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A PATH FOR HORIZING YOUR INNOVATIVE WORK

DEVELOPMENT OF SMART COMMON UTILITY CORRIDOR FOR AN EDUCATIONAL INSTITUTION BUILDING

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Abstract: Smart spaces refer to built environments such as apartments, offices, schools, malls, university campuses, and outdoor areas that are enabled for co-operation of smart objects and systems, and for ubiquitous interaction with frequent visitors. The requirements of Smart spaces of each area are different. Depending upon the need, the smart spaces can be designed. This paper presents the smart space of an educational institute especially developed for the corridor of that institute. To make the corridor smart, first its requirements along with the occupants are studied. Considering the requirements of the occupants, three smart systems are designed and developed for the corridor of the institute. To make the corridor smart and energy efficient, lighting control system is designed which is based on the photosensors and patterning of the lamps. The second system is a prototype of navigation system which shows the location of the cabin or room depending on the users input. The system is wireless and it uses Zigbee modules for communication and PIC microcontroller. The map of the corridor is shown on graphic display, which highlights the way to the cabin or room where user wants to go. The third system is based on Wireless Sensor Network (WSN) which collects the data of temperatures at various points of the corridor and it is stored in excel file. Further, depending on the temperatures, the air-conditioning or fans are controlled. The system is also designed for the security purpose of an institute. The system is designed using LabView.

Keywords: Photosensor, smart space, microcontroller, Zigbee, Wireless Sensor Network (WSN)

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INTRODUCTION

Recent years, there are many researchers are working on projects for constructing ubiquitous computing environment called “Smart Space,” which is equipped with many sensors, actuators and indoor location systems. In many cases, smart spaces are realized in houses [1][2], rooms[3][4], offices[5], and other confined spaces. In corridor, usually people are walking, stopping or passing through. In such a corridor, each user may have different destinations and tasks. So, this corridor needs to support different users which must have various sensors and controlling devices.

Instead of having the luxury of fully illuminated empty corridors, the corridor can be made energy efficient depending on the presence of occupants. Managing lighting in these spaces based on occupancy proves to

be a very effective strategy for energy savings and peak demand reduction [6].

Keeping in mind the above points, the smart corridor is designed. It consists of energy efficient lighting control system, navigation system to assist the visitors in finding the way and wireless system to control the appliances in the corridor along with the security aspect of the building.

This paper is organized as follows: section 2, comparison of smart spaces of buildings, rooms houses and corridors. In section 3, categorization of the occupants and their requirements along with the study of the corridor is discussed. Section 4 explains the block diagrams and details of developed systems. The results and conclusions are discussed in Section 5. The future work is given in section 6.

Various studies [7][8][9][10] have addressed the concept and technologies of smart buildings in various dimensions. A smart building can be viewed as “one that provides a productive and cost-effective environment through optimization of its four basic components: structure, system, service and management and the interrelationship between them” [11].

Smart Corridor

The Smart Corridor is a common space which will be used by various people for various purposes. So, number of various services can be provided in the smart corridor. However, the people are just walking or passing through the corridor. Therefore, while designing the systems for smart corridor energy efficiency is one of the important criteria that have to be considered.

2. Study of work space and occupants:

The corridor of a Department of Electronic Science, University of Pune is taken as an experimental area for which the systems are designed. As an educational institute, a variety of people are using the corridor as per their requirements. The classification of the occupants is given in table 1.1

Type of Occupant	Category
Teaching Staff	Regular Staff and visiting staff
Non-teaching Staff	Office and laboratory staff
Post Graduation students	M.Sc. Part-I and Part-II
Research students	JRF, SRF, RA*
Miscellaneous	Teachers of other colleges/industry, people coming for enquiry, other staff to meet students or staff

Table 1.1 Classification of occupants

*JRF- Junior Research Fellow, SRF – Senior Research fellow, RA-Research Associate

The actual shape and size of the corridor is shown in figure 1.1. The corridor is divided into four sections, A, B, C and D section.

There are in total two cabins of teaching staff in section A and three in section D. There are three laboratories in section A, one in section B and three in section D.

Presently, lights are installed in the corridor. In total, eight tubes (T8, 40W) are fixed in the corridor.

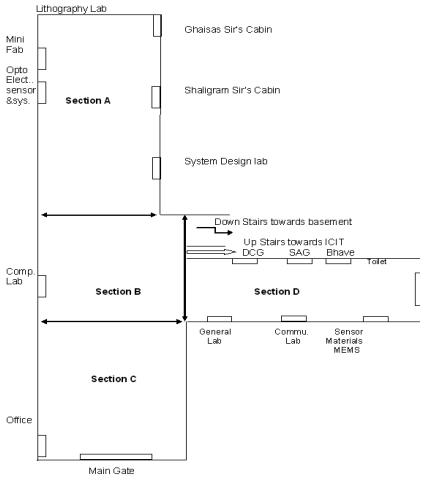

Figure 1.1Design of Corridor

3. Proposed systems for Smart corridor

To make the corridor smart, three systems are developed in which two are wireless systems.

Lighting Control System

Energy efficient lighting control system is developed using microcontroller 80S52. The block diagram of the developed system is shown in figure 1.2

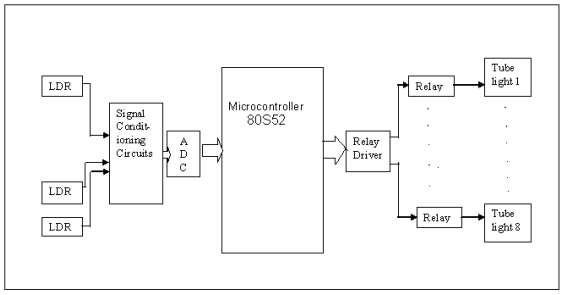

Figure 1.2 Block Diagram of developed lighting Control System [12]

As shown in figure 1.2, the lighting control system uses microcontroller 80S52/80C52 microcontroller. The system has two modes. In mode 1, the inputs from the LDRs are considered. The resistance of the LDR is varying according to the light intensity in the corridor. The signal conditioning circuit converts it into voltage which is given as an input to the ADC (Analog to digital Converter). The output of the ADC is given to the microcontroller and depending upon the light intensity, the tube lights will be turn ON or OFF.

In mode 2, different options of patterning of tube lights are given to user. User can select any one of them and then accordingly tube lights will be ON or OFF. User can also change or design the patterning of luminaires by making a particular tube light

ON or OFF just by setting it to 1 to turn ON or 0 to off the tube light. There are total five options are given in the system. However, they can be increased by changing the programming of microcontroller. The system uses relays which actually turn on or off the tubes [12].

Wireless Sensor Network based system

This system is designed to control the lights, fans and air conditioners. It uses PIR (Passive Infrared Sensor) and thermocouples. The block diagram of the developed system is shown in figure 1.3. NI WSN-3202 programmable analog input node has the range of ±10 V.

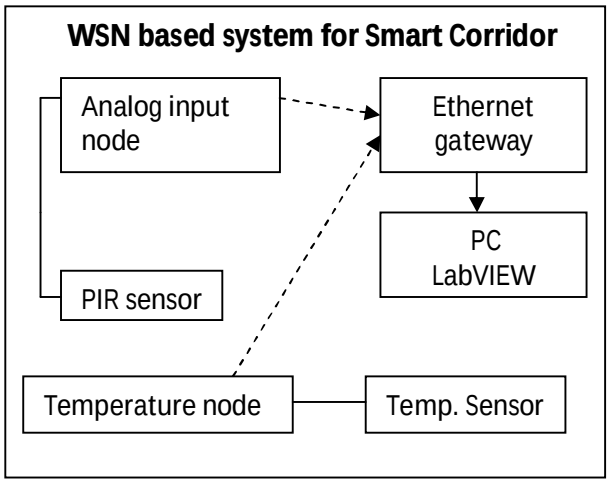

Figure 1.3 Block diagram of WSN based system for Smart Corridor

National Instruments Wireless Starter Network includes NI-WSN-9791 Ethernet Gateway (Fig1.4), NI-WSN-3202 (Fig1.5) programmable analog input node and NI WSN-3212 (Fig 1.6) programmable thermocouple node.

The programming is done using LabView.

The PIR sensor detects the movement of an intruder at night and gives alarm.

Fig. 1.4 NI-WSN-9791 Fig.1.5 NI-WSN-3202 Fig.1.6 NI-WSN-3212

Ethernet Gateway, Programmable analog input node, Programmable thermocouple node

The thermocouple is connected to the temperature node. The data of temperatures at various points of the corridor are recorded in excel file and accordingly lights and fans are controlled.

Navigation system for visitors

The building having more than 10 floors, it is difficult to find the office or cabin or room in a building. So to assist the visitors in finding the way, a prototype of navigation system is

developed. The system is based on PIC microcontroller and Zigbee modules are used for wireless communication. The block diagram of the developed system is shown in figure 1.7

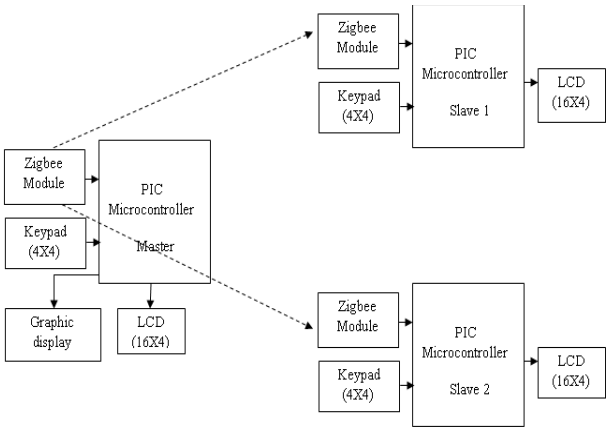

Figure 1.7 Block Diagram of Navigation system to assist visitors

The system has three sub systems. The master board is fixed at the entrance of the building and two slaves board are fixed in cabins or rooms. The master communicates with slaves through Zigbee modules. The map of the corridor is displayed on the graphic display which connected to the master. The list of the faculty members of the institute is put up near the system. The user sees the number given in the list and presses it using keypad. The way showing the arrow towards specified cabin or room is displayed on the graphic display. At the same time, the respective faculty member will receive the indication on the LCD which is connected to the slave. After receiving indication, he/she can give the message accordingly to the visitor at the main gate.

4. RESULTS AND DISCUSSIONS

Results of all three systems are discussed as follows:

Lighting control System

Presently, there are eight tubes of 40W are installed in the corridor. Considering 10 working hours per day, the total energy consumption per day is 3.2 units. The figure 1.1 shows the design of the corridor which shows section A and D are inner sections of the corridor and section B and C are close to the entrance. Therefore daylight (from sun) is present in these sections in working hours. Accordingly, patterning of tubes is designed.

The total energy saving due to developed lighting control system is 84%.

Wireless Sensor Network based system

The front panel is designed in LabView. The data is collected from the temperature sensors which are fitted in four sections. The data is monitored for a day and its graph is shown in figure 1.8.

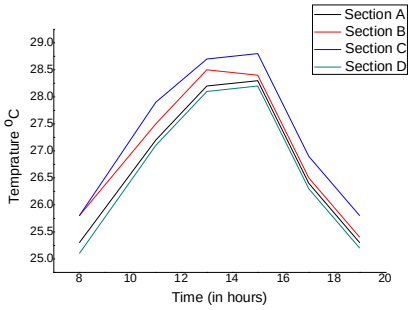

Figure 1.8 Graphs Time Vs Temperature

Navigation system for visitors

The system is designed for wireless communication through Zigbee modules (also known as XBee series). In the proposed system XBee Series 1 module is used which has the range up to 100 ft. for indoor/urban area. The line-of-sight range is up to 300 ft. (100m) and transmit Power output is 1mW. The map is prepared using paint and is loaded on graphic display. The features of the developed system are given below:

1. User can change the map on graphic display by changing the paint file.

2. The person who is in cabin can acknowledge the visitor by pressing the key and can give the message.

3. User can enter the list of person in the institute using keypad.

5. CONCLUSIONS:

Smart corridor may consist of many systems that can be controlled by LabVIEW software with the help of wireless sensor network starter kit. Wireless connectivity is the main advantage of the developed system. Similar type of systems can be designed for various applications. However, LabVIEW software run on host PC, so as long as the host PC is plugged in to a power source and the sensor nodes have adequate battery power, the software can be run.

The main advantage of the developed lighting control lighting control system is that it can fitted in existing wiring setup and thus saved the initial installation cost of a system. The developed system is simple and cost effective as it is based on basic microcontroller. The daylight is integrated with the artificial light system which saves energy. The developed navigation system is wireless, so the advantages of wireless systems such as reducing the fitting/installation charges are applicable to the system. The system is very useful for multistory (having more than 10 floor) buildings, as it is difficult to find the way of particular room/cabin in such building.

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