GNG1103/2101

Design Project User Manual

BRUNSFIELD ENVIRONMENT SENSOR

Submitted by:

[BRUNSFIELD ENVIROMENT SENSOR AND GROUP 20]

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Abstract

The purpose of this user manual is to take the work that has been completed to produce the final prototype of the Brunsfield Environmental Sensor and document it for future tasks and usability for the standard user. The user manual will cover the instructions of how to use the produced device and how the team produced the product. This covers the research and background information needed in the production of the product. It also includes all materials, costs, and equipment needed to reliably produce the final product. Using this user manual, any user can effectively control the device to their needs. Also, any team should be able to continue to work and improve upon the final device.

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*Figure 1- This is a picture of the prototype III before the final addition of the stand-off.*

*Figure 2-This is a photo of the selection matrix used in the selection of the concepts during concept selection*

*Figure 3-5- This is a series of images that shows the testing of the integregity of the final prototypes box case.*

*Figure 6- This is a photo of the wood MDF intial design of the protective box that was later ditched for Arcylic*

*Figure 7- This is a photo of the final Acrylic design of the box, produced after the decision to move to black acrylic*

List of Tables

*Figure 2*

The following table is the table of all the costs from the prototyping phases:

|  |  |  |  |
| --- | --- | --- | --- |
| Name | Sensor Model | Price | Currency |
| Arduino w/WiFi + Bluetooth | ESP32 | $13.69  | CAD |
| Temperature and RH | DHT22 | $10.88  | CAD |
| 2 \* 30mm x 30mm fans |  | $11.98  | CAD |
| 2 Gas Sensors | MQ9 | $12.99  | CAD |
| Ozone Gas Sensor | MQ131 | $29.99  | USD |
| Solderable Breadboard |  | $15.98  | CAD |
| Wires |  | $8.64  | CAD |
| LED's |  | $8.98  | CAD |
| Resistors |  | $14.59  | CAD |
| Micro USB Cable |  | $11.74  | CAD |
| Total Cost: |  | $149.36  | CAD |
|  | Paid | $49.54  |  |
|  | PCB | $1.00  |  |
|  | Hookup Cables | $1.60  |  |
|  | MDF | 4 |  |
|  | Acrylic | 29 |  |
|  | Duties | 1.5 |  |
|  | Total: | $86.64  |  |

List of Acronyms

|  |  |
| --- | --- |
| **Acronym** | **Definition** |
| B.E.S. | Brunsfield Environment Sensor |
|  |  |
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# Introduction

The basic context for the work done was the any assumptions for the work would be that the team was tasked with creating the environmental sensor for the Brunsfield sensor. This itself was based off the assumption that the center was currently lacking a sensor/ a way to monitor its environment effectively. Based off of this need, the team began to generate several broad ideas and designs. Narrowing these ideas/designs down to one main design resulted in the team’s ability to move forward and construct an operational prototype. Through the prototyping phases, the team bounced around several concepts that were then pursued to their limits or until feedback was unhappy towards the prototype. Through prototyping the final design was created and then presented to the client. More assumptions made along the way would include the assumptions of the sensor being able to effectively read the environment of the entire environment in a sense of its range. This could be rendered void by the addition of several of the designed sensors. The document will be organized in a way that allows both users and future teams to operate and build upon the final design generated. This includes images of several different stages of prototyping and how to maintain/construct/operate future scope.

***Block Diagram-***

The following block diagram was added to show the inputs/outputs of the B.E.S.

INPUTS OUTPUTS

-Environment of Brunsfield Environment Dashboard Team members

Brunsfield Sensor------------------------>Sensor--------------->Output------> Changing Environment

(Temperature, CO2, Ozone, be it, temperature, or

Relative Humidity) if hazardous, act appropriately

 | |

 | |

 ------------------------------> Environment Naturally occurring <---------------------

-

*Figure 1*

***Explain the problem and why it is important (‘WHAT?’)***

The problem that we solved with our environment sensor is that the Brunsfield center had an issue accurately getting a live value for Relative Humidity. The machines in the space are sensitive to their environment in that they need to be in a low humidity and an average room temperature to allow them to last longer. When the machines are in an environment that are warm and moist, they tend to rust and malfunction which ends up making the tool useless and either in need of repair or replacement. Our module allows the CEED workers to view the live values of Relative Humidity and Temperature. This module also has gas sensors for safety purposes, allows the CEED workers to view whether the space is safe to work in.

***Explain the fundamental needs of the user (‘WHO?’)***

The needs of the user were a way to monitor the quality of the air within their Brunsfield Center in real-time. Most importantly, the sensor that is most needed was the relative humidity sensor. The other sensors incorporated were decided upon via benchmarking and user feedback. The key was to have the values observed by the environment sensor be able to be displayed in real-time for the CEED employees to be able to ensure the proper parameters of the environment are being met.

***Explain what differentiates your product from others (‘WHY YOU?’)***

The Brunsfield Environmental Sensor differentiates from other products in the sense of its personalization towards the CEED personal. This was accomplished by specializing the design of the sensor and dashboard output around the specific needs of the CEED employees. Where it was expressed that the current method they had, did not allow CEED to view the real-time value of relative humidity. Where our product brings together the ability to gauge the environment of the Brunsfield and the prioritizing of the relative humidity sensor.

***Explain the main function of the product.***

The main function of this project is to accurately display the relative humidity, temperature, carbon monoxide, carbon dioxide, methane and liquified petroleum gasses in a live view to allow the CEED workers to evaluate whether the space is safe for either the users or the machines in the space.

# How the Prototype is Made

The prototype was made by analyzing several different design concepts by the team and benchmarking other similar products for the physical elements. The basic requirements of the physical design given by the user was the ability to be wall mounted, externally-powered, maintainable, and read all necessary values while communicating to the software. The team used ideas generated from looking at the benchmarked products and the constraints that were given to the team. Of these constraints the main were the need to keep the prototype under a budget of 100 dollars, and the other major constraint was the necessity for the final product constructed to communicate with a dashboard output via software. After several concepts were generated, these concepts were narrowed down to one singular concept which took the key/effective aspects from the other concepts previously generated. This final concept was composed of aspects such as a simple box design that incorporated air hole for air filtration. The other aspects would be the amount and what kind of sensors were decided upon. This being the relative humidity sensor, ozone sensor, carbon monoxide, carbon dioxide, temperature, LPG, methane. This concept was summarized in the following diagram:



 After deciding upon these concepts, the team moved forward with designing the dashboard layout. Using client meetings and user feedback, the dashboard layout was given the need to be able to alert the user, via color, about the status of the environment within the room. In addition, the layout was optimized for user experience by using the colors and prioritizing the most important sensors to the user displaying left to right as most people read this way. Then implementing the dashboard output was done and shown to several users to optimize the user experience. The next phase was to have the physical sensor concepts implemented. After deciding upon the sensors, the team had to have the sensors ordered. This resulted in the budget being reached far before the purchasing of all the desired sensors. To overcome this problem, the team reached out to several companies in hope of a potential free product or a sponsorship. This resulted in a company called SainsSmart reaching out and offering to give the ozone and carbon dioxide and covering the shipping. This allowed the team more freedom in the budget and two sensors covered. After the carbon dioxide was delivered, the ozone was realized as not being delivered and therefore cut from the final product. The other parts that were ordered were the materials listed in the bill of materials. The soldering and construction of the sensor were then done and used to test in prototype stage II, this showed the comprehensive functionality of the sensors all brought together. The valeus were sent to the dashboard output for testing, and the code was figured out by having the values of the sensor being sent to an http server which was read and displayed by the dashboard software. Then the box was laser-cut out in black acrylic which was decided over MDF wood, due to its longer longevity and sleek appearance. The next step was the creation of a stand-off for the breadboard with the sensor attached. This stand-off allowed the sensor to be attached to the interior of the box without the need for drilling or damaging either aspect. The combination of the final sensor and box allowed for testing of the final prototype which came back with minimal errors. This allowed for the product to be ready for final testing and from there, due to lack of time for more testing, being ready for presentation to the world.

## Mechanical/Physical

### BOM (Bill of Materials)

Node MCU ESP 32- Microcontroller for project

2 solderable PCB boards

MG 811 Carbon Dioxide sensor

MQ 9 Carbon Monoxide and hazardous gas sensor

DHT 22 Relative humidity and temperature sensor

3D printed Protoboard stand

Jumper wire to connect microcontroller

Acrylic sheets to build box

Micro USB cable for power source

### Equipment list

Soldering gun

3D printer

Laser cutter

Arduino IDE coding software

Ross Videos Dashboard

### Instructions

The process in which you need to take to create this product is:

* 1. Acquire a microcontroller
		1. Plug-in the device via external power source
		2. Test microcontroller, assure that it works
	2. Acquire the sensors that apply to your space
		1. Test sensors, assure that they work
	3. Bring code together into a single code that can run all your sensors and send information to http server
	4. Have Dashboard send to the server for a value and print onto a label.

# How to Use the Prototype

* 1. To use this prototype, supply the microcontroller with power after mounting the box and press the enable button.
	2. Ensure that the controller is successfully connected to the desired WIFI network
	3. Tell the Dashboard code what the IP address is
	4. Put the dashboard display somewhere that is accessible to staff on a monitor of any kind
	5. Use the values from Dashboard output to accurately gauge the environment of the center

# How to Maintain the Prototype

This project does not have maintenance other than pressing the enable button on the microcontroller and inputting the IP address onto Dashboard. The only other maintaining that would be needed for the product would be semi-regular maintenance on the box itself. As it currently lacks the ability to clean itself (via fans or other methods) it would need some minor should some sensor begin malfunctioning. It may need a cleaning via taking the lid off and cleaning the interior.

# Conclusions et Recommendations for Future Work

Lessons that were learned by the team would be proper time management, budgeting, to prepare for everything to go fail, planning contingencies and just in general for the project. As far as continuing work, the recommendations would be to find a way to move the temperature sensor so that it completely reads the temperature of the room, not of the box itself. Another, future scope aspect could be the addition of fans to filter the sensors on the interior of the box to keep the sensors both clean and reading more accurate measurements of the environment outside of the box. The next step would be fixing bugs in the dashboard program to have the program read the live read-outs without the constant flickering of the outputs on the screen and have a constant display of all the values.

# Bibliography

[https://www.amazon.ca/SeeKool-Development-Microcontroller-Integrated-Compatible/dp/B07NPJJ8ZC/ref=sr\_1\_2\_sspa?crid=9WZRTAOW4PWI&keywords=esp32&qid=1570558790&sprefix=esp%2Caps%2C173&sr=8-2-spons&psc=1&spLa=ZW5jcnlwdGVkUXVhbGlmaWVyPUEzTUJCU0g2TFhHQlhRJmVuY3J5cHRlZElkPUEwNDE4MDM5MlQ2Rko1NUtaVkpLWSZlbmNyeXB0ZWRBZElkPUEwNTE4NTQ4MTIzSzlHOUc1TEVSWiZ3aWRnZXROYW1lPXNwX2F0ZiZhY3Rpb249Y2xpY2tSZWRpcmVjdCZkb05vdExvZ0NsaWNrPXRydWU=](https://www.amazon.ca/SeeKool-Development-Microcontroller-Integrated-Compatible/dp/B07NPJJ8ZC/ref%3Dsr_1_2_sspa?crid=9WZRTAOW4PWI&keywords=esp32&qid=1570558790&sprefix=esp%2Caps%2C173&sr=8-2-spons&psc=1&spLa=ZW5jcnlwdGVkUXVhbGlmaWVyPUEzTUJCU0g2TFhHQlhRJmVuY3J5cHRlZElkPUEwNDE4MDM5MlQ2Rko1NUtaVkpLWSZlbmNyeXB0ZWRBZElkPUEwNTE4NTQ4MTIzSzlHOUc1TEVSWiZ3aWRnZXROYW1lPXNwX2F0ZiZhY3Rpb249Y2xpY2tSZWRpcmVjdCZkb05vdExvZ0NsaWNrPXRydWU=)

<https://www.sainsmart.com/products/mg-811-gas-co2-carbon-dioxide-sensor?_pos=1&_sid=c1fdd76c0&_ss=r>

[https://www.amazon.ca/MQ-9-Liquefied-Flammable-Methane-Arduino/dp/B07SMGNNYY/ref=sr\_1\_1?keywords=mq9%2Bsensor&qid=1570740554&sr=8-1&th=1](https://www.amazon.ca/MQ-9-Liquefied-Flammable-Methane-Arduino/dp/B07SMGNNYY/ref%3Dsr_1_1?keywords=mq9%2Bsensor&qid=1570740554&sr=8-1&th=1)

[https://www.amazon.ca/Gikfun-Digital-Temperature-Humidity-Arduino/dp/B06Y63YMSS/ref=sr\_1\_6?keywords=dht22&qid=1570731531&sr=8-6](https://www.amazon.ca/Gikfun-Digital-Temperature-Humidity-Arduino/dp/B06Y63YMSS/ref%3Dsr_1_6?keywords=dht22&qid=1570731531&sr=8-6)

<https://makerstore.ca/shop?olsPage=products%2F5ft-hook-up-wire-22awg-white&page=1>

<https://makerstore.ca/shop?olsPage=products%2Facrylic-12-inch-x-24-inch&page=1>

[https://www.amazon.ca/AmazonBasics-Male-Micro-Cable-Black/dp/B071S5NTDR/ref=sr\_1\_1\_sspa?keywords=micro%2Busb&qid=1570813584&sr=8-1-](https://www.amazon.ca/AmazonBasics-Male-Micro-Cable-Black/dp/B071S5NTDR/ref%3Dsr_1_1_sspa?keywords=micro%2Busb&qid=1570813584&sr=8-1-)

APPENDICES

APPENDIX I: Design Files

<https://makerepo.com/ericpitts/gng1103-a20-environment-sensor> This is the makerepo submission link. This submission along with this manual will have everything needed for this project.

APPENDIX II:

*Figures 3-5**Figure 6*

*Figure 7*