A 3D Simulation of SLAM

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Abstract

This project uses a variation of a graph-based approach to Simultaneous Localization and Mapping (SLAM) known as Real-Time Appearance-Based Mapping. A robot is configured with a RBGD camera and a laser sensor. A simulated environment was created and the robot is tasked with being able to localize itself while also being able to generate a 2D map of the environment as it moves through it.

Introduction

There has been a great deal of study of how a robot can make sense of their environment. If a robot is placed into a room, and it has not been previously programmed with the particulars and objects in the room, it needs to have some means to figure out the layout of the room and the objects within it. One popular use case is the Roomba, which uses the equipped sensors to navigate and create a map of a house. This is a well known and much studied problem in robotics and it is commonly referred to as Simultaneous Localization and Mapping (SLAM).

References and Acknowledgements

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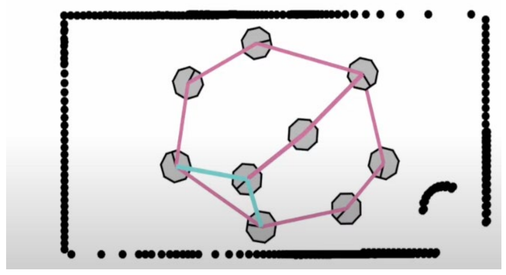
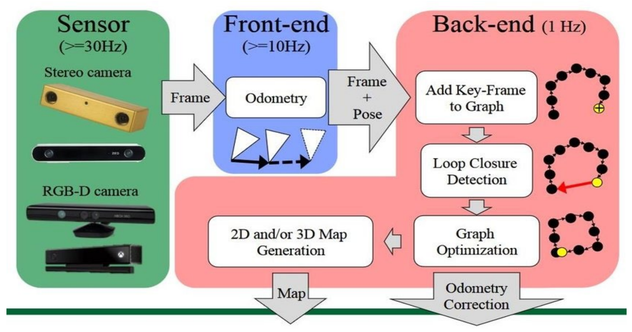
Background

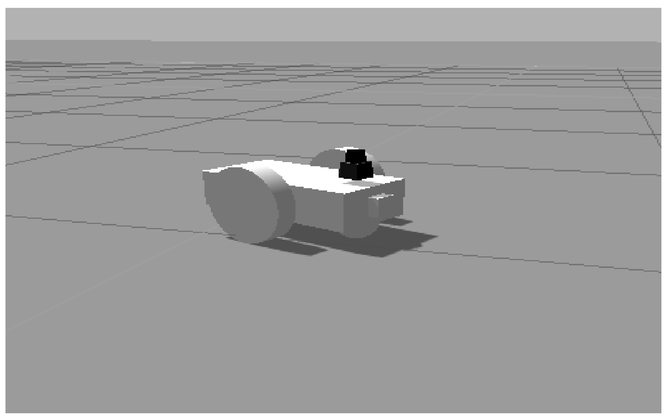
GraphSLAM, like the name suggests, is to use a graph to represent the problem. In computer science, a graph is a representation of a set of objects where those objects are connected in some way through links relating those objects together. Every node in the graph corresponds to a robot location during mapping and the edge between nodes corresponds to some spatial constraint between them.

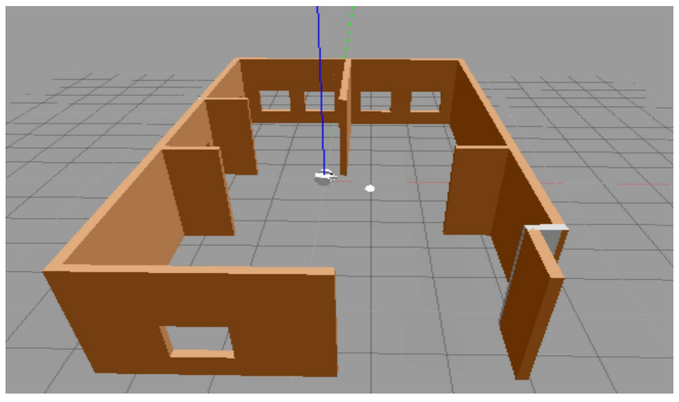


Real-Time Appearance-Based Mapping (RTAB-Map) is a variation of GraphSLAM which can be split into two processes, the front-end and back-end as shown in the diagram below.



Robot and Environment Configuration





Results

Due to the limited graphics capabilities of the current hardware, the robot moved around the environment slowly. To map the provided world, a decision was made to loop around the room once, looping through the middle of the room as shown by the 2D map below. Overall, mapping the environment was successful. Mapping the world in 2D only took one pass to complete and was a fairly straightforward task to do. From the 2D map, the expanding right side of the room is due to that part being unbounded .

Given upgraded hardware a 3D map would have also been created. Even with the current process that was used, there is always room for improvement. Some improvements can be implementing a faster and more efficient SLAM algorithm, putting more obstacles and rooms for the environment to ensure that mapping is accurate, path planning, and of course using a real environment instead of a simulated one.