TEC-V
Milestone 3

TEC-V (Topographic Exploration Cave Vehicle

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2. Faculty advisor from CSE: name and email address.
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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:** Monday 11-21 at 5 p.m.
- **Advisor:** Thursday 11-28 at 3 p.m.

5. Progress of current Milestone (Progress Matrix):

Tasks	Completion%	Michael	Zealand	To Do
False Data	**90%**	**90%**	**0%**	**Remove more false data**
Depth Finder	**100%**	**100%**	**0%**	**See if there is another method to get real time**
Compass and Telemetry	**100%**	**100%**	**0%**	
Cloud Plot Application	**100%**	**50%**	**0%**	**Account for rotation of AUV**
Pool Test	**100%**	**100%**	**0%**	

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

- **<u>Task 1: (False Data)</u>**

During this phase of the task, the primary objective centered on rectifying the data reflected in the cloud plot visualization of the scanned environment. The Ping360 sonar, while active, occasionally registers false readings, mistaking non-existent objects for physical obstructions due to its limited capacity for fine detail. While acknowledging the potential flaws in the formula devised to compute the "most likely to object" based on intensity value array which is given back by the sonar, it generally proves reasonably accurate in most test scenarios.

To address this issue, a code was devised to scrutinize the "distances" variables before and after the currently assessed point. If the discrepancy exceeds a 1-meter range among the three distances, when the code is parsing data from the sonar's data file named data.csv in Unity, it will determine the validity of the variable. This approach might be refined by evaluating the standard deviation between each variable, considering exclusion if it falls outside a defined range, hence flagging it as "false data."

Overall, the adjustments made in the code are observable between images 1 and 2, where **image 1** portrays the initial code output from milestone 2, and **image 2** showcases the modified code that incorporates a 1-meter difference check.

- **<u>Task 2 & 3: (Depth Finder, Compass and Telemetry)</u>**

Context for Telemetry Data Retrieval:

In the pursuit of real-time telemetry data during sonar data collection, the primary objective revolves around discerning any rotations or tilts of the AUV at specific points. The depth, compass readings, pitch, roll, and yaw telemetry data play a pivotal role in understanding the AUV's orientation in relation to the sonar's scan. This information is crucial for precisely determining where the sonar is focused during the scanning process.

<u>Methods Attempted:</u>

Method 1: MavLink Integration

To retrieve essential telemetry data, an attempt was made to utilized MavLink, an open-source tool designed to operate alongside the AUV's Q-Ground operating system. The goal was to access crucial metrics such as depth, compass readings, pitch, roll, and yaw. Despite investing considerable time—approximately a week—into this method, it failed to yield the necessary telemetry data.

- **Pros:**
  - Integration within the AUV's operating system for control and data monitoring.
  - Access to various telemetry data for analysis.

- **Cons:**
  - Inability to retrieve necessary telemetry data despite dedicated efforts.
  - Unsuccessful in establishing a functional data retrieval system.

Method 2: Direct Connection to Blue Robotics Navigation Board

The second option was to explore a direct connection to the Blue Robotics Navigation Board within the AUV as an alternative method. Although this approach successfully retrieved the required telemetry data, it introduced significant latency issues between the code and the Q-Ground system. The latency, averaging around 6 seconds, caused operational disruptions and occasional program crashes, rendering it incompatible with the need for smooth Q-Ground operation during manual control.

- **Pros:**
  - Direct access to essential data from the onboard navigation board.

- **Cons:**
  - Substantial latency issues (approximately 6 seconds) affecting system stability.
  - Incompatibility with the requirement for smooth Q-Ground operation during manual control.

Method 3: Telemetry Data Logging via Q-Ground

The chosen interim method involves leveraging Q-Ground's functionality to log telemetry data as a CSV file during AUV operation. This method relies on synchronized timestamps from both sonar and telemetry data for subsequent comparison in post-processing. However, the rapid scanning rate of the sonar (approximately 0.0005 seconds per angle) poses a challenge. With a full 360-degree scan taking about 3 seconds, only a limited number of telemetry data points align with the numerous sonar data points, potentially leading to comparison errors.

- **Pros:**
  - Utilizes Q-Ground's telemetry data logging feature for synchronized timestamps.

- **Cons:**
  - Limited alignment between rapid sonar scanning and telemetry data points.
  - Potential errors due to the disparity in data sampling rates between sonar and telemetry.
  - Timestamps do not always align, error with dataTime().

Each attempted method for telemetry data retrieval presents its own set of advantages and limitations. While the quest for real-time telemetry data remains pivotal for understanding AUV orientation during sonar scanning, the current methodologies require further refinement to address the challenges encountered, particularly in achieving synchronization between the rapid sonar scanning rate and telemetry data sampling.

- <u>**Task 4: (Pool Test and Cloud Plot Application)**</u>

The primary aim of this task was to devise a methodology capable of accommodating the craft's rotation during or between scans. This method, when applied, should enable the rendering of the scanned environment regardless of the craft's orientation. Even if certain points were not scanned due to rotation, the objective was to produce a cohesive outline of the environment, minimizing significant inaccuracies. However, during the data collection for testing, it became apparent that the timestamps for some scans were absent in the CSV file generated by "Q-Ground." As a result, not all data can be comprehensively interpreted by the code, which relies on comparing timestamps from multiple data files to generate the desired 3D Cloud Plot. Presently, this code remains a work in progress, and the most recent output can be observed in **image 3**. This test involved several scans at varying depths before rotating the craft to a different heading.

Image 1: ()

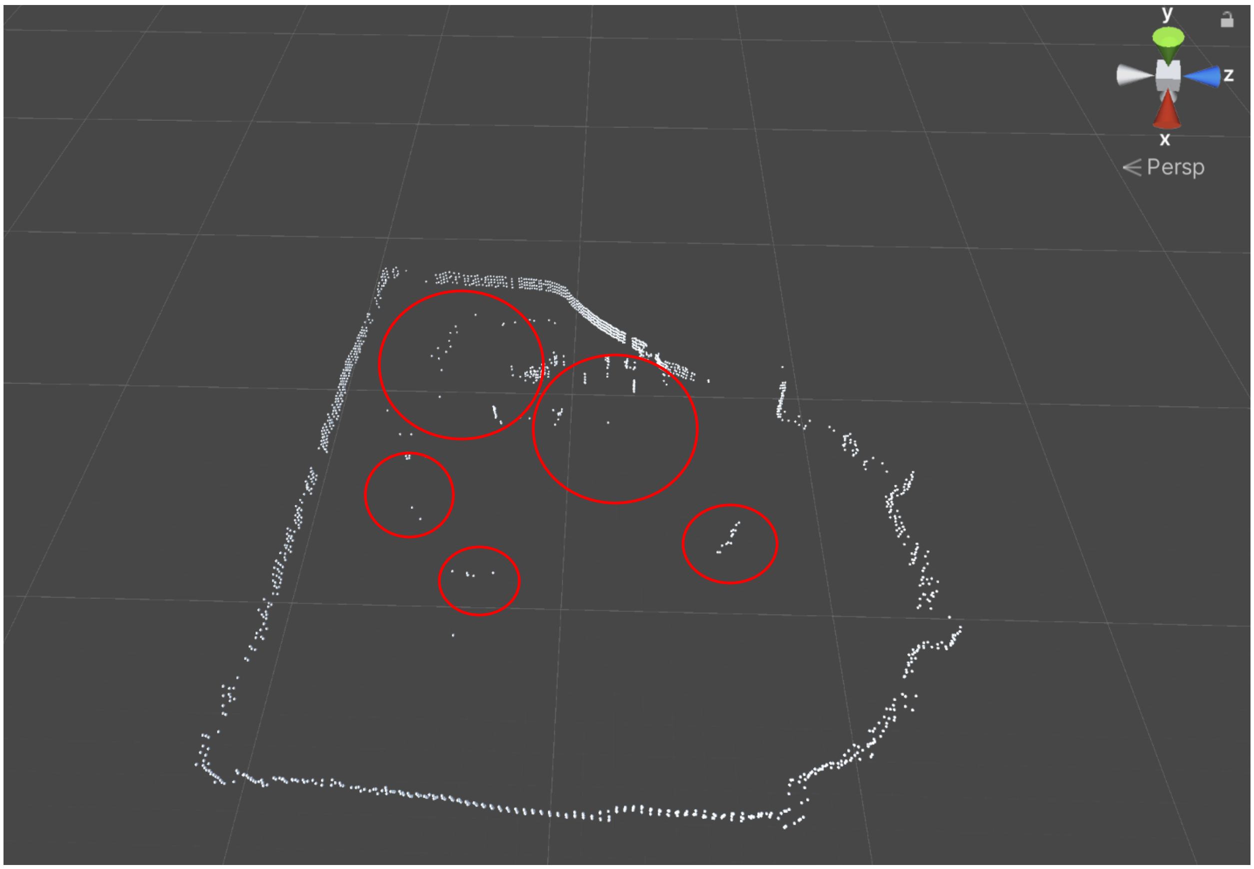


Image 2: ()

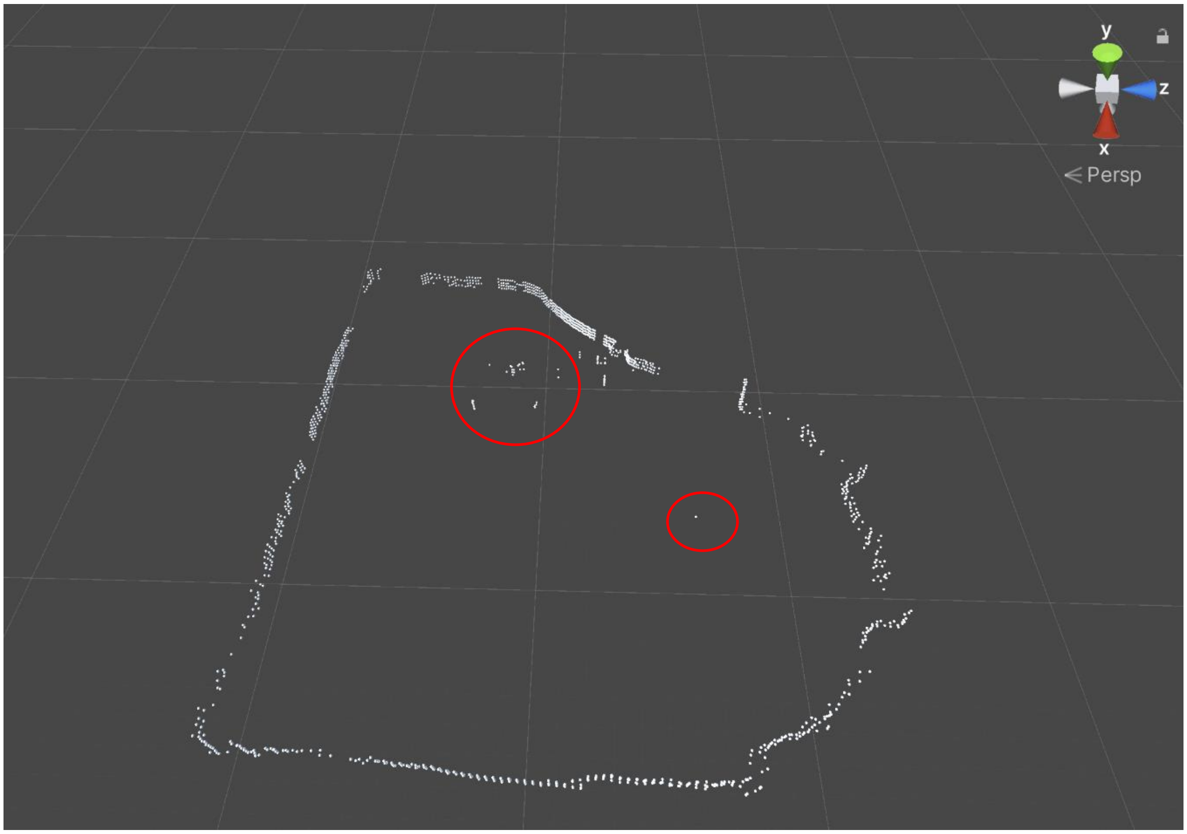
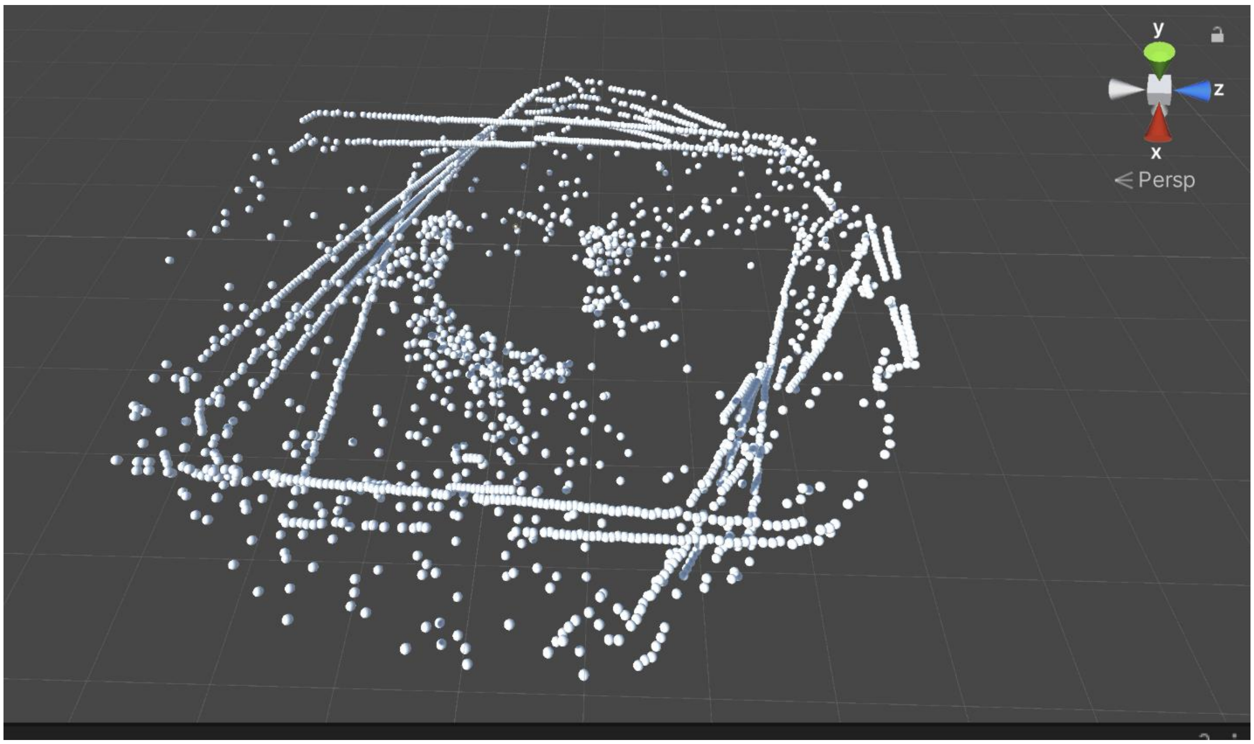


Image 3: ()



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

<u>Mike Dowling:</u>

1. **Filtering False Data:** I dedicated time to devising methods that effectively removed inaccurate data points from our cloud plot. The challenge stemmed from occasional false readings by the sonar, picking up non-existent objects.

2. **Telemetry Data Capture**: I explored various avenues to capture essential metrics such as depth, compass readings, and orientation data during the AUV's operation. The goal was to synchronize this data with sonar scans for future analysis.

3. **Real-world Testing:** We conducted comprehensive tests at the Melbourne Commons pool, specifically focusing on understanding how the AUV behaved during different maneuvers and scanning operations.

4. **Data Integration and Processing:** Following the collection of telemetry and sonar data, my focus shifted to aligning and processing this information. The aim was to generate a 3D representation of the scanned environment. However, challenges arose due to missing timestamps in certain telemetry data.

In addition to these tasks, I worked on developing a user-friendly data visualization platform. This platform aimed to present our collected data in a way that was easily understandable, providing valuable insights into the underwater environment we had scanned. 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.

8. **Plan for next Milestone:**

Task	Michael	Zealand
False Data Improvements	**Create an algorithm to remove false data points or fill in the shadows within the data.**	
Rotation Algorithm	**Identify the data required and reformat it so that it can be transcribed.**	
Autonomy	**Utilizing Gazebo as a testing ground for partial pathing using the current data sets we have.**	

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 Improvements</u>**

Objective: Enhance dataset quality by addressing inaccuracies and shadows.

Approach:
- **Algorithmic Refinement:** Develop robust algorithms to identify and eliminate false data points. This involves analyzing patterns within the dataset to differentiate between valid readings and erroneous data, minimizing the impact of false positives or noise.
- **Shadow Handling:** Address shadowed areas or missing data points within the dataset. Techniques such as interpolation, outlier detection, or sophisticated data smoothing algorithms can help fill gaps caused by incomplete or obscured data, ensuring a more complete representation of the environment.

- **Task 2: Rotation Algorithm**

  Objective: Prepare data for effective interpretation and transcription of rotation-related information.

  Approach:
  - **Data Identification:** Identify key data parameters necessary to capture rotation dynamics. This may involve data related to sensor readings, orientation, or positional changes that indicate the craft's rotation.
  - **Formatting and Transformation:** Restructure the data format to suit the transcription and analysis requirements. This involves organizing and formatting the data in a way that facilitates efficient interpretation and processing, ensuring compatibility with algorithms designed to extract rotation-related information.

- **Task 3: Autonomy**

  Objective: Test and refine partial pathing using datasets within Gazebo.

  Approach:
  - **Gazebo Simulation**: Utilize Gazebo, a simulation environment, to replicate real-world scenarios and test the AUV's autonomy algorithms in a controlled setting. This environment allows for rigorous testing and refinement of algorithms without risking damage to physical hardware.
  - **Partial Pathing Implementation:** Implement and evaluate partial pathing capabilities leveraging existing datasets. The aim is to enable the AUV to autonomously navigate predetermined paths using available data within the simulation, optimizing its ability to maneuver and make decisions based on the data it has.

These comprehensive tasks aim to significantly enhance the dataset quality, enable efficient capture of rotation-related information, and iteratively improve the AUV's autonomy by testing and refining partial pathing capabilities within a simulated environment.

10. Client Feedback on the current milestone:

- Client feedback on recent progress underscores significant advancements across multiple fronts. The strides made in refining the removal of false data points have been well-received, showcasing improved algorithms for identifying and eliminating erroneous data, ensuring more accurate and reliable plot outputs. Additionally, the successful capture of telemetry data has garnered appreciation, emphasizing the importance of acquiring depth, orientation, and compass readings during AUV operations for comprehensive analysis. Moreover, the proposed transition to Gazebo for autonomy validation in a simulated environment has sparked interest, highlighting the proactive approach toward refining autonomy algorithms under controlled conditions. Overall, while acknowledging these strides, the client emphasizes the importance of further refining false data removal, enhancing telemetry data capture, and leveraging simulated environments for continued advancements.

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

a. Represent uncertainty with gray sphere.
b. Integrate robot displacements from center based on the detected change.

12. Approval from Faculty Advisor

a. "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."
b. Signature:____ Date:

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

13. Evaluation by Faculty Advisor

a. Faculty Advisor: detach and return this page to Dr. Chan (HC 214) or email the scores to pkc@cs.fit.edu
b. 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: __________