1 Remote Controller with Scene Capability

• 2 Motion Sensors & 1 Door Sensor

ZHOME Plus (Premium Kit) [2]

• 39 Lighting Control

• 1 Home Controller

• Premium touch screen with Aluminium flush mount

• 1 Remote Controller with Scene Capability

• 4 Motion sensors & 2 Door Sensors

• IP Camera for Video Door Phone

• 3 AC On/Off Control

• 2 Curtain Controllers

Villa Plus

- 45 Lighting Control
- 2 Home Controllers
- Premium touch screen with Aluminum flush mount

- 1 Remote Controller with Scene Capability
- 5 Motion sensors & 3 Door Sensors
- IP Camera for Video Door Phone
- 1 AV Automation
- 6 AC On/Off Control
- 4 Curtain Controllers
- 1 Yale Door Lock with biometric

AV Room Automation

- 6 Lighting controls
- 1 Handheld Remote
- AV & AC Control (1 Room)

Lighting controls adds intelligence and automation to your existing switches. The opening of your doors and lights are controlled as per setting you choose. Based upon the outside luminance it automates your balcony lights. The automatic opening of AC based upon your presence in room and the surrounding temperature.

ZHOME Dimmer & Switch combo devices allow you to convert your switches into special relay switches that provide intelligent automation to your home appliances and lights. The Z-wave technology used can be extended to more rooms at larger distances with the help of Mesh network. So controlling of your lights and appliances not just to any one room but many rooms with one controller.

ZHOME Combo Switch 100-240VIt consists of 2 Relay electromagnetic based switches and 1 Dimming control in a single module chip. It allows adding intelligence to your existing lighting without and re-wiring. The intelligent system also takes care about the load types. It is the best solution to upgrade existing lighting controls with a very low cost module.

Features & Benefits:

- Compatibility with power consideration of switches in India providing a vast application design.
- Small in size that can fit behind wall boxes.
- All types of lighting loads including incandescent, halogen, electronic low voltage, fluorescent, compact fluorescent, magnetic low voltage and LEDs are sensed automatically
- Cut-off in your electricity bills and energy by using efficient lighting solutions.
- Mood lighting and event scenes are done with ease.
- Remembering of last power state at the time of power cuts.
- Wireless Z Wave technology provides automation to long distances.

SYNCO LIVING

Synco Living [3] Home automation and control system provide comfort and superior energy efficiency through intelligent home automation. This system provides Convenient control and switching of HVAC systems, lights, blinds and more.

This system boasts of providing a comfortable home where you save energy costs every month, a pleasant oasis with a perfectly coordinated room climate, and the security of knowing that your home is always monitored even when you are not there.

One system for the entire home

Synco™ living, the intelligent home automation system, turns your four walls into a secure and energy-efficient home. It is a reliable system that thinks along with you and controls many things in the background, including the room temperature and ventilation. Synco living controls your blinds, provides scene control functions, simulates your presence by turning lamps on and off, reports water damage and monitors doors and windows. In addition, a smart phone allows you to access the system at any time – from everywhere.

Comfortable and secure

Synco living's benefits include energy efficient automation that reduces your energy consumption while making your living environment more comfortable. Many functions run automatically so you don't have to think about them or take action. Not only does this eliminate many daily tasks, you also benefit from the system's reliability – extremely accurate values, precise control and great dependability. All components and functions are based on Siemens' many years of experience in building automation.

Adapting to your needs

In addition to easy operation, a comfortable room climate, energy efficiency and security, Synco living also offers a high level of flexibility. For example, if you determine that other scenes would be more suitable, you can customize Synco Living to your new needs, either by programming new scenes or by reprogramming existing ones.

Consistent operation

Synco Living offers operator and display units for different needs. The spectrum ranges from simplest operation from within the room or on the road using a smart phone, operation from a central apartment unit to professional PC tools during commissioning.

Salient features of Synco Living Home Automation System

- Less energy consumption and comfortability by providing many home tasks (HVAC, lights and blinds)
- reduce up to 30% energy wastage and lower CO2 emissions
- adding components are flexible

III. 3. PROPOSED MODEL

We have proposed a power efficient Ethernet based automatic control system to monitor and control the electrical devices and the other appliances of the institutional building or an office building without the human intervention. Our model is being deployed at the classrooms where the automatic switching of lights and other appliances are controlled through a server which can be a workstation server or a laptop based upon the sensors set up in the classrooms. The server can be set into auto mode, which automatically senses the real time occupancy of classrooms and take required actions, or the manual mode in which the user can manually take actions in case of change in schedule of classes, thus proving an efficient and useful power management.

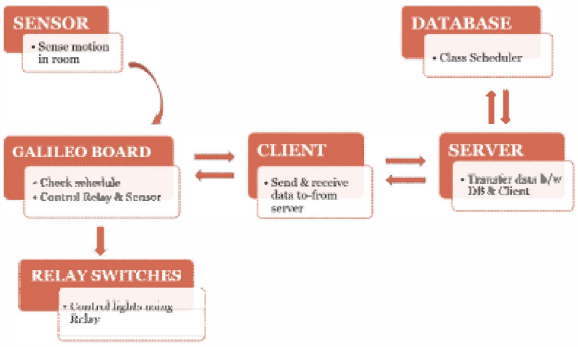

Fig 1 System Architecture

In this model we have motion detectors in each of the classrooms that sense the real time occupancy of each classroom whose output is sent to our Ethernet based Intel Galileo Board that checks the predefined class schedule, being imported through a database set up on the client server. Intel Galileo then takes the required action as defined by the user program and controls the lights of the classrooms though the control of electromagnetic relay switches. The predefined schedule can be uploaded on Intel Galileo through the database set up on the server and can also be manually appended in cases on change in schedule or extra classes. Thus, an energy efficient power management system is being set up in the institutional building.

IV. EXPERIMENTAL RESULTS

The proposed intelligent automated system for an efficient power management is being deployed and tested over institutional building in which the lights of the classrooms are automatically controlled by the IOT device that senses the real time occupancy of the classrooms based on the schedule uploaded on the database server, and takes intelligent action of controlling the lights of the classroom using electromagnetic relay switch. The IOT device used here is Intel Galileo board and the sensor used for sensing the real time occupancy is motion detector sensor. The system architecture of the proposed model is explained by the given below figures which includes a server connected Intel Galileo board that automatically controls the lights of the class by realizing the real time occupancy of the class using motion detecting sensor.

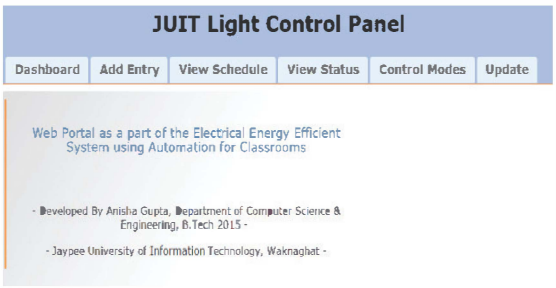

Fig. 2 Sytem web portal design

A control panel page is made on the sever that has various options of adding a new entry into the schedule, viewing the current schedule, viewing the status of the model, setting the control modes of the system and updating the model.

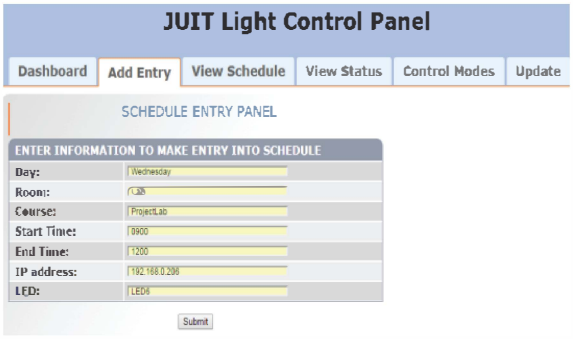

Fig. 3 Sytem web portal add timetable entry

In the Add Entry tab, the user can enter the new information for the new entry to be made in the schedule, defining the attributes of the specific classroom.

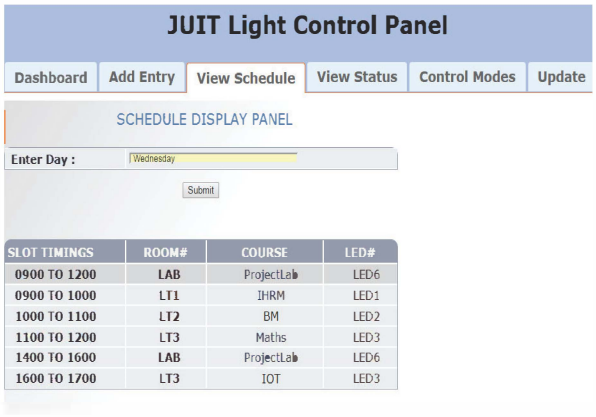

Fig. 4 Sytem web portal timetable design

In the View Schedule tab, user can view the predefined schedule of each day of the weeks which includes all the classes, timings and courses of the specified day.

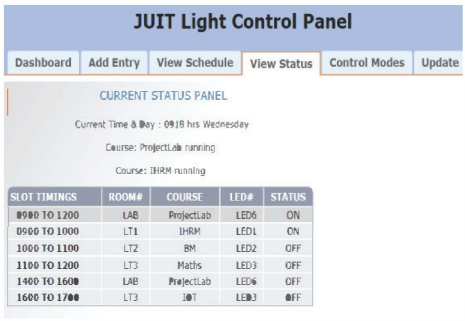

Fig. 5 Sytem web portal view schedule

In View Status tab, the user can view the current status panel of the system.

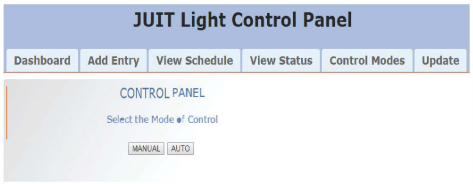

Fig. 6 Sytem web portal autonomous and maual sytem

Fig. 7 Sytem web portal manual control for extra class

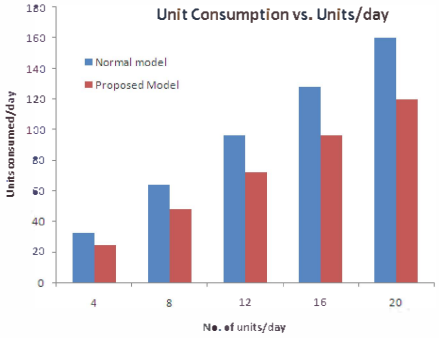

Fig. 9 power consumption

In Control Mode tab, the user can toggle between the auto and manual modes. The auto mode controls the lights of the classrooms automatically based on the predefined schedule and in manual mode the user has on option to manually control the lights of any specific classroom in case of amendments in schedule.

The model is finally deployed over an academic institution over 8 classrooms for the period of 7 days and power efficiency is being recorded and analyzed with an assumption of 4 units/hr consumption.

To compute the improvement in power consumption over proposed and existing system, we have compared the power consumption of system over a period of 7 working days.

Figure 9 shows effect of consumptions rate on total consumption. If consumption rate changes due to increase in number of rooms.

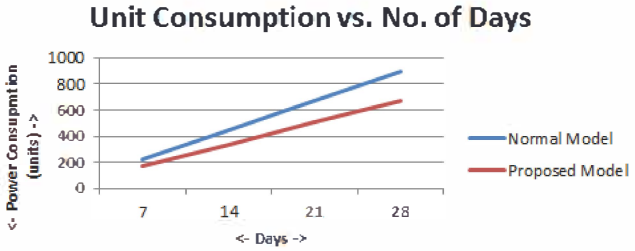

Fig. 10 Change in power consumption over days

V. CONCLUSION

From experimental result section, it is clear that proposed system given have high performance as compare to previous proposed. The main idea of this system is to minimize the power consumtion of system by controlling the power based on the acadmic time table of university, proposed system minimizes the computation power.

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