Senior Design Project Final Report

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Smart Stoves

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Asif Iqbal, Roni Das

Faculty Advisor: Leon Shterengas

Executive Summary

Smart Stoves is an IOT system that is designed for home appliances. This project consists of hardware and both high- and low-level software. Many house fires are caused by gas leakage. Sometimes unattended stoves could lead to potential disaster. This system is designed to notify users of the threat level. Knowing about a gas leak could allow the user to get help before it is too late.

Smart stoves allow user to monitor kitchen area, detects presence of flammable gas in the vicinity, allows the user to turn off/on electric stoves. The system is linked to an android phone application. Using the app, the user can turn/on off stoves. If there is flammable gas in the vicinity, the user will be alerted via the app. The system can also detect if there is unattended stove.

The core part of the system are the sensors and Wi-Fi chip. The purpose of the sensor is to collect raw sensor data. The data is then sent to the Wi-Fi chip. This chip has a build in microcontroller in it. The data is processed here and then sent to a cloud server. In this case, to the AWS. From AWS the data is then sent to the user's phone application. All of this happens in real time. The system itself is small and portable. It is battery powered. A 9v battery is needed to have the system active. To have the functionality of active monitoring of kitchen health, it is recommended that this system is installed in the stove.

Phone application was created using Android Studio. We care much about the customers need. It is well designed, and up to date with the modern app standard.

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Acknowledgements

Special thanks to Professor Leon Shtrengas for advising us. We are grateful to all the faculty members who helped us. Greatly appreciate Lab Engineer Tony for assisting us with soldering and many other things.

Background

Many house fires are caused by gas leakage. Often they are also caused by cooking related reaons. Kitchen equipments left unattended may lead to house fires. According to National Fire Protection Association, the leading case of house fires is cooking related. Majority of these cases, the fire is caused by unattended equipments in the kitchen. Almost 80% of fire deaths are casued by home fires.

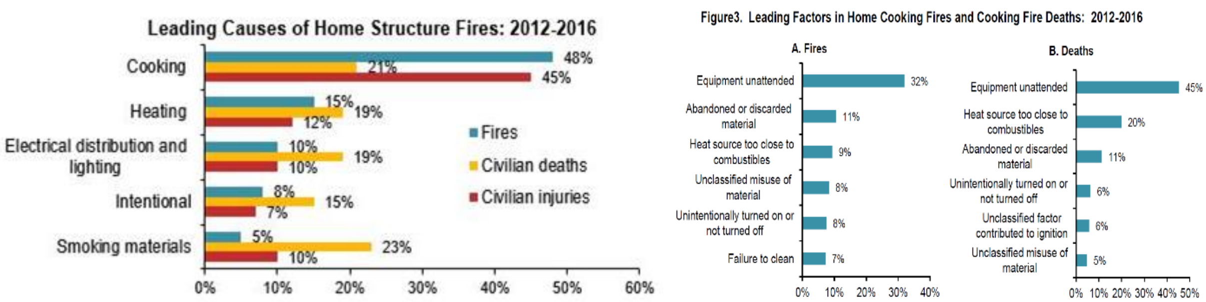


Figure 1 : a) Leading cause of house fire. b) Leading cause of home cooking fire.

The figure #1 above illustrates the leading causes of house fires from 2012-2016. During this time, over 354,000 home structures were destroyed because of fire every year. That is over 1.77 million houses destroyed over the 5 years causing approximately $6.9 billion in property damage. Not only that, but also causing over 2600 civilian deaths and over 11 thousand civilian injuries. Among the cooking related injuries, 32% of the of cases are due to unattended equipment shown in Fig. 1.(b).

The inspiration of our project comes from the fact that current solutions is inadequate for house fire problem described above. Current solution such as smoke detectors are at best a reactive solution to the problem than a proactive one. Smart Stove is designed to inform users the status of other kitchen stoves at all time. Meaning, users can actively monitor the fire hazards conditions in kitchen, even when they are away from home.

Development in internet infrastructure specifically allows our project to be operational. Smart Stoves falls within the category of IoT devices. It is *smart* because the device has access to internet and follows various secure communication protocols. With internet support a user can control Smart Stove from a distance, half a world away.

One of the objectives for this senior design project is to prevent house fire caused by unattended cooking. The second goal is to detect build-up of cooking gas from a faulty cooking system and take fire hazard prevention protocol by notifying necessary personals. Both objectives of this project are integrated in an IoT system which has multiple components for data acquisitions and transmission capabilities.

Smart Stove is developed using few following principles. First of which is data acquisition. As for system requirements, we need to determine a presence of human in front of stoves at all time while cooking. Determining if stoves are in use or not proposes another challenge for this project. Lastly, gas leakage around the supply line in kitchen needs to be monitored all the time.

This project uses multiple sensors for data acquisition part. For natural gas (cooking gas) detection the system uses a sensor node MC105, which can detect relative concentration of methane (CH_4) build up. A PIR motion sensor, to detect human presence in or around kitchen are. BME280, a humidity and temperature sensor, to monitor temperature in the room.

Second stage of this project requires input signal conditioning and data transmission. Each senor modules are accompanied by a robust Wi-Fi module. The Wi-Fi module houses a low powered MCU for data type parsing and processing. Incoming signals are conditioned to interface and processed with MCU unit. MCU unit acts as buffer between singles transmission route and provides additional compute logics in Realtime. Data from sensors then uploaded to a cloud services for end user.

Last stage of this project requires help of cloud services such as Amazon Web Services (AWS). Cloud services use input data to make decisions for cases such as whether stoves are on/off, real time gas concertation level, and if stoves are unattended while in use. The state report is sent to user mobile devices. User can make informed decision based on option available to them.

Social Needs and Impact

Billions of dollars and thousands of lives were at risk due to house fires each year. Our goal is to alert the household and by doing so potentially save lives. As engineers we are always tasks find solutions for difficult problems in ethical manner. On positive note, Smart Stove compensate for human errors in kitchen and help prevent house fire. The use of this technology will help save billions of dollars' worth in property damage and our precious lives. The small footprint of the device requires less material to build from, which in turn leaves little to no carbon emission. The application provides additional security in consumer's home and relief stress from firefighters.

However, aside from positive effects of this technology, we must also take into consideration the negative sides of it. As an IoT device, it is constantly sending real time data to the cloud. For hackers, it is possible to tap into the system to eavesdrop if proper protocols are not maintained by the user. It is also possible to send false data and cause the user to ignore real warnings. Even though encryption is used, data can never be hidden from prying eyes. We must improve on the device communications to make sure that such event does not occur.

There are existing gas detector systems and security technology for detecting motion which can be used in the kitchen area to achieve the same feat. The issue with that is, they were designed for industry usage not for normal consumer uses. And most importantly, those devices are not smart. Meaning those devices do not interact with other devices unlike our system where the user receives data and threat level in real time. Once again proving how valuable and impactful our system can be to the end user.

A concern regarding this project can be highlighted during data acquisition part, where user's data is collected through various sensors. User must agree to give system the permission to collect adequate data for flawless operations of the system. This concern can be address by being transparent about how the total system works to the user. Overall, the negative societal impact of this design project is minimal.

Customers and their requirements

Meeting customer demand requires current inside knowledge of market shares in Home Safety Industry. This product competes directly with Smoke Detectors. Therefore, shares the same market segment. According to “Smoke Detector Market”, by Power Source, “the total market is expected to grow from USD 1.31 Billion in 2015 to USD 2.52 Billion by 2022”. The rise in demand is fueled by two major factors in industry. The first being inherent development in construction industry where the second being expected rise of population in urban area.

Smart Stove’s market share falls within consumer industry. The target customers for this type of product is anyone with a kitchen, government regulators and fire safely officials along with current Stove (appliance) market and natural gas delivery services. While the end users are general population, however, establishing a permanent standard through government official and training fire departments staffs in using these devices can lead to less fire hazards cases each year. Permanent link between appliance industry will help integrate this system efficiently, removing any unnecessary human errors during installation. Demography for targeted varies extensively. However, general target group is considered above 13 years of age and have access to kitchen at home. Senior citizen, especially with dementia, is considered a focused target group because the probability of leaving the stoves on is higher.

A large sample of survey data from varying range is needed to conclude customer’s requirements list. However, based on the trend in Smoke Detector industry, approximation of requirements can be made. Customers for Home Safety in Fire Prevention industry requires their system to be robust, reliable, informative, easy to use and lost cost enable. Additionally, these devices require low maintenance, change battery once every 12 months for Carbon Monoxide alarm. All the components used to design project is low cost and ultra-lower powered, such as ESP-32 WiFi module can operate in sleep mode to conserve energy. Smart Stove fulfills all these requirements and offer additional features which were never used before in industry. For example, users will be immediately notified if there is gas leakage in their home, even in the case when user is away. User can interact with phone app to check status such as if their stoves is on/off, air quality, or if stove fire is being attended by someone in the vicinity. With the help of all this crucial information, user can take an informed decision.

Engineering Specification

There are many challenges to be considered when designing an IoT smart home device. In developing an engineering specifications list, which provides insight in how to tackle each challenge from a practical viewpoint. List below presents a top view of all the specification for this project.

Hardware:

1. MC105 Catalytic Flammable Gas Sensor
2. PIR motion sensor
3. BME 280 : Temperature and Humidity Sensor
4. ESP-32 WiFi Module with Built in MCU
5. Hall Effect Current Sensor
6. Solid State Relay
7. Circuit Accessories : voltage regulators, capacitors etc.

Software:

1. Embedded Programing: i.e.. Arduino IDE, Atmel Studio
2. AWS Configuration
3. Android Studio : Mobile Application

The MC105 is a catalytic type gas sensor which detects combustible. It can detect methane, butane, propane etc. For a combustion to occur, the gas concentration must be within the Flammability Range. Meaning the gas concentration must be within the Lower Explosive Limit and Upper Explosive Limit. For example, the Flammability Range for Methane is 5%-15%. Mc105 output represents the LEL percent. Once it crosses the LEL, there is a chance of explosion. Our system will detect the gas and will alert the end user if the LEL is above 10%. The system output is analog. The internal ADC of the MCU is used to convert this value to digital data. The parameters of this sensor are shown below:

Model		MC105
Sensor Type		Catalytic Type
Standard Encapsulation		Plastic
Working voltage(V)		2.5±0.1
Working current(mA)		150±10
Sensitivity (mV)	1% CH4	20～50
	1% C3H8	30～70
Linearity		≤5%
Measuring range(%LEL)		0～100
Response Time (90%)		≤10s
Recovery Time (90%)		≤30s
Working Environment		-40～+70℃ <95%RH
Storage Environment		-20～+70℃ <95%RH

Figure 2: MC105 Gas Sensor Electrical Characteristics.

For the PIR motion sensor, EKMB series from Panasonic was used. Primarily because how easy it integrates into IoT devices and its low power. The maximum current consumption for this sensor is 6 micro amp and the minimum is 1 micro amp. As We can see it requires very low power. The specific characteristics for this sensor are shown below.

■Maximum rated values

Items	Value
Power supply voltage	-0.3 to 4.5V
Ambient temperature	-20 to +60℃ (No frost, no condensation)
Storage temperature	-20 to +70℃

■Electrical Characteristics

Items		Symbol	1μA type	2μA type	6μA type	Conditions
Operating voltage	Max	Vdd	4.0V			–
	Min		2.3V			
Current consumption (In standby mode) Note 1)	Ave	Iw	1μA	2μA	6μA	Ambient temperature: 25℃ Iout=0 Vdd: 3V
Output current (during detection period) Note 2)	Max	Iout	100μA			Ambient temperature: 25℃ Vout≧Vdd-0.5
Output voltage (during detection period)	Min	Vout	Vdd-0.5V			Ambient temperature: 25℃ Open at no detection
Circuit stability time (when voltage is applied)	Ave	Twu	25 sec		–	Ambient temperature: 25℃ Iout=0 Vdd: 3V
	Max		210 sec		10 sec, Note 3)	

Figure 3: PIR Motion Sensor Electrical Characteristics.

The operating voltage ranges from 2.3 to 4 volts. This sensor has digital output. Thus, no ADC is needed. It has a detection range of 12 meters. Overall, it is an efficient sensor.

BME 280 Temperature and Humidity is a off the self-sensor node with built in SPI and I^2C support. The module houses a tiny Bosch silicon temperature IC along with memory management and calibration circuit. The operating range of the sensor is between -40 to 85 °C. The average current draw when operating at 25 °C (typical), is about 3.6 µA.

ESP-32-Wroom Wi-Fi module is a popular Bluetooth and Wi-Fi supported microcontroller operating at 2.4 GHz bandwidth. Module consists of Xtensa® single 32-bit LX6 MIPS based microprocessor, antenna and passive components. Power consumption varies based on general IO pins used during operation. The average current consumption is around 300mA when Wi-Fi is on. However, during deep sleep module only draws 300 µA.

MLX91217 is high speed Current sensor IC operates based on hall-effect principle. It can measure 5 mT to 450 mT in either direction (north or south). The maximum current consumption is 15 mA according to the datasheet.

A generic Solid Stay relay is used in design specification for this project. Relay is rated for 40 A current output; however, it is not reliable. Due to COVID-19, the prototype of this part of the project using Relay was not feasible because of inaccessibility of lab equipment and other missing components.

Software solutions includes programing ESP-32 with Arduino compiled libraries, configurations of AWS services and Android Studio Java based application development. Hardware components were programed using C. There is no coding involved in setting up AWS. However, there are many configuration needs be made, i.e. IAM Role , Iot Core etc. in having an operational online server for receiving and processing data. Development of android application is done using Android Studio IDE. Java language is need for coding along with AWS dependencies for accessing cloud services.

Design Concepts

As with developing any new design concept, it is imperative to start from few possible vantage points within a given industry. Smart Stove's root start is given by Professor. Shterengas' description of the project, which states, "Develop a multiple sensor system capable of raising alarm if moving object poses chemical threat." This description gave us a baseline for target industry and initiated conceptualizations of various product ideas. Few parameters set by Prof. Shterengas' project proposal includes multi-sensor system, capable of raising alarms, battery operation, and uses of microprocessor to log events etc. These parameters served as guidelines in the brain storming process for this project.

Using the guidelines, few applications of chemical sensors were derived from combinations of brain storming and online research. These applications were categorized in their respective industry for more clarity on this subject matter. Industries which were considered includes Defense, Farming, Consumer Electronics, and Petroleum market. Applications of chemical sensors in Defense industry described Chemical weapons detections system, Illegal Drug Detection. In Farming, possible idea included detection of common harmful reagents for plants, pesticides etc. For Petroleum industry, the idea was to detect oil resources available around the world. In consumer market, Gas Stoves were discussed in conjunction with age old smoke detector.

Feasibility of this project along resources available for this project dictated evaluation process of possible applications of gas sensors. In discussion with Prof. Shterengas, we narrowed the application in two industries, Farming and Consumer market. The criteria for this project also expected a low powered, battery operated system. Upon more research in these industries and freshness of these ideas, Smart Stoves was conceived. There are few key factors which contributed in decision making process for Smart Stoves. Insightful discussions with Prof. Shterengas provided new approaches in making Smart Stoves viable. We conceptualized inputs required to make informed decision for stove's on/off status. Initially, discussion included in utilizing pressure sensor in combination with humidity sensor to determine if the stove is turn on or off. However, practical examples proved this approach to be not feasible and output to be unpredictable. A new idea was conceptualized using Hall sensor for current detection. However, this approach only works for electric stoves but not traditional gas stoves. The idea is to monitor current consumption by electric stove. If the stove is drawing significant current then it is simply On, otherwise it’s Off. This simple realization leads us to theorize our own smart power supply. In this model, the electric stove interfaces with this project’s power supply, allowing us to monitor current consumption at all time. The smart power supply has few essential components, Hall effect sensor, Solid state Relay and accompanying ESP-32 Wi-FI module. Hall sensor provide contactless current consumption data from house main outlet. The Solid-State Relay is the barrier between the main and the appliance. If user choose to turn Off the stove form phone, EPS-32 to receives the signal from cloud and switches the solid state relay off, cutting of the power to the stove. Evaluation criteria is fully realized and design concept for Smart Stoves was achieved.

Design Optimization

The system design itself is not heavy on cost. It does not pose any threats. Being a battery powered system, it is safe to use. Sustainability on the other hand depends on the user. Our system will be someone near the kitchen. When people are cooking spices/flower/steam etc. are in the air. It is highly likely that those will make their way into the sensors. The flammable gas sensor has an exposed part. If those materials make there way in there, which they will in due time, it can greatly affect the performance of the sensor. For sure it will decrease the sensors lifespan. There is no way around this as every flammable gas sensor has exposed part where tiny molecules can make their way in. This will take a long time for it to happen unless this device is being used in a restaurant. In consumer household, unless there is heavy cooking going on every day, the gas sensor should be okay for few years. Given how low cost our system is, it is easily replaceable. The cost of the raw crucial part is shown below.

Materials	Purpose	Cost	Source
ESP-Wroom-32	Wifi Module	2 @ 9.00	Mouser Electronics
Winsen MC105	Combustible Gas Sensor	1 @ 2.70	Ebay
EKMC-Panasonic	Motion Sensor	1 @ 10.55	Mouser Electronics
BME 280	Humidity Sensor	1 @ 8.98	Ebay
MLX91217LVA	Current Sensor	1 @ 3.72	Mouser Electronics
Solid State Relay 10A	Current Switch	1 @ 3.66	Ebay
	Total :	$ 38.61	

Table 1: Cost of this project.

work etc. Small parts like that in bulk does not cost as much. Thus, $40.00 is a good estimate. The system is small and portable, and battery powered. This is safe to use.

Smart Stoves requires low maintenance in working environment. It is low powered, hence battery operated and work in the principle of sleep/awake cycles periodically. Design decision for this device is also motivated by available budget and resources available to us. There are number of factors considered in design optimization for the top-level system.

In developing a new product cost per device varies drastically at different stage of development cycle. At prototype stage, budget for Smart Stoves are shown in Fig.2. Initial cost at this stage is high and do not reflect accurate final cost of device when mass produced. From Fig.2 , it is apparent that most if the cost is associated in programming the microcontroller using Atmel ICE rather than components used for final design. All software used in the project adds no additional cost, since all are freely available to use.

Safety:

There is no inherent risk of using any components used in this project. All the parts use ultra-low power and draws relatively low current. Design shapes and sizes of individuals items concurrently poses no health risk to its user, since its small and contains no sharp angles. Final design contains housing for top-level and individual units, which translate to safe handling of this product. During maintenance period, replacing battery pack, design elements can be handled without taking any safety precautions.

At prototype stage of Smart Stoves, however, certain precautions need to be taken in testing of Natural Gas Detection Module. In ensuring reliability for this module, overdriven methane gas needs to be feed into MC105 to monitor its sensitivity and outputs. This is done using a lighter gas fluid under an enclosed glass doom facing down. The relative size of enclosure is small, therefore small amount gas trapped inside materialized to a high concentration. This small amount of gas leaked poses no threat, however, precautions are taken by removing any forms of items which can cause a first to start.

Similarly, humidity sensor used in design doesn’t actively requires for safety precaution. However, delivery method to sensor requires careful handling. Boiling water is used to drive the output of humidity sensor to its saturation point. In reducing the risk of mishandling, only a small portion water is boiled in a large open kettle and senor is placed above it. Therefore, risk involved in designing is minimal.

Sustainability:

Smart Stoves is designed having low-powered and efficiently requirements as foremost parameter. There are many factors to considered when using battery powered device such as current draw, temperature, humidity, surface mount devices (SMD) etc. Accurate estimation on lifespan for each component will take a large sample data over many years. All the parts at prototype stage were chosen based on its low current draw (Engineering Specification) and cost. When mass produced as SMD, this current draw will be less which will extend the lifespan of Smart Stove even more. The goal when used as battery powered system is to follow set and forget rule. End-user will need to change battery every 12 months for proper operation, as they do for Smoke Detector. This reflects on sustainability of this project such that it requires less effort and maintenance in upkeeping this product. Although, when used as hardwired system, energy used to operate the product will have negligible effect on end-users billing. Overall system performs as highly suitability device without the need to frequently use external resources such as additional energy or maintenance.

Design evaluation:

When employing new engineering solution to real world problems, there are always trade-offs to consider. This project was mostly constrained by time and budget. In taking cost cutting measure, we only considered cheap parts during research and development. For example, BME280, is a humidity sensor used to measure water vapor from food steam. It is a low-cost sensor; however, it has maximum operating temperature of 85 °C. The required location for this sensor is around air vent above stoves, therefore it can guarantee so sample any water vapor caused by heating food content. The temperature in this vicinity could rise well above 85 °C when cooking process is ongoing. This can cause the sensor to malfunction, or even destroy is completely. However, this trade off is made during prototype stage given working environment for BME280 never exceed this range. By prototyping using low cost system, enable us to assemble all parts for this project at low cost, yet simulating real life capabilities of Smart Stoves. Not all low-cost items lead to big trade-offs in this project. Gas Sensor, MC105, is a low-cost solution, yet measuring parameters for this sensor is well within real world application. Software solution can also be trade-off, because there is newer suitable design language than Java which can accelerate design process much more efficiently. However, time allocate for this project poses another constraint of learning new language for app development. The outcome of this design decision by both team member is to develop only in Android environment, leaving iOS for future upgradability.

The project evolved over the course of this class. Initially, the goal was to simply devise a smart system that replaces current smoke detectors. However, through various design consideration the system was upgraded to it’s current standard. Arrival of COVID-19 also induced a new challenge by restricting our access to lab equipment. Therefore, smart power supply system was never prototype, only conceptualized. Despite all these challenges, the main part of this project remain stable and in working condition.

Testing methods and results

In order to make the project feasible, various design concept is conceptualize along with its test methods. Underlying principle for each individual component used in the project remained same. First test functionality and tolerance of each sensor node. Second integrate these components in given design and supply input. Finally, monitor output on mobile phone. At each stage operations were verified, and consistency checked. Figure below is the top-level circuit assembled in lab.

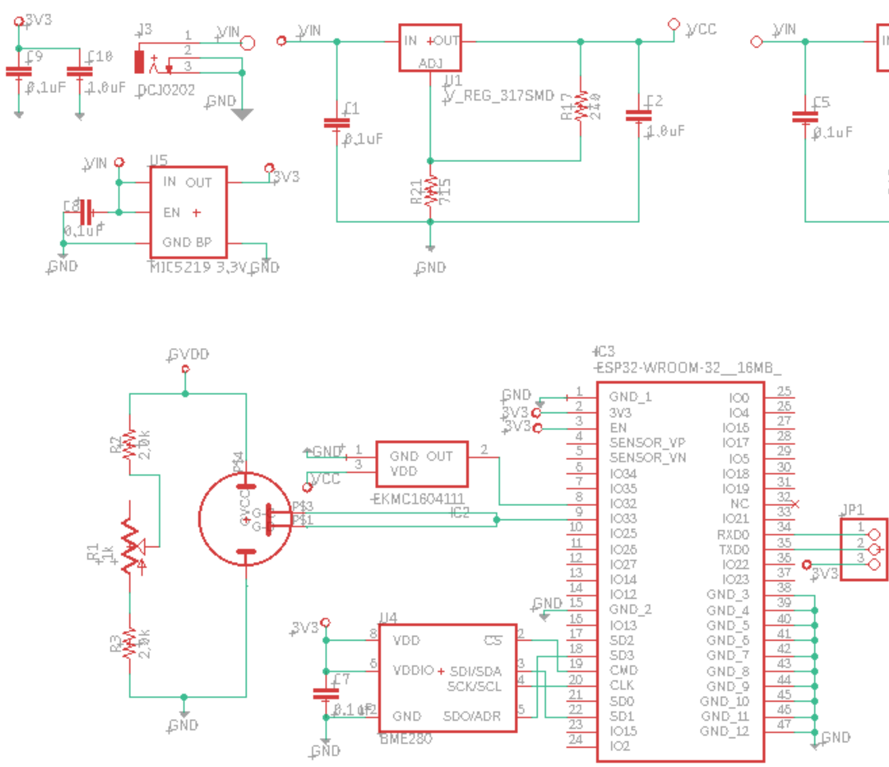


Figure 4: Top level schematic.

Each sensor was tested individually. First, we will look at the behavior of the gas sensor. The gas sensors input was from a gas lighter.

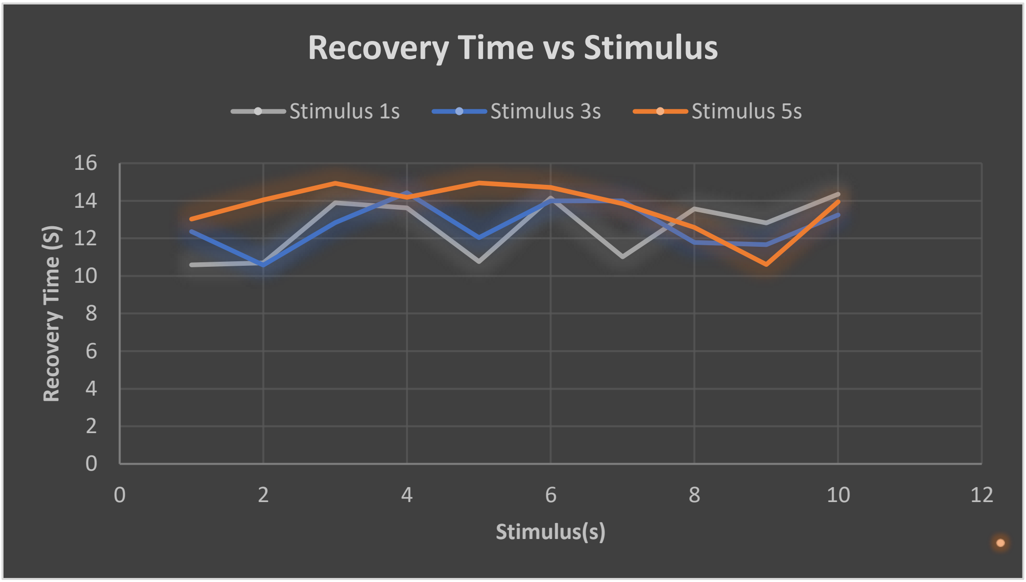


Figure 5: MC105 Gas Sensor stimulus.

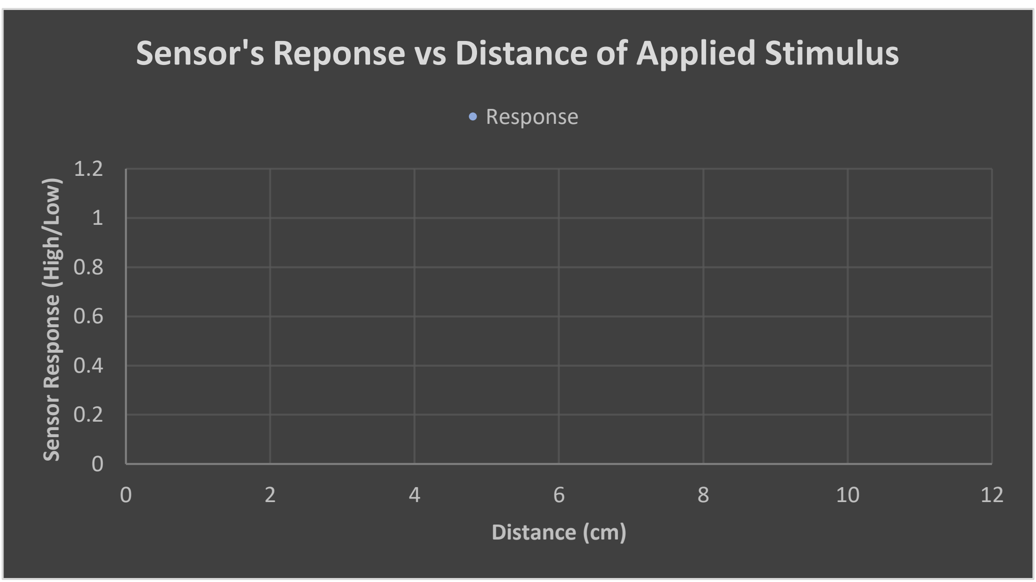


Figure 6: MC105 Gas Sensor stimulus vs distance.

The figure 5, represents the recovery time for the MC105 flammable gas sensor. The applied stimulus was butane gas from a gas light. The light was held at point blank range. The gas was released for 1s, 2s, and 5s (seconds). A timer started the moment the stimulus supply stopped, and the timer stopped when all the LEDs were turned off, meaning the sensor is not sensing anymore and it is ready for another measurement. The recovery time for this sensor is roughly 12s as the data sheet has it. From our experiment, we concluded that the maximum recovery time is right under 15s. It varies depending on how long the stimulus was applied. The Lower bound being a little over 10s and the upper bound being almost 15s.

The figure 6 illustrates the how close the gas must be for the sensor to detect it. A 1 represents that the sensor was able to detect it and a 0 represents that sensor failed to detect it. The stimulus was applied from a variety of range (cm). The experiment concludes that using a gas lighter as a stimulus, the sensor has a detection range of 3cm.

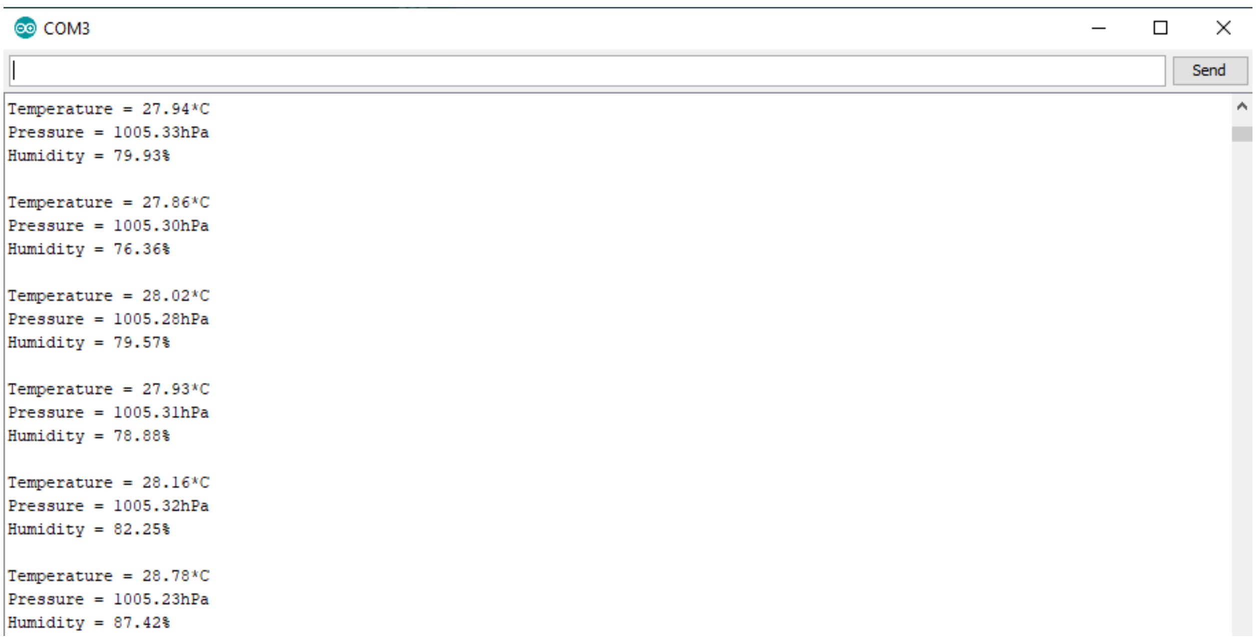


Figure 7: BME280 sensor output at normal condition

The data collected from BME280 humidity and temperature sensor. As shown, temperature reading is well within the error margin. The device uses a 10-bit ADC to convert analog signal after compensation value loaded from internal register. This behaviors can justify minor changes in temperature/pressure/humidity readings.

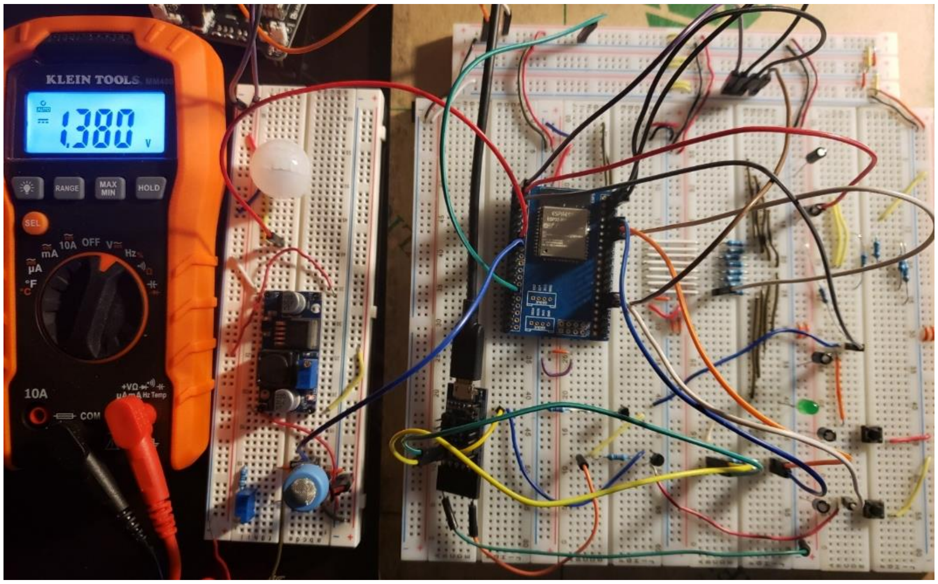


Figure 8: Combined Gas and Motion sensor.

Figure above describes the prototype of PIR motion and Gas sensor together, as it would exist in real world. ESP-32 module is the middle IC, where two sensors are located on left of the picture. Motion sensor outputs digital logic at level 3.3 V.

Figure 9: Coding ESP-32 using Arduino IDE.

Figure above depicts the coding of ESP-32 Wi-Fi module with MQTT protocol for cloud access. The topic for publishing is *sensor_Data* is chosen appropriately. When uploaded to MCU, the hardware takes real time data from sensor nodes and sends it off to AWS IoT core.

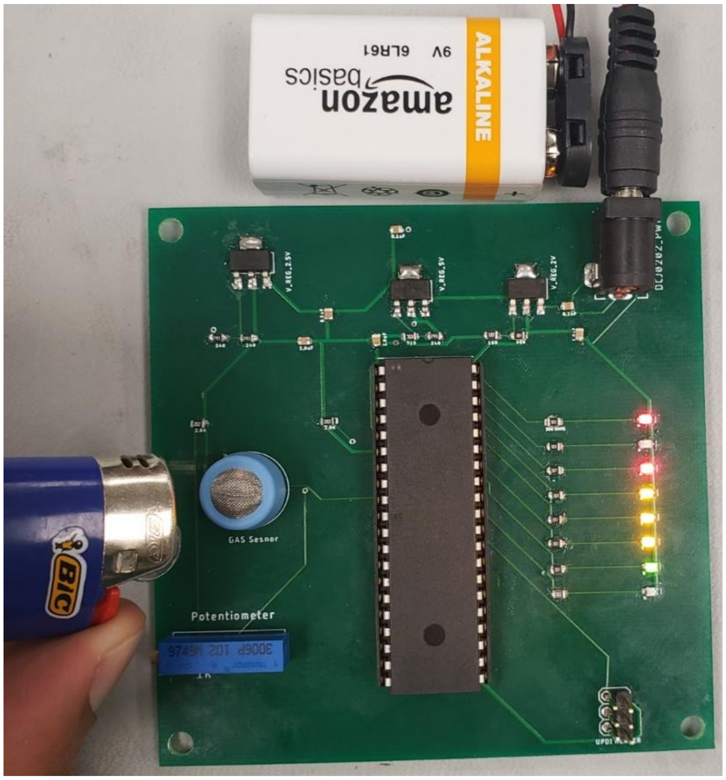


Figure 10: PCB version of Gas sensor.

This is an earlier revision of for gas monitoring system. As input is applied, LED bank shows the output as concentration.

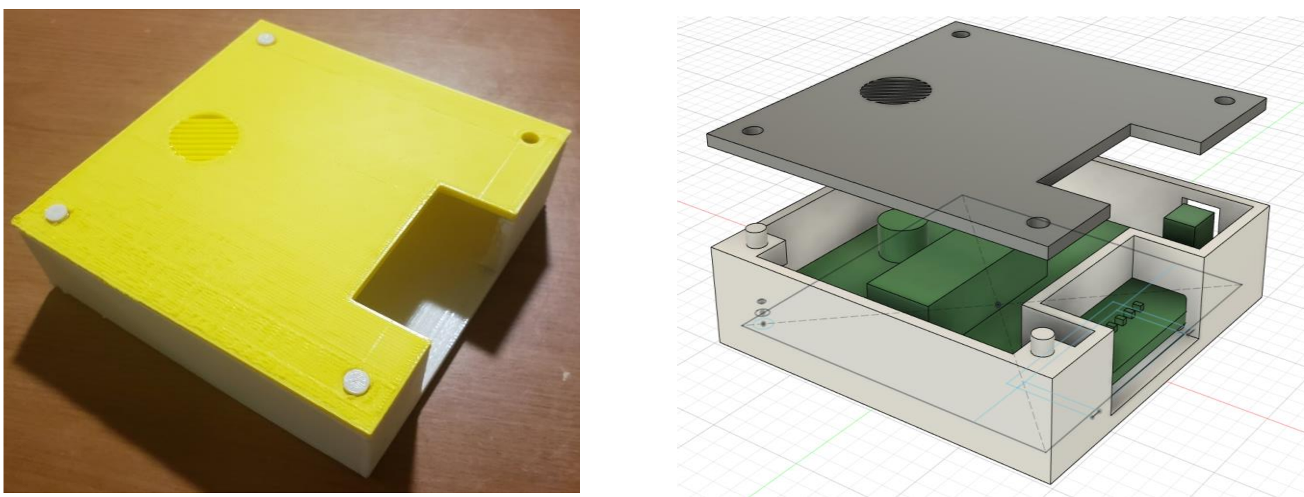


Figure 11: 3-D prototype of enclosure for Gas Sensor Monitoring.

Fusion 360 is used to model and create an enclosure for PCB in figure 11.

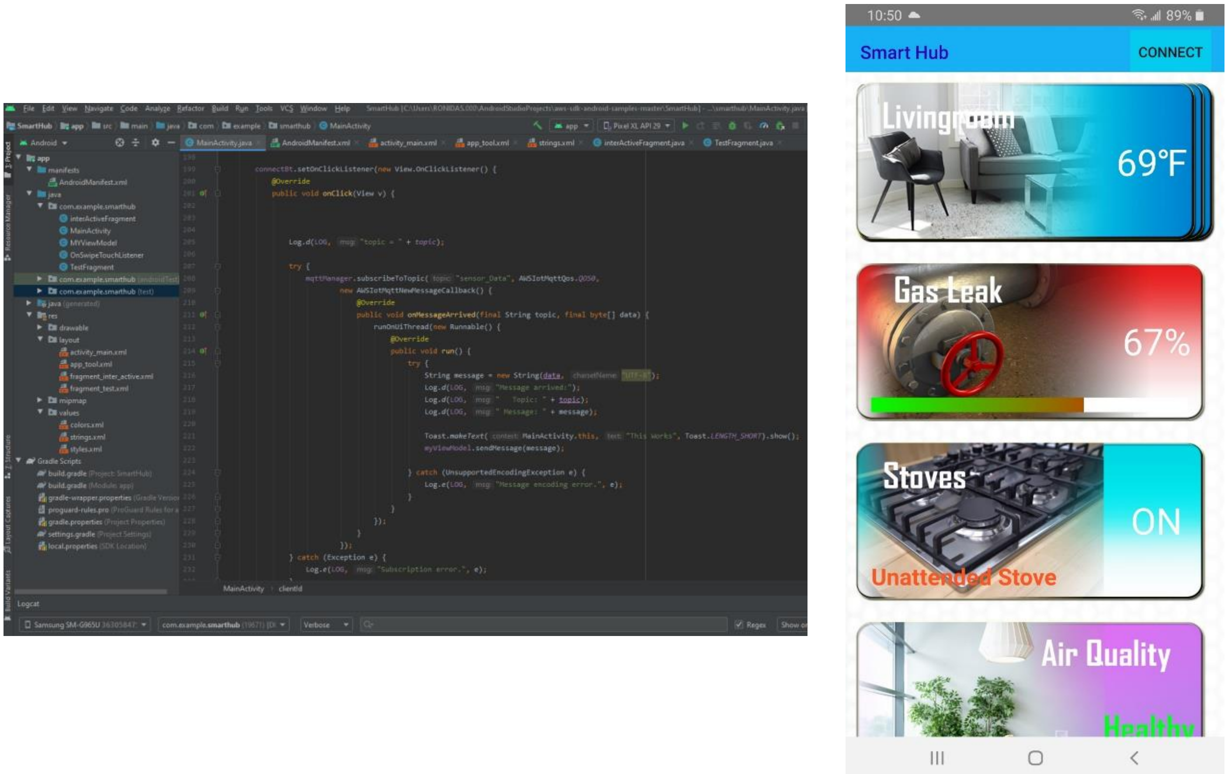


Figure 12: Mobile Application for Smart Stoves.

The app named Smart Hub, is used to monitor kitchen health by providing user real time data of natural gas leak, room temperature, and stove's condition.

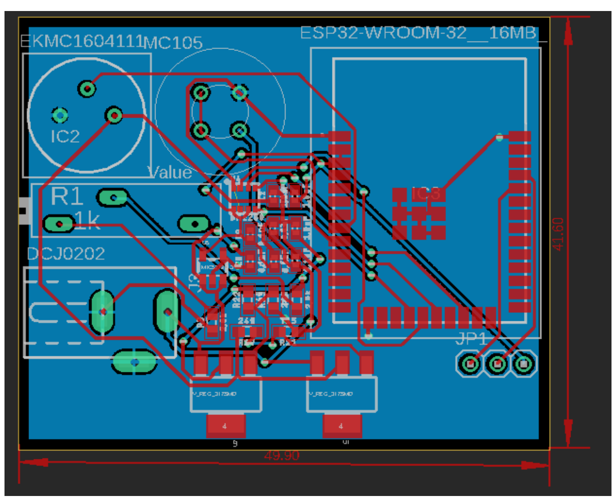
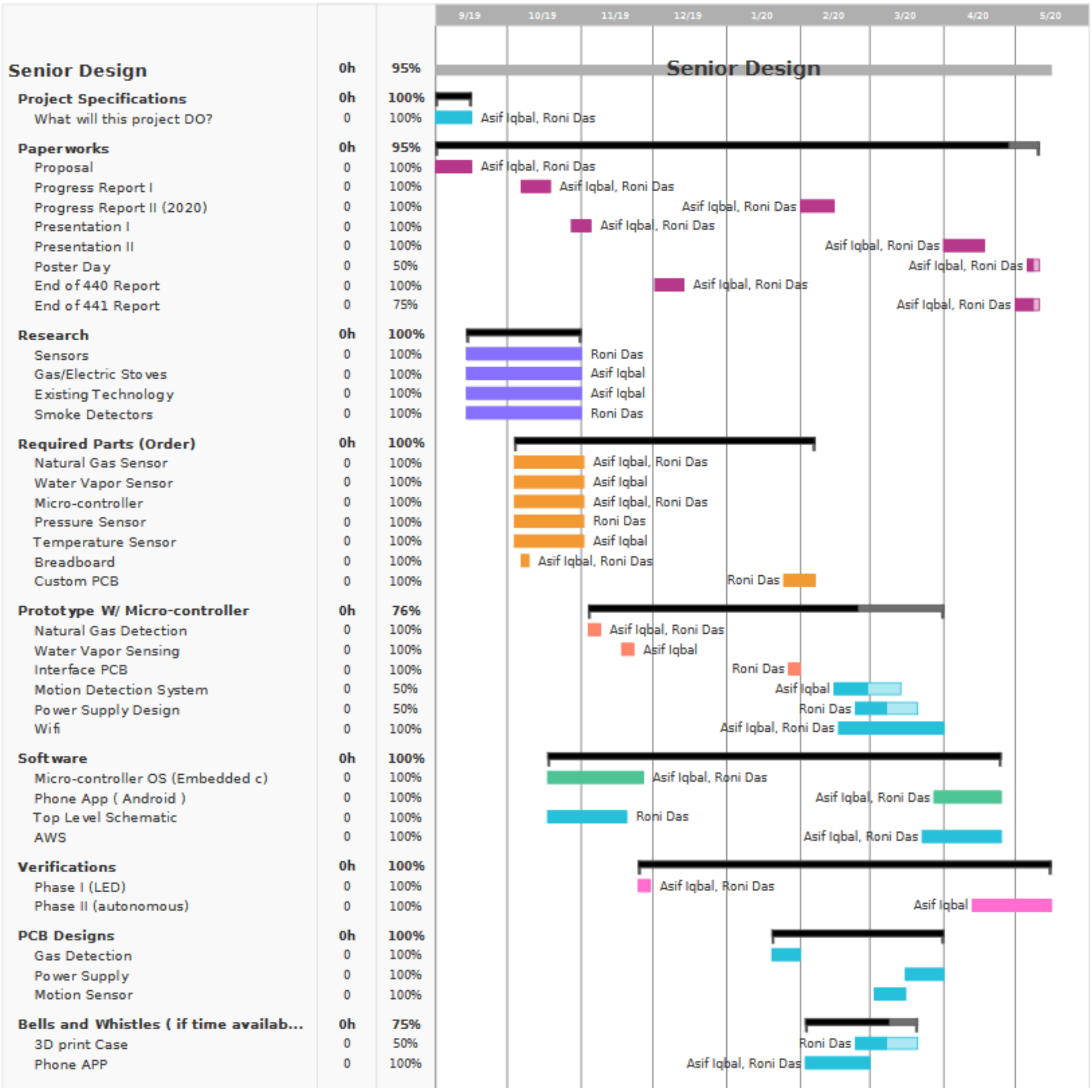


Figure 12: PCB layout for Top-Level schematic.

Conclusion :

Smart Stoves is a work in progress. We are pursuing the project after graduation. This senior design project challenged us in utilizing our accumulated engineering knowledge over past years from various courses. For example, Modern Sensors course taught us to identify and chose suitable components for data acquisition for this project. Embedded System Design course prepared us well for microcontroller programing, which enables us to process acquired data quickly and at a low cost. Signal processing is a major side quest for this project, which requires adequate understanding of inputs vs outputs and what they represent. Research regarding concept idea at the beginning of this project required us to brainstorm new solutions for a product that does not yet exist in market. Solutions which can be employed in making fire hazard less probable. At prototype stage, we learned how to code in Embedded C, as a team, in order to efficiently test system components. Although methods used in engineering Smart Stoves were not always easy and straight forward, it taught us to be patient and try a different approach in solving problems.

Gannt Chart:



9/19
10/19
11/19
12/19
1/20
2/20
3/20
4/20
5/20
Senior Design 0h 95%
Senior Design
Project Specifications 0h 100%
What will this project DO? 0 100%
Asif Iqbal, Roni Das
Paperworks 0h 95%
Proposal 0 100%
Progress Report I 0 100%
Progress Report II (2020) 0 100%
Presentation I 0 100%
Presentation II 0 100%
Poster Day 0 50%
End of 440 Report 0 100%
End of 441 Report 0 75%
Research 0h 100%
Sensors 0 100%
Gas/Electric Stoves 0 100%
Existing Technology 0 100%
Smoke Detectors 0 100%
Required Parts (Order) 0h 100%
Natural Gas Sensor 0 100%
Water Vapor Sensor 0 100%
Micro-controller 0 100%
Pressure Sensor 0 100%
Temperature Sensor 0 100%
Breadboard 0 100%
Custom PCB 0 100%
Prototype W/ Micro-controller 0h 76%
Natural Gas Detection 0 100%
Water Vapor Sensing 0 100%
Interface PCB 0 100%
Motion Detection System 0 50%
Power Supply Design 0 50%
Wifi 0 100%
Software 0h 100%
Micro-controller OS (Embedded c) 0 100%
Phone App (Android) 0 100%
Top Level Schematic 0 100%
AWS 0 100%
Verifications 0h 100%
Phase I (LED) 0 100%
Phase II (autonomous) 0 100%
PCB Designs 0h 100%
Gas Detection 0 100%
Power Supply 0 100%
Motion Sensor 0 100%
Bells and Whistles (if time availab... 0h 75%
3D print Case 0 50%
Phone APP 0 100%
Asif Iqbal, Roni Das
Asif Iqbal
Roni Das

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Appendix A:

Team meeting was held with Professor. Leon Shterengas on every Friday at noon during the fall semester. There was also appointment-based meeting during spring semester before COVID-19. Online based meeting took precedence during the outbreak.