Electronics and Electrical Communications Engineering Department
Cairo University
ELCN 4026 Wireless Networks

Assignment # 1

The goal of this project is to use MATLAB to design a radio prorogation simulator with GUI interface that produces an arbitrary number of samples of propagation path loss using a d^n path loss model with log-normal shadowing. The simulator should also help the network designer in evaluating the coverage characteristics. The GUI should the user to either read the measurements from a file or manually input them. The outputs of the GUI should

1) Prevent the user from inputting any wrong data.
2) Graphically illustrate the samples on the scatter plot.
3) Plot the estimated model equation on the same figure.
4) Help the user to compute the received power at any arbitrary distance.

Output 1:
Use your simulator to produce 50 samples at each of five different TX-RX separations (a total of 250 predicted path loss values). Plot these values as a function of the TX-RX separation (this plot is called scatter plot). Repeat for 3 different values of the path loss exponent *n*.
Hint: The simulator should allow the user to either read the data from a file or input them manually or generate them based on inputs that the user specify (number of distances, number of measurements per distance, ….). The simulator should provide a check that ensures that the input TX-RX separation is greater than or equal to the close-in reference distance.

Output 2:
For each value of the 3 graphs, use the MMSE technique learnt in class to estimate the path loss exponent n^* and σ^* using the 250 samples of each graph. Then draw the estimated path loss model on the same figure. Comment on the accuracy of the MMSE in light of your results.

Output 3:
Show whether or not does the number of samples per TX-RX separation affect the accuracy of the MMSE estimation process.
Hint: You may plot the accuracy versus the number of samples.

Output 4:
Develop a page in the GUI interface that allows the user to specify the sender, receiver, and channel inputs such as:

- The separation between the transmitter (TX) and the receiver (RX).
- The operating frequency of the system.
- The path loss exponent *n*.
- The standard deviation of the log-normal shadowing σ.
- The close-in reference distance.
- The number of the desired predicted samples.
- The transmitter power.
- The transmitter and receiver antenna gains.
- Any other needed system parameters.

The outputs should help evaluate the coverage properties of any specific wireless radio system. More specifically:

1. If a user specifies all the inputs listed above, and specifies a desired received power and a specific value of the TX-RX separation distance, the GUI should report back the percentage of time that the received power will be exceeded at the receiver.
2. If a user specifies all the inputs listed above, and specifies a desired percentage of time that the received power will be exceeded at the receiver, the GUI should report back the maximum value of the TX-RX separation that will meet or exceed the specific percentage.

Verify the functionality of your GUI by example.

Notes:

5) All simulations should be in MATLAB.
6) Full mark = Clear well written Report + 5 minutes demo. A significant portion of the grade is on your analysis and insights on the obtained results.
7) Number of pages in the report should not exceed 15, including figures/tables/references/….
8) Minimum font size 10.
9) Number of students per group is limited to 4.
10) Submit the report in PDF format + MATLAB code to akhattab@eng.cu.edu.eg.
11) Submission and Demi due: Monday 10/4/2023 (5 minutes demo during class time).

Objectives:

1) Be familiar with the issues involved in the design of wireless communication networks.
2) Be able to apply suitable propagation and channel models to different wireless links.
3) Demonstrate the ability to run MATLAB simulations with GUI support.
4) Students will work in groups to demonstrate teamwork, flexibility and tolerance.