UESTC4020: Wireless Sensor Networks

Laboratory Sessions 1 & 2

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Note 1: In this lab, you will work in a group of two students. You should cooperate proactively and take part in all aspects of the laboratory session including design, planning and execution. It may happen that you may not be able to finish the exercises during the lab sessions. That is fine. The lab should be solved in Matlab. Since you have access to Matlab outside the lab sessions too, we would encourage you to work with your lab partner outside the lab sessions and demonstrate the results in the lab sessions. In this lab, first you will familiarise yourself with simple Matlab coding techniques to solve some problems predominantly related to physical layer issues in a wireless sensor network.

Note 2: You need to use good coding practices. For example, ensure that you use meaningful variable and function names. Most importantly, use appropriate annotation to explain what your code does at the beginning and to clarify what each important line of code does.

Exercise 1: [10%]

Load the given file 'labdata.txt' in Matlab workspace. It contains file with location of 50 sensor within 1 square kilometre area. (hint: use 'load' function).

Plot them as shown in the figure 1 below.

Once you have the data, **find** the WSN located closest to the centre, i.e. location (0,0). Assign that node as a sync (which collects all the data in the networks).

In the plot, **mark** it in a different colour with a different marker (it is shown in red in the given Figure 1).

Exercise 2: [20%]

Unit disk model of coverage only considers distance. Assume that the maximum distance covered by the node transmitters are 10m.

Write Matlab code to find how many nodes doesn't have another node within 10m coverage.

Now, **increase** the coverage by 5m to 15m. Take a note of how many users remains out of coverage.

Repeat the process until you find the minimum coverage distance required to ensure that all the nodes have at least another node within the coverage.

Plot the relation between coverage distance and number of nodes remains out of coverage range (i.e. 0 neighbours within coverage range).

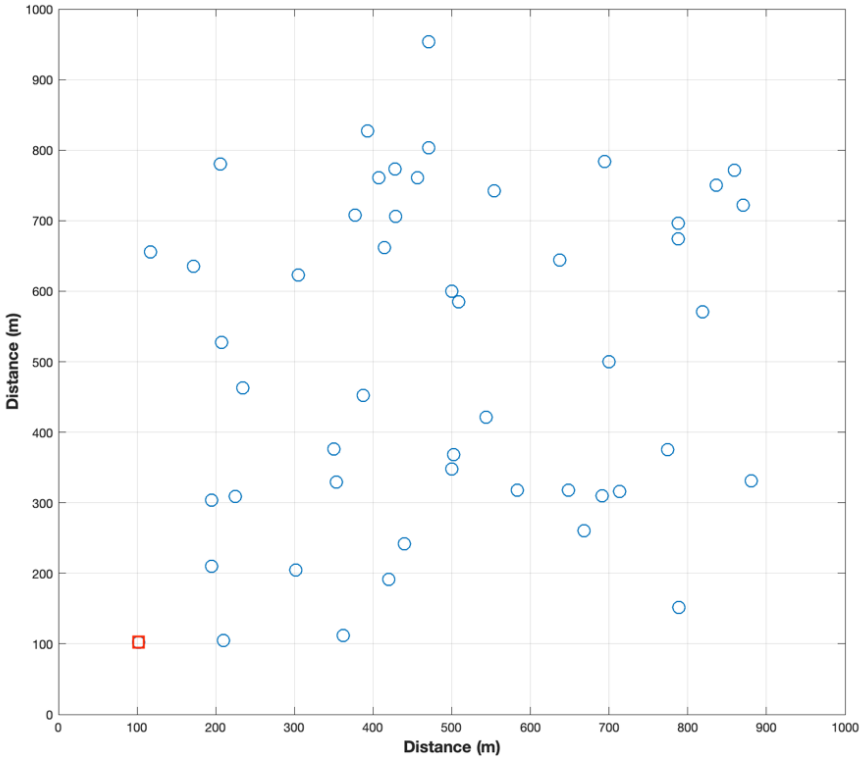


Figure 1: An example of random WSN node deployment.

Exercise 3 [20%]

Implement the following deterministic formula in Matlab to calculate transmit power requirement when received power requirement is -50dBm.

$$P_r = P_t \times G_t G_r \left(\frac{\lambda}{4\pi d}\right)^2$$

Note that the symbols have their usual meanings. You can assume that both transmit and receive antenna has gain of 1. You should demonstrate results for the following frequency values: [430 MHz, 900 MHz, 2.4 GHz].

(You can consider plotting a bar chart to show relative variation in the requirement).

Now, **write code** to use Shanon's capacity formula to find the expected bit rate for a given bandwidth. Assume that the bandwidth is 500KHz.

$$C = Blog_2(1 + SNR)$$

You can assume that the noise floor is -85db. How much bit rate you can expect to achieve for the given scenario? In order to increase bit rate by 10%, what will be the required increase in transmit power? Your code should provide result for a given frequency. Demonstrate your results for the three spectrum bands used in Exercise 3. Explain the result.

Exercise 4 [50%]

The final exercise involves writing an algorithm for finding average number of hops required by each node to reach the sync (using the minimum distance found in exercise 2). Now this problem will have many solutions depending on how you are selecting the next hop to eventually reach the sync. The key objective of your algorithm will be to minimise the number of hops. Write the algorithm and implement it in Matlab.

Increase the minimum coverage distance found in exercise 2 by 10 meters each time until your average hop number doesn't improve. Record the minimum number of hop count and corresponding received power (or expected bit rate).

Explain the working principle of your algorithm.

Show a plot highlighting the route taken by the farthest node from the sync to reach the sync? How many hops does it require?

Provide a comparative analysis of your results and comment on the advantages and drawbacks of your solution (energy cost, overloading possibility, etc). What is the impact coverage increment on hop count? What impact does it have on bitrate? Justify your answer.

Marking Criteria

Elements	F-E 20-39	D 40-49	C 50-59	B 60-69	A 70-100
Presentation, clarity and communication of ideas (30%)	Poor presentation without meaning and lot of irrelevant material	Elementary presentation with some mistakes and some irrelevant material	Satisfactory presentation with meaning and almost no irrelevant material	Good presentation with clear meaning and no irrelevant material	Excellent presentation with very clear meaning and precisely relevant material
Theoretical/ Mathematical /Technical Content (30%)	Poor or no technical content and analysis without referencing	Elementary technical content and analysis with limited referencing	Satisfactory technical content and analysis with some referencing	Good technical content and analysis with relevant referencing	Excellent technical content and analysis with precisely relevant referencing
Results & Discussion of the set exercise (40%)	Poor or no results	Elementary results with limited discussion and comparisons	Satisfactory results with some discussion and comparisons	Good results with critical discussion and comparisons	Excellent results with thorough critical discussion and comparisons