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Indoor Smart Lighting Controlling using Human Detection

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ABSTRACT

Smart building is a place that provides smart services based on ambience factors and the dwellers needs to promote energy efficiency and at the same time emphasis more on health and comfort needs. The development of smart lighting in the building should be remotely controlled according to the suitability of the current occupants as well as surrounding factors such as area, total occupancy, room size and surrounding intensity. The development of smart lighting should also provide comfort to the populace as well as targeting power optimization based on its current demand. In this proposal, a prototype that develops smart lighting is proposed. In this proposal, the lights will be ON if human existence is detected and vice versa. Lights switching ON rates are also increased by the increase of occupancy and decreasing otherwise. Hence power energy can be optimized whereby it also reduces excessive release of greenhouse gasses. Some tests for the capability of the prototypes developed towards the current needs of the building have been carried out, and giving significance results.

Key words : Smart Building, Human Detection, Energy Efficiency

INTRODUCTION

A smart home or smart building is a place that provides intelligent facilities and services that understand the building dwellers and taking into account the building current environment such as weather, temperature, lighting, and humidity. Smart building should provide the kind of services that is comfortable, safe, secure and with the optimum use of energy [1,2]. One of the human requirement in smart building is thermal comfort, i.e. individual comfort based on their the thermal stability [3,4]. One of the inducing factors in thermal comfort is environment factors (humidity, air temperature, air velocity, radiant temperature) and also personal factors (metabolic rate/heat and clothing) [5,6]. Other inducing factors for thermal comfort in workplace are the illumination intensity measuring brightness. Adequate light intensity is factor influencing employee's mood and comfort [7],[8].

Organized operation for light control in a building would make the environment more interesting to live in, giving a better mood for the occupants, while energy saving and longer life span for the lights. This is due to lights is switched ON only during peak demand and OFF or the brightness is lessen when it's not in used. Simultaneously, it will lessen the use of energy required for lighting purposes and eventually will lessen the power needed for cooling the building due to less usage of the heating components. Cooling process in a building is correlated to human thermal. Therefore, the lighting and cooling of a building plays an important factor in creating comfortable environment for the employee [9].

Based on the needs, we proposed an early provisioning of smart building in terms of lighting and air condition control in the building. This is because the current available services in a building did not put into account the current environment of the building as well as not update the current energy consumption for the power management. In many situations, all lightings in a building are switched ON even though there are only a few dwellers in the building; forgetting to switched OFF the lights and air condition when leaving the room, lacking enough brightness or building centralized air condition features that makes the room temperature is too cold or sometimes too hot. This will jeopardize the dweller's comfort which eventually will affect the dwellers emotion, productivity, and health [10, 11]. The environment and comfortable facilities is the basic requirement that should be provided by the employer to encourage employee to produce their best performance at work. According to [12], research shows that 83% of employees rated appropriate working area with good lighting and air temperature as conducive.

The expected work environment can be seen as in Figure 1 in [13] and [14] below that show lightness suitability among the employee is the main concern for them in an office. Therefore, in our provisioning of smart home or smart building proposal, we have developed one basic study to develop a system to control the lighting in a smarter way. That is, the light is switched ON and OFF automatically following the current environment of the individual at the place. All developmental work for the project is using embedded-based microcontroller that can control several sensors at one time.

The remainder of this work is organized as follows. Section two briefly discusses the methods used in the previous study to produce smart lighting Section three describes the

implementation of the smart lighting. Section four describes testing, result analysis and discussion while finally, Section five concludes this paper and discusses directions for potential future work.

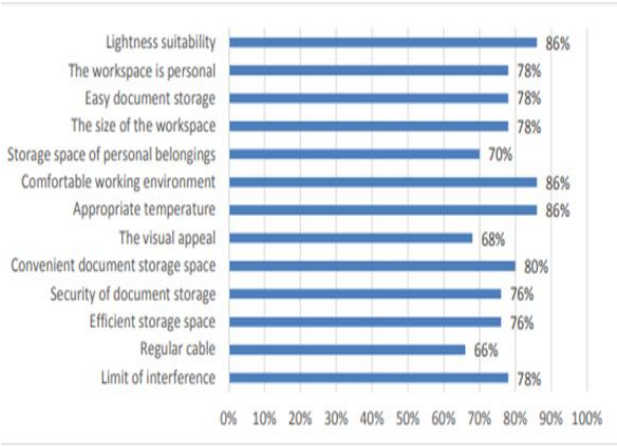

Figure 1: Expected Work Environment [10]

1. RELATED RESEARCH WORKS

Sampathkumar. S et al., 2013 [15] has introduced intelligent lighting to provide significant brightness at the required location. In this research, the lighting brightness is provided using LED bulbs by detecting human body movement, so that the corresponding light will be ON/OFF based on the detection. Hence, the prototype can distribute appropriate light brightness according to human needs.

Location-based lighting control was improved further by [16] combining surrounding brightness, location and occupants current behavior to provide sufficient lighting according to current needs. Current brightness condition is taken into consideration by [17] who introduced an energy efficient method to control indoor lighting with current daylight condition as well as changes in user attendance. The light sensor is placed at the ceiling of the transparent building to detect and gather data on surrounding and working area brightness. The information on the occupants attendance; gathered through the occupancy sensor, together with the surrounding brightness of the work space; is then transmitted to the light sensor located at the ceiling to control the light switching to ON/OFF. With other words, surrounding factors such as surrounding brightness and current attendance of the occupants are considered to create intelligent lighting system. While [18] proposed a remote monitoring LED using handheld devices. The current status of the energy consumption is displayed online on the screen of the handheld devices. In this proposal, the researcher take advantage on the gadget used daily, as tools to control the lights; and in addition; eases the user to monitor energy consumption through the handheld devices. Hence, energy usage is optimized.

2. THE PROVISIONING OF SMART LIGHTING

The busy of daily activities and busy schedule sometimes make people forgot to switch off the lighting which eventually contributes to wastage of electrical power. Power consumption can be reduced by providing a smart lighting system which controls in a smart way by detecting the numbers of human body entering and exiting at certain places. Additionally, system will detect the right numbers of lighting to be switched ON based on the numbers of occupant to avoid energy wastage which eventually resulting in power optimization.. This method is used by sensing IN/OUT of human body and calculating the dweller's numbers that will enters and exits the room. Through this method, all lightings in the area will be switched ON/OFF automatically whenever anyone entering or exiting from the area crosses the developed sensor.

2.1. Prototype Development

There are two PIR motion sensors to detect the existence and exiting of the people at the entrance. LED light used to indicate the existence of object. LED light is one proposed to be used in the provisioning of the smart building.

According to [19] LED intensity can contributes to energy savings which light dimming activities can cut up to 40% of the energy used, prolonged lamp life up to 25% longer and also can saves 50% of maintenance cost as summarized by Table 1. Several related research work on lighting control using LED lights were used in their developmental prototype as in [20], provides a synergetic effect between lighting efficiency of LED and reduce energy consumption for heating and cooling in a building.

Table 1 : The Saving of LED Activity

LED Activity	Benefit
Remotely ON/OFF and dimming of lights	40% of energy saving
	50% of light maintenance cost
	Prolong lamp life 25%

LCD used to display the number of people while Arduino microcontroller is used to program the integration of the components and the flow of the prototype. Figure 2 shows the proposed location of the PIR motion sensors.

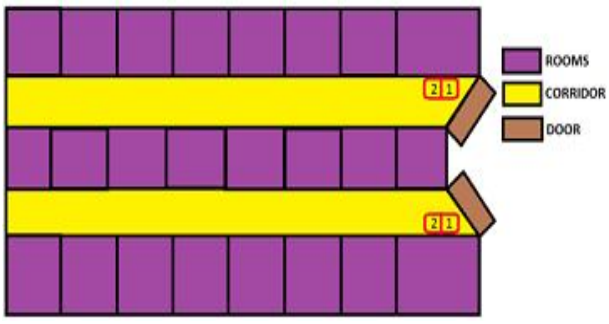

Figure 2: The layout of the location of the sensors

The main function of this project is act as an auto switching system which will detect the entry of person using motion sensor and make the lights turn on.

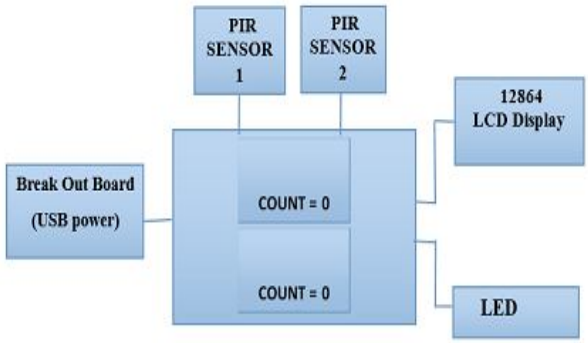

Figure 3: Prototype Setup

Figure 3 shows the block diagram while Figure 4 shows the complete setup of the prototype. The system will detect the entry of people and automating the switches to turn on lights. The motion sensor will detect the entry of anybody and sent the data to microprocessor. There will be an initial value for variable called "count" (count = 0), which will be programmed to microprocessor. then there will be a count for every entry that will be stored by adding 1 to count (count + 1). While, another sensor which is located at the exit door; detected the exit of people and data will be sent to the microprocessor. The second sensor's data will be counted by deducting 1 value from the count (count - 1). When the count value equal to zero (count = 0), then the system will turned off all the lights. The number of every entry and current value will be displayed in LCD screen.

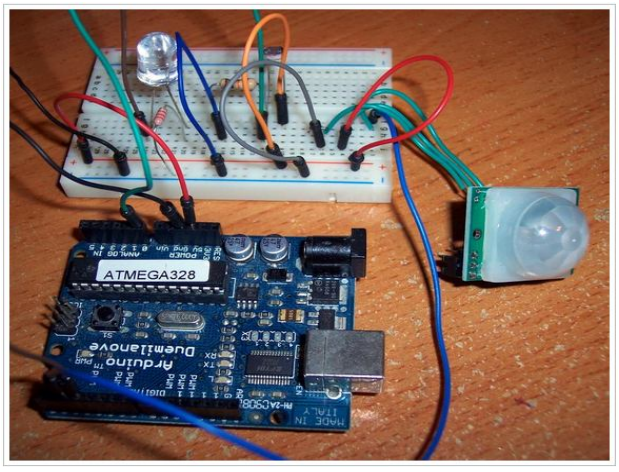

Figure 4: Complete Prototype Setting Up

Arduino platform is a microcontroller to develop the prototype which consisting of an Arduino Uno R3 and is programmed using C programming language.

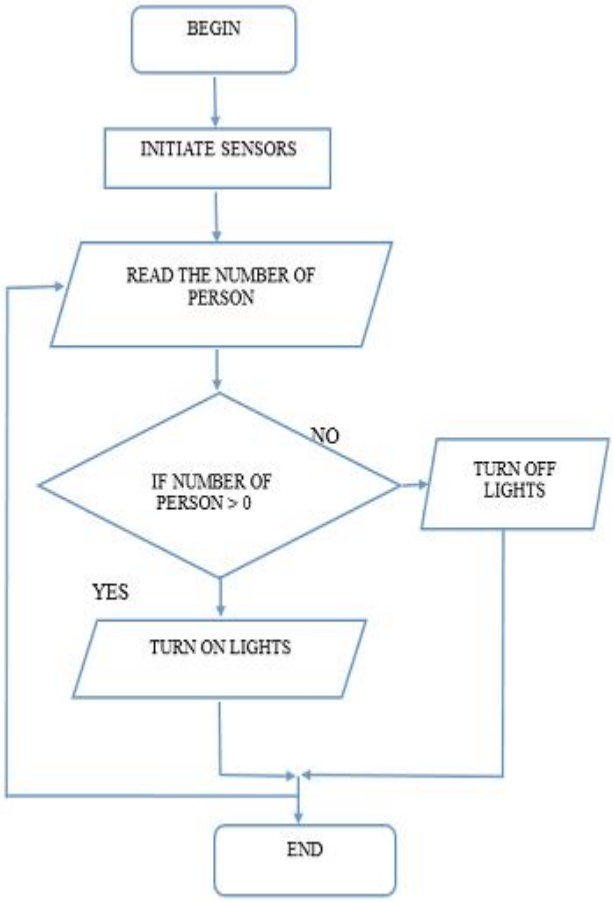

Figure 5: Example of an image with acceptable resolution

Figure 5 shows the flowchart of the system prototype as shown by the flow, the system works after each instruction is executed based on the conditions. When sensors are initiated, the sensors will read the number of person in the particular area. Every detection of Sensor 1 and 2 will affect the number of person. If the number of person is more than zero (> 0) than the lights will turn on. Else when the number of person is zero (0) than the lights will turn off. The system will keep reading the numbers of person from the sensors. The process of reading the numbers of person to turning on/off lights is kept in loops until the device is off.

3. TESTING, RESULT AND DISCUSSIONS

Experiments conducted on several objects as simulation to the dwellers numbers entering and exiting the room. Both sensors are able to detect the existence and the exiting of people which is indicated by the LED lights.

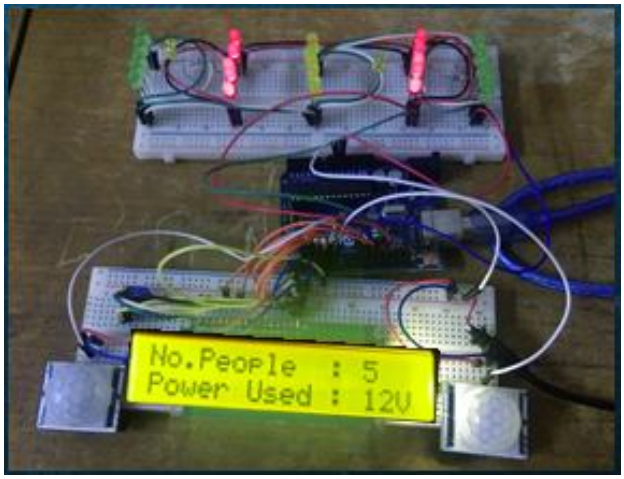

Figure 6: System testing – number of people detected and volt value

Figure 6 shows the testing of the experiment done which indicates the number of people, the number of LED lights switched ON/OFF and the usage of power. According to [21], visual performance and visual comfort of occupants in the building influenced by light distribution. As such, in this prototype, the lights to be turned ON and OFF will be based on the number of people detected.

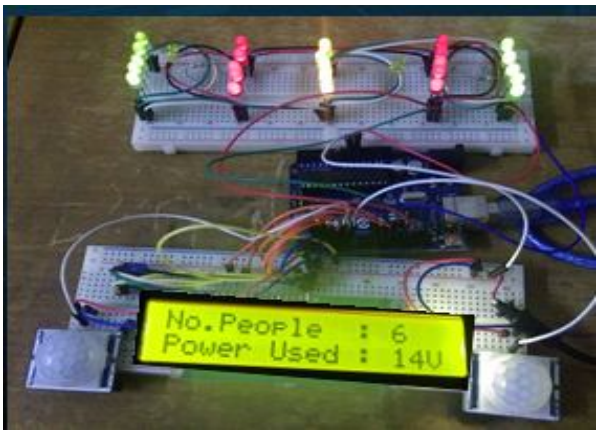

Figure 7: System testing – Increasing of volt with the increasing of people

One simple calculation is done by comparing the numbers of dwellers against the numbers of lights switched ON/OFF, numbers of lighted LED lights and total voltage used. In this experiment, LED is in OFF condition if the number of people is 0. This is indicated clearly by no lights are ON and the voltage value is initiated to 10 volts. On the other hand, the lights are switched ON if the numbers of dwellers are detected more than 5 and with increased value of voltage as shown in Figure 7 and Figure 8 respectively. Tests are conducted more than 10 times to see the functionality of the components and to see the consistency of the result.

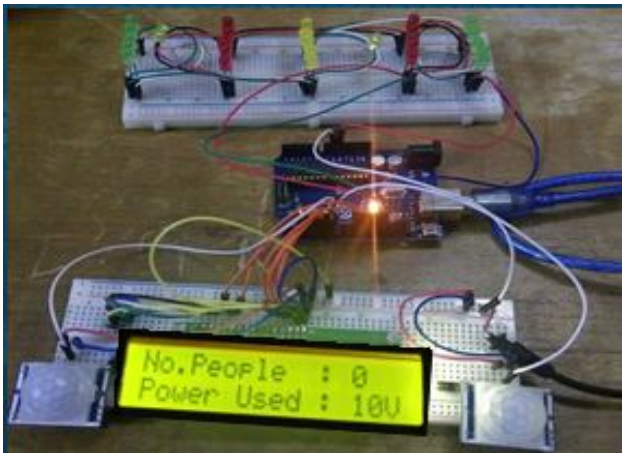

Figure 8: System Testing – No people detected with lower value of volt.

Figure 9 shows the graph plotted for the number of people over power used. From the graph, volt consumed is moving exponentially with number of dwellers and switched ON lights. The more the number of LED light is switched ON, the more the power is consumed.

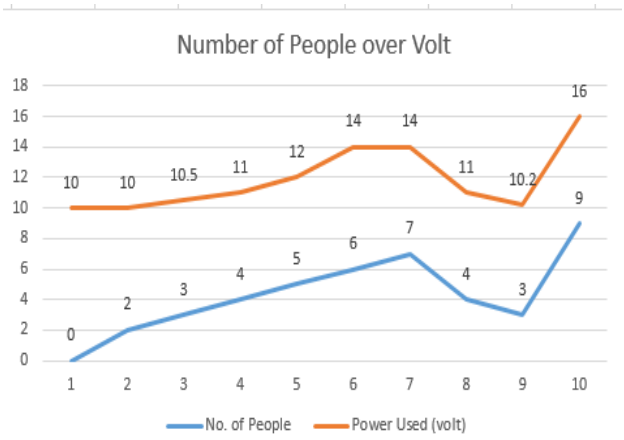

Figure 9: Number of People over Volt

4. CONCLUSION

One simple prototype developed to implement smart lighting in a building. The developed smart lighting is controlled by sensing the number of dwellers entering an area in the building. The numbers of people entering in the building will determined the number of lights switched ON at the current time. The more people detected in the building, the more lights will be switched ON, and hence the more electricity power will be used. On the other hand, if less people entering the area, lesser lights will be switched ON, and inadvertently lessened the usage of electric power. Several experiments are done to show the effectiveness of the prototype developed with the lights switching ON and voltage power used. Other words, smart lighting development satisfy the environment needs for lighting to be switched ON during peak demands. However, a lot more consideration needs to be taken into account for future development, such as the ambience brightness, thermal comfort from brightness perspective and infrastructure readiness.

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