

Industry Projects Submission 1

ME 639 - Introduction to Robotics

IIT Gandhinagar

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We attest to abide by the stated collaboration policy: We understand that all sorts of collaboration are allowed, however plagiarism will not be tolerated. If we use material from some other source (or from friends), we will cite them appropriately.

Planys Technologies

Path planning of an AUV to perform a bathymetric survey

Statement of Our Understanding of the Project (in 200-300 words)

We need to develop a feasible path and scanning strategy to cover the given map area in 2D and estimate the depth for gaps in measurement. The specifications (i.e. dimensions, DOF and thruster specifications) of the Autonomous Underwater Vehicle (AUV), non-contact depth sensors (frequency, cone) and the map are available. Considering the 4 DOFs given for the AUV i.e. Surge, Heave, Yaw, Pitch, the scanning/path planning strategy needs to account for major obstacles in the relief-rich environment and generate a path for proper coverage of underwater features.

The depth is measured by calculating the 'flight time' or 'to-and-fro' travel time of the echo-sounder, whose beam is modelled as a cone of 6° tip angle for accuracy. Fast gimbal is assumed.

Tentative Approach and Tools we May Need to Use (not more than 3-4 sentences)

Initially, a feasible path is to be identified for a complete coverage. Certain area coverage algorithms in literature, for example, parallel/perpendicular acoustic transects, vertical cell-decomposition with convex hull(VCD-CH) and other convex polygon triangulation based algorithms, may be used to create the path plan. Additionally, the gimbal control on the sensor will cover a certain area repetitively on the same traversal to reduce the number of trips for accurate depth portrayal of depth features.

Key Assumptions Made in Approaching the Problem (in enumerated list from)

1. The AUV will traverse the area at a depth where the seabed is within sensor range.
2. Basic control algorithms are integrated into the AUV (i.e. dynamic obstacle avoidance, depth attitude maintenance will be automatically carried out)
3. Density/temperature of seawater has relatively low variation and we have an accurate measurement of sound speed in seawater for return time calibration of the sensor.
4. Gimbal of the sensor can ensure a fast scan in comparison to the AUV speed.

Key Questions to Clarify the Requirement of the Project (in enumerated list form)

1. Any known sudden changes in depth levels in the given area
2. High slope region detailing expected?
3. Amount of detail expected as a minimum requirement.
4. Any specific features which can be used as a test measurement for the minimum requirement.
5. Control Algorithm (Should we develop, or in case Planys can share the control algorithm being used currently, should we try and modify for this task)? In terms of detail, we would also like information on the rate of change limits on each DOF.
6. GPS Unit Specifications
7. Whether lesser survey subplot size has any disadvantage over larger plot size.
8. Presence/absence of gimbal on sensor. Speed of gimbal.
9. How do engineers at Planys intend to deal with high relief in area 1?
10. What are general problems faced in a bathymetric survey?

11. How do bathymetric surveyors deal with suspended features(such as rock outcrops)?

Expected list of Deliverables (check all that apply)

- ☒ ~~A brief explanation of the concept (including type of robot, number of links and joints, and other such details)~~
- ☒ ~~Figures/drawings/sketches showing the concept~~
- ☒ ~~Relevant equations of the robotics solution~~
- ☐ Codes incorporating the solution
- ☐ Representative plots/or other representative results from the codes
- ☐ CAD drawings
- ☒ ~~Explanation of the solution and the results~~
- ☒ ~~Statement about limitations and future recommendations~~