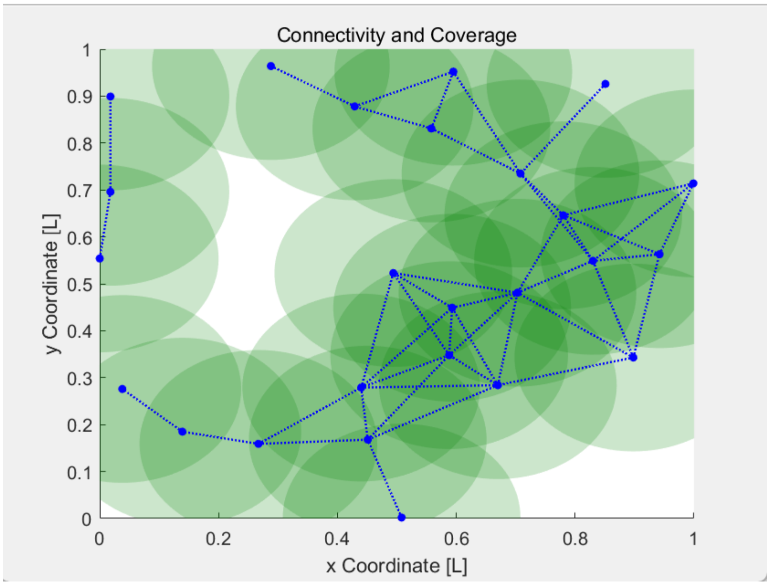
ECE9047: Laboratory 3 Report

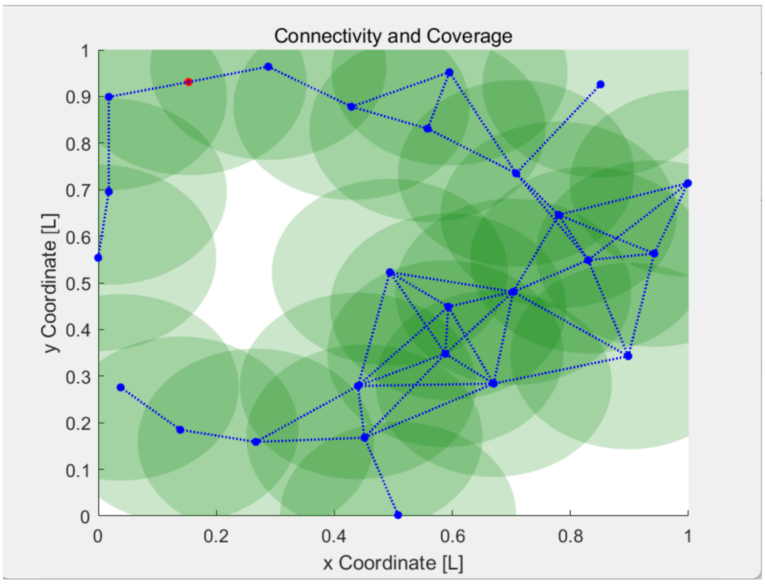
Objective

In this lab, it is required to analyze a pseudo-randomly generated wireless sensor network (WSN) consisting of 25 nodes within a unit square environment. The objective is to ensure full connectivity of the network and evaluate its performance in terms of communication coverage, node connectivity, and robustness. Additional nodes may be added to achieve full connectivity. Specifically, I compute the Voronoi tessellation and Delaunay triangulation of the network and analyze the maximal breach and support distances.

Connectivity Analysis



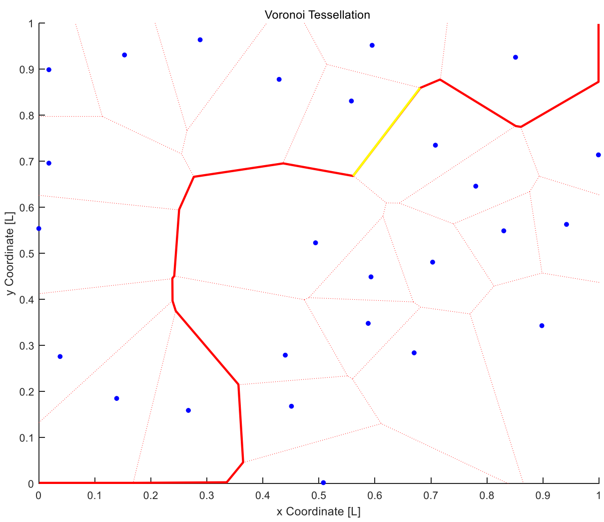
The network was evaluated under a communication radius R_C=0.25L, as shown in the figure. Originally, the network is not fully connected and there are some isolated nodes on the left. In order to create a fully connected topology, one new node is added (marked in red in the connectivity diagram below). The resulting network forms a connected graph with at least 1-connectivity. This is the minimum number of nodes to achieve it, and no more nodes are added in consideration of complexity. However, due to the sparse distribution in certain regions (e.g., upper left corner), some nodes act as single points of failure, which means that disconnecting them would partition the network. Therefore, the network is 1-connected, with critical nodes that could cause disconnection if they fail.



Coverage Analysis

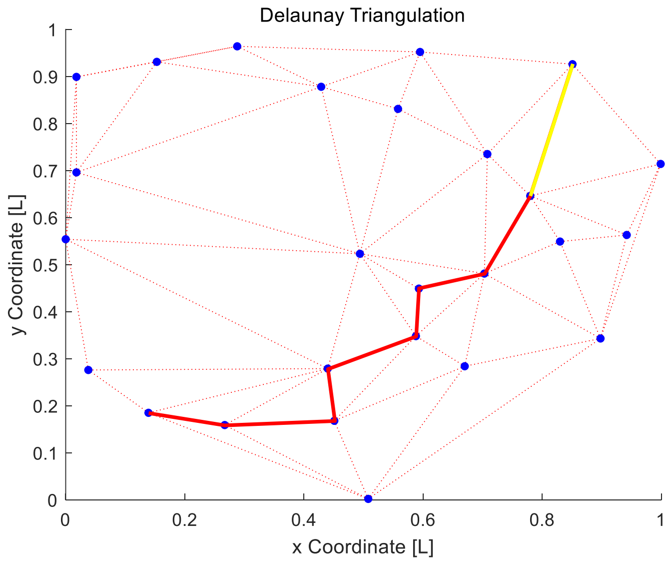
Coverage was assessed with a sensing radius R_S=0.2L. As shown in the connectivity and coverage diagram above, coverage is uneven across the environment. Denser node clusters in the center offer overlapping sensing regions, while significant uncovered areas remain, especially near the top-left and central portions of the field. Thus, the K-coverage across the field is zero in certain regions. No additional nodes were added for the purpose of coverage, and these gaps were accepted for the analysis.

Maximal Breach Distance



The maximal breach path was calculated along the edges of the Voronoi tessellation, from coordinate (0,0) to (1,1), favoring regions that are furthest from any node, as shown in the figure. The path is highlighted in red in the Voronoi diagram and the yellow line represents the segment where the maximum breach distance exists. It is calculated manually by comparing and estimating the distance step by step. The breach distance corresponds to the minimum distance from each edge along the path to the nearest node, with the total cost being the sum of these minimum distances. Finally, the calculated maximum breach distance is 0.089L.

Maximal Support Distance



In the figure above, the maximal support path was computed by traversing the Delaunay triangulation from the node nearest (0,0) to the node nearest (1,1). The cost along each triangle edge is defined as half the edge's length (i.e., the maximum distance to any point along the edge from a node). Again, it is calculated manually by comparing and estimating the distance step by step. The path is shown in red in the Delaunay diagram, and the yellow line represents the segment where the maximum support distance exists. Finally, the calculated maximum support distance is 0.119L.