Area Sweep Coverage With Obstacle

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2 May 2018

Overview

About the Coverage problem

Coverage problem is one of the popular problems in wireless sensor networks and many researchers are exploring this field to find the best way to solve this problem. Various methods exists to solve coverage problem in sensor networks.

In area sweep coverage we monitor certain point of interest periodically. For example, in case of forest monitoring, full coverage will be required to detect any unusual activity like forest fire etc.

Sweep Coverage and Sweep Period

- **Sweep Coverage :** Let U = [$u_1, u_2, \ldots, u_n$] be a set of points on a two dimensional plane and M = [$m_1, m_2, \ldots m_p$] be a set of mobile sensor nodes. A point u_i is said to be t-sweep covered if and only if at least one mobile sensor node visits u_i within every t time period.
  The set U is said to be globally sweep covered by the mobile sensor nodes of M if all u_i are t-sweep covered.

Sweep Period

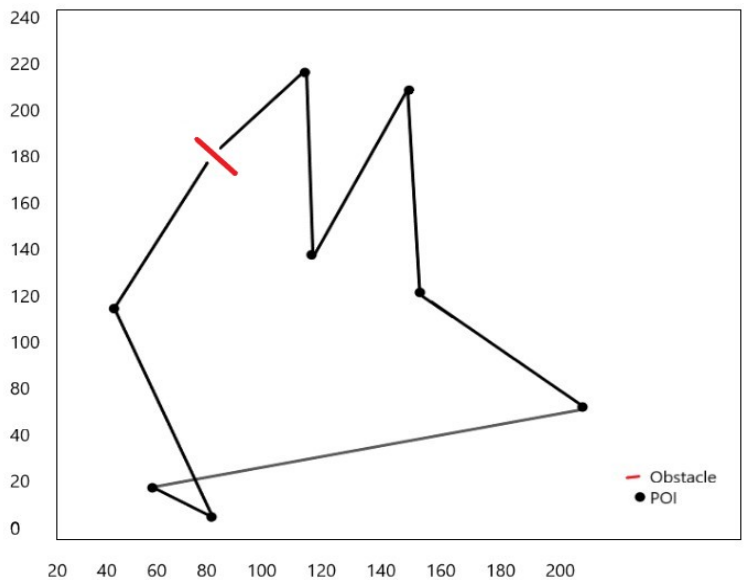
The time period **t** is called the **sweep period** of the points in U.

Area Sweep Coverage and Point Sweep Coverage

- **Area Coverage :** Main objective of sensor network in the area coverage is to cover a region which contains a collection of space point inside the region. Each point inside the region should also be monitored.
- **Point Coverage :** Motive in the point coverage is to cover a set of point with known location that need to be monitored. It can be also solved as a special case of area coverage problem.

Explanation of Problem Statement

In this picture demonstrates the problem statement as obstacle comes in the way that interrupts our sensor tour, So we will find another tour to reach out the sensor node by finding the tour which has the minimum number of sensor nodes.



My Contribution

We have started by converting given the area of interest in the square of size $\sqrt{2}$ after that we have pointed out all the point of interest in the bounded region and find out the tour by TSP algorithm. If a line-shaped obstacle is present in our tour then we will find out minimum cost of the tour which gives the minimum number of mobile sensor nodes for covering the area of interest.

My Contribution

We implemented the algorithm in python and calculated the sweep period of a point inside the region. We show that the sweep period is effected in the presence of obstacle.

Algorithm :

- Compute the path as previous work.
- Sensors moves along its designated path.
- When obstacle in sensed by the sensor node, it avoid the obstacle by finding the minimum path using sensor and turns towards the minimum path and comes in the same path after crossing the obstacle.

My Contribution

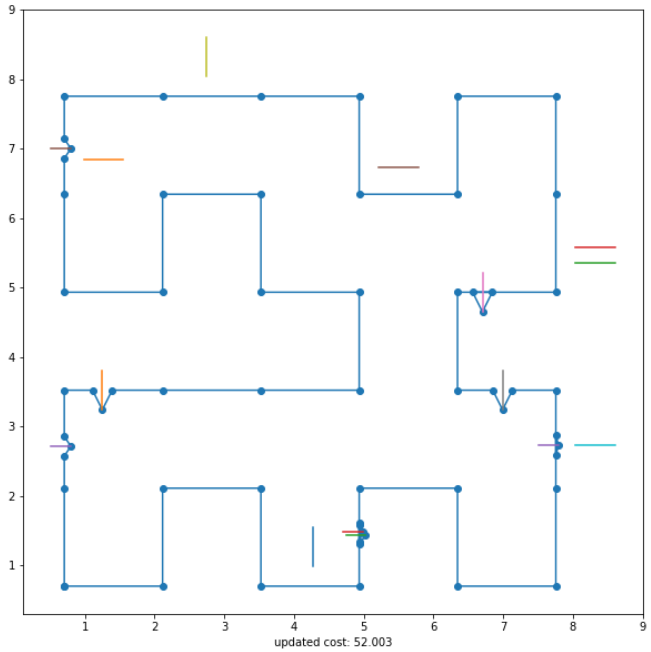


Figure A. Minimum Cost presence of 15 obstacles

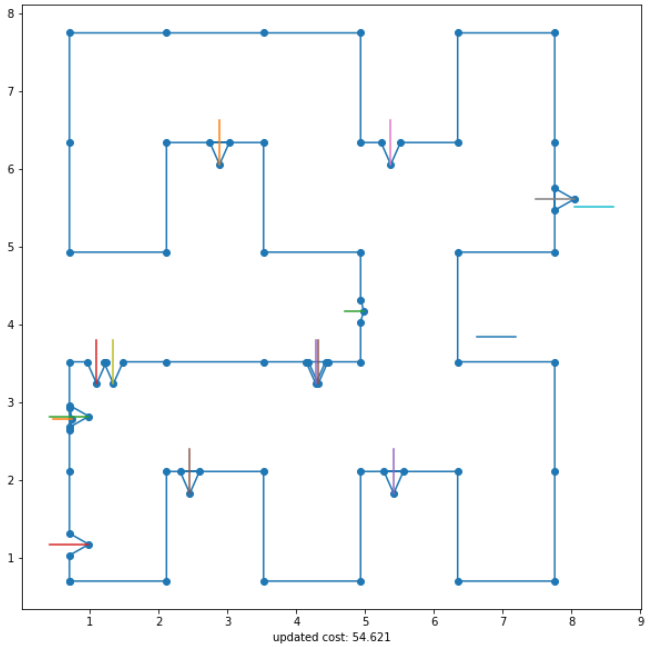


Figure B. Maximum Cost presence of 15 obstacles

My Contribution

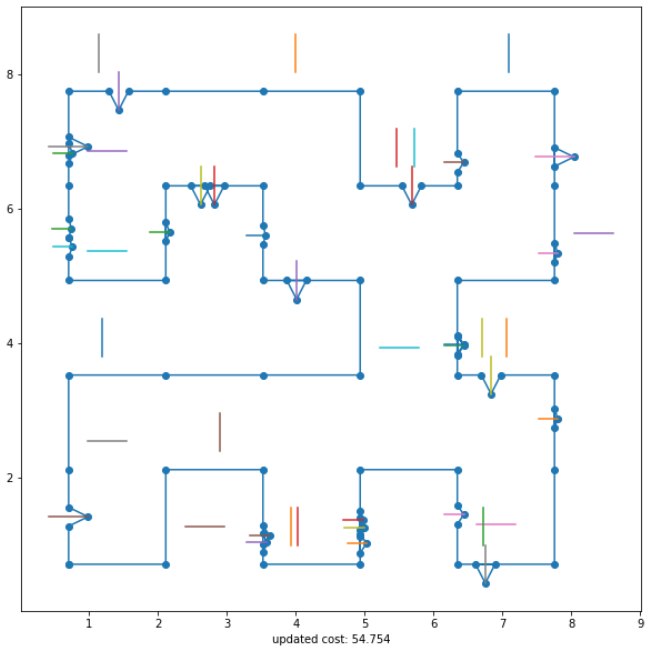


Figure A. Minimum Cost presence of 45 obstacles

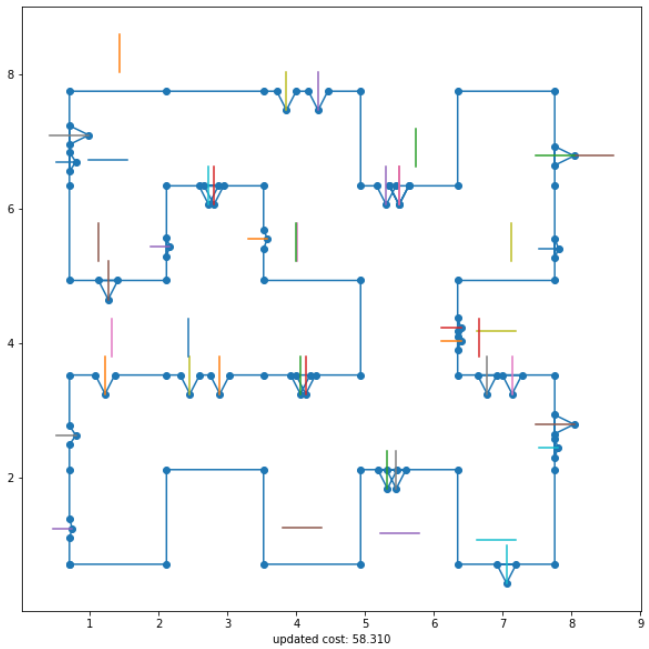


Figure B. Maximum Cost presence of 45 obstacles

My Contribution

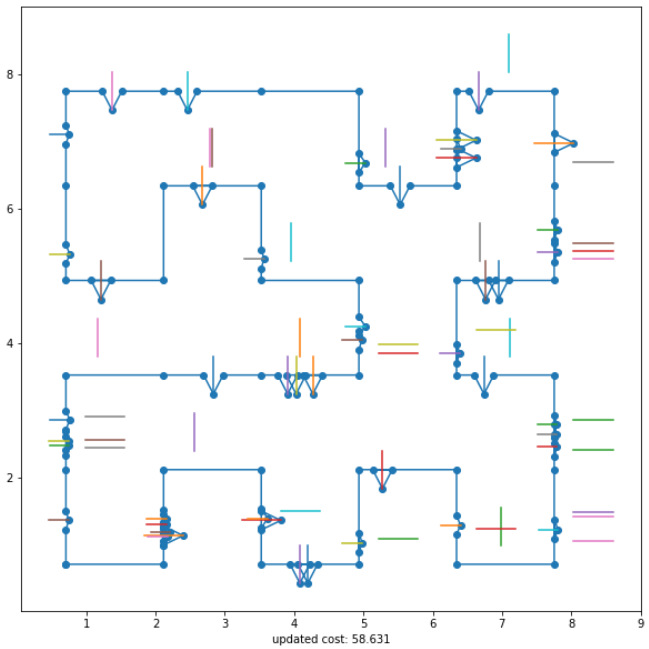


Figure A. Minimum Cost presence of 75 obstacles

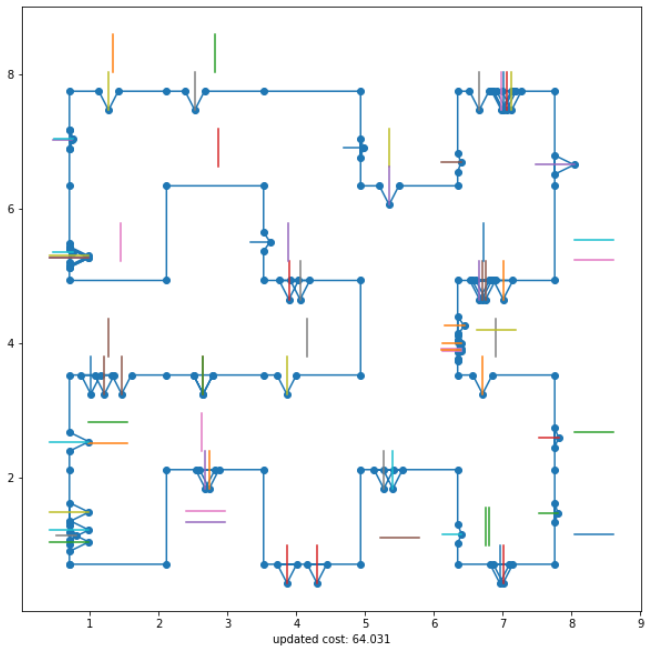


Figure B. Maximum Cost presence of 75 obstacles

Performance Analysis

No. of obstac-les	Initial Cost absence of obs..	Avg. Cost presence of obs.	Avg of (Initial - Upda-ted)Cost	Path Increase (%)
5	49.35	51.555	2.205	4.46
15	49.35	53.083	3.733	7.56
25	49.35	54.241	4.891	9.91
35	49.35	55.523	6.173	12.50
45	49.35	56.566	7.216	14.62
55	49.35	58.736	9.386	19.01
65	49.35	59.404	10.054	20.37
75	49.35	61.683	12.333	24.99

Conclusion

The project started by dividing the given bounded region into $\sqrt{2}$r of squares and then find out all the point of interest. After finding the point of interest TSP is applied to find out the minimum path which covers the given bounded region and then applied TSP to find out the minimum path which covers all the point of interest in the presence of obstacle.
Finally we ended with a conclusion which provide path difference in absence of obstacle and presence of obstacle that suggest the number of sensor which we can increase to cover the bounded region.

Reference

Barun Gorain,Partha Sarathi Mnadal, *LaTeX: Approximation algorithms for sweep coverage in wireless sensor networks*, 2014.

Weifang Cheng, Mo Li, Kebin Liu, Yunhao Liu, Xiangyang Li and Xiangke Liao, *LaTeX:"Sweep coverage with mobile sensors,"* 2008

Thank You