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Thesis Introduction
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Introduction

The area of Robotics is a large field with many areas of research and even more applications. Motion planning, mechatronics, localization, mapping, and artificial intelligence are just a few of the many fields under the umbrella of robotics. Robots are used in small domestic settings, such as those used to vacuum floors to applications in the sky (UAVs) and underwater (AUVs). Future wars will likely be dictated by whose autonomous robotic army is more robust.

Autonomous Underwater Vehicles (AUVs) are a relatively recent development and natural successor to the manned underwater exploration devices and tethered underwater robots still in common use today. They offer a number of obvious advantages; most importantly, they reduce the need for manned underwater exploration – a dangerous feat considering temperature and pressure at depth. Beyond that, they can explore less spacious regions because of their size, and reduce the likelihood of losing the robot due to a tether becoming tangled. Cons include an underwater lifespan due to the fact that the robot has to provide its own power, and losing the robot due to errant motion planning or other malfunctions. However, correctly configured and built, the advantages of such a system become great.

One application of such an autonomous vehicle can be seen in under-ice mapping and localization. Acquired data could be used for reports on global warming, marine habitats, correcting ocean models, and more. An autonomous robot offers more mobility and a quicker execution time – no need to carry cables and/or generators – when the need for such constraints exists.

The technologies and techniques utilized for such a project are much the same as would be necessary for a terraneous (on land) robot. Techniques such as particle filtering and Kalman filtering are still relevant for this study, though special consideration needs to be made for the
new environment (water), including current movement and inconsistent ice depth. The robot no longer has wheels or feet; instead, it is controlled by a single propeller for thrust and fins for navigation.

This thesis seeks to explore under-ice mapping and localization for an Autonomous Underwater Vehicle. The implementation of this project will be mostly by simulation, as the extent of ocean ice along the California coastline is negligible. However, preliminary experiments may be possible by using a tarp or pool cover to mimic ocean ice.

Under-ice mapping and localization will be tested with standard filters (aforementioned), and changes will be made on the traditional techniques in order to better suit for our needs. Chapter 2 is devoted to background information related to AUVs, and Chapter 3 is an analysis of related work. A look and implementation of mapping techniques will be discussed in Chapter 4, and localization techniques in Chapter 5. Chapter 6 will look at Simultaneous Localization and Mapping (SLAM) algorithms. Chapter 7 will introduce an implementation of an under-ice mapping and localization system. Chapter 8 presents the simulation and experimental results. Finally, Chapter 9 serves as a conclusion and discussion of future work.