ASSIGNMENT 2 BRIEF

Qualification	**BTEC Level 5 HND Diploma in Computing**		
Unit number	Unit 43: Internet of Things		
Assignment title			
Academic Year			
Unit Tutor	Ho Hai Van		
Issue date		**Submission date**	
IV name and date			

Submission Format:

Format: This assignment is an Individual assignment and specifically including 1 document: You must use font *Calibri size 12, set number of the pages and use multiple line spacing at 1.3. Margins must be: left: 1.25 cm; right: 1 cm; top: 1 cm and bottom: 1 cm.* The reference follows Harvard referencing system. The recommended word limit is *2.000-2.500 words*. You will not be penalized for exceeding the total word limit. The cover page of the report has to be the Assignment front sheet 2.

Submission: Students are compulsory to submit the assignment in due date and in a way requested by the Tutors. The form of submission will be a soft copy posted on http://cms.greenwich.edu.vn/

Note: The Assignment *must* be your own work, and not copied by or from another student or from books etc. If you use ideas, quotes or data (such as diagrams) from books, journals or other sources, you must reference your sources, using the Harvard style. Make sure that you know how to reference properly, and that understand the guidelines on plagiarism. *If you do not, you definitely get fail*

Unit Learning Outcomes:

LO1 Analyse what aspects of IoT are necessary and appropriate when designing software applications

LO2 Outline a plan for an appropriate IoT application using common architecture, frameworks, tools, hardware and APIs

LO3 Develop an IoT application using any combination of hardware, software, data, platforms and services.

LO4 Evaluate your IoT application and detail the problem your IoT application solves, the potential impact on people, business, society and the end user and the problems it might encounter when integrating into the wider IoT ecosystem

Assignment Brief and Guidance:

You currently work as a product developer for a new startup where you design IoT products for the consumer, corporate, government and defence clients. As part of your role your manager has tasked you to plan and develop a new IoT product, service or application for a potential client. You are required to identify a target user and conduct tests with this user and include this feedback into multiple iterative versions of your product.

Part 1 (Assignment 1): For the first part, you must:

- Plan an IoT application for a specific target end user and the tests you intend to conduct with this user. This plan will be in the form of a document and will include supporting evidence and material, such as user personas and customer journey maps.
- Create multiple iterations of your application and modify each iteration with enhancements gathered from user feedback and experimentation. This will follow the pathway outlined in your plan.(log book,)

Part 2 (Assignment 2): For the second part, you must produce a report to prove that:

- Show evidence about Developed IoT application using any combination of hardware, software, data, platforms and services (video or images of your IoT system with code snippet)
- Evaluate your IoT application and detail the problem your IoT application solves, the potential impact on people, business, society and the end user and the problems it might encounter when integrating into the wider IoT ecosystem

Learning Outcomes and Assessment Criteria		
Pass	**Merit**	**Distinction**
LO3 Develop an IoT application using any combination of hardware, software, data, platforms and services.		
P5 Employ an appropriate set of tools to develop your plan into an IoT application. **P6** Run end user experiments and examines feedback.	**M5** Reconcile and evaluate end user feedback and determine advantages and disadvantages of your chosen IoT techniques.	
LO4 Evaluate your IoT application and detail the problem your IoT application solves, the potential impact on people, business, society and the end user and the problems it might encounter when integrating into the wider IoT ecosystem		
P7 Evaluate end user feedback from your IoT application.	**M6** Undertake a critical review and compare your final application with the original plan.	**D3** Critique the overall success of your application. Did it solve your problem? What is the potential impact on people, business, society and the end user? What problems might it encounter when integrating into the wider IoT ecosystem?

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ASSIGNMENT 1 ANSWERS

LO3 Develop an IoT application using any combination of hardware, software, data, platforms, and services

P5 Employ an appropriate set of tools to develop your plan into an IoT application

We will develop our plan using tools from Cisco Packet Tracer. It helps us layout the actual IoT application development better and also acts as a simulation for testing our requirements for the IoT application. As said in our application, we want to make automatic lighting that can detect motion in a room and can turn on/off light based on the current brightness in the room. There is also a push-button for the light so it can be turned on/off manually. When this button is double-pressed, the automatic lighting will be turned off. This means the light will be turned on/off indefinitely. The timeout for the light when an automatic process is currently set to 15 seconds. If no motion is detected within 15 seconds, the light will be turned off if it is already turned on automatic mode. Other way, as we said, we do not acquire the necessary module to do a Wi-Fi connection for remotely control the light via a website or phone app. But it is possible to do so in Cisco Packet Tracer, so we would like to try it out.

1. **Network setup**

First, we will set up the network required for the IoT application, this will include routers/switches/access points for devices connectivity, a light, a server, PC/Tablet for testing out remote control through the website. The network setup will be done with the following step:

Step 1 - Place out the following objects: A PC, Tablet, a switch, a router, and an access point.

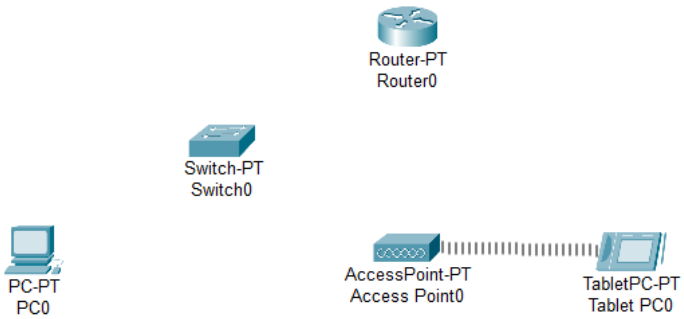


Figure 1: Network Setup - Step 1

Step 2 - Connect the PC to the switch using Copper Straight-Through FastEthernet0 (PC) to FastEthernet0/1 (Switch). Then connect the switch to the router using the same cable from FastEthernet1/1 (Switch) to FastEthernet0/0 (Router). And the access point Port0 to the switch FasterEthernet2/1 using the same cable.

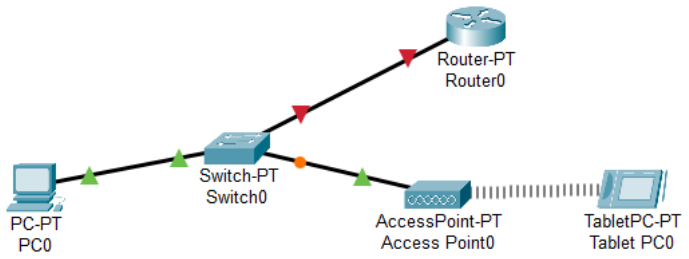


Figure 2: Network Setup - Step 2

Step 3 - Click the Router0, go to the Config tab, and choose interface FastEthernet0/0. Configure it as follow:

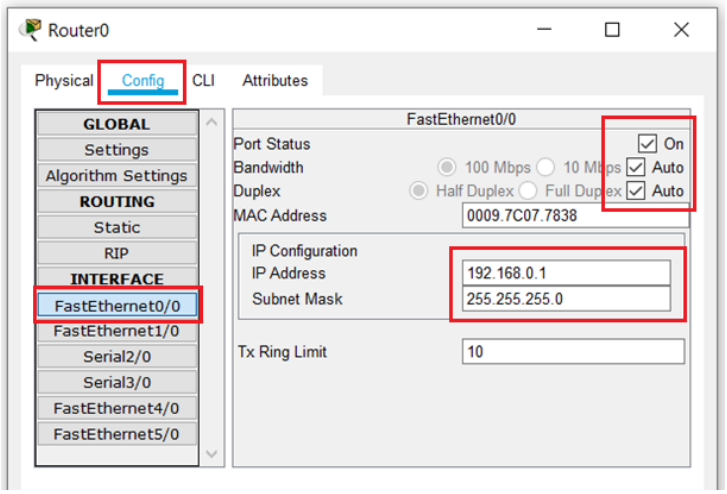


Figure 3: Network Setup - Step 3

Step 4 - Click the PC, go to the Desktop tab, choose IP Configuration and interface FastEthernet0. Configure it as follow:

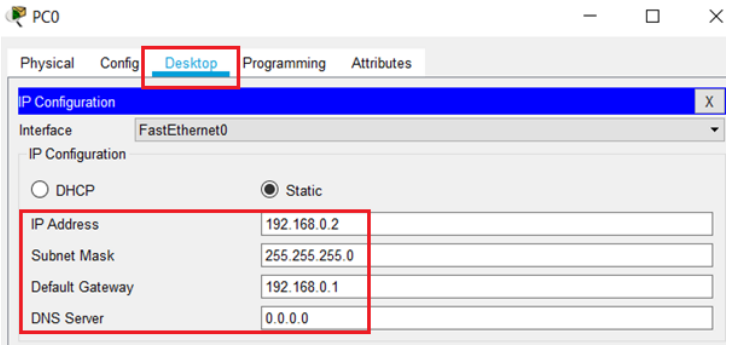


Figure 4: Network Setup - Step 4

Step 5 - Click the access point, go to the Config tab, and choose Port 1. Configure it as follow:

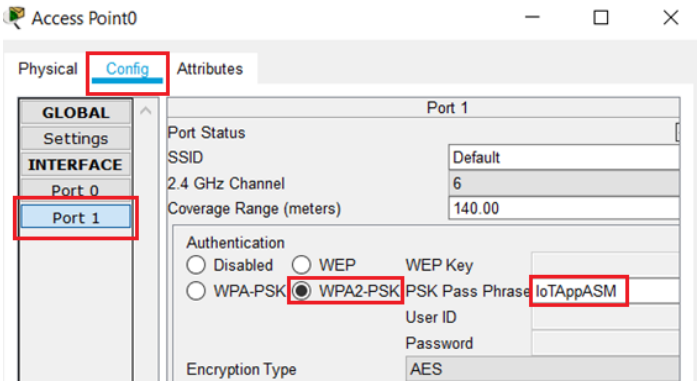


Figure 5: Network Setup - Step 5

Step 6 - Click the Tablet, go to the Config tab, choose interface Wireless0. Configure it as follow:

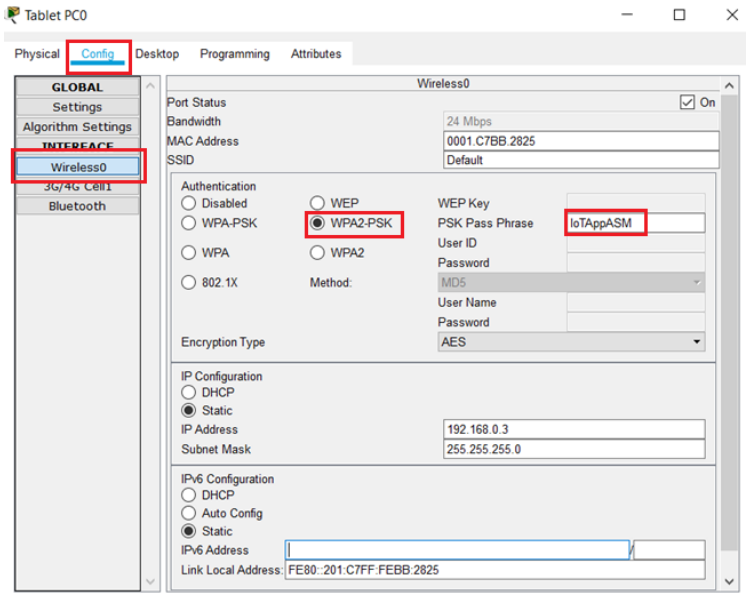


Figure 6: Network Setup - Step 6

After all the devices in the above part are both connected, we will configure the IoT devices so it can also connect to the network. This will be done through the next steps:

Step 7 - Place out a home gateway and a light.

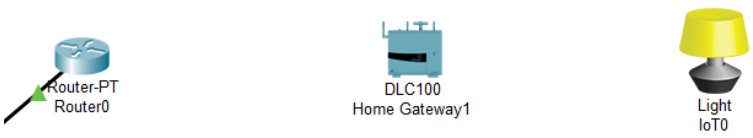


Figure 7: Network Setup - Step 7

Step 8 - Connect the router FastEthernet1/0 to home gateway Ethernet1 and home gateway Ethernet2 to light FastEthernet0. Both using Copper Straight-Through cable.

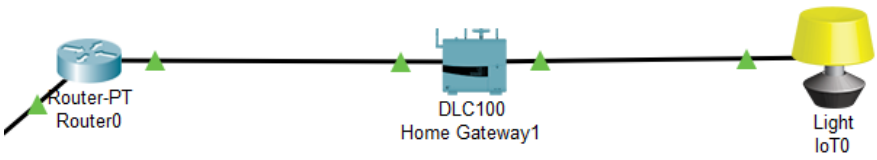


Figure 8: Network Setup - Step 8

Step 9 - Click the router, go to the Config tab, choose FastEthernet1/0. Configure it as follow:

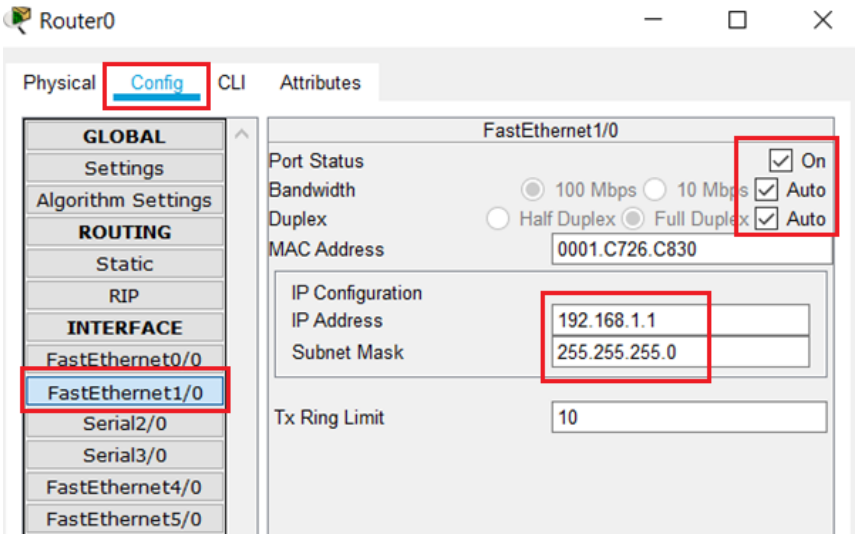


Figure 9: Network Setup - Step 9

Step 10 - Click the home gateway, go to Config tab, choose the LAN interface. Configure it as follow:

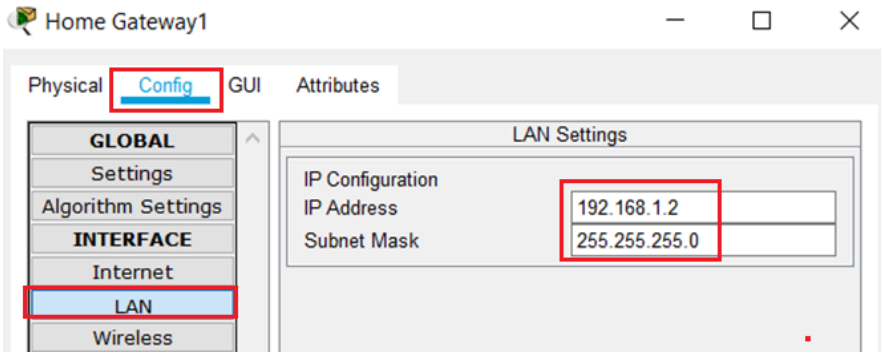


Figure 10: Network Setup - Step 10

Step 11 - Click the light, go to the Config tab, choose FastEthernet0 interface. Configure it as follow:

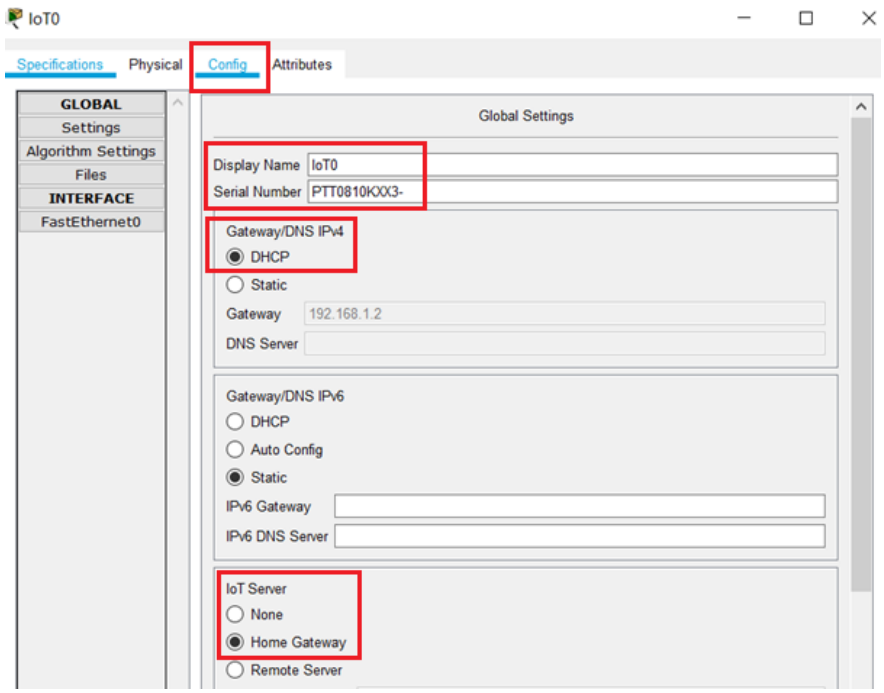


Figure 11: Network Setup - Step 11

Currently, all the devices are both connected. General, it looks like the below figure (figure 12). We can now turn the light on/off remotely through a website using a PC or a Tablet. But that is not sufficient, we want it to be able to turn on/off automatically and we want to be able to turn/off the automatic process remotely as well. So, we will perform that in the next section.

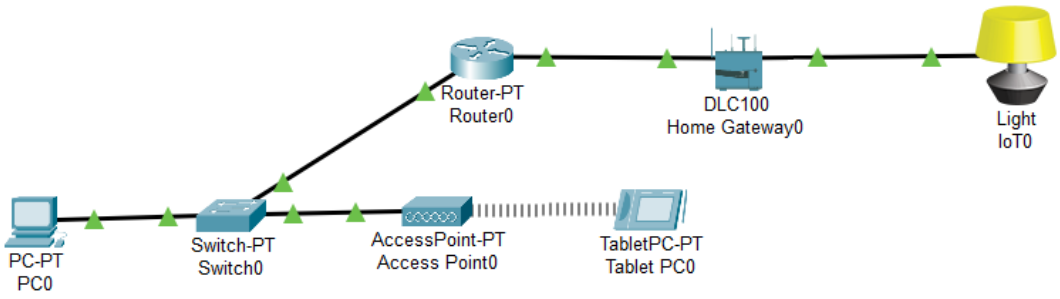


Figure 12: Network Setup

2. MCU setup

First, we will set up the MCU board for the light. It will include the board itself, a motion sensor, a photosensor (or photoresistor on TinkerCad), and a button for turning on/off the light manually (can also be used for turning on/off the automatic process). This will be done with the following steps:

Step 1 - Place out the board, motion sensor, photosensor, and a button:

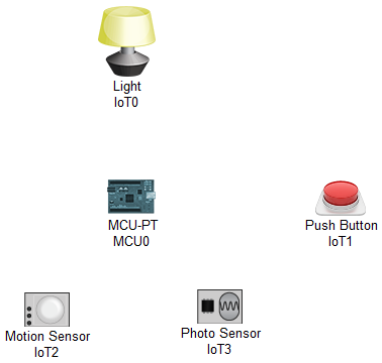


Figure 13: MCU Setup - Step 1

Step 13 - Connect the board D0 to motion sensor D0, board A0 to photo sensor D0, board D1 to light D0, and board D2 to button D0.

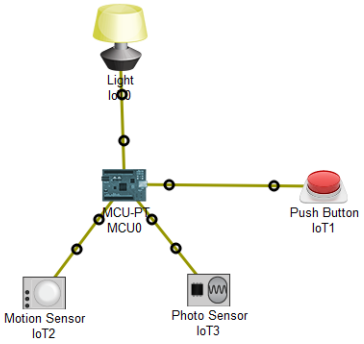


Figure 14: MCU Setup - Step 2

Step 14 - Click the board, open the Programming tab, go to the Physical tab, drag the PT-IOT-NM-1CE module to the board. This will add a port for the MCU to connect to the home gateway.

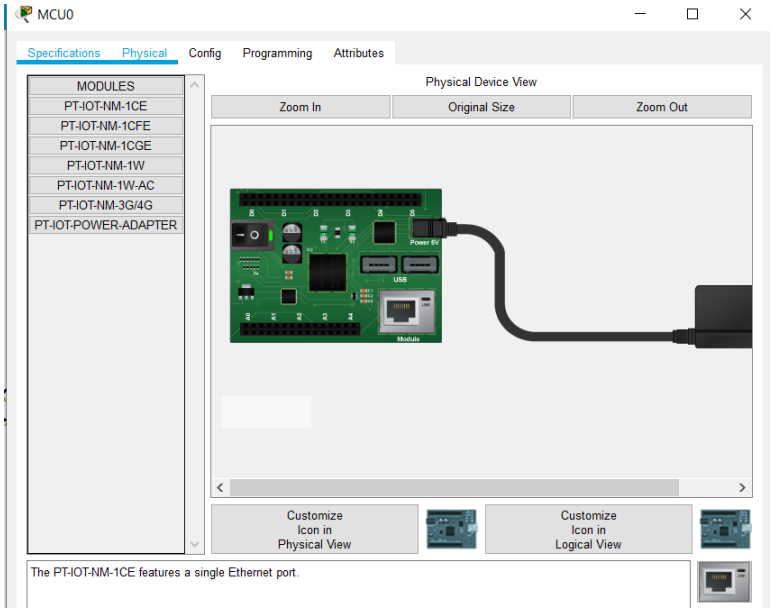


Figure 15: MCU Setup - Step 3

Step 15 - Connect the MCU Ethernet0 to the home gateway Ethernet2 using Copper Straight-Through cable.

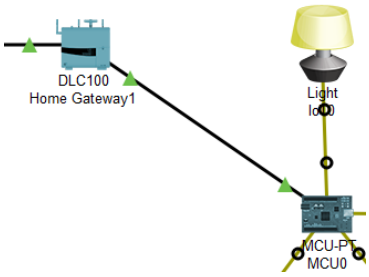


Figure 16: MCU Setup - Step 4

Step 16 - Now click the MCU board, go to the Config tab, and choose Ethernet0. Configure it as follow:

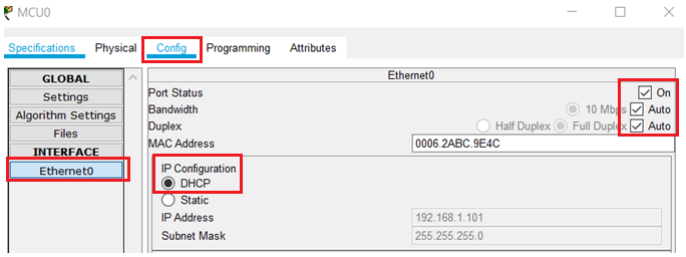


Figure 17: MCU Setup - Step 5

Step 17 - Then choose the Settings tab of MCU. Configure it as follow:

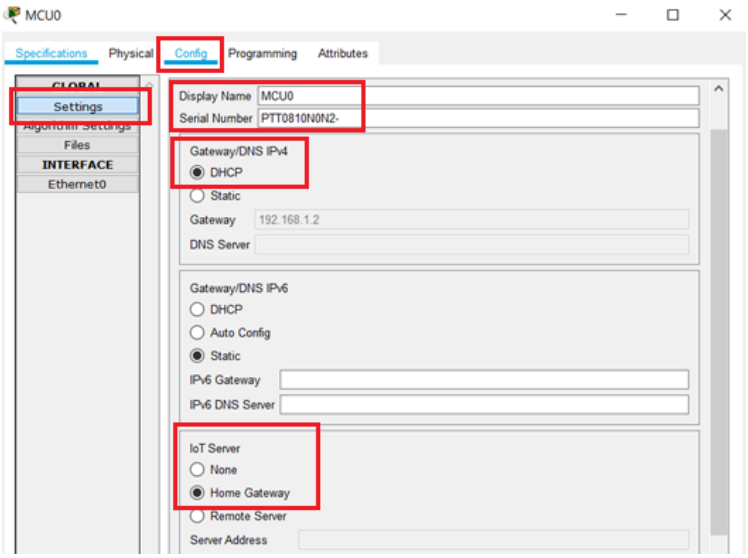


Figure 18: MCU Setup - Step 6

Step 18 - Then go to the Programming tab of the MCU, create a new Project called Automatic Light with the Empty template using language Javascript.

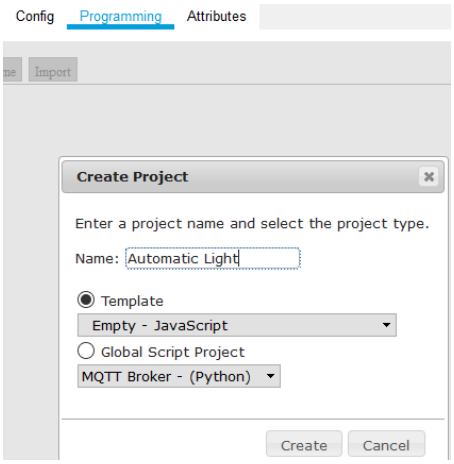


Figure 19: MCU Setup - Step 7

Step 19 - Open the project, and open main.js. Paste in the following codes:

```
var l_state = false;
var l_auto = true;
var l_remote = false;
var b_state_prev;
var prev;
var twice = false;
var next = 1;
var DATE = Date.now();
var LIGHT = 1;
var BUTTON = 2;
var MOTION_SENSOR = 0;
var PHOTO_SENSOR = A0;
//Timeout
var TIMEOUT = 15000;
var CURRENT = Date.now();
var DELAY = 500;
var THRESHOLD = 450;
var BRIGHTNESS = 1;
function setup() {
      pinMode(LIGHT, OUTPUT);
      pinMode(BUTTON, INPUT);
      pinMode(MOTION_SENSOR, INPUT);
                IoEClient.setup({
                type: "MicroController",
                states: [
                          {
                                    name: "Light On/Off",
                                    type: "bool",
                                    controllable: true
                          },
                          {
                                    name: "Light Auto On/Off",
                                    type: "bool",
                                    controllable: true
                          },
                          {
                                    name: "Light Timeout",
                                    type: "number",
                                    imperialUnit: "ms"
```

```
                        },
                        {
                                name: "Light Brightness",
                                type: "options",
                                options: {
                                        1: "Dim",
                                        2: "Bright"
                                },
                                controllable: true
                        }
                ]
        });
                b_state_prev = button_released();

        IoEClient.onInputReceive = process_state;
        IoEClient.reportStates([l_state, l_auto, TIMEOUT, BRIGHTNESS]);
}
function process_state(states) {
        states = states.split(',');
        if(parseInt(states[0]) != l_state) {
                l_state = parseInt(states[0]);
                l_remote = true;
        }
        if(parseInt(states[1]) != l_auto) l_auto = parseInt(states[1]);
        if(parseInt(states[2]) != TIMEOUT) TIMEOUT = parseInt(states[2]);
        if(parseInt(states[3]) != BRIGHTNESS) BRIGHTNESS = parseInt(states[3]);
}
function loop() {
        IoEClient.reportStates([l_state, l_auto, TIMEOUT, BRIGHTNESS]);
        var pressed = false;
        var double_pressed = false;
        var b_state = button_released();
        if(b_state) {
                var cur = Date.now();
                if(!b_state_prev) {
                        pressed = true;
                        if(prev) {
                                if(cur - prev <= 550) {
                                        double_pressed = true;
                                        prev = 0;
                                } else prev = cur;
                        }else prev = cur;
                }
        }
        if(double_pressed) {
                l_auto = !l_auto;
                Serial.print("Light Auto: ");
                Serial.print(l_auto);
                Serial.print("\n");
        }
        if(l_state) {
                if(l_remote) {
                        CURRENT = Date.now();
                        l_remote = false;
                }
                customWrite(LIGHT, BRIGHTNESS);
                if(CURRENT + TIMEOUT > Date.now()) {
                        if(pressed) {
                                customWrite(LIGHT, 0);
```

```
                                    l_state = false;
                          }
                          if(!l_auto) CURRENT = Date.now();
                          else if(digitalRead(MOTION_SENSOR)) CURRENT = Date.now();
                }else {
                          customWrite(LIGHT, 0);
                          l_state = false;
                }
      }else {
                if(l_remote) {
                          l_remote = false;
                          customWrite(LIGHT, 0);
                }
                var b = analogRead(A0);
                var m = digitalRead(MOTION_SENSOR);

                if((l_auto && m && b <= THRESHOLD) || pressed) {
                          l_state = true;
                          CURRENT = Date.now();
                }
      }
      b_state_prev = b_state;
}
function button_released() {
      var bt = digitalRead(BUTTON);
      if(bt) return 0;
      else return 1;
}
```

After network setup, it is fully functional, and can be remotely controlled through a phone, pc, or manually using a button. It can now detect motion and turn on/off light accordingly. When the button is pressed twice consecutively, the automatic process will turn off and the light will turn on/off indefinitely. Though in our requirements, it is also required that the automatic process is turned off within a certain timeframe. It is possible in Packet Tracer because it is a simulation but it will require more modules in practice.

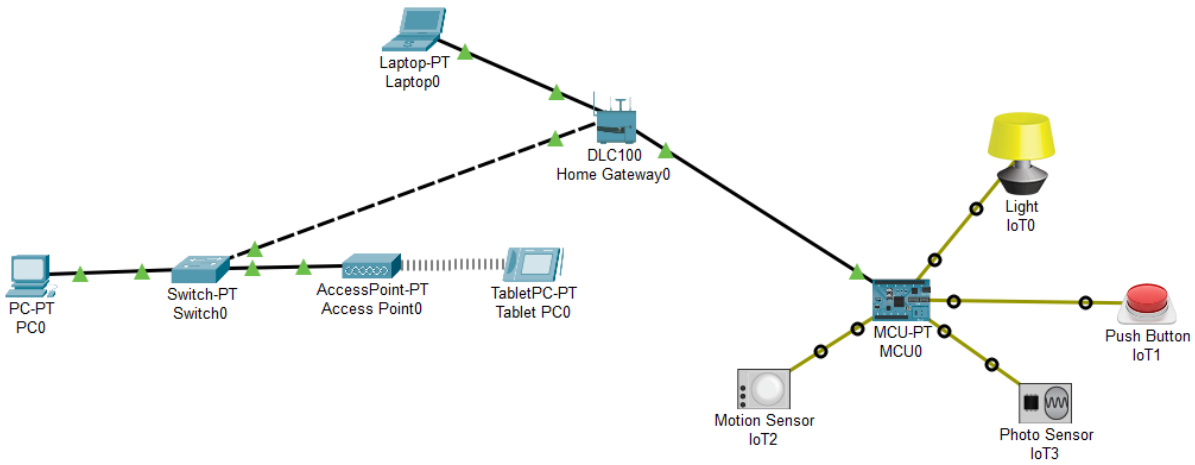


Figure 20: Auto-Light System

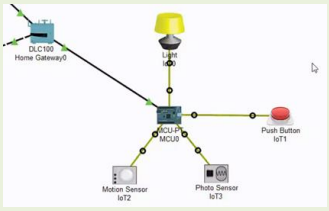
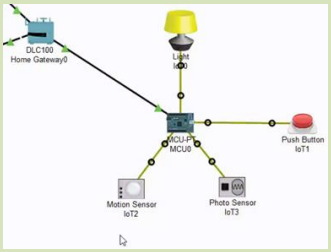
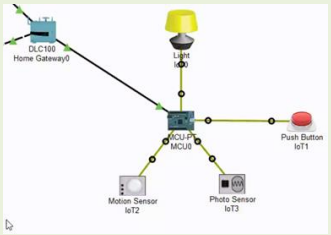
P6 Run end-user experiments and examines feedback

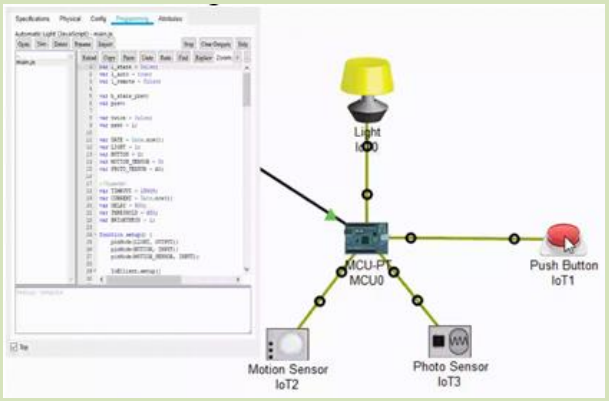
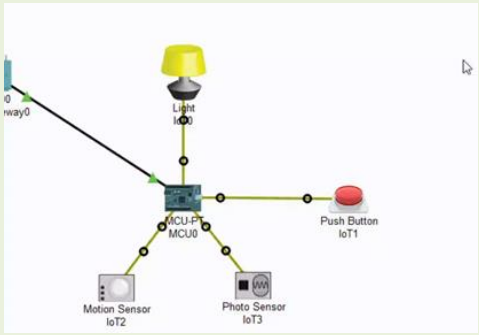
After created the IoT application, we want to run some tests on the app. This will make sure it works as intended and to see whether it features work properly. The test will be performed interactively and remotely. An interactive test is when we interact with the devices themselves. In this case, it is by pressing the button to turn on/off the light or the automatic process, and by creating motion for the motion sensor. Finally, the remote test is by using the website on a PC/Laptop/Tablet for controlling the light.

1. Interactive Test

We will perform several tests for the interactive part involving using the given button. The results shown in this test table are all GIF files. They can be run by opening the link. Clicking on the image in PDF file or "Ctrl + Click" image in Word file.

Table 1: Interactive Test

	Tests	Results
1	Test for whether the light can be turned on/off using the button.	When the button is first pressed, the light will turn on. Then pressed again, it will turn off. 
2	Test for the motion detection, so light will turn on accordingly.	Motion can be done by hovering the mouse while holding Alt button around the motion sensor. As we can see the light is turned on due to the current brightness in the room is low. 
3	Test for whether the light will turn off automatically if the motion is not detected.	When no motion is detected, it will turn off the light after 15 seconds. 

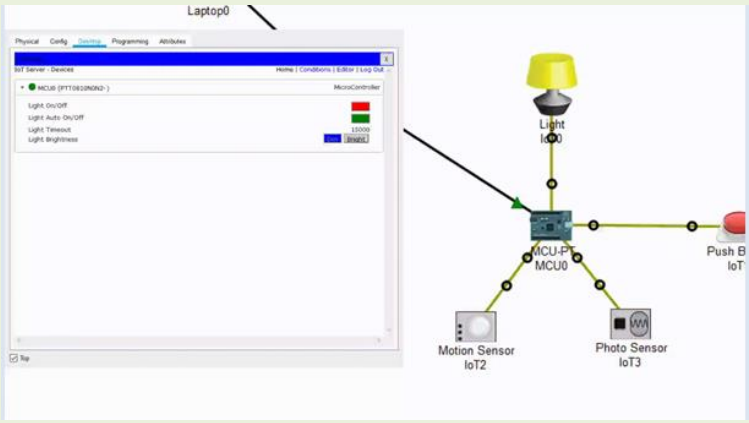
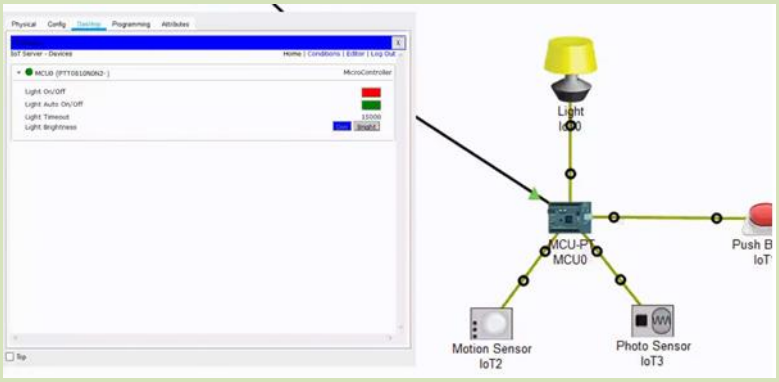
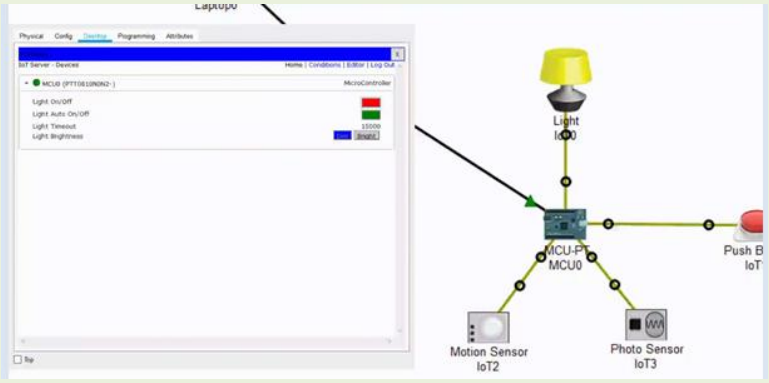
4	Test to see whether the automatic process for the light can be turned on/off.	When the automatic process is turned off, the light will not turn on if there is motion and will not turn off even if there is no motion. We can test this by first turning off the automatic process and create motion to see whether the light will turn on. 
5	Test to see whether the light will continue to turn on if there is still motion.	For this particular test, we have adjusted the timeout for the light down to 7 seconds. This means after 7 seconds without motion it will turn off the light. First we will see the light turning off after 7 seconds without motion. Then we will see it continuously turning on if there is still motion. 

As we can see, the interactive test has shown that the features for using the light have been properly tested and working accordingly. The button for turning on/off the light and the motion sensor are working as intended. With that, we can now move on to do the remote test.

2. Remote Test

For the remote test, we will conduct somewhat the same set of tests as the interactive test. But it is done remotely through a website on a PC/Laptop/Tablet, we will use a PC in this case. Again, all the results shown are GIF files which can be played by “Ctrl + Click” the image in a Word file or simply clicking it in a PDF file.

Table 2: Remote Test

	Tests	Results
1	Test for whether the light can be turned on/off using the website.	Logged into the IoT Monitor, we can see that the light can be turned on/off remotely by using "Light On/Off" option. 
2	Test to see whether the automatic process for the light can be turned on/off remotely.	When the automatic process is turned off remotely, and the light turned on, we can see that it does not turned off automatically even if there is no motion detected. 
3	Test to change the brightness of the light.	It is seen that we can change the light brightness using the "Light Brightness" shown in the website. 

After we conclude the testing phase, both the interactive and remote tests have shown excepted results. The light can both be controlled remotely and interactively. Now comes where we get our user feedbacks by getting them to try using the light.

3. End-user feedbacks

We have conducted a small survey of 12 participants by having them using this light. It helps us gain more insight into our IoT application to see how we can improve or whether it has any impact on practical usage. The survey contains 10 questions, 5 of which is a multiple choices questions, and the other 5 are small paragraph question. Below are the feedbacks gathered and explain/evaluate for each question:

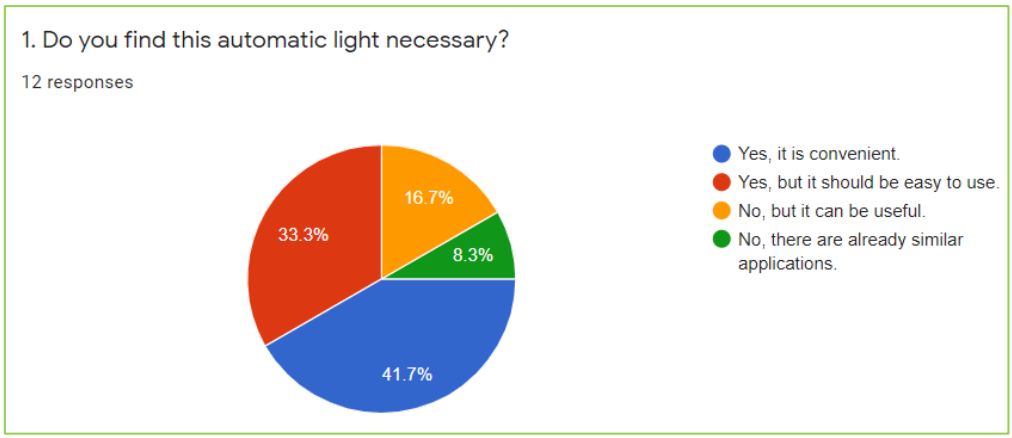


Figure 21: End-user feedbacks - Question 1

Question 1 - In this question, we have asked the user whether they found this IoT application necessary, 41.7% for "Yes, it is convenient", 33.3% for "Yes, but it should be easy to use", 16.7% for "No, but it can be useful", and 8.3% for "No, there are already similar applications". This probably indicates that some do not mind having to manually turn on/off the light while the others find it convenient to have the light turn on/off automatically. The results imply that this IoT application is necessary because it might be the case that people might feel lazy in turn have to walk around for the switch of the light or they forgot to turn off the light which could lead to energy waste. But the application should also be easy to use. (Multiple choices question)

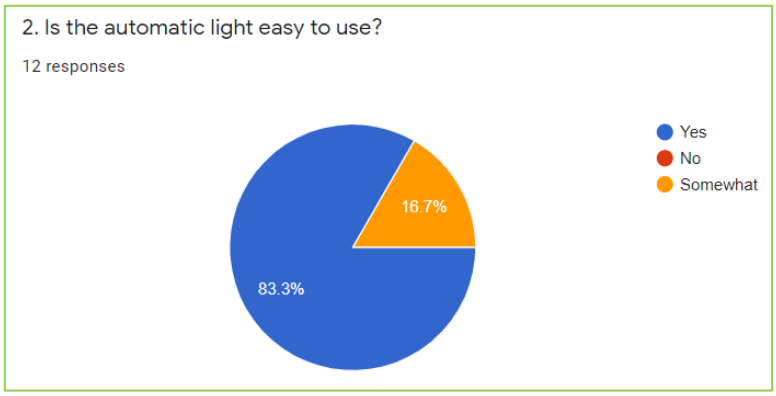


Figure 22: End-user feedbacks - Question 2

Question 2 - In this question, 83.3% of the responses say that our IoT application is easy to use. This means that there is are not much problem with using the light by either the button or the website. The 16.7% probably indicates that might be a problem within the button or website that has been overlooked. Other than that, there seems to be no one found it hard to use. (Multiple choices question)

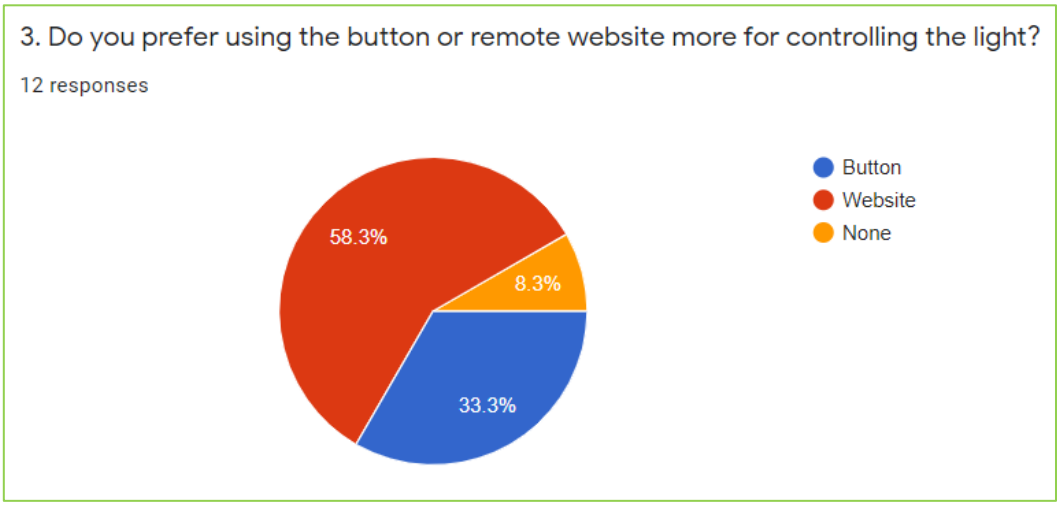


Figure 23: End-user feedbacks - Question 3

Question 3 - This question is mainly to ask about how they feel about using the light. Whether they prefer the button or website more or none of those, this depends on their preference and user experience. It seems that websites are more preferred than buttons (58.3% over 33.3%). This indicates that the usage of websites means they find the experience fresh and convenient. Though there is still a small percentage of 8.3% find none of which is preferable. (Multiple choices question)

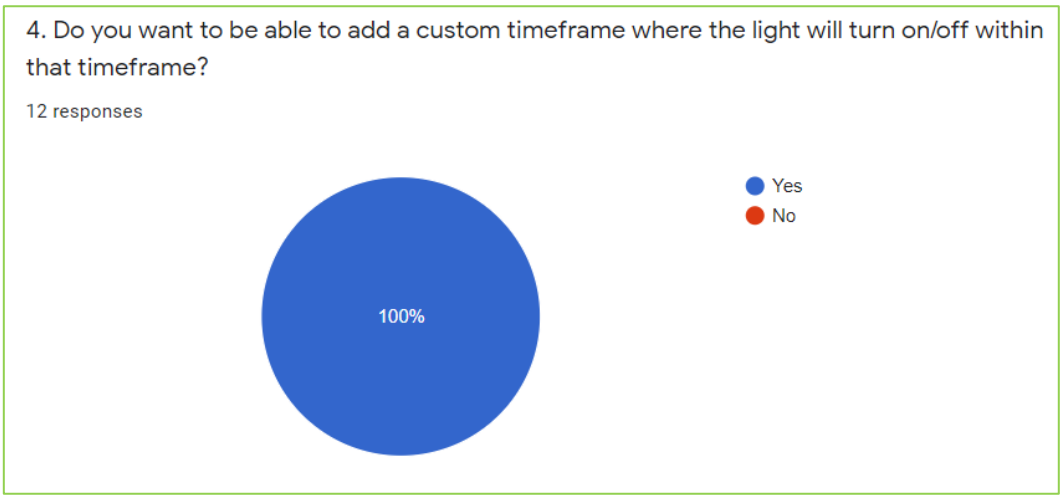


Figure 24: End-user feedbacks - Question 4

Question 4 - All the responses want to have the custom timeframe feature. It seems that they find this feature quite convenient since it is probably useful when setting up for a party or a date at the house. Or they might want to have the light turned on automatically when a certain frame in the night falls in. (Multiple choices question)

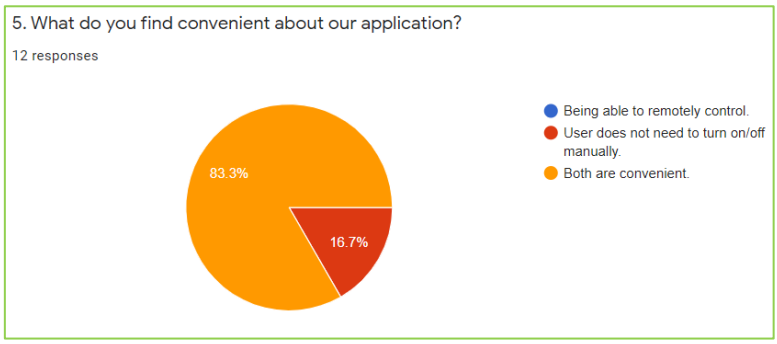


Figure 25: End-user feedbacks - Question 5

Question 5 - This question is asked to find out how they think about our IoT application convenience. There are 83.3% for "Both are convenient", 16.7% for "User does not need to turn on/off manually", 0% for "Being able to remotely control". This means that our design choice for using both remote control and motion sensor can be very flexible. But there are also some only prefer the motion sensor over the remote control. (Multiple choices question)

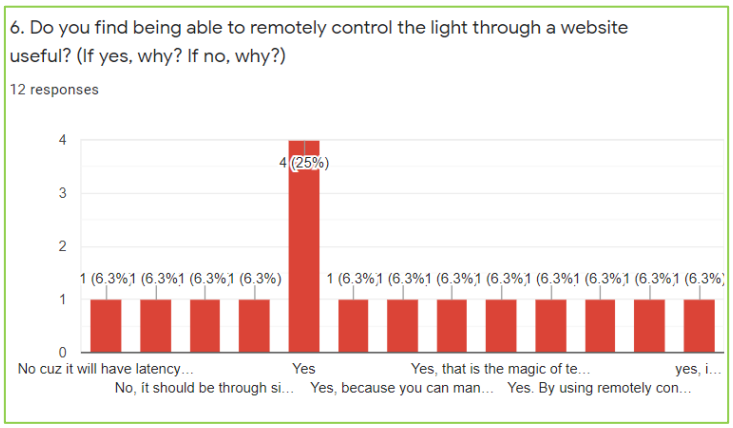


Figure 26: End-user feedbacks - Question 6

Question 6 - Most of the responses find it relatively useful to be able to control the light through a website. The reasons include: just by using the internet they can easily control it, good for user experience, no need to find the remote, not having to walk around to get to the switch, and overall just find it useful. There are also responses that do not find it reasonable to use a website to control light. The reasons are because there might be latency so it is not good if they want instant light and it might too complicated. It is understandable since old people who are no so

familiar with technology might find it difficult to use. And not having a good network connection can cause some trouble too. (Short-answer question)

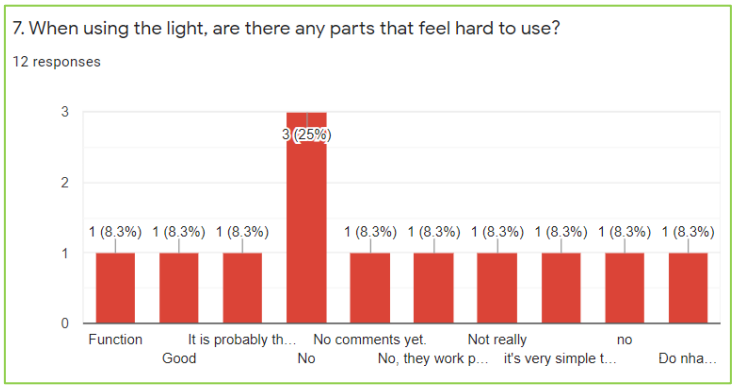


Figure 27: End-user feedbacks - Question 7

Question 7 - Most of the answers said it is easy to use and it works fine. Though there are some answers that say the motion sensor might be too sensitive and the button feels a bit buggy. Overall, it provides an easy to use the experience to the user. (Short-answer question).

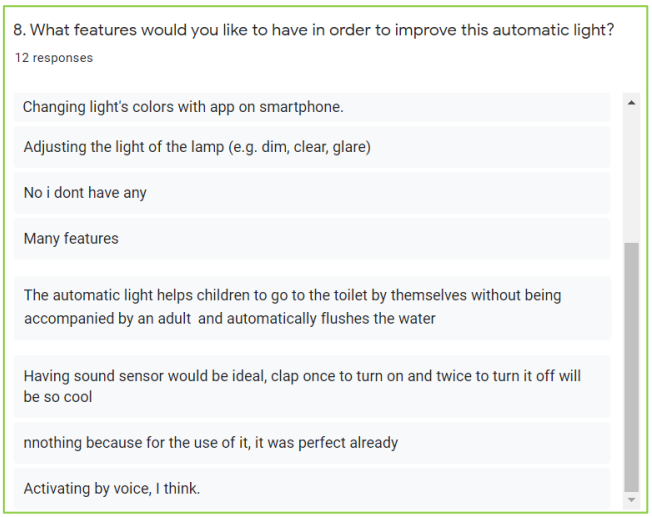


Figure 28: End-user feedbacks - Question 8

Question 8 - This question mainly asks the end users what feature they would like to have for the light. Most of them says there is nothing to suggest since it is fine already. There is also one response that mention the usage of sound sensor for automatic lighting by clapping. Another response says that the automatic light is good for children not having to have their parent go with them to the bathroom and says it should be able to flush the water automatically. This indicates there should be a feature that can link between different IoT applications. A different suggestion is to add more color to the light and being able to adjust them. (Short-answer question)

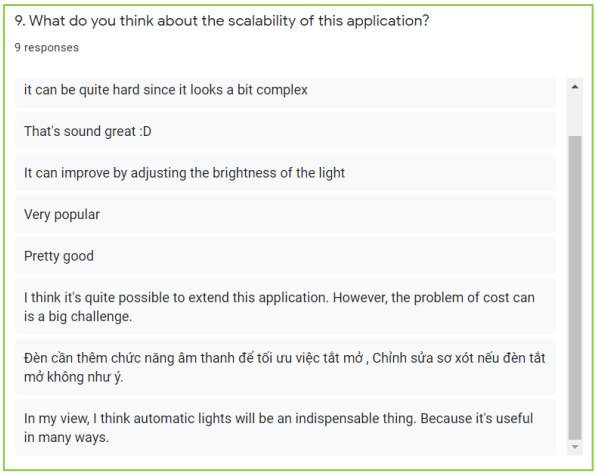


Figure 29: End-user feedbacks - Question 9

Question 9 - There are only nine responses to this question. We asked this question to see whether our application can be scaled further. It seems that the responses vary somewhat. One response thinks that the cost of the application can be a problem. A different response thinks that this application will be an indispensable thing since it is useful in many ways. Another response says that it can be hard since the application looks a bit complex. Other responses think it can be scaled more by adding more features. (Short-answer question)

Figure 30: End-user feedbacks - Question 10

Question 10 - There are ten responses to this question and the other two were left unanswered. The responses to this question also vary but not much. Most answers think it is much more useful and convenient than current household lighting. One the other hand, one answer said that it can be good for people that can be forgetful. Another answer thinks that it is only convenient if the user understand how to use it. A different one thinks that it is better to use this application in hotels, villas, mansions than a family house.

M5 Reconcile and evaluate end-user feedback and determine the advantages and disadvantages of your chosen IoT techniques

Internet of things (IoT) is the hot point in the Internet field. It helps to intercommunicate physical objects furnished with sensing, actuating, computing power, and connect to the Internet. With the help of sensors, actuators, and embedded microcontrollers, the verdict of the smart objects is realized. Wherein these smart objects colligate data from the environment of development, process them, and take reasonable actions. Thus, the IoT may generate unbelievable benefits and helps human beings in living a smart and luxurious life. Due to the potential utilization of the Internet of things (IoT), it has ended up being an unmistakable subject of logical research. We used the motion sensor, photoresistor, and some techniques to can control lights by ways other (switch and website through connect networking).

First, the motion sensor helps our lights turn on/off based on the movement. Mean, when our lights sense the movement where it is installed then it will light, and after a certain amount of time (or when the movement ends) light will off. Opposite, if it doesn't sense the movement then it will don't light. However, when using the motion sensor also have disadvantages. Suppose, when you are sleeping, you can cause some movement incidentally. At that time, lights will light - this can wake you up or make you feel uncomfortable.

Next, the photoresistor helps our lights can tur on/off by see the current brightness of the room. If the room fairly bright, lights will be don't turn on. Opposite, if the room seems a bit dark then lights will be turned on and it also will turn off after a certain amount of time (or the room turns bright even without the turn lights on). According to some opinion then use the photoresistor almost doesn't have disadvantages and that the same with my think before when decided to use photoresistor.

On the other hand, we also use some techniques to can the automatic process stop of the lights - this will overcome the disadvantages when using a motion sensor. We use switch and website for that. The website helps us can use/control lights when "lazy" (not near the switch) and help us can install/custom time work of the lights. Notwithstanding, this has one disadvantage is you can't using it when don't have to connect to the internet and don't have a laptop, PC, smartphone, tablet. This means, you only can use this function when you have one in some devices like a laptop, PC, smartphone, tablet, and your device must be connected to the internet. Next, the

switch helps the users can turn on/off manually. It helps us can control/use lights when don't have internet. In addition, it also helps old people or some people who are not tech-savvy still can use/control lights. Until now, using the switch also didn't cause any disadvantages.

Summary, based on the feedbacks of end-user and tests. The techniques we have chosen almost both have advantages and disadvantages. Nevertheless, these techniques can support each other and bring the best for user experiences.

LO4 Evaluate your IoT application and detail the problem your IoT application solves, the potential impact on people, business, society, and the end-user, and the problems it might encounter when integrating into the wider IoT ecosystem

P7 Evaluate end-user feedback from your IoT application

After doing the survey, we have gathered responses from the end-user and we will rely on it for closer assessment. We would like to more closely evaluate their feedback so can gain some further details about our IoT application and ways to improve it.

Based on the results of the first two questions, it is reasonable to say that our application does have some impact on people's life. The automatic is easy to use means that their experience with our application is overall good. Furthermore, the necessity of our application shown in the first question means that people are having trouble with using a normal light with switches. They could have probably found it to be an inconvenience and want to have a better replacement. This means our application with automatic light turning on/off and remote control is one of the solutions to them.

Next, based on the third question, it seems that we have made the right choice not to fully use remote control but to also use a button. Because some people might already be used to using a switch/button instead of remote control through the website so they find using a button is easier. Moreover, it can help old people use our IoT application much better since they might not be able to use the website since it can be too complicated.

Aside from this, the fourth question tells us that we need to add the timeframe feature for the light. It must be the case that they want to set up automatic lighting

at a certain timeframe so that can they can better set up for a party or something similar or it can also help them focus on different matters.

For the fifth question, most users think both remote control and motion sensor are convenient but there are also some that think only motion sensor is convenient enough. This could mean either they do not like using the remote control or the remote control is somewhat complicated.

In the sixth and seventh questions, we can see that using a website for remote control can be useful and quite a new experience for the user. It is most convenient, but as mentioned, it can also become too complicated for some people which will need to rethink our design decision. And mostly, there are not any parts that feel hard to use for the users. But even if, this conflicts with the suggestion that it can be somewhat complicated when using a website. So we might need to redesign how to use the remote control for the light.

Next, in the eighth question, there are some features suggestions such as adding sound sensors to the light and the ability to interact with other IoT applications. Moreover, they want to have more freedom in adjusting the light brightness, color.

Finally, in the two ninth and tenth questions, it seems that the current version of our IoT application has a bit of a problem such as a cost and complexity. So it should mostly be used in a larger house and for people that are familiar with the technology.

In summary, we have the following improvements:

1. *Adding the timeframe feature for custom light on/off time.*
2. *Provide a better user experience/friendly by improving the website and developing a mobile phone application for more usage.*
3. *Adding more features such as light color changing and sound sensor while trying to maintain an "easy to use" experience for the users.*
4. *Develop a way that our IoT application can communicate with other IoT applications. (e.g. API)*
5. *Develop a better way of using the button without feeling buggy.*

M6 Undertake a critical review and compare your final application with the original plan

According to the original plan of us, the requirements for this application are to turn the light on when there is a person in the room and the current brightness of the room is low (not turn it on when the brightness is high). Next, after some fixed amount of time, if no one is in the room, then it is turned off. Next, when the automatic process is stopped, the light is turned will off within a certain timeframe. Finally, there should be a switch for the light bulb so that the users can turn on/off manually. However, after the survey, we receive much feedback that they desire can use/control lights through the website and need to add the timeframe feature for the lights.

In the original plan of us, lights only can use/control manually with a switch. It will slightly inconvenient when you not near the switch or when you lazy move. And using the website to use/control lights by smartphone, tables,...etc brings for user experience better. Thereby, it has met the needs set out. Other way, a timeframe feature for the lights also added. So, we can install/custom time work of lights. This means setting up automatic lighting at a certain timeframe so that can better set up for a party or something similar or it can also help focus on different matters.

Based on that feedback, can see that our application still has some shortcomings. After realize and identify shortcomings in ourself application, we improved and test again then given the final application. How surprising, new all functions after improvement in the application can support some old functions before and this makes our application more complete and much better than the application in the original plan.

On the other hand, can see that our application also fully and few shortcomings than compared with automatic lamps that are available on the market today. Though, the price issue after the finished product still cannot be solved yet. This is a challenge when we wanna create an application both have full functions and have a price reasonable.

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