Dublin Engineering and Design Academy
Entrepreneurship Project 2024

AquaGuardAI

DUBLIN ENGINEERING AND DESIGN ACADEMY

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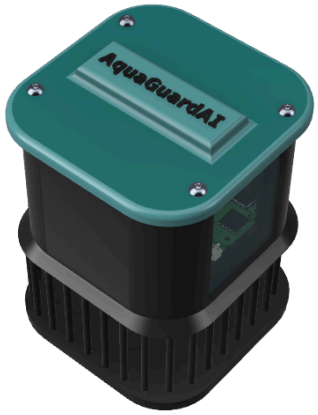

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“We need to stop overflow into the sea...we observe industrial plants year-round and can physically see the difference when they have pumped into the sea.” - Marine Conservation Society

Problem Description

Everyday, 2 million tons of sewage and industrial and agricultural waste are discharged into the world's oceans. This problem is known as sewage discharge. Sewage discharge leads to many effects such as thermal pollution, endocrine pollution, eutrophication, hypoxia, and algal blooms. Over 1000 marine species are affected negatively by sewage discharge. The United States government spends an estimated $32,000/month at every major industrial sewage site to prevent sewage discharge. There are three major problems with sewage discharge. For one, sewage discharge destroys water-based ecosystems. Through the previously mentioned effects, water ecosystems are heavily damaged and many marine species lose their ecosystems. Secondly, sewage discharge leads to a large amount of air pollution. When water is contaminated with an excess of harmful chemicals, a large amount of chemicals is released to the air. These chemicals can be harmful to many land-based ecosystems. Finally, sewage discharge is a big money spender, as stated earlier, the US government spends $32,000/month at every major industrial sewage site to combat discharge. As of now, sewage discharge is hard to detect and quantify, and serves as a huge issue in the environmental niche. AquaGuardAI hopes to create an easy-to-install water quality monitoring and sewage discharge detention system to combat the three major negative effects of sewage discharge stated above.

Research Summary

The idea of AquaGuardAI came from Adithya's curiosity of industrial waste. He wondered how all of the polluted water impacts ocean species, and if the current methods in place truly work. Turns out, many of these methods are deployed exclusively by governments, and they are very hard to install. We then did more research on current techniques, and settled for AquaGuardAI's unique selling proposition (USP) to be having easy-to-install, AI-based sensors. Competitors such as Evoqua Water Technologies have also delved into the realm of sewage discharge detection. However, AquaGuardAI excels by being easy-to-install, and having live feed transmission to the website, for anyone to access. We then did more research on the implications of this model. This model would save around $9,000/month at every sewage discharge site, and have positive impacts for over 1000 marine species.

Solution Summary

Develop a convolutional neural network linked to an easy-to-install sensor to be placed in numerous sewers. The AI model will detect, and monitor sewage discharge and display in real time on the AquaGuardAI website. By helping detect sewage discharge, a lot of the work is eased off of environmental regulators, and they may initiate already-used tactics to combat sewage discharge, such as waste-water treatment and diversion. To transmit back to the website, AquaGuardAI utilizes the Internet of Things (IoT) to allow the live transmission back to our sensor. AquaGuardAI hopes to conserve our environment from the many tragedies of sewage discharge.

Backend Aspects:

In the image below, the routes for both fetching water quality data from the sensors as well as adding new data into the backend systems are portrayed. Utilizing Python Flask's built-in function "@app.route" we were able to effectively route the "GET" method with the sensor_data subdomain link.

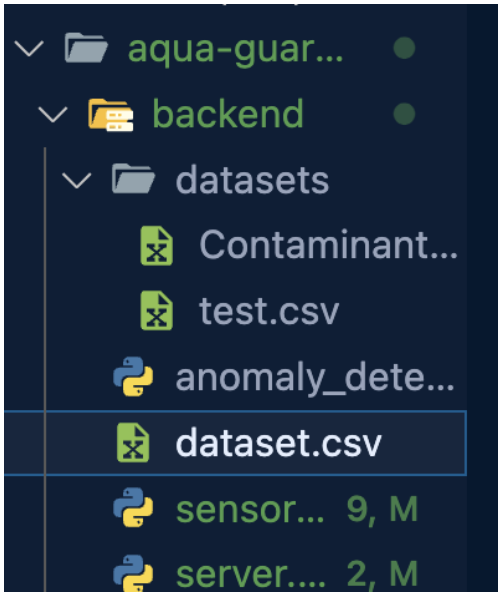
```python
# Route for fetching water quality data from sensors
@app.route('/api/sensor_data', methods=['GET'])
def get_sensor_data():
    return jsonify(sensor_data)

# Route for adding new data into the system
@app.route('/api/add_water_quality', methods=['POST'])
def add_water_quality_data():
    data = request.get_json()
    # Adding timestamp to the received data
    data['timestamp'] = datetime.now().isoformat()
    water_quality_data.append(data)
    return jsonify({"message": "Water quality data added successfully"})
```

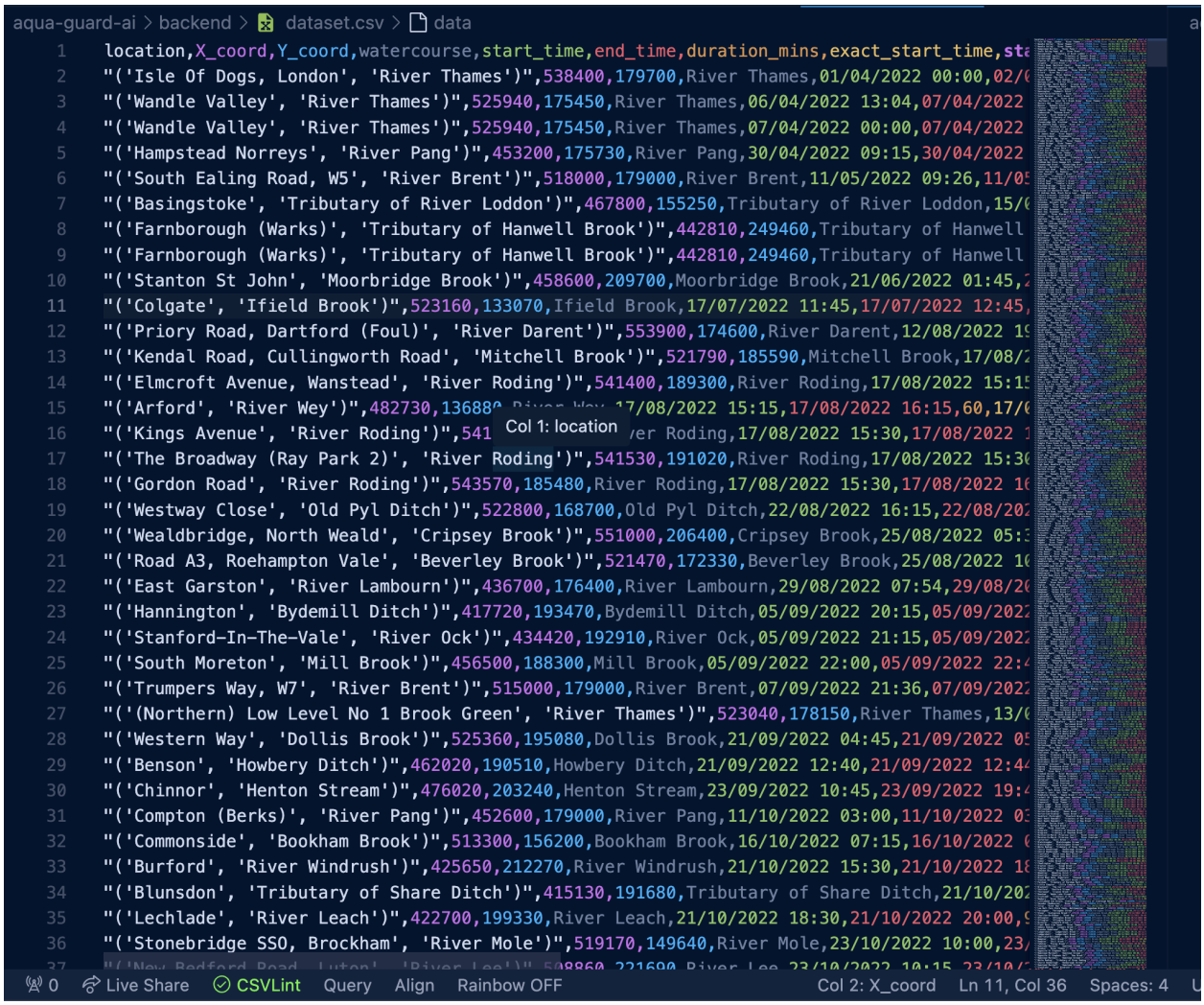
By defining the function *get_sensor_data()* with no parameters, we were able to use a Python library called **Jsonify** to return the sensor_data.

For the second function, *add_water_quality_data(),* we used Javascript's datetime.now() built-in function to intialize the timestamp to the received data, otherwise known as "data['timestamp']." Furthermore, we appended (essentially, adding to the end of a list or given data structure), the data to the *water_quality_data* variable initialized earlier within the code. Finally, once again using Jsonify, we returned a message to the user stating that the water quality data was successfully added, to ensure the entire process went through as planned.

The folder & file structure for the backend systems are shown below. As seen, *dataset.csv* is a CSV, otherwise known as a Comma Separated Value file taken from Kaggle. We included two different folders differentiating the backend from the frontend, with the *datasets* folder including other various scraped datasets we didn't use as the "end product" in terms of the software itself.

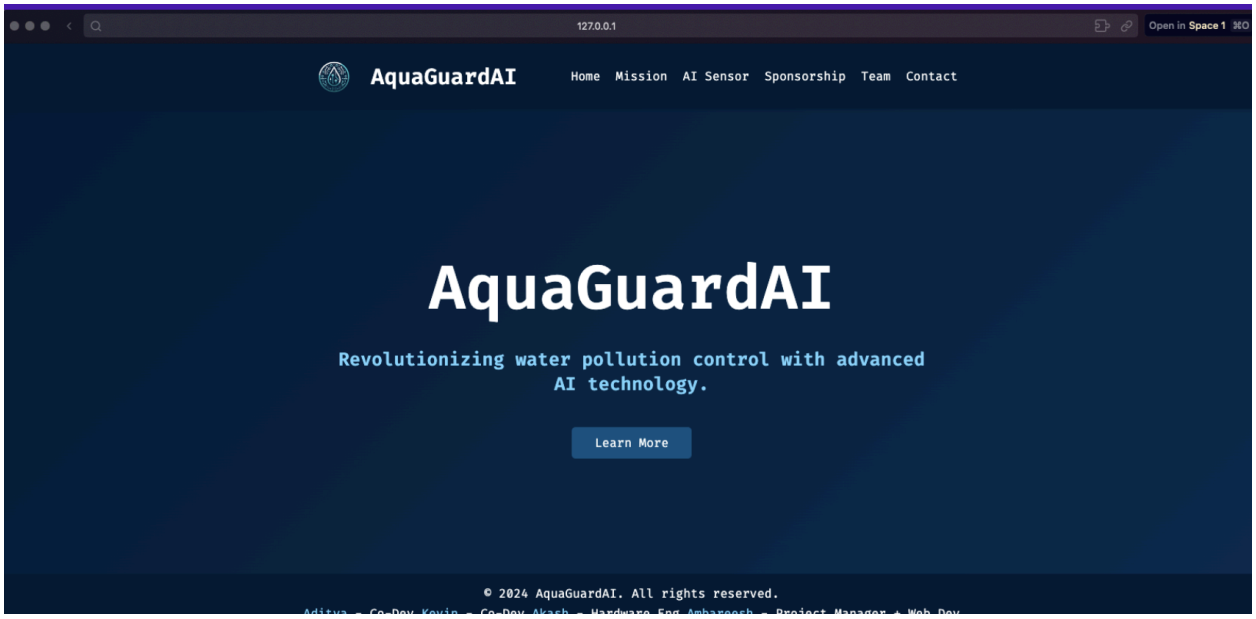


As accentuated by the CSV file, *dataset.csv,* it has various parameters or attributes such as the location, the X and Y coordinates, start_time, end_time, etc.



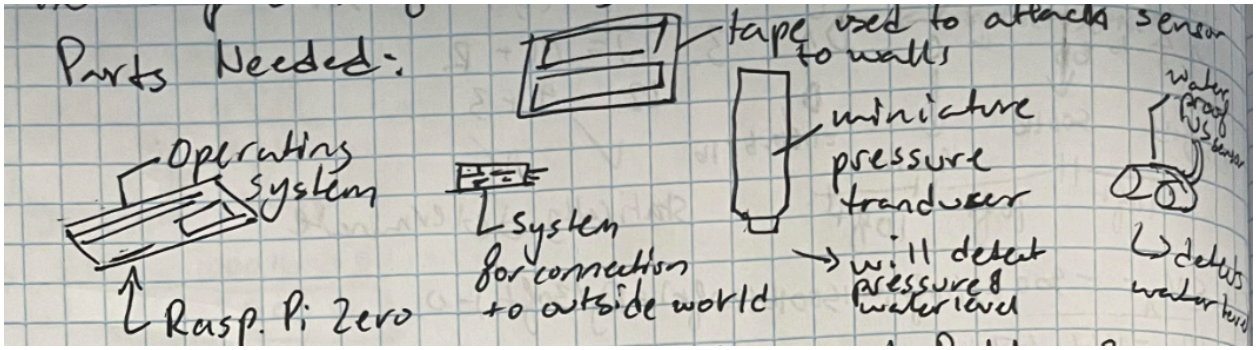
Frontend Aspects:

Here is the full front-end website look. This was coded using simple HTML, CSS, and Javascript for the simplicity of it, as we didn't want to dive too deep into libraries/frameworks such as React, which would make the file management and overall component structure a lot less manageable and more messy.



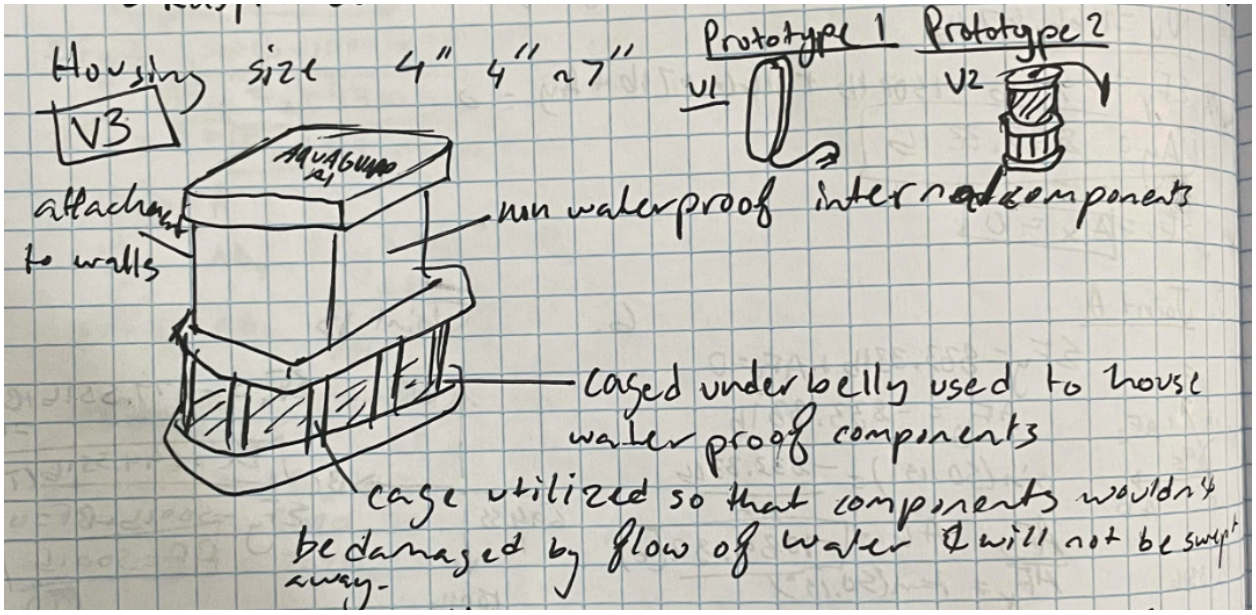
Design Aspects:

To create a design of a sensor capable of detecting sewage discharge it was essential to find the parts required for such a task. For this objective, we collectively decided to utilize the Raspberry Pi Zero for its miniature nature and operational capabilities. For connecting with software to the outside world we utilized an ESP-prog(ESP32). However, due to the constraint of water not interacting well with electricity, to detect discharge we can find the component's pressure and water levels which will predict discharge using a miniature pressure transducer and a waterproof ultrasonic sensor.

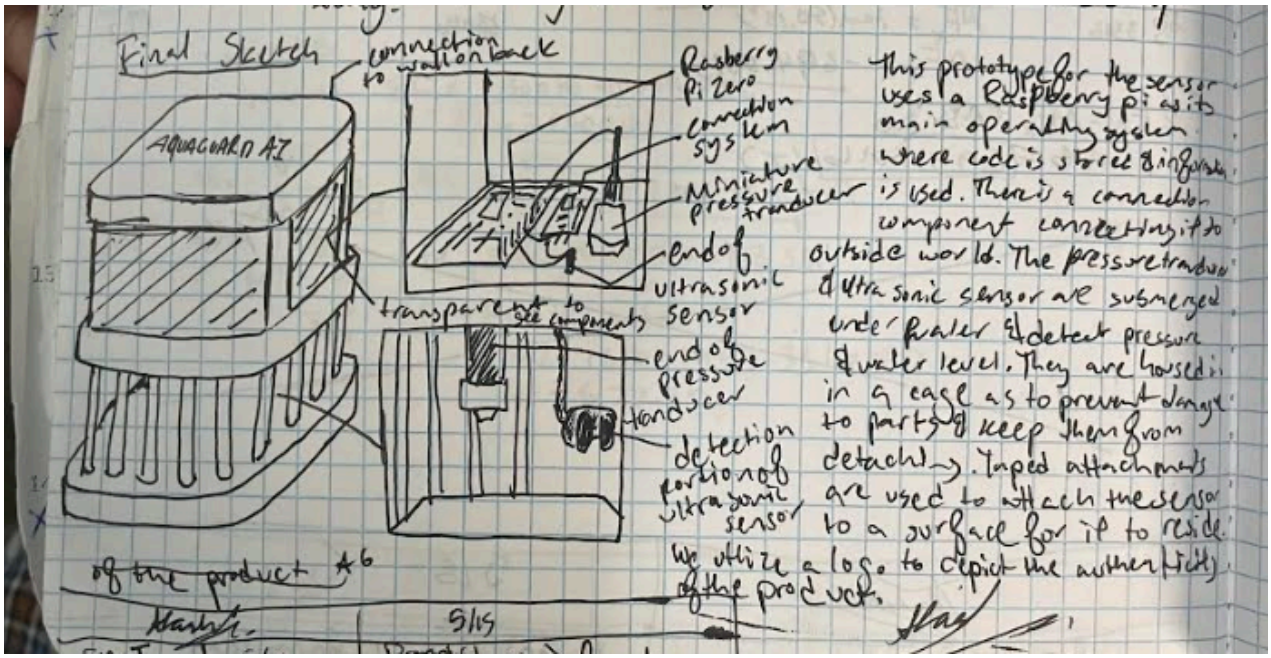


The next part of the prototyping process was coming up with an adequate housing structure that fits the components and is aesthetically pleasing.

We decided on having this housing no more than seven inches in height and constrained it to a four-by-four-inch box for ease of use. During the later stages of this process, we decided to add transparent plastic to see the functionality of internal components and check for leaks. Furthermore, the underside of the sensor includes parts exposed to water for detection. In pursuit of preventing damage to these components due to strong surges of water and preventing them from detaching and ending up as waste if damaged, we implemented a cage system for protection.

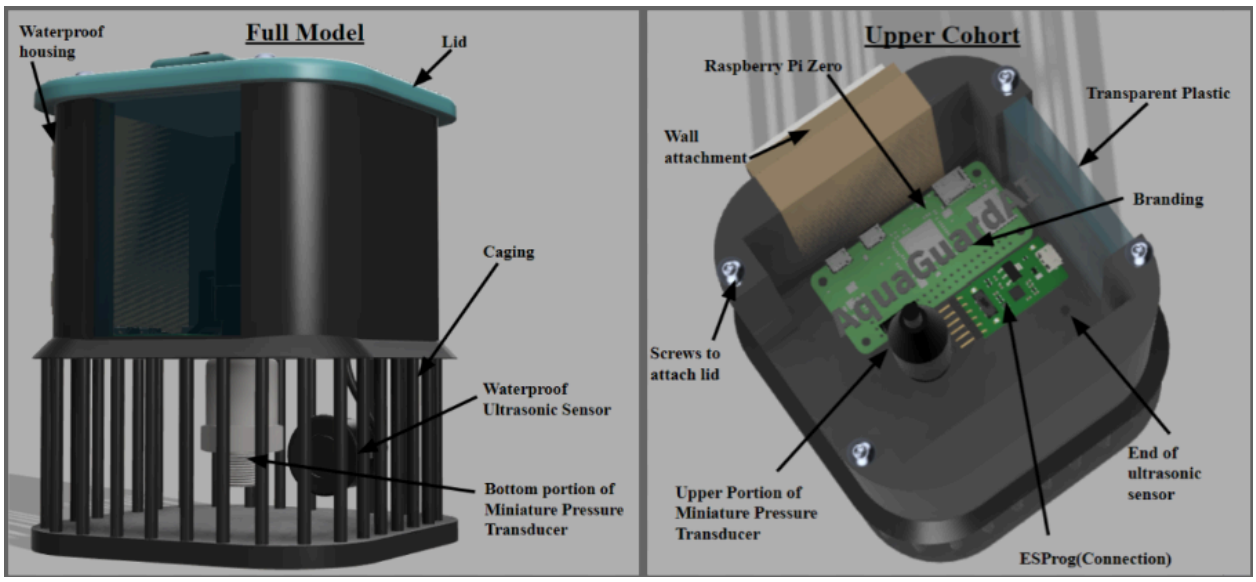


As a result, we decided upon a final design of the sensor, where internal and external parts are exposed and can be observed.



Through sketching and gaining a general idea of the product, we understood the components and execution involved in creating the design. Thus, by utilizing Computer Aided Design through the software

Fusion 360, these aspects were highlighted and added upon to make the final product more user-friendly and applicable to real-world systems.



Product Evaluation

Target Market

AquaGuardAI will have three tiers of noncustomers. Tier 1 will include environmental regulators, specifically in sewer and waste contamination. Tier 2 will consist of government officials in charge of sewage regulation. Tier 3 will consist of air pollution activists. AquaGuardAI will assume a more business-to-business (B2B) marketing strategy, to cooperate with their methods of preventing discharge, once detected and monitored.

Survey Responses

We looked at threads from environmental regulators (through sources such as Reddit and Quora) in the field of water contamination, and also a few of our peers in our engineering classes. We have discovered that many of the environmentalists have never seen a solution in this niche, and believe that this solution has widespread implications. Many of our classmates agree that this product effectively combats the problem of sewage discharge. 10 out of 10 students said that our sensor model would be effective. 9 out of 10 students said that our AI model was efficient with the trained datasets.

Financials

AquaGuardAI seeks to be funded mainly by angel investors in the field of environmental regulation and technology. In addition, we will be starting online crowd-funding campaigns. The money raised will be used for the distribution of our sensors, and the development of the

machine learning algorithm, primarily to increase its accuracy in a variety of situations.

Key Contributors

Adithya Gnanasundar: During this year's entrepreneurship project I took on the role of project manager, SCRUM master, and backend developer. Leading my group, I successfully made sure that everyone did their part. Additionally, I coded the backend AI system that was connected with the backend Flask server written by Kevin. I made sure that not only the documentation, but also the video presentation, assignments, and other various tasks were completed not on time, but BEFORE time. The reason I was able to complete my tasks before time was because of the SCRUM framework. While I coded the structure for the AI, Kevin was responsible for debugging my code. This made sprints relatively easier to finish with the added collaboration. In addition to project manager and backend, I also assisted Kevin and Ambareesh on designing our slide deck.

Akash Guntamadugu: During this year's entrepreneurship project I worked on implementing sketches and Computer Aided Design to the sensor to create a fully-fledged prototype of AquaGuardAI. Firstly, in my engineering notebook, I used the design process elaborated in Principles of Engineering to recognize constraints and deliverables which were then used to decide on the various parts that needed to be used. Through sketching various versions, I created a final sketch in which all components and configurations are depicted with an explanation of the purpose and functionality of design changes. Using this as a preface, I created a CAD model of the AquaGuard AI sensor using Fusion 360. Using this design I created captivating visuals of the sensor ranging from multiview designs to exploded views. Other than the design of the sensor, I helped in various facets of documentation and preparing the slideshow. In addition, I was the sprint reviewer for our team. I made sure that all of our sprints were being completed on time, and effectively.

Kevin Anand: I took on the roles of creating the slidedeck, creating the original website, and setting up the backend systems in order to directly connect it with the frontend code (otherwise known as the website) from Ambareesh. I also took on the role of debugger. When Adithya or Ambareesh sent me code updates, I would carefully look through and test their code in meaningful applications. This helped make sure our work was effective, and helped us complete our sprints in a timely manner.

Ambareesh Budaraju: I took on the roles of frontend designer, and backlog refinement. I utilize various animation techniques from CSS and Javascript to make our website unique and stand out. Once connected to the flask server, our website will be able to transmit live-feed data from the sensors onto our website. In addition, I served as the backlog refiner for this project. I would check-in on the product backlog to make sure our team has planned improvements. In addition, I assisted Adithya and Kevin on designing our slide deck.

References

How much raw sewage is released into rivers and the sea, and what are the rules? (n.d.). BBC. Retrieved May 16, 2024, from https://www.bbc.com/news/explainers-62631320

Sewage Spills & Sewage Releases | City of Berkeley. (n.d.). The City of Berkeley. Retrieved May 16, 2024, from https://berkeleyca.gov/city-services/livable-neighborhoods/sewage-spills-sewage-releases