TEC-V

Milestone 2

TEC-V (Topographic Exploration Cave Vehicle

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2. **Faculty advisor from CSE: name and email address.**
   - Marius Silaghi, *Professor | Electrical Engineering and Computer Science*
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3. **Client: name and affiliation**
   - Dr. Stephen Wood, *Professor | Ocean Engineering and Marine Sciences*
     - Program Chair for Ocean Engineering

4. **Date(s) of Meeting(s) with the Client for developing this Plan:**
   - **Team Meetings:** Wednesdays at 3 p.m.
   - **Client Meetings:** Monday10-23 at 5 p.m.
   - **Advisor:** Thursday 10-26 at 3 p.m.

5. **Progress of current Milestone (Progress Matrix):**

Tasks	Completion%	Michael	Zealand	To Do
Research	**100%**	**20%**	**80%**	
Read Data from Ping 360	**100%**	**50%**	**50%**	
Interpret Intensity Values to distances	**100%**	**80%**	**20%**	
Ping360 Data -> .csv	**100%**	**100%**	**0%**	
Pool Test	**100%**	**100%**	**0%**	
Pool Data to 3D model	**75%**	**100%**	**0%**	**Make it faster**

6. **Discussion (at least a few sentences, ie a paragraph) of each accomplished task (and obstacles) for the current Milestone:**

- **Task 1: (Read Data)**

During this task, our objective was to extract data from the Ping 360 sonar. We conducted this testing on a different Autonomous Underwater Vehicle (AUV) called KODA, which was available in the Ocean Engineering Laboratory and already equipped with the sonar, unlike our project's AUV (TEC-V).

The primary aim of this task was to gain a comprehensive understanding of the data retrieval process from the sonar. This endeavor presented a level of complexity due to the unique communication system employed by the AUV to communicate with the topside receiver. Specifically, communication between the AUV and the topside receiver was established through an ethernet connection, and to initiate communication with the AUV, we had to connect to it via SSH (Secure Shell).

Once we successfully established the SSH connection, we were then able to harness the capabilities of a Python package made available by the manufacturer of the Ping 360 sonar on GitHub. This package facilitated our ability to issue commands to the sonar and retrieve the data it was capturing. The data received was packaged in the form of a message, containing several extraneous data points that were not pertinent to our research objectives. Our primary focus revolved around two key elements:

- **Angle of Sonar Perspective:** We concentrated on determining the specific angle at which the sonar was currently directed, providing us with valuable information about the orientation of the AUV.
- **Intensity Values Array:** The data also included an array consisting of 1200 intensity values. This array served as a critical component of our analysis, as it contained the information we needed to gain insights into the underwater environment and potential obstacles.

This process of data extraction and analysis was instrumental in advancing our understanding of the sonar's capabilities and its integration into our AUV project.

- **Task 2: (Intensity Values)**

Upon receiving the intensity values, they are promptly stored in an array for further analysis. These intensity values fall within a range of 0 to 255, where a reading of zero indicates the absence of any contact (essentially no object detected), while a value of 255 signifies the highest intensity, indicating the presence of a solid object in the sonar's field of view.

The challenge here lies in the possibility of the sonar picking up false data, including reflections and other unintended contacts, rather than the specific objects we were primarily interested in, such as underwater walls. To mitigate this issue, we developed a sorting algorithm tailored to our needs. This algorithm scans the intensity values, identifying instances where high-intensity values are closely grouped together. From this cluster, we select the lowest five values and calculate their median.

Once we obtain this median value, we employ its corresponding index within the intensity array to perform calculations. These calculations leverage the sonar's signal emission speed and the speed of sound in water to derive a distance measurement for that specific point.

Admittedly, this method may not appear highly accurate or precise at first glance. However, the results we are presently obtaining are remarkably close to the actual values. This approach serves as an effective means to filter and interpret the data, allowing us to make reliable estimations regarding the distances to objects in the sonar's path.

- **Task 3: (Data to CSV file)**

After obtaining the two crucial values, we proceed to store them in a "data.csv" file for future reference. This serves as a simple data repository. The data is structured in the following format: [depth, angle, distance].

As for the depth parameter, it is important to note that it is not currently functioning as an automatic measurement tool. Instead, within the code, to acquire depth information for each set of data, the user is required to manually trigger a scan by pressing the spacebar. Following the completion of each scan, the depth value is updated by incrementing it by one. This approach effectively delineates different sections of data and allows us to track the depth-related changes in our recorded information.

- **Task 4: (Pool Test)**

On the 21st of Saturday, our team embarked on a trip to the Clement Pool located at Florida Tech. We deployed the AUV KODA into the pool waters and conducted a series of scans. The objective was to assess the functionality of our Python program, which was designed to extract angle and distance data from various points within the pool.

The endeavor proved to be a resounding success, resulting in the collection of six distinct sets of data. These datasets have been saved for future utilization in creating a cloud plot, enabling us to visualize and analyze the underwater environment effectively. **See Image 1.**

- **Task 5: (3D Model)**

Following the successful data collection process, our next objective was to visualize the results. By leveraging the distance and angle data, and employing straightforward linear algebra techniques, we were able to transform these data points into [x, y, z] coordinates. These coordinates provided the foundation for creating visual plots.

For the current phase of our project, we opted to utilize Unity's environment setup to visualize and display the data plots. While Unity serves as a practical choice for showcasing our results, our long-term goal is to develop a custom platform of our own. This custom platform would streamline the data interpretation process and offer greater flexibility for our specific project needs. **See Images 2 and 3.**

Image 1: (Data Transposed over Google Maps image of Clemente Pool)

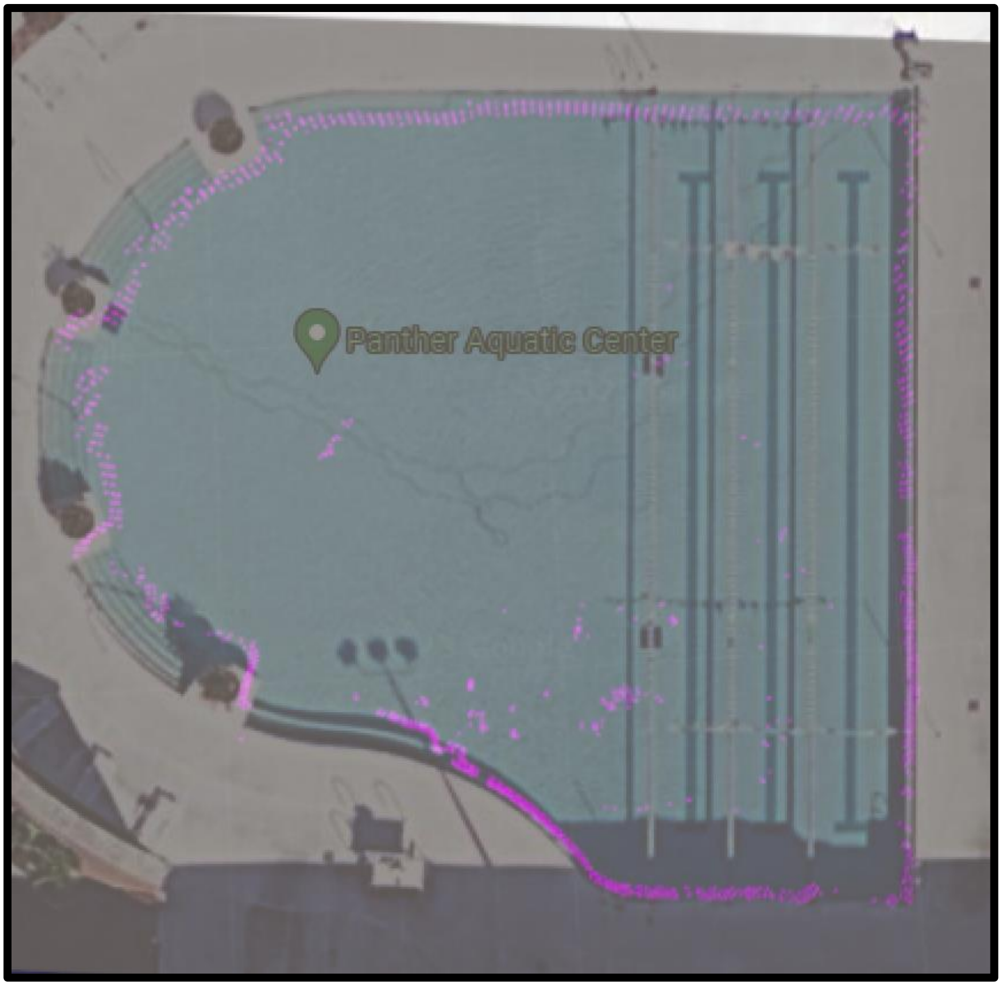


Image 2: (Side View of Data Plot in Unity)

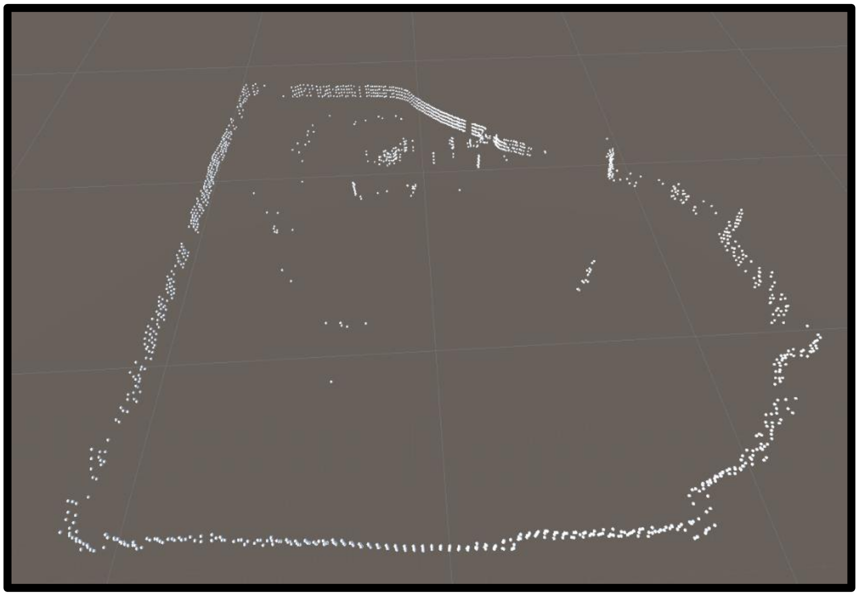
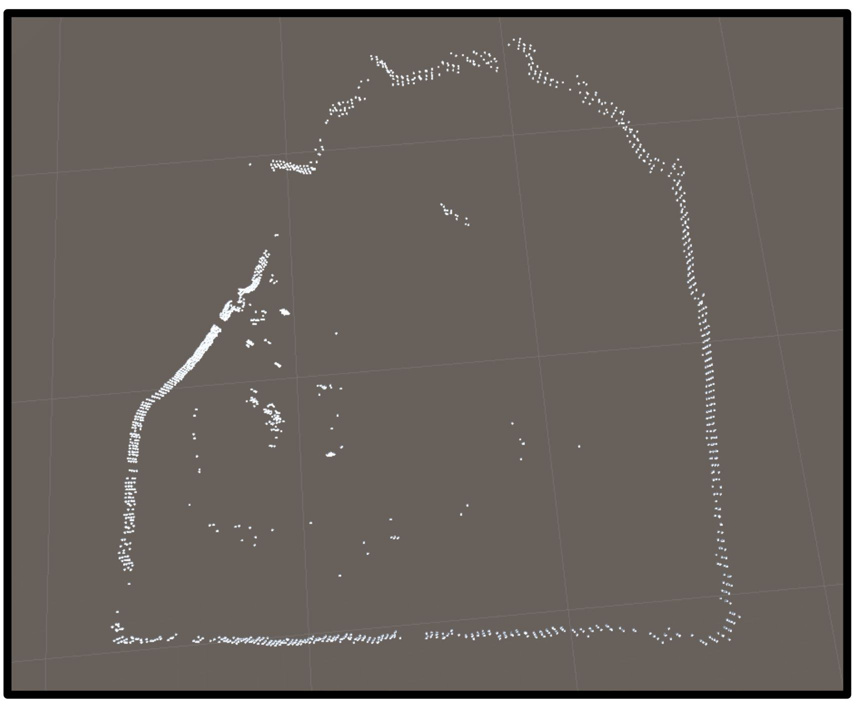


Image 3: (Top View of Data Plot in Unity)



7. Discussion (at least a few sentences, ie a paragraph) of contribution of each team member to the current Milestone:

<u>Mike Dowling:</u>

During this milestone, I spent my time in lab on Mondays, Wednesdays, and Fridays, from 3 to 7 p.m., collaborating with the TEC-V group as they carried out updates on the AUV. My primary focus revolved around testing the Python program I had developed to extract data from the Ping360 sonar.

Following thorough testing and once I was confident in the data retrieval process, our team made a field trip on Saturday, the 21st, to the Clemente pool. There, we conducted tests involving the AUV KODA and the sonar system.

Subsequently, I then focused my efforts to the setup of a user-friendly environment for displaying and showcasing the data we had collected. This involved the creation of a visualization platform to effectively present and interpret the acquired data.

Zealand Brennan:

I contributed to the research effort focused on the Blue Robotics Ping 360 Python library, which was used for interacting with and retrieving data from the Ping 360 sonar. Additionally, I helped in developing the initial code necessary for reading and extracting data from the sonar.

8. Plan for next Milestone:

Task	Michael	Zealand
False Data	**Create an algorithm to remove false data points or fill in the shadows within the data.**	
Depth Finder	**Identify the protocols to find and retrieve this data.**	
Compass and Telemetry	**Identify the protocols to find and retrieve this data and save the information.**	
Cloud Plot Application		**Work on creating an environment that will transpose the data.**

9. **Discussion (at least a few sentences, ie a paragraph) of each planned task for the next Milestone or "Lessons Learned" if this is for Milestone 6**

- **<u>Task 1: (false data)</u>**
  - To enhance the current data plotting formula and mitigate the influence of false data values that do not correspond to actual contacts, we will implement a refined approach. This refined formula will involve a data filtering step to exclude unreliable values. By establishing a threshold or criteria for what constitutes a valid contact, we can disregard data points falling below this threshold. The modified formula will then proceed to plot only the data points meeting the defined criteria, resulting in a more accurate and reliable representation of the underwater environment. **See Images 4 and 5.**

- **<u>Task 2: (Depth Finder)</u>**
  - To enhance our system's functionality and improve the depth tracking process, we will implement the ability to directly read and record the depth data from the AUV's sensors. This modification will replace the current system, which relies on a scan counter to approximate depth. By directly reading the depth information, we can accurately associate each dataset with its corresponding depth level. This will result in a more precise and automated method for capturing and organizing data based on depth, eliminating the need for manual intervention, and enhancing the overall efficiency of our data collection process.

- **Task 3: (Compass and Telemetry)**
  - To further enhance our system's capabilities, we will incorporate the ability to retrieve data from both the compass for heading information and telemetry data. The compass data is of utmost importance in the current phase of our project, providing critical orientation information. Additionally, we will design the system to capture and save telemetry data, even though it may not be immediately necessary, as our project is not currently in the operational phase where the craft is in motion. However, this preparatory step will ensure that we have access to comprehensive telemetry data when we progress to the stage where the craft is actively deployed and operational, thereby providing a more holistic understanding of its performance and status.

- **Task 4: (Cloud Plot Application)**
  - We are actively engaged in developing our own framework for a cloud plot application. This application will have the capability to directly read the data and create plots within its own customizable environment. This approach will eliminate the need to rely on external platforms like Unity for visualization, affording us greater control and flexibility in how we represent and manipulate the data. This development will streamline the data interpretation process and allow for a more tailored and efficient plotting experience.

Image 4: False Data

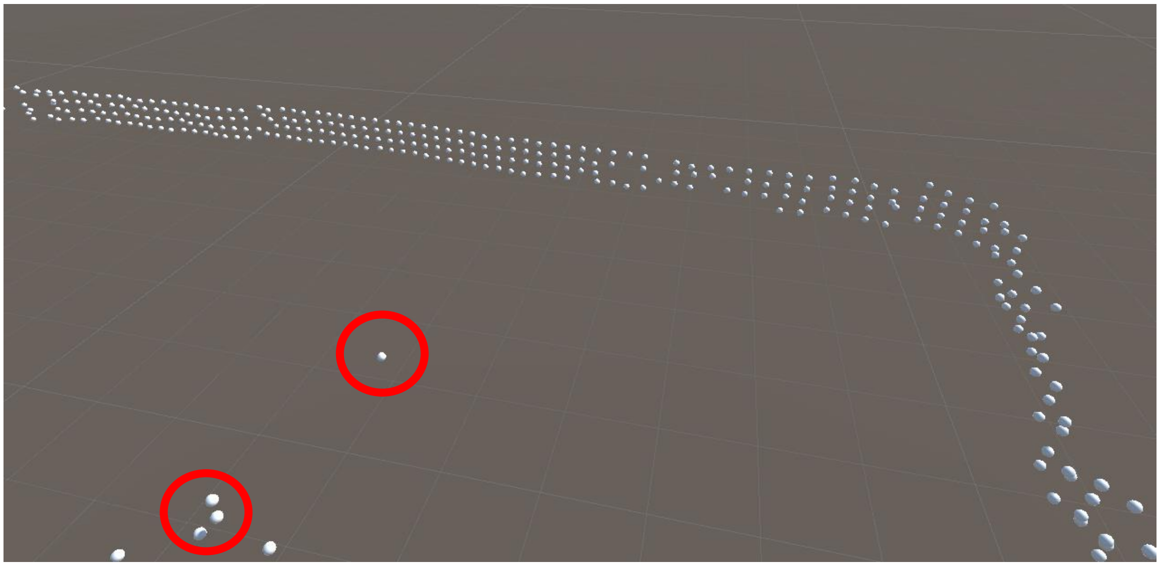


Image 5: False Data

10. Client Feedback on the current milestone:

- Considering the significant advancements achieved during this milestone, which encompassed data acquisition, data interpretation, and plotting the customer has expressed a high level of satisfaction with our progress. In response to this positive feedback, the customer has also expressed an interest in further refining our process by identifying and eliminating false values that have been causing challenges in our plotting efforts in addition to incorporation of other navigational features to further help with accurate data.

11. Faculty Advisor feedback on each task for the current milestone:

- **Use Gazebo's Virtual Environment:**
  - **Create a render of the scanned environment**
  - **Test autonomous functions**
- **Get telemetry data from AUV**

12. Approval from Faculty Advisor

- "I have discussed with the team and approved this project plan. I will evaluate the progress and assign a grade for each of the three milestones."
- Signature:____ Date:

----- on a separate page ---------

13. Evaluation by Faculty Advisor

- Faculty Advisor: detach and return this page to Dr. Chan (HC 214) or email the scores to pkc@cs.fit.edu
- Score (0-10) for each member: circle a score (or circle two adjacent scores for .25 or write down a real number between 0 and 10)

Michael Dowling	0	1	2	3	4	5	5.5	6	6.5	7	7.5	8	8.5	9	9.5	10
Zealand Brennan	0	1	2	3	4	5	5.5	6	6.5	7	7.5	8	8.5	9	9.5	10

- Faculty Advisor Signature: ______________________________ Date: __________