Energy Competent Building Automation And Control System

STUDY ON ARCHITECTURE DISPARITY

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Abstract —The presented paper describes the concepts of Energy Competent Building Automation and Control (ECBAC) using the concepts of Intelligent Energy Management Network (IEMN) for Building Automation Control (BAC) and sensor network. The proposed work is characterized by its energy efficiency, which is able to control the use of various electrical appliances and minimize the use of overall energy consumption. Considering the environmental constraints, sensor provides a path for ECBAC by helping an appliance understand the desire of a user and hence provide an appropriate BAC. Zigbee Technology has also been pioneer which works under IEEE 802.15.4. It is more compatible, efficient and much reliable than other technologies leading to less consumption of energy when used for real world applications.

Keywords—competent, sensor, efficiency, power consumption.

I. INTRODUCTION

Optimum usage of electricity or conservation of energy is one of the major concerns these days. Wastage of electricity cannot be avoided but can be minimized, if we efficiently use it. The same can be achieved if brains are added to the daily household electrical appliances. A sensor based energy competent system can be an excellent solution for the same. Energy conservation [1] refers to reduction in energy consumption which is achieved by incorporating efficient energy consumption techniques, resulting in diminution of energy consumption from conventional energy sources.

The paper deals with diverse sensors explicitly occupancy sensor, infrared sensor and temperature sensor. Sensor is a device that produces a measurable response to a change in a physical condition, such as temperature or thermal conductivity, or to a change in chemical concentration thus bringing awareness from the environment. Sensors are particularly useful for making in-situ measurements such as in industrial process control and work as an important part to any measurement and automation application.

The organization of the paper is as follows, section II enclose the related studies that have been done so far on this area, Proposed Methodology and the system architecture have been portrayed in Section III of the paper. Section IV expresses result outcome focused on the efficiency factor. Finally, Section V concludes the work and recommends the future direction of the work.

II. RELATED STUDY

A. Building Automation and Control

Building automation describes the advanced functionality provided by the control system of a building. A building automation system (BAS) is an example of a distributed control system. The control system is a computerized, intelligent network of electronic devices designed to monitor and control the mechanical electronics, and lighting systems in a building [2]. The architectures are based on the characteristics of a typical building energy management system logic. These model's philosophy was based on the general concept of a model with the capability of being adapted to any building's specific requirements, provided that appropriate ''mapping'' of the building's areas and its elements is elaborated. The components included in the model are as follows:

- *Indoor sensors*: Sensors that measure or record temperature, relative humidity and luminance in the building areas.
- *Outdoor sensors*: Sensors for the outdoor conditions such as temperature and luminance which are essential for the efficient model's operation.
- *Controllers*: This component category contains switches, diaphragms, valves, actuators etc.
- *Decision unit*: A real time decision support unit is included, with the following capabilities.

B. Energy Efficiency

Energy efficiency [3] is a valuable resource that creates a win-win solution on multiple fronts. It is as one action five major consumer and societal benefits. It saves consumers money, increases comfort, protects the environment, enhances the economy, and promotes national security. The benefits can be enumerated as:

- Using advanced and state-of-the-art technologies to provide better quality energy services with less energy.

- Getting the most productivity from every unit of energy.
- Getting the desired energy services which includes comfortable homes, profitable businesses, convenient transportation, with less energy use, less air pollution, and lower total cost.
- Eliminating energy waste.

C. Zigbee Wireless Sensors

ZigBee [4] is a specification for a suite of high level communication protocols which uses small, low-power digital radios which are based on the IEEE 802 standards for personal area networks. Applications of Zibgee technology include wireless light switches, electrical meters with in-home-displays, and other consumer and industrial equipment that requires short-range wireless transfer of data at relatively low rates. The technology defined by the ZigBee specification is intended to be simpler and less expensive than other WPANs, such as Bluetooth. ZigBee is targeted at radio-frequency (RF) applications that require a low data rate, long battery life, and secure networking. ZigBee has a defined rate of 250 kbit/s best suited for periodic or intermittent data or a single signal transmission from a sensor or input device.

Zigbee devices are of three types:

- *ZigBee coordinator (ZC):* The most capable device, the coordinator forms the root of the network tree and might bridge to other networks. There is exactly one ZigBee coordinator in each network since it is the device that started the network originally. It stores information about the network, including acting as the Trust Center & repository for security keys.

- *ZigBee Router (ZR):* As well as running an application function, a router can act as an intermediate router, passing on data from other devices.

- *ZigBee End Device (ZED):* The End devices Contains just enough functionality to talk to the parent node (either the coordinator or a router); it cannot relay data from other devices. This relationship allows the node to be asleep a significant amount of the time thereby giving long battery life. A ZED requires the least amount of memory, and therefore can be less expensive to manufacture than a ZR or ZC.

The ZigBee network layer [6] natively supports both star and tree typical networks, and generic mesh networks. Every network must have one coordinator device, tasked with its creation, the control of its parameters and basic maintenance.

Within star networks, the coordinator must be the central node. Both trees and meshes allows the use of ZigBee routers to extend communication at the network level. ZigBee builds upon the physical layer and medium access control defined in IEEE standard 802.15.4 (2003 version) for low-rate WPANs. The specification goes on to complete the standard by adding four main components: network layer, application layer, ZigBee device objects (ZDOs) and manufacturer-defined application objects which allow for customization and favor total integration.

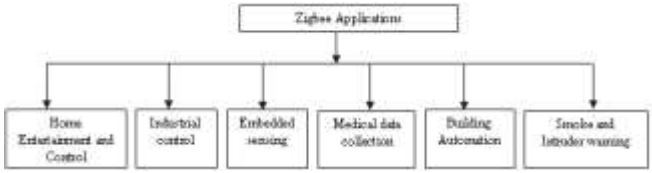

Figure1. Possible situations when user is in the room

ZigBee nodes can go from sleep to active mode in 30 ms or less, the latency can be low and devices can be responsive, particularly compared to Bluetooth wake-up delays, which are typically around three seconds. Because ZigBee nodes can sleep most of the time, average power consumption can be low, resulting in long battery life.

III. PROPOSED METHODOLOGY

The sensor based energy competent system is based on the fundamentals of usage and implementation of sensors along with the daily household devices which are very frequently used. The architecture design allows the implementation of an energy network monitoring and controlling systems which allows a user to access the appliances as per his desires and at the same time helps in saving the electrical power usage.

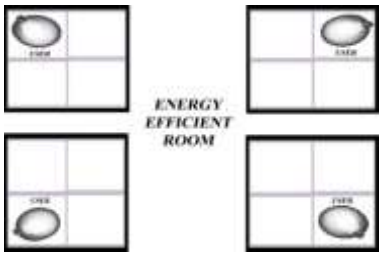

Figure2. Possible situations when user is in the room

A. SYSTEM ARCHITECTURE

The architecture proposes that the usage of electricity per day / consumption can be reduced that is the wastage of power can be reduced by adding brains to the devices which are user friendly in nature. This user friendly network works on a high signal only when it senses a user X entering into a room. The occupancy sensor senses a user at a distance ‘d’ meter from the room. The motor attached along runs and the door opens only when the distance of the user from the door is less than ‘d’ meter. In case, if the user is at a distance more than d meters then the motor does not work and the doors do not operate.

In a room a user has the basic requirement of operating a fan, an air conditioner or a blower as per desires and to switch on lights whenever and wherever required. In this methodology the user not only has an access to these electrical equipment’s but can also adjust and modify them as per his needs. The provision of entering the desired temperature is also provided beyond which the fan should automatically be turned on or off. The Infrared sensor senses

the user's position and accordingly the corresponding light emitting device is turned on, only for the time the user is present at that particular position as shown in figure1.

Moreover the system is designed in such a way that whenever a user exits from the room, the power supply is automatically turned off resulting in saving the electricity.

IV. RESULTS

Conservation of energy results when energy efficiency is combined with smart energy practices like turning off lights, television, computers [5] , and any other electronic appliance that are not being utilized. Considering a practical example of a simple room where there are appliances such as Air Conditioner (A/C), bulbs and an automatic door. The following table shows the per hour power consumption by the appliance in the present scenario:

TABLE I. POWER CONSUMPTION BY DIFFERENT ELECTRONIC APPLIANCES

Component	Quantity	Per Hour Power Consumed
Automatic Door	1	0.35 KW
Air Conditioner	1	1.335 KW
Bulb	1	0.1 KW

As per the proposed architecture, the number of bulbs active at a time results is one fourth the number of bulbs which are active in a single room, so when the power supply is turned on three fourth power of the total power which was previously consumed is now conserved.

TABLE II. SIMULATION RESULT OF THE PROPOSED ARCHITECTURE

Component	Quantity	Daily Routine	Proposed Architecture
Air Conditioner	1	1.335 *24*1 = 32.04 kW	1.335*0.5*24 = 16.02 kW
Bulb	4	0.1*4*24 = 9.6 kW	0.1*4*24*0.25 = 2.4 kW
Automatic Door	1	0.35*1*10*2 = 7KW	0.35*10*2*0.75 = 5.25 KW
1 Room	-	48.64 KW/day	23.67 KW/day
Floors	-	972.8 KW	473.4 KW

Generally, if the door of the room is automatic it remains open for every 20 seconds every time it senses a person approaching it, but the projected work is user defined and automatically closes the door as soon as the user has entered the room. The time for which the door is in ON state as per the requirement of user is not more than 15 seconds. Hence, at every entry done by a user in the room, the proposed concept holds true in saving approximately one fourth of the power. Analyzing the third constraint which is a user defined air conditioner, the device will only be active when the user defined threshold temperature is achieved. Hence if we take an average of the time period for which the A/C is active, it results to be approximately 50% of the original scenario.

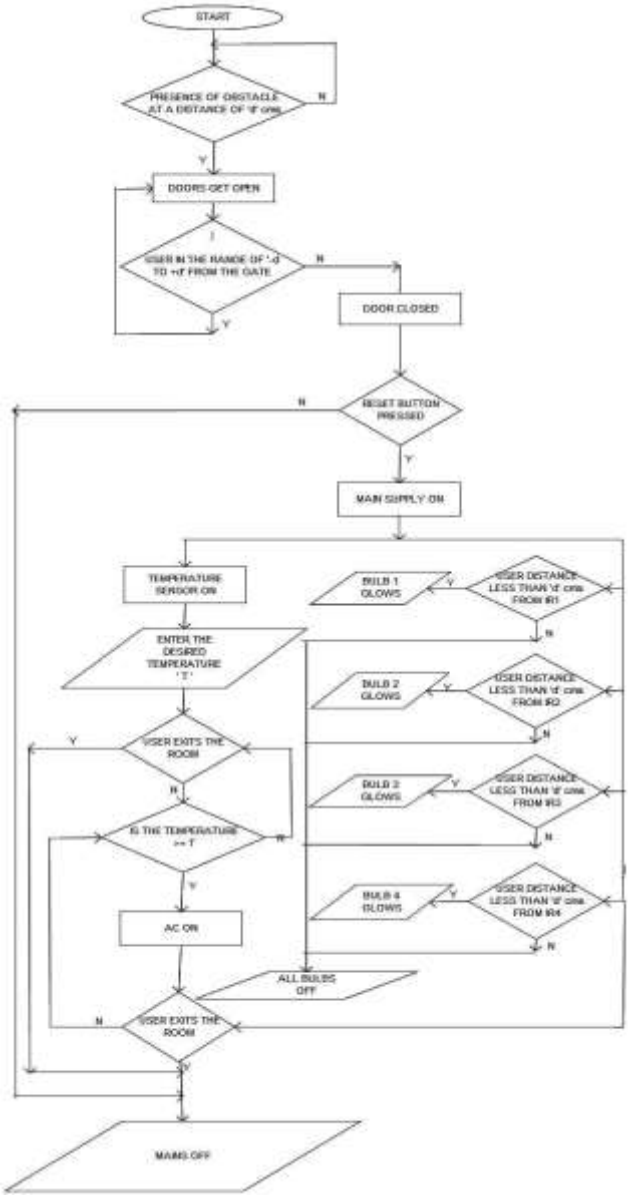

Figure 3. Flow graph of proposed architecture.

Thus, the comparative study on energy consumed via two different architectures is performed on the basis of their power rating for a single room where user is present for the entire day and for a floor comprising of 20 rooms

V. CONCLUSION AND FUTURE SCOPE

The presented architecture represents practically energy efficient [6] system. Following are some actual statistics which holds the validity of the above made statement:

This methodology can further be modified to be implemented for a larger version including a floor or an apartment. Apart from controlling only the basic requirements i.e. power consumed by lights and the fan only, the scheme can further be modified for various other appliances to make them user friendly and make the system more energy competent.

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