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| June Patrick Dacaya |

Smart-Home with Solar Monitoring Entry 0NC

Status

/1 Hardware present?

/1 Title Page

/1 Declaration of Joint Authorship

/1 Proposal (500 words)

/1 Executive Summary

# Declaration of Joint Authorship

We, June Patrick Dacaya, Adrian De Braga, Bao Quy Diep, and Nam Nguyen confirm that this work submitted is the joint work of our group and is expressed our own words. Any uses made within it of the works of any other author, in any form (ideas, equations, figures, texts, tables, programs), are properly acknowledged at the point of use. A list of the references used is included. The work breakdown is as follows: Each of us provided functioning, documented hardware for a sensor or effector. I and Adrian provided PLC functionalities and a Temperature sensor. Bao provided another temperature sensor. Nam provided a light sensor. In the integration effort Nam is the lead for further development of our mobile application, June and Adrian is the lead for the Hardware, and Bao is the lead for connecting the two via the Database.

# Proposal

We have created a mobile application, worked with databases, completed a software engineering course, and prototyped a small embedded system with a custom PCB as well as an enclosure (3D printed/laser cut). Our Internet of Things (IoT) capstone project uses a distributed computing model of a smart phone application, a database accessible via the internet, an enterprise wireless (capable of storing certificates) connected embedded system prototype with a custom PCB as well as an enclosure (3D printed/laser cut) and are documented via this technical report targeting OACETT certification guidelines.

Intended project key component descriptions and part numbers  
Development platforms: Nucleo-F401RE running the STM32 chip, Arduino, Raspberry Pi, and Blue pill with Arduino IDE.  
Sensor/Effector 1: PLC functionalities performed by NUCLEO Wi-Fi PLC Stackable components with Temperature sensor, RTD PT100 with a 4-20 ma transmitter, which is one of the most accurate temperature sensor in the market, it is also almost immune to electrical noise which makes it more suitable in an industrial environments. The PLC functions will be performed by three components: X-NUCLEO-PLC01A1 which performs basic PLC input/output functions, X-NUCLEO-OUT01A1 which is another input/output component which supports voltage of up to 24V, and an X-NUCLEO-IDW01M1 which supports internet connectivity through a Wi-Fi connection.

Sensor/Effector 2: MCP9808 is an I2C temperature sensor which will be used to monitor the temperature indoor. It is one of the more precise temperature sensors in the IoT world.  
Sensor/Effector 3: VEML 7700 ambient light sensor which runs in Arduino. A light sensor that will be used to monitor luminosity indoor/outdoor.

Sensor/Effector 4: RPI 8MP CAMERA BOARD is an 8 mega-pixel high resolution camera which will be use to record/snap images of the home’s surroundings.

We will continue to develop skills to configure operating systems, networks, and embedded systems using these key components to create a smart house that will have a solar panel activity monitoring as well as to monitor in-house temperature, security system, and a unique user base data available through a cloud base database. The Wi-Fi PLC component will be used to monitor the solar panels in conjunction with the RTD P100 outside a smart house. The temperature sensor will be used to manage the house temperature and the light sensor will be used to monitor and control the lights installed in the house. All the functionalities of the smart house will be monitored through an android mobile application which users can download. The user’s mobile application will have the eyes and controls for the smart house.

Our project description/specifications will be reviewed by, Kim Huynh from Alpha Lab, ideally an employer in a position to potentially hire once we graduate. They will also ideally attend the ICT Capstone Expo to see the outcome and be eligible to apply for NSERC funded extension projects. This typically means that they are from a Canadian company that has been revenue generating for a minimum of two years and have a minimum of two full time employees.

The small physical prototypes that we build are to be small and safe enough to be brought to class every week as well as be worked on at home. In alignment with the space below the tray in the Humber North Campus Electronics Parts kit the overall project maximum dimensions are 12 13/16" x 6" x 2 7/8" = 32.5cm x 15.25cm x 7.25cm.

Keeping safety and Z462 in mind, the highest AC voltage that will be used is 16Vrms from a wall adapter from which +/- 15V or as high as 45 VDC can be obtained. Maximum power consumption will not exceed 20 Watts. We are working with prototypes and that prototypes are not to be left powered unattended despite the connectivity that we develop.

# Executive Summary

This document will guide the future investors about our Smart-House Project. The project will be smart house that will be control just by using an android mobile application. Users will have their own personal data securely stored in the cloud while having a complete access to it. Users will be able to monitor their solar panels, doors, indoor temperature, and surroundings with just a tap in the app. The mobile application is their window to their house while being at work or at home. The smart house project will be complete in conjunction with the hardware components such as temperature sensors, light sensors, motors, and camera. The smart house project aims to be a complete, secure, and a mobile project. The main goal for this project is to have a secured, automated, and accessible for the users.

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# 1.0 Introduction

Nowadays, Smart Home is getting popular to people. Modern and new technologies are coming out every day in order to support people. Smart Home is an application that could help people to overview and control their house efficiency way. The structure of smart home application consists of sensor and application layer. The sensor gets the primitive data from the house that monitored by using various sensor and user input. Then the primitive data is stored in the database. The application layer displays the database that users request for. There are some advantages that users have when they use the smart home app. First one is energy efficiency; user can adjust the thermostat of their house on their way home to control the temperature so when they get home, they don’t feel cold in the house. That is about energy efficiency. Secondly, smart home helps to save energy and money. When people leave the kitchen without turning the light off, the light will turn itself off. So, no more energy will be wasted. In addition, it helps the home owners have more security about their house. When people walk out of their house and five minutes later, they don’t remember if they lock the door so they can open the app and check it then lock it easily. The Smart-Home system will also to monitor solar panel activity and its history.

## 1.1 Scope and Requirements

It is an Internet of Things (IoT) capstone project that uses a distributed computing model of a smart phone application that was developed in the previous months and will be constantly updated, it will support database access via the internet to read and display data as well as control various functionalities for example: turning the lights off. It will incorporate closely with an enterprise wireless (capable of storing certificates) connected embedded system prototype with a custom PCB for sensors we provide: luminosity sensor, temperature sensor, and camera as well as an enclosure (3D printed/laser cut) for the project. The project will be documented via an OACETT certification acceptable technical report that will have a minimum of 9000 words. We will not be doing a CSA testing for this project because we are only making a prototype of a bigger project.

Mobile Application Specification:

* Developed using Android Studio
* Supports API version 21 (Lollipop)
* Supports database connectivity
* Internet Connection

Database Specification:

* Firebase database
* Realtime database
* NoSQL functionalities

Hardware Specification:

* PCB will be developed/organized using Fritzing.
* Custom PCB will be printed in our Prototype Laboratory
* Enclosure will be printed in our Prototype Lab or an 3D printing company.
* Should not be left unattended
* Assembled in our classroom

Report

/1 Hardware present?

/1 Introduction (500 words)

/1 Scope and Requirements

/1 Background (500 words)

/1 References

# 2.0 Background

We would like to thank our collaborator Kim Huynh from Alpha Lab for supporting this project. Our solar PLC will have an X-NUCLEO-OUT01A1 which is going to be where all the components will be connected too. The RTD pt100 and 4-20 mA transmitter will be connected to a Wheatstone bridge/differential amplifier to find the voltage/temperature difference of the sensor. We have another temperature sensor, the MCP9808 which is an I2C sensor which can be used to compare the temperature between the RTD, to find a more exact temperature. A VEML 7700 ambient light sensor to monitor the light level. All these sensor/effectors will be connected to the PLC which will have a wireless connection to our app. The App will have a database storing the readings it receives from the sensors.

Administrator, (2016). Temperature sensor from RTD PT100 4-20mA transmitter and Arduino, Retrieved from <http://www.absolutelyautomation.com/articles/2016/02/09/temperature-measurement-rtd-pt100-4-20ma-transmitter-and-arduino>.

Jacob Beningo, (2018). Creating a Custom Wireless Programmable Logic Controller (PLC), Retrieved from <https://www.digikey.ca/en/articles/techzone/2018/jun/creating-a-custom-wireless-programmable-logic-controller>

# 3.0 Methodology

## 3.1 Required Resources

Report

/1 Parts/components/materials (500 words)

/1 PCB, case (500 words)

/1 Tools, facilities (500 words)

/1 Shipping, duty, taxes (250 words)

/1 Working time versus lead time (250 words)

### 3.1.1 Parts, Components, Materials

### 3.1.2 Manufacturing

### 3.1.3 Tools and Facilities

### 3.1.4 Shipping, duty, taxes

### 3.1.5 Time expenditure

Working time versus lead time.

## 3.2 Development Platform

### 3.2.1 Mobile Application

Status

/1 Hardware present?

/1 Memo by student A + How did you make your Mobile Application? (500 words)

/1 Login activity

/1 Data visualization activity

/1 Action control activity

Include screenshots such as Figure 1. Testing. Progress.



Figure 1. By Android Studio - https://developer.android.com/studio/, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=74094999

### 3.2.2 Image/firmware

Status

/1 Hardware present?

/1 Memo by student B + How did you make your Image/firmware? (500 words)

/1 Code can be run via serial or remote desktop

/1 Wireless connectivity

/1 Sensor/effector code on repository

### 3.2.3 Breadboard/Independent PCBs

Status

/1 Hardware present?

/1 Memo by student C + How did you make your hardware? (500 words)

/1 Sensor/effector 1 functional

/1 Sensor/effector 2 functional

/1 Sensor/effector 3 functional

The initial schematic design, Figure 2, based on datasheets (Bosch Sensortec, 2019) led to a breadboard layout Figure 3 that was realized Figure 4.

How did you build your Prototype: Breadboard?

Then a PCB was designed, Figure 5, and populated (Figure 6). Bill of Materials, Case, Time commitment. Testing. Progress.



Figure 2. Initial schematic. This work is a derivative of "http://fritzing.org/parts/" by Fritzing, used under CC:BY-SA 3.0.



Figure 3. This work is a derivative of "http://fritzing.org/parts/" by Fritzing, used under CC:BY-SA 3.0.



Figure 4. Breadboard prototype.

### 3.2.4 Printed Circuit Board

Demo

/1 Hardware present?

/1 PCB Complete and correct

/1 PCB Soldered wire visible but trim, no holes or vacancies

/1 PCB Tested with multimeter

/1 PCB Powered up

How did you build your Prototype: PCB?



Figure 5. PCB design This work is a derivative of "http://fritzing.org/parts/" by Fritzing, used under CC:BY-SA 3.0.



Figure 6. Humber Sense Hat Prototype PCB.

### 3.2.5 Enclosure

Demo

/1 Hardware present?

/1 Case encloses development platform and custom PCB.

/1 Appropriate parts securely attached.

/1 Appropriate parts accessible.

/1 Design file in repository, photo in report.

How did you build your Prototype: Case?



Figure 7. Example enclosure.

## 3.3 Integration

Demo

/1 Hardware present?

/1 Data sent by hardware

/1 Data retrieved by mobile application

/1 Action initiated by mobile application

/1 Action recieved by hardware

Report

/1 Enterprise wireless connectivity (250)

/1 Database configuration (250 words)

/1 Security considerations (500 words)

/1 Unit testing (900 words)

/1 Production testing (100 words)

### 3.3.1 Enterprise Wireless Connectivity

How did you make a Database accessible by both your Prototype and Mobile Application?

### 3.3.2 Database Configuration

### 3.3.3 Security

### 3.3.4 Testing

Unit testing and Production testing.

# 4.0 Results and Discussions

Is your prototype perfect? What did you learn?

# 5.0 Conclusions

If you were making 1000 of these.

Report

/1 Hardware present?

/1 Checklist truthful

/1 Valid Comments

/1 Results and Discussion (500 words)

/1 Conclusion

# 6.0 References

Bosch Sensortec. (2019, July). *BME680 - Datasheet.* Retrieved from Robert Bosch GmbH: https://ae-bst.resource.bosch.com/media/\_tech/media/datasheets/BST-BME680-DS001.pdf

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# 7.0 Appendix

## 7.1 Firmware code

Demo

/1 Hardware present?

/3 Code runs concurrently for all sensors/effectors

/1 Project repository contains integrated code

Status

/1 Memo including updates

/1 Financial update

/1 Progress update

/1 Modified Code Files in Appendix

/1 Link to Complete Code in Repository

## 7.2 Application code

Demo

/1 Hardware present?

/1 Memo by student A

/1 Login activity

/1 Data visualization activity

/1 Action control activity

Report

/1 Login activity

/1 Data visualization activity

/1 Action control activity

/1 Modified Code Files in Appendix

/1 Link to Complete Code in Repository