RESIDENTIAL COLLEGE ENERGY SAVING AUTOMATIC LIGHTING SYSTEM

By

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FINAL PROJECT REPORT

Submitted to the Department of Electrical & Electronic Engineering
in Partial Fulfilment of the Requirements
for the Degree
Bachelor of Engineering (Hons)
(Electrical & Electronic Engineering)

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CERTIFICATION OF APPROVAL

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Approved:

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Project Supervisor

UNIVERSITI TEKNOLOGI PETRONAS

TRONOH, PERAK

September 2012

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

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Nadia Adila binti Ridza Saifuddin

ACKNOWLEDGEMENT

First and foremost, I would like to say Alhamdulillah; I thank God that I am able to finish this project on time.

I would like to express my sincerest gratitude to my supervisor, Dr.Mohamad Naufal Mohamad Saad for his guidance and patience throughout the entire duration of the project. I really appreciate all the advice and support he has given me in order for me to complete this project.

I am grateful for my parents and siblings for understanding my hectic schedule during the period of my final year project; thank you for all the support.

Last but not least, I would like to thanks my friends and those who have helped me with this project whether directly or indirectly..

ABSTRACT

The residential college uses a lot of electricity since it is the place where students reside during the academic semester. The current lighting system in the residential area does not efficiently uses electricity as they are operated manually. This causes waste as some of the time lights are not switched off for a long time. To solve this problem, an Automatic Lighting System is a unique approach by combing both daylight sensing and also motion sensing to reduce the time lights are used. The project shows how the system will operate when applied. Estimated electrical energy consumption is calculated to show how much money is spent with the current manual lighting system and also with the Automatic Lighting System. By the end of the project, it is approximated that the Automatic Lighting System saves up to 90% in costs.

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LIST OF ABBREVIATIONS

PIR	Passive Infrared
LED	Light Emitting Diode
LDR	Light Dependent Resistors
kWh	Kilo-Watt hour
W	Watts

CHAPTER 1
INTRODUCTION

1.1 Project Background

The residential area of Universiti Teknologi Petronas is the most used area whenever students are not attending lectures. Among all the residential areas in the university, Village 5 is deemed to be a favourite among students; as such the blocks in Village 5 are subjected to more use during academic semesters with full student enrolment. The continuous and unmonitored usage of lights in the common areas like the stairs and corridors between houses causes massive electrical energy waste and also waste of money. A simple solution is to put in a timer to regulate the switching of the lights based on a regular time, but these days, automatic lighting system are much more preferred.

Automatic lighting systems are much more reliable and efficient. Studies done on an office building in San Francisco showed that a building with an automatic lighting system is fifty percent more energy saving than one without. This shows that an automatic lighting system is suitable to be put to use in Village 5.

1.2 Problem Statement

The current lighting system in Village 5 is operated manually where students switch on and switch off the lights in the building. This leads to very inefficient use of lights as students will usually switch on the lights as soon as it is dark and the lights will only be switched off when someone notices the lights are still turned on the next morning of the following day which may take longer than necessary. The most serious scenario is when sometimes the lights are left switched on for 24 hours.

An automatic lighting system that utilises the use of daylight sensing and also motion sensors applied will be able to significantly reduce the usage of lights in the common areas of the blocks in Village 5. The new automatic lighting system will only switch on the lights when the environment is dark. The motion sensors will detect the movements of the students and thus will only specifically switch on the lights accordingly.

1.3 Project Objectives

The objectives of the project are:

- To investigate the average amount of electrical consumption in Village 5
- To find suitable electrical devices that will be suitable for an automatic lighting system
- To construct a suitable lighting system that is applicable to the conditions in the residential area of Village 5

1.4 Scope of Study

This project requires an understanding in the field of power systems and also domestic electrical system in regards to applications in daily lives. The primary focus is to find suitable devices to use for an automatic lighting system that will replace the current manual lighting system in residential Village 5 blocks.

CHAPTER 2
LITERATURE REVIEW

2.1 Automatic Lighting System Saves Energy

Today's technology allows buildings to have smarter systems of using electrical appliances such as the standard lightings, air-conditioning and other appliances. A tough challenge is to integrate an automatic lighting system into buildings with different needs in different areas. Such scenarios need unique approach to optimize lighting energy saving.

Most automatic lighting system utilises a daylight sensing device to detect the presence of natural daylight. A photocell is used on the main circuit which is then connected to specific devices that will either switch on and off when the environment is light or dark. Usually, the photocell will switch the lights on when the environment is dark.

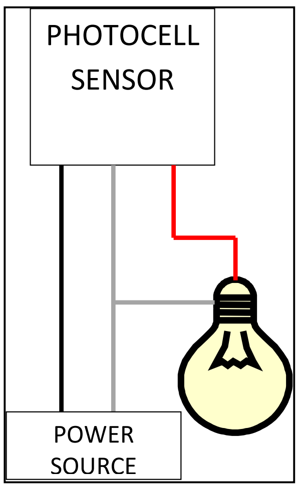


Figure 1 : Basic connection of a photocell to light and power source

Using a photocell for an automatic lighting system is an efficient choice as it does not require any programming and will only need to be set to either LIGHT-ON or LIGHT-OFF. This way, the lights in a building are dependent on the environment; whether due to the approach of night or weather change.

Automatic lighting systems these days also utilises the use of motion sensor. With a presence of a moving object as big as a person, the motion sensors will switch on lights in specific areas only and will switch off the lights after a set period of time. This state saves energy as some locations in buildings are less commonly used than others.

Dimming and controlling light brightness is deemed to be efficient in managing lighting energy. The brightness of lights when vary accordingly with regards to the environment and any natural daylight available will allow less lights to be used. The level of brightness can also be controlled depending on the location in a building and also the settings of the room; for example the brightness in an office is different than that in a laboratory.

An automatic lighting system will definitely save energy and money. However, only by knowing the needs and specifics of the subject building will the lighting system be fully efficient and optimal throughout its use.

2.2 Sensors

As stated in the introduction, this project requires the use of certain sensors in order to construct an energy efficient lighting system. To be more specific, this project requires the use of photocells for daylight sensing and also motion sensors to detect movements.

2.2.1 Photocells for Daylight Sensing

A regular daylight sensing circuit will have a Light Dependent Resistor (LDR). The LDR will normally have a high resistance but the resistance will drop drastically when the LDRs are illuminated with light.

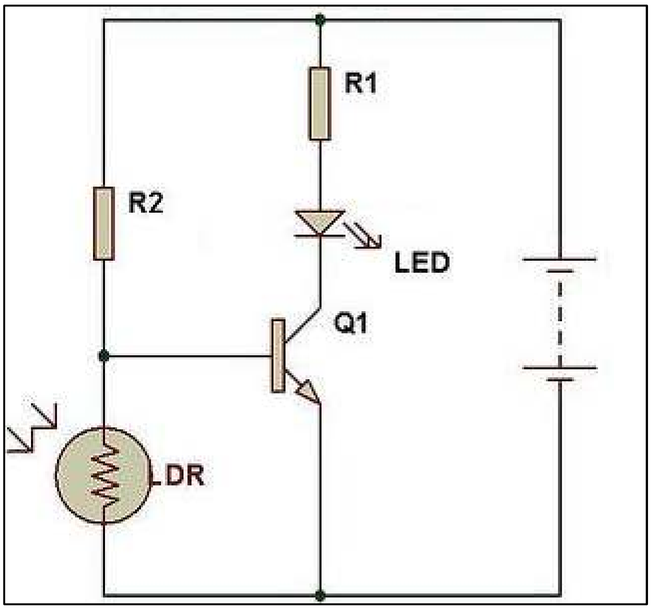


Figure 2 : A light sensing circuit

Basically, there are two kinds of light sensors that use an LDR; a light detector and a dark detector. For this project, a dark detector is used. A dark detector does not detect darkness, but rather the absence of light. Using the circuit in Figure 2 as a reference, the resistance of the LDR will match the threshold resistance when the light level decreases, thus causing the LED to switch on.

The daylight sensor that will be used in constructing the automatic lighting system will be almost similar to the one described above. The sensor will be connected to a distribution board to each floor since each floor may be subjected to different light situations.

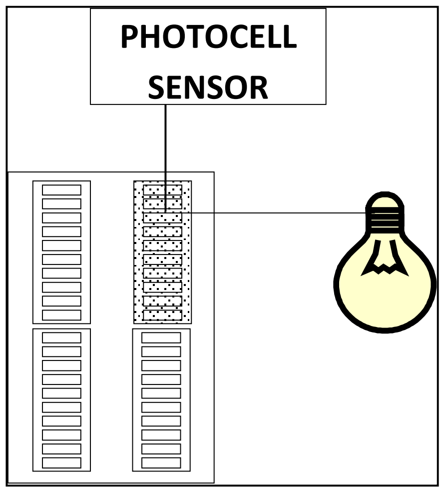


Figure 3 : Photocell sensor connection

2.2.2 Motion and Beam Sensors as Switches

For this project, motion detectors will replace the roles of switches. Instead of depending human assistance to switch on and switch off the lights, the motion detector uses a motion sensor in its circuitry to detect the presence of movement or motion and change them into electric signals which will then enable the lights.

Motion detectors are either passive or active. Both kinds of motion detectors are aided by motion sensors to detect motion but only active motion detectors gives out signals and measure the feedback reflected back to it. A passive motion detector however only senses the motions and produce and output such as turning on lights or alarms but it does not receive any kind of feedback in return.

A popular type of motion detector is the Passive Infrared Sensor (PIR). This type of motion detector does not actually detect movements of objects, but monitors and detects the infrared signature of the human body, which is heat. The motion detector senses the change in temperature in a certain range of field, like when a human walks by, the change in heat will trigger the motion detector which in turn will act as a switch to turn on lights, open doors, trigger alarms, etc.

Figure 4 : A regular outdoor PIR sensor

To be included in the automatic lighting system are photoelectric beam sensors. A photoelectric sensor typically consists of a transmitter and an emitter. The photoelectric sensor works by emitting an infra red light via a light transmitter which is directed to a photoelectric receiver. The photoelectric receiver will detect an object when the beam directed to it is blocked. This arrangement is called through beam or an opposed arrangement.

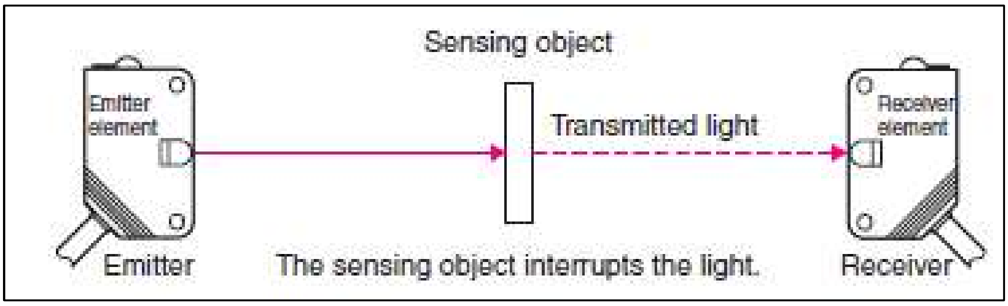


Figure 5 : A through beam arrangement

Both types of sensors are to be used during the night. When in place, the motion detectors will switch on specific lights when there are students passing by. The photoelectric beam sensor will be placed strategically as to aid lighting by predicting which lights should be switched on next.

2.3 LED Lighting vs. Fluorescent Lighting

LED bulbs or LED lighting are becoming more and more popular in today's modern times. LED stands for Light Emitting Diode. The main component of an LED is the p-n junction; a semiconductor material that is doped with impurities. The p-n junction allows charge carriers to flow into it thus allowing photons to be released.

Unlike regular bulbs or lightings that uses gas, filament or plasma as a lighting source, LED bulbs uses the semiconductor materials in the diodes as a source. This is known as a solid state lighting.

LED bulbs contains is a more advanced form of light bulb compared to the regular incandescent bulb. A standard LED bulb has diodes, a mini transformer and some chip-sets. These components convert electricity into light efficiently that only little heat is produced.

Solid state lighting using LEDs are becoming more and more common because the benefits. Some of the advantages of using LED lamps are:

- Energy saving qualities – a standard LED bulb converts most of the electrical energy into light with little heat produced; unlike incandescent or fluorescent bulbs (example: an 8W LED bulb produces the equivalent amount of light to a 65W incandescent bulb.)
- Longer life span – lasts up to 50 times longer than incandescent bulbs
- More durable – more resistant to vibration and shock
- Better light quality – relatively minimal ultraviolet and infrared radiation
- Safer – does not contain hazardous material like mercury
- Recyclable – up to 90% of an LED bulb can be recycled

Converting from fluorescent and incandescent to LEDs is a smarter choice for the future as it will definitely prove much more beneficial in the long run.

CHAPTER 3
METHODOLOGY

3.1 Calculating Electrical Energy Consumption

In Universiti Teknologi Petronas, student who live in the compound of the university live in one of the six residential areas; Village 6 (or called Old Village 5), Village 1, Village 2, Village 3, Village 4 and Village 5.

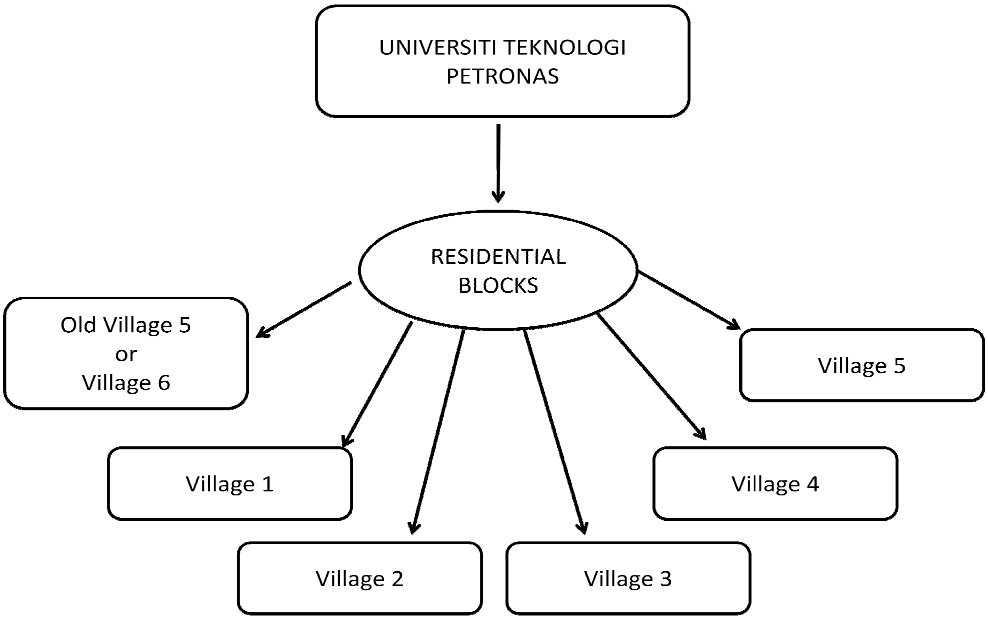


Figure 6 : Tenaga Nasional Berhad tariff rates

There are 10 blocks in Village 5. Each block has five floors, two back staircases and one main staircase. For each floor there are four houses and 1 corridor. Lastly for each house, there are 6 rooms, one bathroom and one pantry. Using this information, we can calculate the total lights there are in the residential area of Village 5.

Thus, to compute the total number of lights in Village 5, the calculations are as follow:

1 HOUSE	= 1 CORRIDOR	=> 6 lamps
	= 1 PANTRY	=> 2 lamps
	= 1 BATHROOM	=> 2 lamps
TOTAL OF LAMPS IN 1 HOUSE		=> <u>10 lamps</u>
1 FLOOR	= 1 CORRIDOR	=> 8 lamps
	= 4 HOUSES	=> 10 X 4 = 40 lamps
TOTAL LAMPS ON 1 FLOOR		=> <u>48 lamps</u>
1 BLOCK	= 5 FLOORS	=> 48 X 5 = 240 lamps
	= 2 BACK STAIRS	=> 9 X 2 = 18 lamps
	= 1 MAIN STAIRS	=> 5 lamps
TOTAL LAMPS IN 1 BLOCK		=> 263 lamps
TOTAL LAMPS IN VILLAGE 5		**=> 263 lamps X 10 blocks**
		=> <u>2630 LAMPS</u> in Village 5

Next, we estimate the number of hours the lights are used or turned on in duration of one day or 24 hours. There are at least four situations that can be classified according to the standard scenario of the average student life during academic semesters. These situations are:

Normal situation	=> 12 hours per day
Usual situation	=> 14 hours per day
Drastic situation	=> 20 hours per day
Extreme situation	=> 24 hours per day

In a normal situation, the lights will be switched on for about 12 hours a day, but in extreme cases some of the lights are switched 24 hours long.

Next is calculating the electrical consumption of the lights in Village 5. Estimating the average electrical energy consumption in one of the Village 5 blocks will set as a yardstick for comparison.

The general calculation to find out the average consumption is by a simple formula. The first thing needed is to find the watts used by the appliance; in this case a general fluorescent lamp that uses a polyester vacuum impregnated ballast. The figure below shows a label of the lights used in the Village 5 blocks.

Figure 7 : Information label on a light that is standard issued in Village 5 blocks

The fluorescent lights in the blocks uses 36W of power. To estimate the average cost of a single lamp, we must first find the kilo-watt hour (kWh) of the lamp by dividing the Watts of the appliance with the hours of use. Then it will be multiplied by the charges set by the electric utility company before multiplying it with the total number of lights in the village.

$$\frac{Watts}{1000}\ X\ x - hours = kWh$$

$$kWh\ X\ tarrif\ cost = RMx.xx$$

$$RM\ x.xx\ \ X\ number\ of\ days = RM\ y.yy \text{ per month}$$

$$RM\ y.yy\ X\ total\ number\ of\ lights = RMz.z.z$$

	TARIFF CATEGORY	UNIT	RATES
1.	**Tariff B - Low Voltage Commercial Tariff**		
	For Overall Monthly Consumption Between 0-200 kWh/month		
	For all kWh	sen/kWh	39.3
	The minimum monthly charge is RM7.20		
	For Overall Monthly Consumption More Than 200 kWh/month		
	For all kWh (From 1kWh onwards)	sen/kWh	43.0
	The minimum monthly charge is RM7.20		
2.	**Tariff C1 - Medium Voltage General Commercial Tariff**		
	For each kilowatt of maximum demand per month	RM/kW	25.9
	For all kWh	sen/kWh	31.2
	The minimum monthly charge is RM600.00		
3.	**Tariff C2 - Medium Voltage Peak/Off-Peak Commercial Tariff**		
	For each kilowatt of maximum demand per month during the peak period	RM/kW	38.60
	For all kWh during the peak period	sen/kWh	31.2
	For all kWh during the off-peak period	sen/kWh	19.2
	The minimum monthly charge is RM600.00		

Figure 8 : Tenaga Nasional Berhad commercial tariff rates

**Using the Tenaga Nasional Berhad commercial tariff rates is to act as a reference to determine the electrical energy consumption. Here, the tariff is assumed as RM 0.393.*

Now, we can calculate the electrical energy consumption by the four situations.

1. Normal situation (lights switched on for 12 hours per day)

$$\frac{36W}{1000}\ X\ 12hours = 0.432kWh$$

$$0.432kWh\ X\ RM\ 0.393 = RM0.17$$

$$RM\ 0.17\ \ X\ 30\ days = RM\ 5.09 \text{ per month}$$

$$RM\ 5.09\ X\ 2630\ lights = RM\ 13,395.33$$

2. Usual situation (lights switched on for 14 hours per day)

$$\frac{36W}{1000}\ X\ 14hours = 0.504kWh$$

$$0.504kWh\ X\ RM\ 0.393 = RM0.20$$

$$RM\ 0.20\ \ X\ 30\ days = RM\ 5.94 \text{ per month}$$

$$RM\ 5.94\ X\ 2630\ lights = RM\ 15,627.88$$

3. Drastic situation (lights switched on for 20 hours per day)

$$\frac{36W}{1000}\ X\ 20\ hours = 0.72kWh$$

$$0.72kWh\ X\ RM\ 0.393 = RM0.28$$

$$RM\ 0.28\ \ X\ 30\ days = RM\ 8.49 \text{ per month}$$

$$RM\ 8.49\ X\ 2630\ lights = RM\ 22,325.54$$

4. Extreme situation (lights switched on for 24 hours per day)

$$\frac{36W}{1000}\ X\ 24hours = 0.864kWh$$

$$0.864kWh\ X\ RM\ 0.393 = RM0.34$$

$$RM\ 0.34\ \ X\ 30\ days = RM\ 10.19 \text{ per month}$$

$$RM\ 10.19X\ 2630\ lights = RM\ 26,790.65$$

From the calculated results, we can see that on average, up to RM 26,000 is spent on lights alone. This is just the estimated cost for the lights in one village only. If we assume that for every village there are an equal amount of lights, then the total estimated energy consumption of lights ONLY for all the residential villages is close to RM 157,000.

3.2 Automatic Lighting System Plan of Operation

The automatic lighting system depends on the presence or absence of natural daylight. The lights in the corridors will only switch on when the absence of light reach a certain level. The lights will also be switched on when there motion is detected. This is achieved via PIR motion detectors and photoelectric beam sensor.

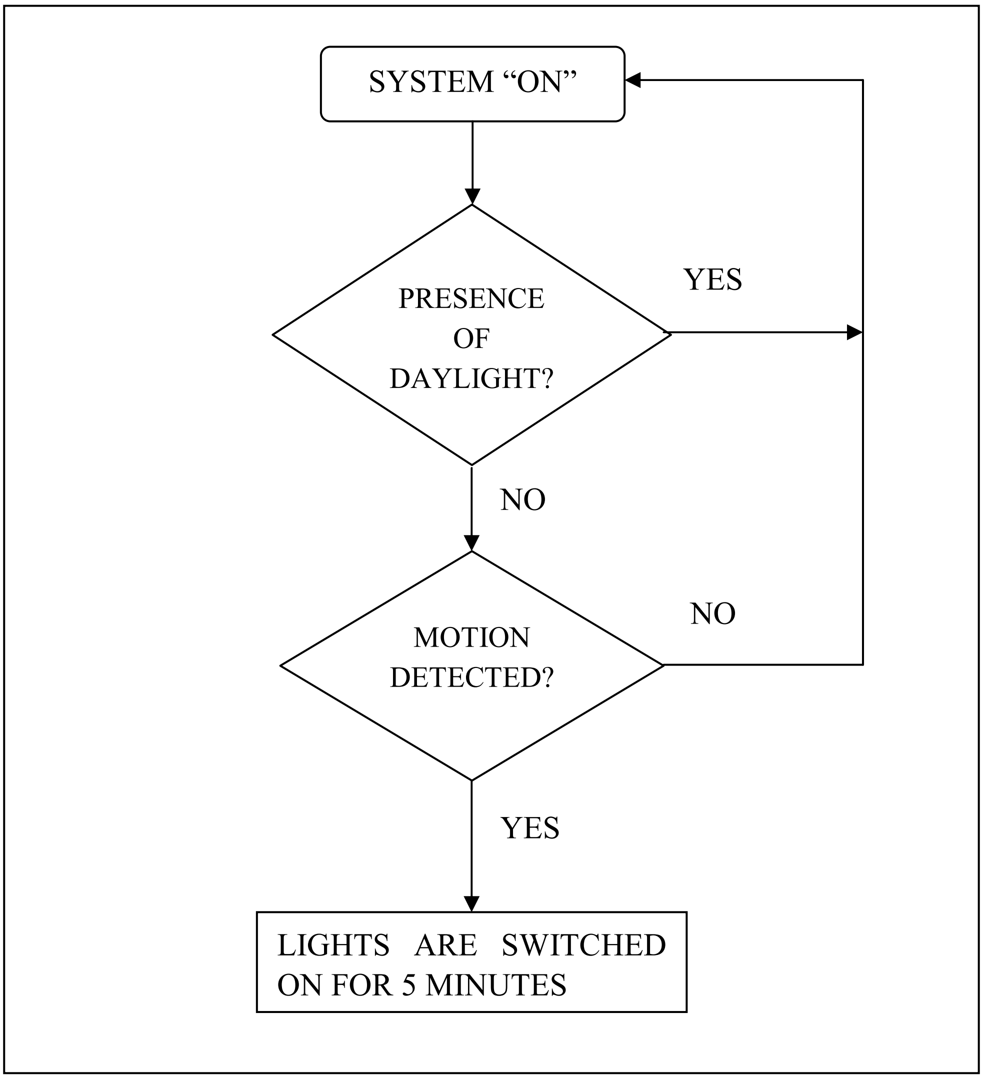


Figure 9 : Basic flowchart of how the automatic lighting system functions

The general idea is to have the lights switched on for a period of time that would allow students to walk through the corridors or up and down the stairs with enough time before the lights are switched off.

3.3 Components Selection

The components that will be needed for the automatic light system to function are:

- PIR motion sensor
- Photo electronic beam sensors
- Daylight sensing device

3.4 Placement of Sensors

There will be two kinds of motion sensors that will be used; the PIR and photoelectric beam sensor. The motion detectors must be place strategically along the corridors and staircases as to maximize efficiency.

3.4.1 Stairs

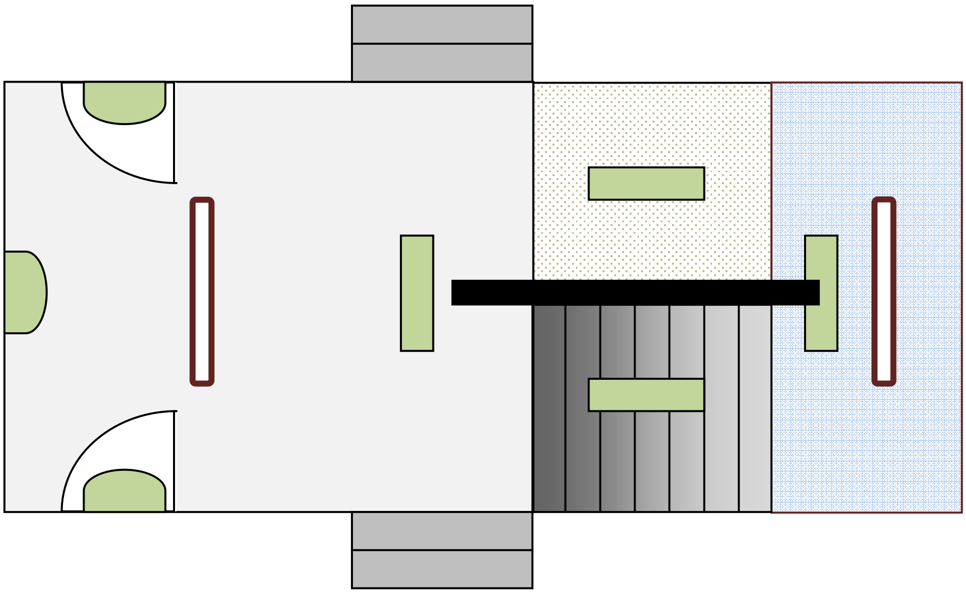


Figure 10 : Plan view of the placement of motion sensors in the stairs area

Table 1 : Legend for Figure 10

Symbol	Meaning
	PIR motion sensor
	Lights / Lamps

The placement of the sensors is determined by analysing and determining the best positions that will maximize the efficiency of the motion sensors. In the area of the staircases, the most effective location to place the sensors are:

- 1 unit above each door
- 1 unit between the doors
- 1 unit on the landing of the stairs
- 1 unit above each flight of stairs
- 1 unit between stairs

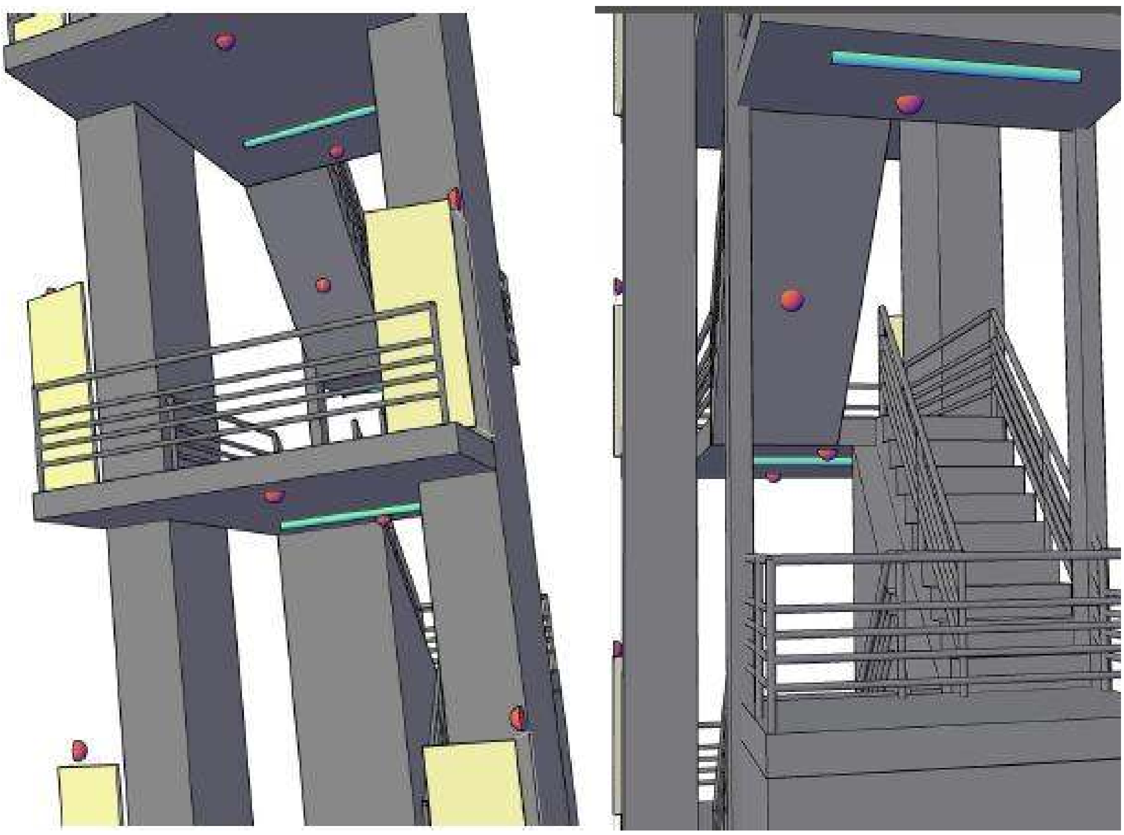


Figure 11 : Placement of sensors

3.4.2 Corridors

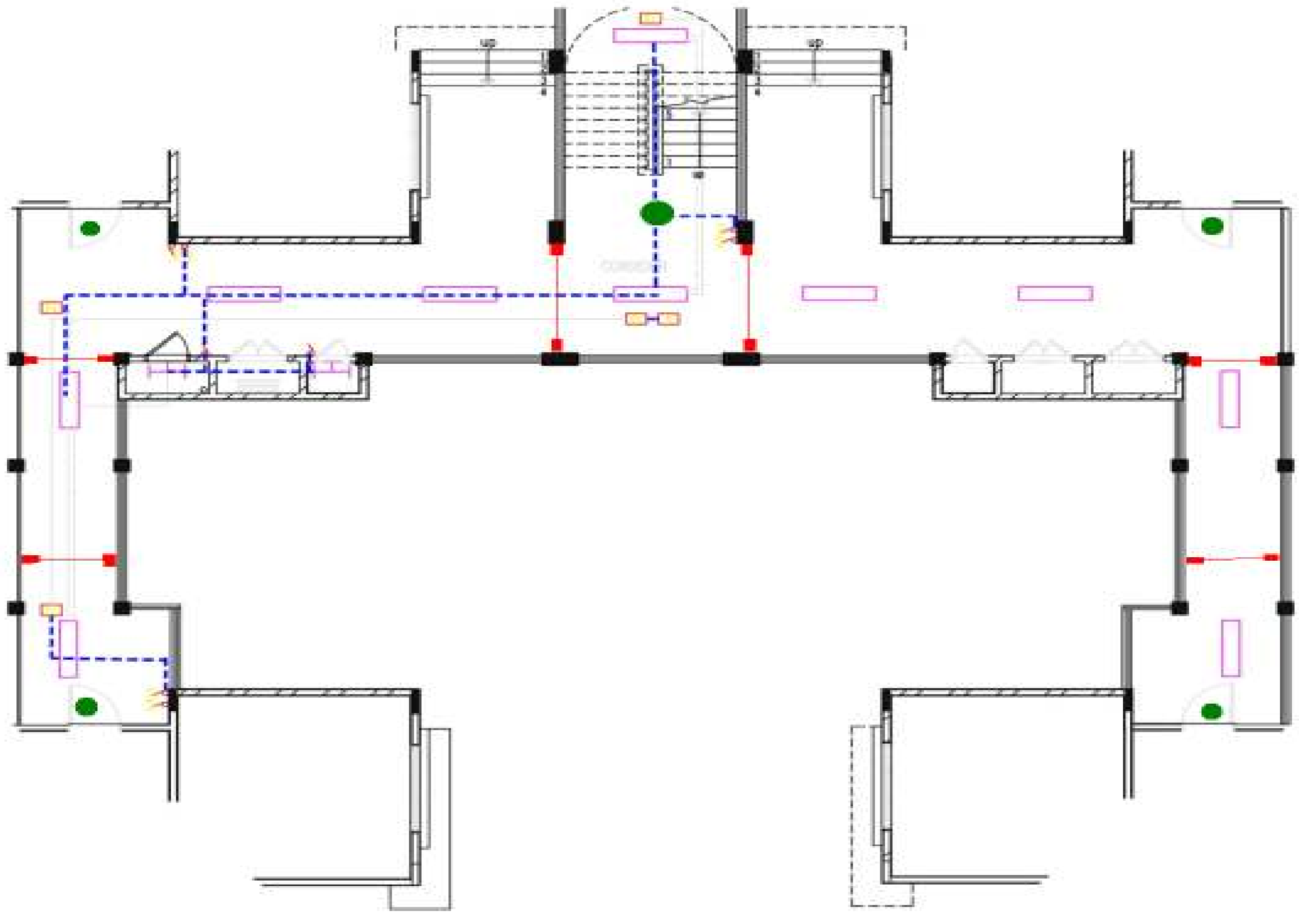
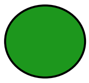


Figure 12 : Plan view of the placement of motion sensors in the corridor area

Table 2: Legend for Figure 12

Symbol	Meaning
	PIR motion sensor
	Photoelectric beam sensor
	Lights / Lamps

The determination of placement of sensors in the corridor area between the four houses is different than that of the stairs area. Since the corridor acts like a junction between the four houses, the sensors are placed so that they can detect and “predict” which direction the student is walking to, and thus switch on the corresponding lights.

For the corridors, photoelectric beam sensors will aid the PIR motion detectors. For the corridor area, the placements of the sensors are:

- 1 main PIR sensor near the stairs
- 1unit PIR sensor above each door
- 3 units of photoelectric beam sensors on each side of the corridors

CHAPTER 4
RESULTS AND DISCUSSIONS

4.1 Analyzing Scenarios

Based on the layout of the motion sensors we can predict the scenarios of how students will normally move through the corridors and stairs. From this, a truth table can be plotted to determine which sensor will be triggered and which light will switch on.

4.1.1 Stairs

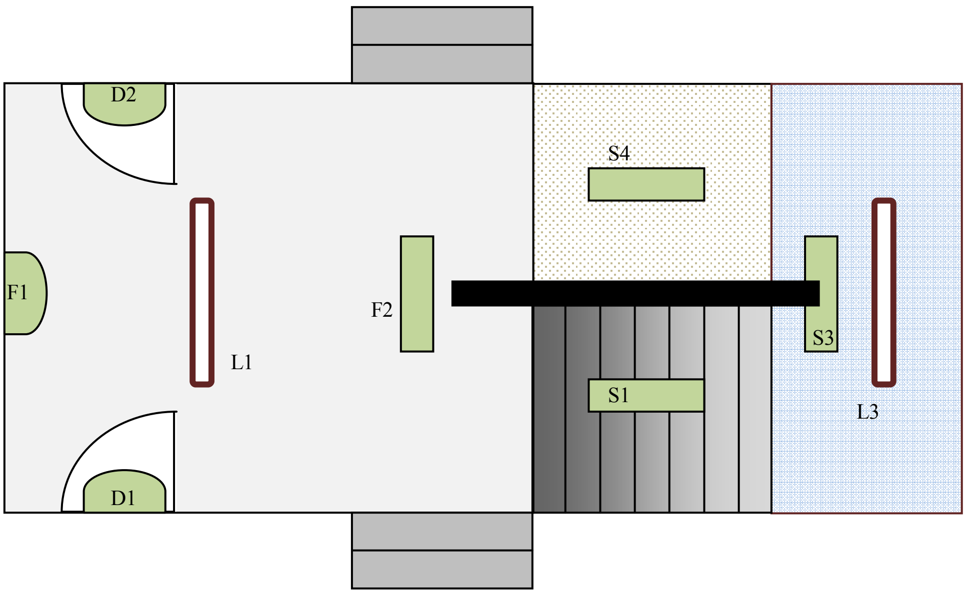


Figure 13 : Sensors and lights labelling at the stairs (Note: Sensor S2 and light L2 is on the next floor and thus is not seen in this diagram.)

The sensors are placed strategically so that its use is optimised efficiently. The PIR sensors above the doors are D1 and D2, the sensors between the two doors is F1 while F2 is the sensor between the two flights of stairs going up or down is F2. The sensors above each of the stairs are S1and S2; Figure 13 does not show S2 as S2 is on the other floor. The sensor for the landing between the stairs is S3 while the sensor for the next flight of stairs is S4. For the purpose of explaining the scenarios, only three lights will be used; the light between the houses L1, the light on the landing L3 and the light on the next floor is L2.

Let us take one scenario when a student goes out door 1; sensor D1and F1 will activate; this will light corresponding light L1 only, while the other lights are OFF. Then, let us say that the same student moves towards the stairs, sensor F2 will detect movement, however only L1 will still be the only one ON. Then, the student decides to go up, this time sensor F2 and S1 detects the movement, the corresponding light that will be ON is L3 while L1 goes OFF again.

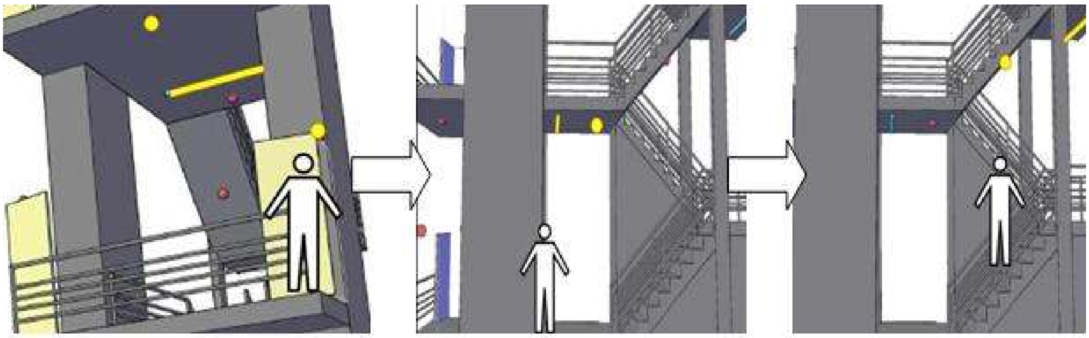


Figure 14 : Student goes out of the house and up the stairs

Then, as the student continues up the stairs, the student passes through S3 and to the other flight of stair with sensor S4; the corresponding light that will switch on is L2 which is on the next floor.

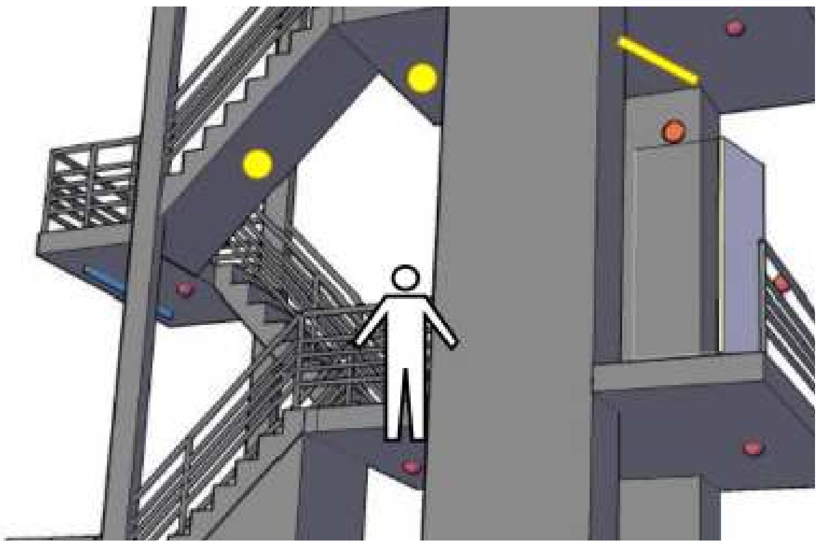


Figure 15 : Student goes to the next floor

Based on the scenario, we can predict other student movements such as moving towards the lower levels and also to the opposite house. From there, a truth table is formed to see the flow of sensors and lights. From the table 3, it is clear that at any one time a maximum number of two lights will be switched on.

Table 3 : Scenario of students moving throughout the stairs area

F1	F2	D1	D2	S1	S2	S3	S4		L1	L2	L3
1	0	1	0	0	0	0	0		1	0	0
0	1	0	0	0	0	0	0		1	0	0
0	1	0	0	1	0	0	0		0	0	1
0	0	0	0	1	0	1	0		1	0	1
0	1	0	0	1	0	0	0		1	0	0
0	1	0	0	0	0	0	1		1	1	0
0	0	0	0	0	1	0	0		0	1	0
0	0	0	0	0	1	0	1		1	1	0
1	1	0	0	1	0	0	0		1	0	1
0	1	0	0	1	0	0	0		1	0	1
0	0	0	0	1	0	1	0		0	0	1

4.1.2 Corridors

The sensors in the corridor area need to be placed at areas that will be able to detect the direction the person walking is heading to. For the corridor area, a different type of motion sensor will be added to aid the PIR motion sensor; this sensor is the beam sensor.

From figure 16, the labelling of the sensors and lights are clearly shown. PIR motion sensors are placed at the main stairs, M and also on top of every door to the four houses B1, B2, B3 and B4. The beam sensors are A1, A2, C1, C2, C3 and C4. The lights are labelled as L1, L2 L3, L4, R1, R2, R3 and R4.

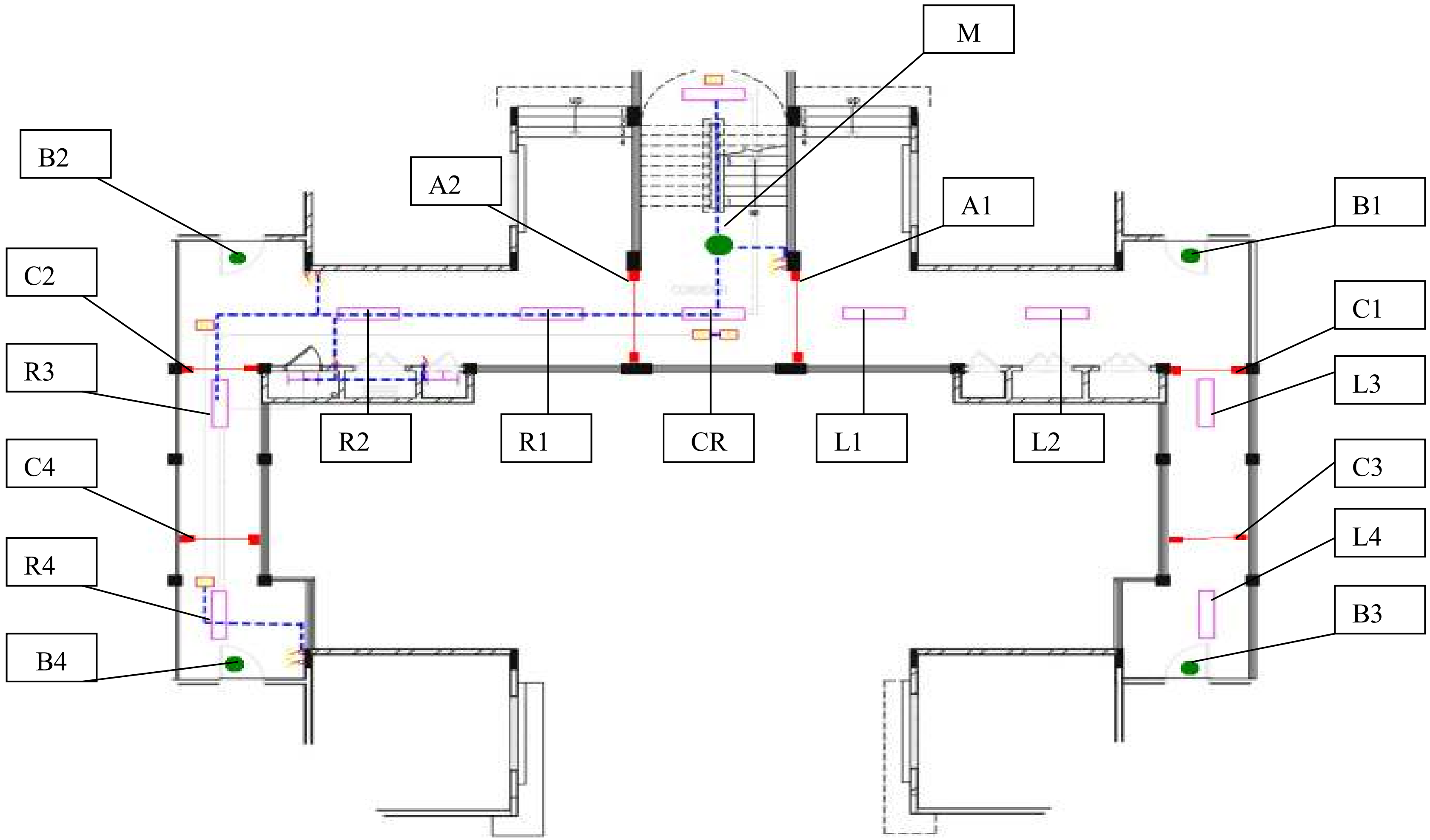


Figure 16 : Labelling of the PIR motion detectors and beam sensors in the corridor area

Let us look at a scenario where one student goes up the main stairs; the sensor M will detect movement and will light CR, L1 and R1 to allow the student to see both the left and right side of the corridor. Then let us say the student move to the right of the corridor, the student will pass through A1 thus lighting up CR, R1 and R2. Then as the student walks by, M will no longer detect any movement thus switching off light CR. As the student goes to the first door of the house, B2, lights R2 and R3 will switch on; if the student goes into the house the lights outside will switch off; if the student continues walking and pass through C2, lights R3 and R4 will switch on. These lights will remain switched on while the student passes through until C4. When the student is detected by B4, only light R4 is on. Figure 17 depicts the scenario.

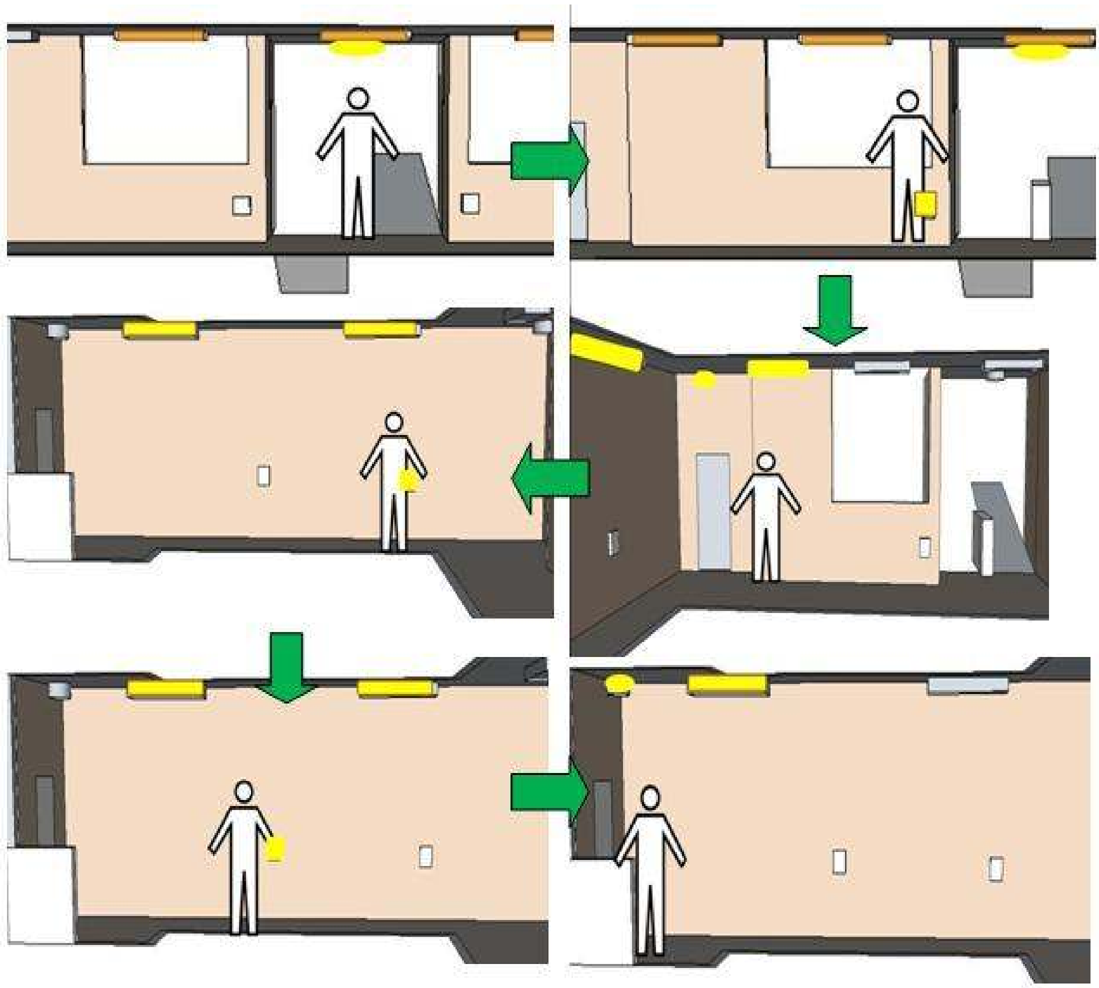


Figure 17 : Student walking through the main corridor

Table 4 : Scenario of students moving at the main corridor area between four houses

M	A1	A2	B1	B2	B3	B4	C1	C2	C3	C4		CR	R1	R2	R3	R4	L1	L2	L3	L4
1	0	0	0	0	0	0	0	0	0	0		1	1	0	0	0	1	0	0	0
1	0	1	0	0	0	0	0	0	0	0		1	1	1	0	0	0	0	0	0
0	0	1	0	0	0	0	0	0	0	0		0	1	1	0	0	0	0	0	0
0	0	0	0	1	0	0	0	0	0	0		0	0	1	1	0	0	0	00	0
0	0	0	0	0	0	0	0	1	0	0		0	0	0	1	1	0	0	0	0
0	0	0	0	0	0	0	0	0	0	1		0	0	0	1	1	0	0	0	0
0	0	0	0	0	0	1	0	0	0	0		0	0	0	0	1	0	0	0	0
0	0	0	0	1	0	0	0	0	0	0		0	0	0	0	0	0	0	0	1
0	0	0	0	0	0	0	0	0	1	0		0	0	0	0	0	0	0	1	1
0	0	0	0	0	0	0	1	0	0	0		0	0	0	0	0	0	1	1	0
0	0	0	1	0	0	0	0	0	0	0		0	0	0	0	0	1	1	0	0
0	1	0	0	0	0	0	0	0	0	0		0	0	0	0	0	1	1	0	0
1	1	0	0	0	0	0	0	0	0	0		0	0	0	0	1	1	1	0	0
1	0	0	0	0	0	0	0	0	0	0		1	1	0	0	0	1	0	0	0

The truth table for the corridor is compiled in Table 4 which also includes a scenario when a student walks out of a house to the main stair. According to the table, at any one time, the maximum number of lights that will be switched on is three. That is more than half of the normal situation where all nine of the lights are switched on for the entire duration.

4.2 Estimating Electrical Energy Consumption with Automatic Lighting System

The main objective of the Automatic Lighting System is to save energy and money by cutting down the time the lights are used. To observe the efficiency of using the lighting system, a comparison must be done between the current electrical consumption with an estimated electrical consumption using the automatic lighting system. In order to do so, it is required to know how long the lights will be switched on by calculating approximately how many times a student will pass through the affected areas; the value will then be multiplied by the total number of students in the blocks.

In every Village 5, there are two students per room; six rooms per house; four houses per floor; five floors per block. Therefore:

1 ROOM = 2 STUDENTS

1 HOUSE = 6 ROOMS
= 6 X 2 => 12 students per house

1 FLOOR = 4 HOUSES
= 12 X 4 => 48 students per floor

1 BLOCK = 5 FLOORS
= 5 X 48 => 240 students per block

There are 2 entrances to each house; the front door through the corridor or the back door through by the side staircases. Let us assume that half of the students in the house use the front door and the other half uses the back door. Therefore, for each block:

1 HOUSE	= 6 STUDENTS (main door/corridor)		
	= 6 STUDENTS (back door/side stairs)		
1 FLOOR	= 4 HOUSES		
	= 6 X 4	=> 24 STUDENTS (main door/corridor)	
	= 6 X 4	=>24 STUDENTS (back door/side stairs)	
1 BLOCK	= 5 FLOORS		
	= 24 X 5	=> 120 STUDENTS (main door/corridor)	
	= 24 X 5	=> 120 STUDENTS (back door/side stairs)	

Since there are two side staircases:

120 STUDENTS (back door/side stairs)

$= \frac{120}{2}$ => 60 STUDENTS (back door/side stairs)

Therefore, the final tally would be:

- 120 students use the corridor
- 60 students use one side of the stairs
- 60 students use the other side of the stairs

Now that we have estimated the number of students, we can now approximate how many times a light is switched on. Let us focus on one of the stairs first with a scenario of students using the stairs to either enter or leave the block. Recall that there are nine lights along the stair area; five main lights on each floor and four lights on the landings between each floor.

Since 60 students use one side of the stairs, the ground floor light would be used for 60 times. The students of this floor will not need to go upstairs, thus we subtract the students who live on this floor; 48 students continue on to the next floor. These 48 students will use the light on the first landing and first floor area. Then 12 students will stay on this floor; subtract 12 with the remaining 48 students will leave us with 36 students. This calculation is continued on for the next floors, which will leave us with:

Table 5 : Number of times lights are switched on at the side stairs

Floor	Light	No. of Students That Pass Through
Ground Floor	Main light	60
	Landing light	48
First Floor	Main light	48
	Landing light	36
Second Floor	Main light	36
	Landing light	24
Third Floor	Main light	24
	Landing light	12
Top Floor	Main light	12
	TOTAL	**300**

To calculate the students that use the front door, we must consider the corridor area and also include the main staircase. The corridor area has nine lights; we can exclude one light since it is included with the stair's light set. Out of those nine lights, one light is excluded as it will be considered as the corridor stair's light. Considering the positions of the houses, four lights will be passed by 12 students, while another four will be passed by 6 students.

Therefore for each floor, the total number of times the lights will be switched on in the corridor area when all students are considered is:

$$(12 \times 4) + (6 \times 4) = 72$$

Thus making the total for one block is **<u>360</u>**.

The same calculation for the corridor staircase is similar to the side staircases. The number of students however is 120.

Table 6 : Number of times lights are switched on at the corridor stairs

Floor	Light	No. of Students That Pass Through
Ground Floor	Main light	120
	Landing light	96
First Floor	Main light	96
	Landing light	72
Second Floor	Main light	72
	Landing light	48
Third Floor	Main light	48
	Landing light	12
Top Floor	Main light	12
	TOTAL	**<u>576</u>**

The total number of times a single pass through for all students in one Village 5 block is:

300 + 360 + 576 = **<u>1,236</u>** <u>times</u>

Suppose that students will go out at night for dinners and other activities, we assume that the students will go out a total of two time a day which makes one student pass by approximately four time; one for going out for the first time, one for going back in, one for going back out and one for going back in. Thus:

1,236 X 4 = **4,944** times

Now we can use this number to estimate how long the lights will be switched on. Our last assumption is that the lights will be switched on for ten seconds each time.

4,944 X 10 seconds = 49,440 seconds

When we convert this to hour, it will equal to 13.73 HOURS. Using this value, the estimated electrical energy consumption can be calculated.

$$\frac{36W}{1000} \; X \; 13.73 \; hours = 0.4943kWh$$

$$0.494.3kWh \; X \; RM \; 0.393 = RM0.19$$

$RM \; 0.19 \; X \; 30 \; days = RM \; 5.83$ per month per block

$RM \; 5.83 \; X \; 10 \; blocks = RM \; 58.28$ per month for 10 blocks

If we compare it with the current manual lighting system for the corridors and stairs area ONLY:

$$\frac{36W}{1000} \; X \; 12hours = 0.432kWh$$

$$0.432kWh \; X \; RM \; 0.393 = RM0.17$$

$RM \; 0.17 \; X \; 30 \; days = RM \; 5.09$ per month per block

$RM \; 5.09 \; X \; 750 \; lights = RM \; 3{,}817.50$ per month for ten blocks

The calculations still shows that even though only the stairs area and corridor area are applied with automatic lighting system, the cost is significantly reduced; up to 90% which clearly shows that the automatic lighting system saves energy very efficiently.

CHAPTER 5
CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusion

This project; Residential College Energy Saving Automatic Lighting System is an applicable project that is readily available however to apply it to the Village 5 lighting system will require a unique approach by combining motion daylight sensing device and motion sensors. The start up cost of the Automatic Lighting System is quite expensive, however it will be very beneficial in the long run. The automatic lighting system significantly cuts electrical usage by more than 50% while the cost is significantly reduced up to 90%.

5.2 Recommendations

As the project progress towards the end, there are a few recommendations for the Automatic Lighting System to improve the effectiveness of the system. Some of the recommendations are:

- The placement of the motion sensors should easily be adjusted should there be any changes to the buildings
- The fluorescent lights currently used must be replaced by LED lights
- An emergency button should be included so that the system will be bypassed should any emergency situations occur

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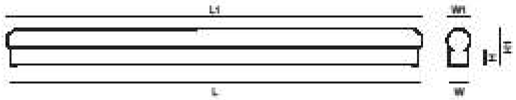
APPENDIX A

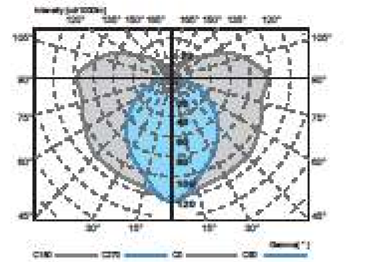
Indoor | General Lighting | Diffused Batten - Round

Design for ceiling, wall and pendant using suspension system with round daikon diffuser for visual comfort. For general applications where modest style is required. This fitting improves on visual comfort by reducing direct glare from the fluorescent tube. Lighting fixtures for more diffused light which softens surrounding objects. New plastic snap-on end-cap using variety type of diffuser for good upward light distribution and aesthetic appeal.



TM5 Utilization Factors

Utilization factors			LOR =64.9% DLOR =47.8% ULOR =17.1%								
Room reflection			Room index								
C	W	F	0.75	1	1.25	1.5	2	2.5	3	4	5
0.7	0.5	0.2	29	34	39	42	47	50	52	56	58
	0.3		24	29	34	37	42	45	48	52	55
	0.1		20	25	29	33	38	42	45	49	52
0.5	0.5	0.2	27	31	35	38	42	45	47	50	52
	0.3		22	27	31	34	38	41	44	47	49
	0.1		19	23	27	30	35	38	41	44	47
0.3	0.5	0.2	24	28	31	34	38	40	42	45	46
	0.3		20	24	28	31	34	37	39	42	44
	0.1		18	21	25	28	32	35	37	40	43
0.0	0.0	0.0	15	10	21	23	27	29	31	34	36
			SHR NOM =1.50 SHR MAX =1.69 SHR MAX TR =2.23								



Photometry result or data are available for interior lux calculation upon requisition.
Photometry constructed by own Goniophotometer accurately measure the intensity distribution LOR, photometric factors and lumen per watt of light fittings.

Technical Data

Body	Made of heavy gauge sheet steel.
Diffuser	Wide choice of diffuser type for selection.
Paintwork	Fully coated with a high gloss white epoxy polyester powder, giving resilient finish.
Light Source	Fluorescent TLD lamp of 18W, 36W.
Electrical Data	240V, 50Hz, Power factor 0.9.
Wire	HR 105° C.
Ballast	Polyester Vacuum Impregnated.
Condenser	Metallised Polypropylene Film.
Starter	SERIES(4W-22W), SINGLE(4W-80W).
Lampholder/ Starterholder	Moulded from Polycarbonate Material.
Optional/ Components	Fused terminal block/Electronic ballast/Emergency pack.

Dimensions

MODEL NO.	NO. OF LAMP	L(MM)	L1(MM)	W(MM)	W1(MM)	H(MM)	H1(MM)
SD 120(S)	1x18W	620	639	58	69	41	108
SD 220(S)	2x18W	620	630	58	130	41	109
SD 140(S)	1x36W	1229	1248	58	69	41	108
SD 240(S)	2x36W	1229	1239	58	130	41	109

G13 | CLASS I | IP20

Note : Subject to +/- 1.5mm

*SJ Lite reserves the right to change and amend the specification without prior notice.

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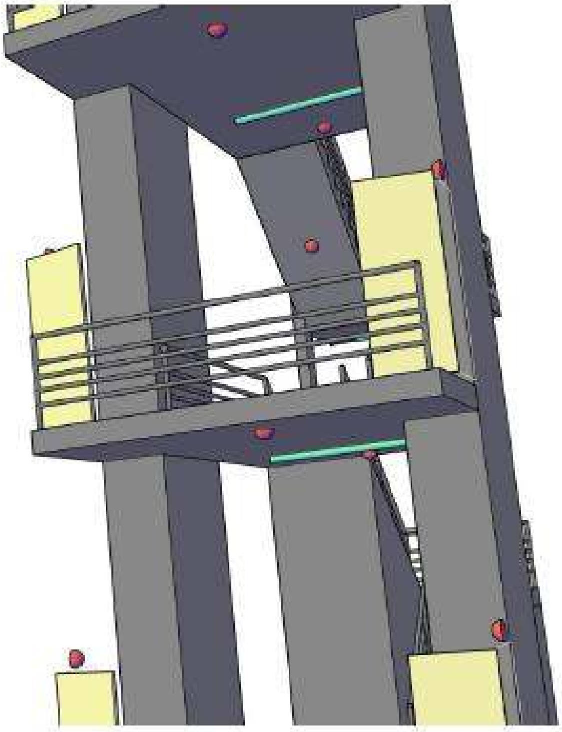
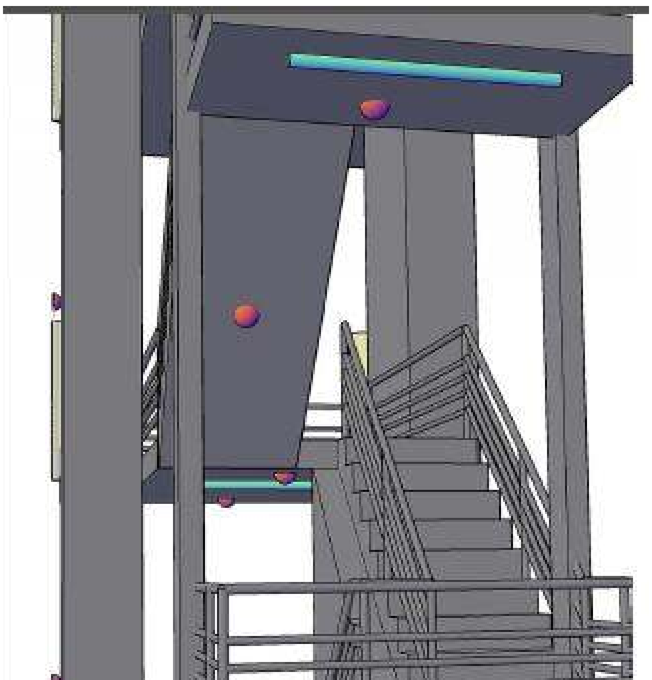
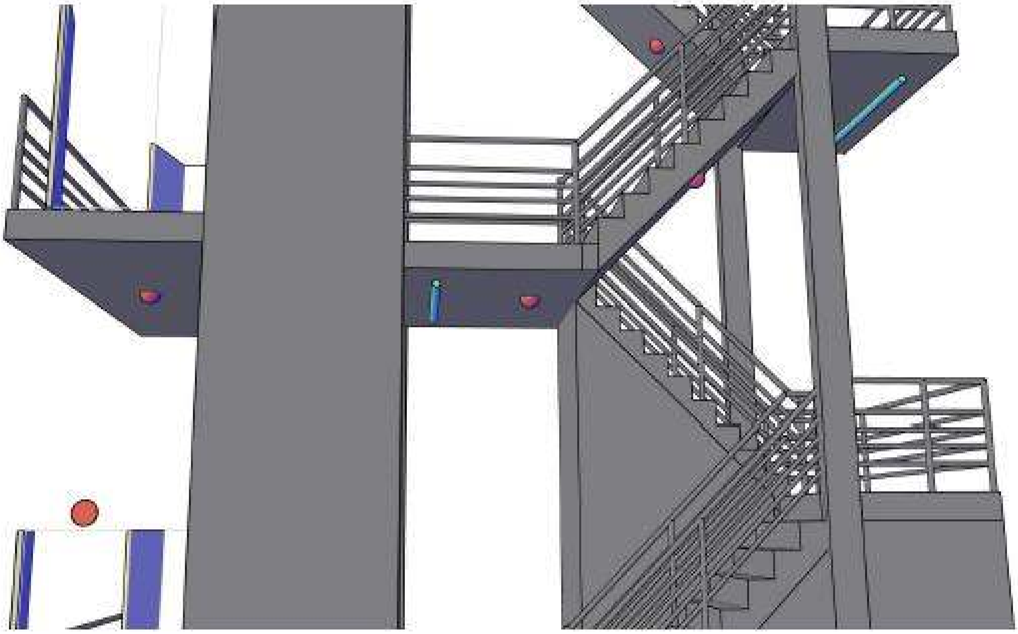
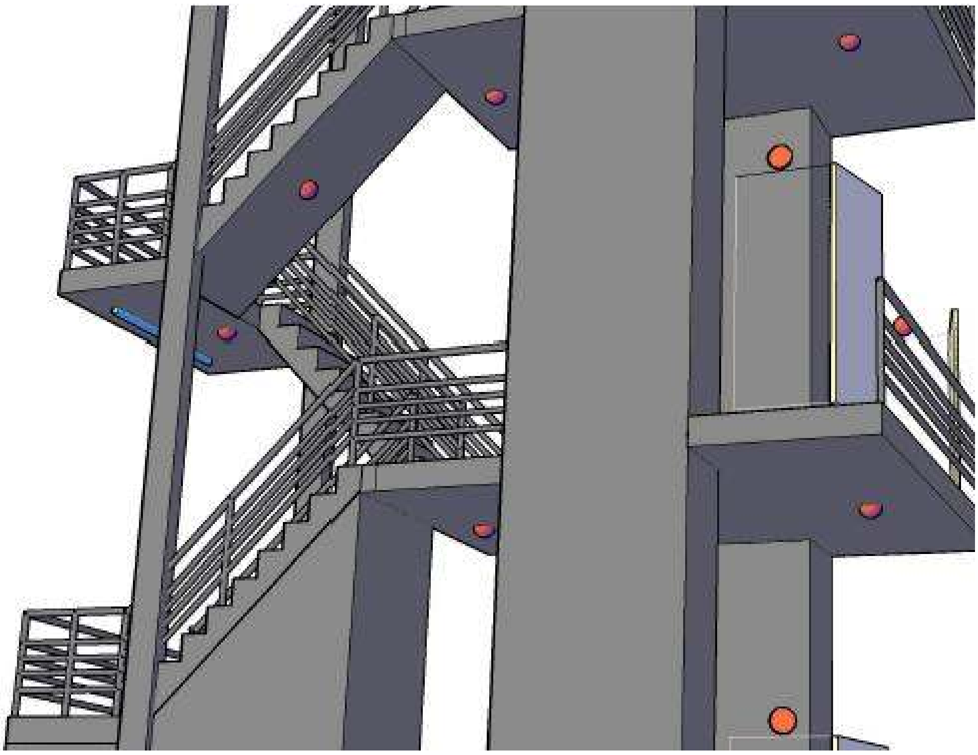
APPENDIX B









APPENDIX C