Coverage Efficiency in Autonomous Robots With Emphasis on Simultaneous Localization and Mapping Algorithms

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Abstract

Coverage efficiency is a major goal of certain autonomous robotic systems. In the field of robotic lawnmowing, coverage efficiency has yet to be fully developed and there are different methods to approach coverage efficiency. The solution this paper covers is uses Simultaneous Localization and Mapping, known as SLAM. Using a laser scanner, SLAM algorithms constantly ping the environment, and uses that data to create a map detailing the obstacles of the environment Once obstacles are mapped, the algorithm process the map, and dictates where the robot can move, where it has moved, and where it currently is in relation to the obstacles. This data will enable the robot to cover the entire lawn.

Introduction

Today, automated systems have supplemented humans in previously labor-intensive tasks. Automated lawnmowers are an example of these systems, but the currently available technology in automated lawnmowing is inefficient and primitive. This paper will propose and implement an alternate method to automated lawnmowing, known as Simultaneous Localization and Mapping, then report back the results.

Background

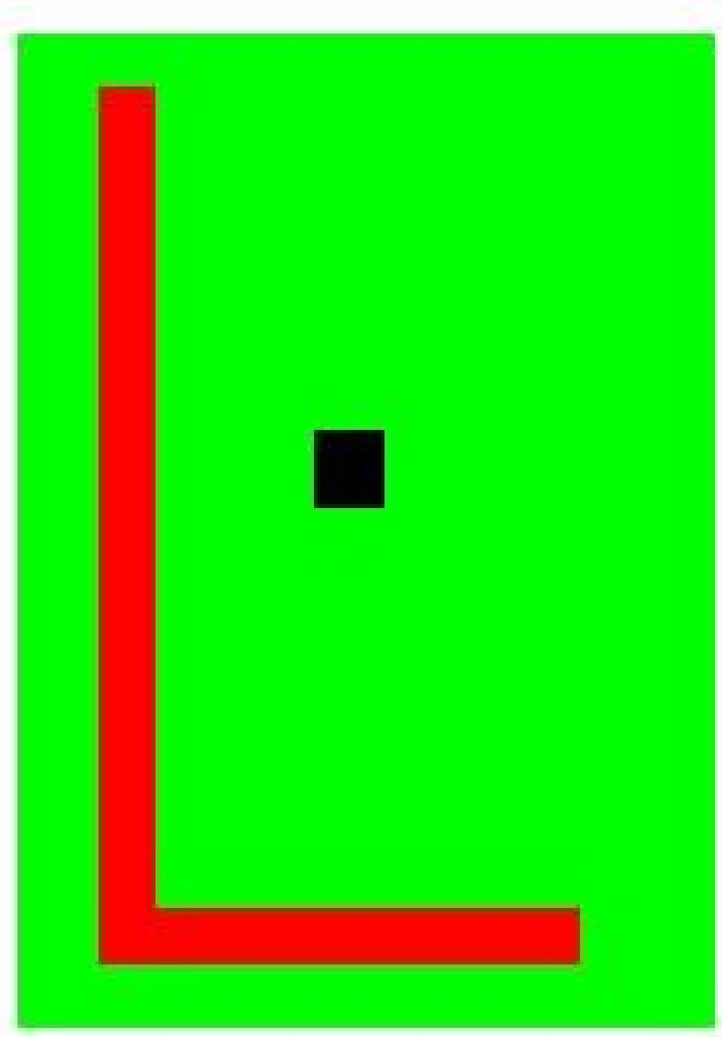
Commercial autonomous lawnmowers today do not have processing systems appropriate for efficient coverage. Current approaches to commercial robotic lawnmowing operate under the idea that if a lawmower is constantly mowing the lawn, then the lawn stays constantly mowed. This is done by a series of random cuts and turns, which if given enough time, theoretically could cover an entire unmowed lawn. Another aspect of this method is the use of "bump-and-go" technology. The system does not recognize the presence of obstacles until it actually hits it, and when it does hit obstacles, it does not store their locations for future use. This method is horrifically inefficient in terms of time and energy, when backtracking is taken into consideration. Random cuts also contain the possibility that a certain section of the lawn will never get mowed. This project proposes a different approach to this method: use of mapping techniques to recognize landmarks, avoid obstacles, and navigate an environment This method consists of three parts: 1) Use of a constantly updating laser scanner to recognize obstacles, 2) Creation of obstacle map using the laser data, and 3) Processing that obstacle map for run time efficiency. Success is determined by how effectively the robot avoids the obstacles and how quickly it runs through the lawn.

Discussion

Before the SLAM algorithms can be implemented into a physical robot, it must first run in a simulation. The current version of the simulation consists of a pre-created matrix based environment where the obstacles and terrain have been set. The robot is placed in the environment and keeps track of its position and obstacles, via the use of a coded coordinate system and a scanner mimic. Versions in development will not use a coded coordinate system and will recognize boundaries. The robot moves and scans through the environment so long as obstacles are a certain distance away. Obstacles are recognized, and the robot begins to create its own independent matrix environment. The output of this mapping process matches the locations of the obstacles in the environment, and gives the robot an idea of where it can and cannot move.

Results and Conclusions

Visual Representation of Sample Environment
Red=Obstacles
Black=Lawmower



Mapping Output
0's Represent Spaces
1's Represent Obstacles

11111111111111
10000000000001
10100000000001
10100000000001
10100000000001
10100000000001
10100000000001
10100000000001
10100000000001
10111111111111
10000000000001
11111111111111

Conclusion

This confirms that the mapping proportion of the program works for similarly structured environments. Updated versions will allow the recognition of terrain types, and dissimilar structured environments. Once those are working, the program will be able to process the map for optimal paths using a real environment