Simultaneous Local Area Mapping

Introduction

This is a review of the implementation of SLAM in robots. SLAM stands for Simultaneous Local Area Mapping. SLAM is always framed as a solved problem and it allows a robot to map an unknown environment, while it navigates, using its understanding of its surroundings. [1] SLAM allows for a machine to generate an understanding of its surroundings and display a 2D or 3D graphic all while navigating. SLAM does this by incorporating all of the sensory data available to the robot into a perceived understanding of its environment. SLAM is not specifically hardware based. It is the interaction between hardware and software algorithms that give the result described above [4]. This review paper will focus on the use of SLAM in autonomous vehicles.

Commercial Application For SLAM

SLAM was developed in the 1980s and is most most famously used in the application of self driving cars. It has grown considerably since then, grossing a market value of $50 million dollars in 2017 alone and is expected to reach $8.23 billion by 2027 [6]. Since its inception, cars and semi-autonomous to autonomous robots have utilized the technique [8]. Depending on the sensors used to gather information for the vehicle, the retail price of the technology can vary greatly. The cost of a system is mostly dependant on the type of sensor used. For example, designs that use LiDar sensors are by far the most accurate but they are also the most expensive. Machines that use LiDar can cost over 5,000 dollars [2]. Application in industry, research and self driving cars tend to use these devices because they have the highest rate of reliability. This ends up making the retail cost of self driving cars go up, which deters the public from purchasing them. This, however, is not the only way to use SLAM. Cheaper systems can be created using regular cameras or RGB-D cameras [7]. Telsa's autopilot uses multiple cameras and ultrasonic sensors. Even with less accurate hardware they are able to make a reliable system and compensate with robust software algorithms [3]. Most Vehicles also use a Global Positioning System or an Internal Navigation System to supplement the information received from the sensors

`How SLAM works

The hardware is a necessary component of using SLAM. The sensors gather detailed and varied amounts of information. The program or algorithm takes that information and uses it to generate a picture of the vehicle's surroundings. No matter what hardware is used, the computational side stays mostly the

same. The program that runs the autonomous vehicle must use its sensors to constantly update its understanding of its surroundings. The vehicle then uses the information to identify landmarks and uses these landmarks as it moves to understand its place in the room. The landmarks serve to ground the machine in the surrounding world, instead of just relying on one or a combination of contradicting sensors [4]. The process of making landmarks also allow the vehicle to understand where it is in times where the robot loses continuity for some reason. The landmarks allow for the vehicle to reassign its place when given a different perspective on the same room [7]. To do this, the information from the sensors are processed into odometry data. Odometry data is and estimation of change in position over time. Depending on the sensor technique used, this can take a considerable amount of time [2]. A large problem when designing these programs is to make sure that the program can process the information received before the system is updated. If it fails to do this, the system will lagg and the vehicle will not have an updated map of its surroundings. This means that SLAM is very demanding on processors. In developing this program, currently C# or other .Net frameworks are used. There are also libraries for RGB-D cameras called, Kintinuous and ElasticFusion. ROS, or the Robot Operating System, has SLAM functionality as well [2]. The technology can be used in autonomous vehicles that are designed for public use, like the Tesla, or are designed for corporate use, like wherehouse bots.

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