Automatic Office Lights Project Proposal

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Abstract - **AutOffice are working for DayTech to achieve smart lights in their office - split into different areas, and achieve control via the internet. This report highlights the functional requirements, system design and how scalability and IoT are implemented and achieved.**

I. Introduction

A. Background

The new startup company specialising in smart homes, and IoT related projects - Daytech are looking to create a functional system to assist with automating lights around their office, and they've hired AutOffice services to implement this for them. This encompasses a control panel like system that is able to be controlled by the staff in the office via a website link. The purpose of being able to use an online system like a control panel basis is to have control over different rooms, not just one - and ensuring the solution is remote, implementing their main belief of IoT. Currently, the lights are turned on and off manually by the staff - proving to be a time-consuming and unproductive task.

B. Current System

The current system embeds manually functioning the turning on and off of lights, which as mentioned is time-consuming, especially if it's done for multiple rooms - such as large corporate offices or schools. If we assume that for each respective room it will only be the employees in that room that will take care of the lights being on or off manually, there still will be someone who is checking to see they are closed for security reasons at the end of the day - which can be tedious.

C. Proposed solution

AutOffice aims to provide an intuitive interface to users. This is aimed to be executed through an IoT web application so that users can control if lights are to stay on or off. For this system to become scalable it is vital to test and create this solution for 10 different rooms, where a master switch could automate all the lights at once, and be able to control individual lights in seperate rooms - meaning the proposal embeds multiple combinations. Testing this for 10 rooms will ensure it is possible and therefore is scalable to work with a higher number. It will also serve as a security factor, especially when it comes to meeting rooms and being able to maintain the privacy and noise control between your office and what's happening outside that room, eliminating distractions.

D. Stakeholders Impacted

The stakeholders from this application that could be impacted are; staff, managers, security.

Staff: Able to control and monitor the lights and their current state via the app, and can change this according to their preference.

Managers: uphold the same responsibility as staff however would be responsible for checking to see all the lights are off before end of day, perhaps being able to check on a main page to see which lights aren't off - again through the control panel like interface.

Security: Check the building to ensure lights all remained closed after end of day, if there are any on - use the application to close them, and let the manager know incase there are any faults in the application and need to be addressed.

E. Benefits

-Increase in convenience, time efficient, especially in the long run

-Added and improved security; especially in a commercial setting where at times not having any light coming in might be beneficial due to the confidential work such as defence companies

-Helps preserve furniture and valuables because of the harsh sunlight

-Be More energy Efficient

II. Literature Review

Abstract

A smart home revolving the rapidly changing technology era is becoming more popular to be used in households, especially more modern and new houses. It is common to see some smart home elements that are embedded in households; such as google homes, smart lights and electronic locks such as ones that can be biometrical. This review examines the approach taken to embed a software-based home automation system with the aim to increase security, this design is aimed for home owners. The results indicate the features that were being focused on to implement into the smart home such as, automatic locks, lights, and even using sensors to check if doors are closed and alerting if a door has been opened for too long were met with some gaps being present however overall the objectives were met.

Introduction

The Bachelor Thesis; Internet of Things for Home Automation by Mohamad Hisham Moubarak discusses the idea of a smart home - which can look appealing from the outside, but coherently explains the underlying issues and problems it can cause and how to minimise risks. The issue present about security and user's privacy data is being addressed, through interconnected devices which are working together to achieve an embedded system via the internet that is able to be control multiple systems in the house. This would include; smart lights, doors, email notifications if there is a mistake, facial

recognition and remotely traceable cameras. While this thesis doesn't present IoT on a scalable format, it could be extended to be used in multiple homes or even commercial offices achieving scalability.

Body

Historical Development:

The concept of IoT was discussed in the thesis, outlining the purpose of it and how it was made to be helpful when introduced in the year 1998 by Kevin Ashton. As predicted, and evident by present day inventions and growth for the concept - this paradigm has created in its own self; a name, and grounds to work on to enable the world of technology to react new heights. However, with rising technology innovation - it also comes at a risk of jeopardising security and privacy, which goes back to the main goal of this thesis. Scrutinising personal data and privacy has become more prone in today's day and age. IoT defined as "System of interrelated computing devices, mechanical & digital machines, objects, animals or people that are provided with unique identifiers and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction" [2]. Technology evolving in the past 20+ years since this concept was introduced has been able to evolve into a more coherent, functional and helpful way compared to the past, the reason this thesis focuses on security is as mentioned the risk that new knowledge within the field brings. IoT was also initially introduced to assist with environmental systems, and has now been expanded to help an everyday person, family or in a commercial setting to make things easier and add value.

Materials and Methodology

The thesis uses a Raspberry Pi (RPi) as the microprocessor, easy to control and use and something more on the inexpensive side. The publish/subscribe bi-directional connection has been done through PubNub to establish high security and Ionic is used as the smart home functions are controlled via a mobile app. Contrary to my project which will be using Heroku as the publish/subscribe feature and using Node to create a website for the user-interface; both still however implementing the same coding languages; HTML, CSS & JS. The Architecture of the system is split into 2 diagrams; the first is a more basic one highlighting the different materials and sources used for the physical implementation and the second is a more elaborate explanation of how PubNub API is achieved and embedded with a mobile and RPi to achieve connectivity. As this project is done through a physical implementation there are documents displaying the use of AutoCad to design a home model on a design plan basis, and the real result after. This is followed by the components used to attach the RPi and other sensors to it which has been executed through a car model.

Technical Solutions

This underlined the components used for this simulation which included the physical materials such as servo motor, smoke detector, web camera etc; essentially, everything involved in being able to achieve the desired aim and objectives. RPi was used for this project; as mentioned due to the low cost and easy functionality of it and was implemented by downloading Raspbian onto a microSD card. JSON has been used as it is easier to program and used to exchange data between PubNub, RPi and mobile app - similarly in my project, I will also be using JSON to exchange data between Heroku and my User Interface website. PubNub and RPi were able to exchange data by having a channel name, subscription key and publish key in common with each other - establishing mutual grounds to successfully communicate. The OpenCV library was used on RPi to initialise and implement the RPi Module camera.

Results

The results of the smart features embedded within the system are discussed including the basic logic used of 1 = on and 0 = off to publish and subscribe through the use of PubNub. Similar thing was also done for the automatic lock with a servo motor, where the button click would send JSON string a value to lock or unlock the door - this feature could have increased functionality by perhaps also adding a latch for additional security and programming in a similar format. The features implemented were all done as a binary format to be concise, efficient and achieve results desired.

Conclusion

To conclude, although this thesis was not based off a scalability topic it did involve a large amount of IoT and which can be made scalable and can be used in various settings such as; schools, commercial offices, homes or government offices. To make the solution scalable there could be added sub tabs in the categories on the mobile app created for this, to control different functions in different places and having control. Overall, this thesis was very interesting to read and analyse in order to achieve a smart home, and ultimately increase the security and privacy of users.

III. Requirements

Head System can be viewed as the parent system, and Node System as the child.

A. System Functional Requirement

Head System:

Head System Requirement	
Function / Aim	Pass on a signal to be able to control the lights via a bluetooth and Wi-Fi signal after cloud servers are used to collect data from.

Head System Requirement	
Description	Nodes will be implemented to ensure different lights in different rooms can be controlled at a time to ensure scalability and that the aim of the project is being achieved.
Inputs / Source	JSON format data
Outputs	Lights being able to turn or off Data from the node id in JSON format
Impacts	Due to requiring dependance for the functionality of the system, if one node fails it will impact the head part of the system and can therefore can cause technical difficulties, and also prevent the lights from being remotely controlled.

B. System Functional Requirement

Node System:

Node System Requirement	
Function / Aim	Receive signal from the head controller to be able to control the sub sections of which sub room and sub light it wants to control.

Node System Requirement	
Description	Fundamentally the opposite of what the head system is doing, by connecting to the head controller to control the lights via a bluetooth signal that's sent.
Inputs / Source	JSON format data received from the head controller
Outputs	Lights being able to turn on or off, or choose specifically which ones
Impacts	Technical difficulties such as power outage, connection problems could prevent control remotely.

C. Non-technical / Functional Requirements

Realistically, the controllers should work with a specified time of 2-4 seconds to turn on or off the lights, speeding this process up could be damaging - however in this prototype they are around 1-2 seconds apart.

IV. Project Details

A. System Design

Figure 1: Proposed Solution Diagram - This diagram is presented in a hypothetical format given 3 different rooms and the sub lights that the nodes will control, however the real solution will embed 10 rooms and just like that a future solution could embed 100 rooms or more - as it will be a scalable solution.

Figure 2: Proposed Web Application - The diagram below represents a rough idea of how the web application would look encompassing the different pages and the results it should produce. It is split into the head and node controller, where the head acts as the main page and avenue that leads to the sub rooms / sections you want to control the lights in; once in that sub section you will be able to control the designated lights in that room. We have assumed there are around 5 lights per room.

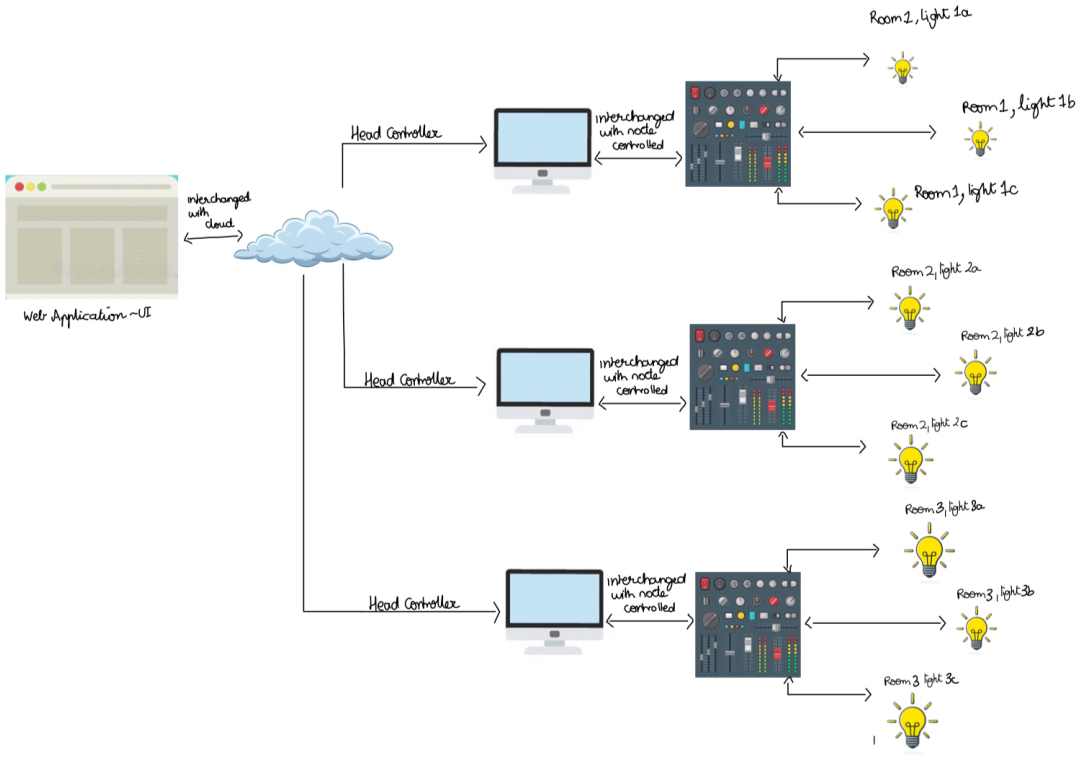


Figure 1: Proposed Solution Diagram

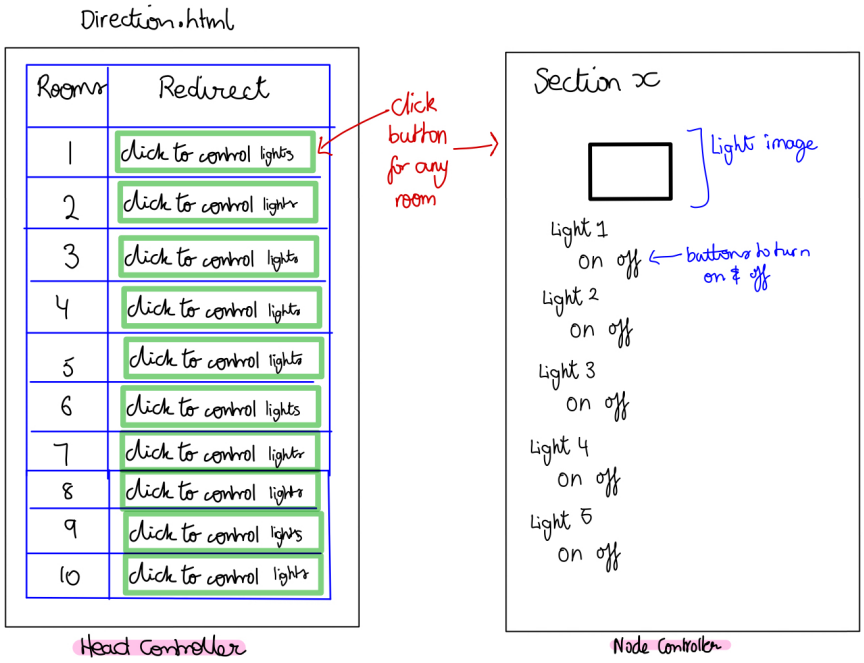


Figure 2: Proposed Web Application

B. User Interface

The user interface in the form of a web application is aimed to assist users be able to control if the lights are on or off, further being able to control specific rooms and their sub lights within those rooms.

C. Head Controller

The head controller exemplifies a many to one relationship with the cloud server - ie) there are many head controllers connected to one cloud server. Depending on different architecture design of buildings, a head controller will be identified for each room in the building that essentially acts as the parent room and the node controllers then being the child rooms. The communication between the head controller and cloud will be done via Wi-Fi. JSON data will be retrieved from the cloud server by the head controller and additionally wait for incoming data to initiate the node controllers connection.

D. Node Controller

Similar to the head controller, the node controller also upholds a many to one relation but in relation with the head controller. However, unlike the head controller the communication between the head and node controller will be via bluetooth or Wi-Fi. It's important to note that the node controller will be connected to many lights which can then be controlled separately. As indicated by the diagram, the head and node controllers will work interchangeably and need each other just as equally to function. The head control will send data regarding which room to open to be able to execute the instruction for the lights, and the node controller will

consequently send the situation of the lights back to the head controller.

V. Data Format & Online Services

A. JSON

The cloud server could send data to the head light control via:

Figure 3: App -> Cloud -> head controller -> node controller

Figure 4: Node controller -> head controller -> cloud

```
{
  “headController”: 3, //id area of where the request is recieved from
  “nodeRoom”: 3.1, //sub area of recieved request ie) room 3, blind 1
  “type”: “ACTION” //has to perform an action
  “lightMotion”: //array displaying what node controller should perform
  [
    “1=on”, //light 1 is on
    “2=off”, //light 2 is off
    “3=off”, //light 3 is off
    “4=off”, //light 4 is off
    “5=on” //light 5 is on
  ]
}
```

Figure 3: App -> Cloud -> head controller -> node

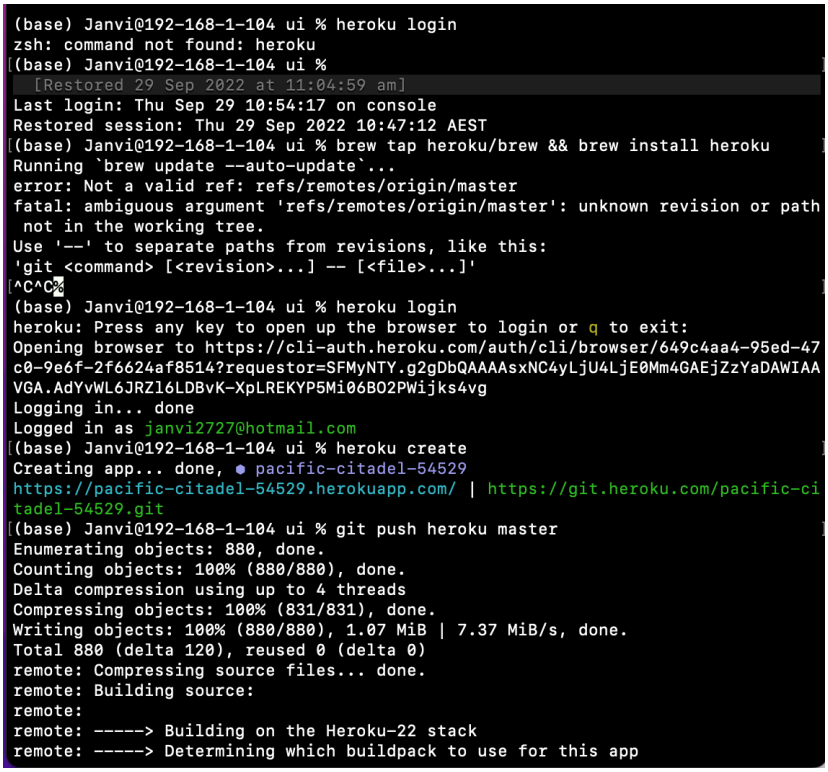
```
{
  “headRequest”: 3, //id area of where request should be received
  “nodeController”: 3.1, //id of sub area where request is sent from
  “type”: “DATA”, //request received should be treated as data
  “lightMotion”:
  [
    “1=on”, //light 1 is on
    “2=off”, //light 2 is off
    “3=off”, //light 3 is off
    “4=off”, //light 4 is off
    “5=on” //light 5 is on
  ]
}
```

Figure 4: Node controller -> head controller -> cloud

B. Heroku

I deployed this via Heroku, downloading Heroku CLI was particularly challenging for me as it wasn't working despite trying everything on their website and troubleshooting techniques - however I did eventually manage to download it and was given a link for a website. The image below

shows the heroic login working and creating an app with the web address: *https://pacific-citadel-54529.herokuapp.com/*



VI. Scalability

Scalability was achieved by having control online via a web application and not through a physical control panel increases the practicality of the application and differs from the original situation. Planning to have lights in seperate rooms of seperate parts of the office and separate sections able to be controlled by not only more than one person but also having control online. Hypothetically, if a control panel was used it would still not be the most productive solution as employees would have to walk up to one to be able to use it; still lacking in time efficiency. Through the connection of head controllers with node controllers, the functionality of the lights is controlled. Load balancing: by the servers being load balanced they are all able to share the load and divide it up between each other to handle users. Cloud storage: data accessible from cloud means it can be taken and used from different places, increasing convenience.

VII. Prospects

A. System Demonstration

B. Constraints

A constraint for this project for myself was time - due to having a very busy schedule with my other 3 university units and working it was difficult to be able to dedicate an extreme amount of time for this project. More time usage also meant when an error was generated or found after testing, it would take longer to be able to fix those and this would eventually dig into the time frame of producing something. However, I do recognise that is something that I could have controlled and still done a more elaborate elaboration.

C. Improvement Areas

Some areas for improvement are but not limited to:

-Give access to rooms only to employees working in that room and master key to someone who would be responsible for

checking all the lights are turned off prior to the office closing
-Add an alarm to notify if lights are on, or email
-Create a setting which configures up / down buttons for the lights to be dimmed or bright, being able to adjust it to your liking
-Connect lights to smart speaker such as Google Home
-Would consider setting up a circuit via RPi and using python to create a GUI mockup so that through the web application- UI, you are able to click on a button for on fully, off or be able to dim them to your liking would be programmed respectively to on, off, or brightness levels ie) level of 50-100 etc
-I would also have chosen a thesis to review that implemented a more scalable approach, however the one I chose I found highly interesting myself and relevant to my topic but on a larger scale.
-In the future I would've also like to have images loop through for each designated lights and also be able to say what room you're in exactly depending on the one you click on.

VIII. Conclusion

This project was to be able to assist commercial business, we hope AutOffice was able to deliver a feasible and efficient solution to DayTech with what they wanted. We hope the solution was able to implement JSON and Heroku to your needs and assist your staff with this problem.

IX. References

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