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RBE550 – Assignment 1

An application of motion planning that I find interesting relates to autonomous underwater vehicles (AUV). My MQP at WPI was designing, constructing, and programming a robot to collect plastic waste along the ocean's shorelines. The robot did not go underwater as seen in the picture below, but it encounters many of the same problems as AUVs.

We spent the majority of the year getting the robot just up and running so we didn't get to apply any serious motion planning. The goal is that the robot can identify waste and maneuver itself to collect it, correcting for drift and avoiding obstacles. However, in its current state, the robot does not have sensors (namely a lidar) to support obstacle avoidance.

Our robot had the luxury of floating on-top of the water to simplify things into a 2D motion planning problem, however, AUVs must operate in 3D space underwater. AUVs are increasingly being used to replace human divers for deeper or more dangerous search applications. Zhu et al. brings up the search for MH370 as an example of the need for AUVs. There are many complicating factors for AUV motion planning:

- Underactuated robots (Chang et al., 2025)
- Lack of visibility (Zhu et al., 2022)
- 3D space complexity (Yang et al., 2023)

Traditional motion planning algorithms struggle to meet the needs of AUV navigation. Yang et al. details how popular algorithms such as visibility graphs, RRT, A* can be computationally intensive and will occasionally reach local minima. Some researchers are turning to fuzzy logic to handle uncertainty and simplify calculations (Ding et al., 2024, Zhu et al., 2022). Others are using neural-networks and reinforcement learning to better adapt to the dynamic ocean environment.

I'm very interested in the challenges that AUV navigation proposes as they are unique to the ocean environment and there is a growing need for improved motion planning. I hope this course will help me understand even a fraction of content in the papers I found because there appears to be lot of recent innovation in the area.

References

Chang, D., Chow, S., Player, T. R., & Hollinger, G. A. (2025). *Adaptive and Informative Planning for an Underwater Vehicle-Manipulator System*.

Ding, F., Wang, R., Zhang, T., Zheng, G., Wu, Z., & Wang, S. (2024). Real-time Trajectory Planning and Tracking Control of Bionic Underwater Robot in Dynamic Environment. *Cyborg and Bionic Systems*, *5*, 0112. https://doi.org/10.34133/cbsystems.0112

Yang, J., Ni, J., Xi, M., Wen, J., & Li, Y. (2023). Intelligent Path Planning of Underwater Robot Based on Reinforcement Learning. *IEEE Transactions on Automation Science and Engineering*, *20*(3), 1983–1996. https://doi.org/10.1109/TASE.2022.3190901

Zhu, D., Yan, T., & Yang, S. X. (2022). Motion planning and tracking control of unmanned underwater vehicles: Technologies, challenges and prospects. *Intelligence & Robotics*, *2*(3), 200–222. https://doi.org/10.20517/ir.2022.13