iBeacon Based Ranging

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Ranging:

To come up with the ranging equation, we implemented an algorithm that scanned for a specific control beacon at known distances. The way it functions is that with each button press, the RSSI, Tx Power, and the distance to the beacon (which is pre-determined) are stored in lists.

We took two approaches to come up with the ranging equation. First, we performed the ranging experiment inside the link lab with the beacon being incrementally distanced from the receiver by 0.5m. However, this did not yield good results, as seen in Fig. 1.

Background pattern

Description automatically generated

Figure : Ranging equation data collection test performed indoors

Our assumption is that this is due to the multipath effect of signals interference, which gives us RSSI values which may be incorrect. To remedy this, we performed the same experiment outside the link lab, and we obtained much better results, as shown in figure 2:

Background pattern

Description automatically generated

Figure : Ranging equation data collection test performed outdoors

We decided to stop the testing at 8.5m because the default setting for the minimum\_rssi in the BLERadio.start\_scan() function is set to -80 and we thought that would be a good place to stop.

These data points were then fed to a graphing tool to try and approximate the distance-rssi-tx\_power equation. The graphing tool is shown below in figure 3. We came up with three different range functions based on some theories we found [here](http://www.davidgyoungtech.com/2020/05/15/how-far-can-you-go) and the short paper from the assignment. The first function we tried was

We tried all three equations because they generally follow the data points about as close as each other. However, since equation 3 is matching the datapoints we have the closest, we decided to use that for the final measurement. This is not fixed however the user can change a single definition in the code called EQN from 0 to 2 to choose any of these three equations with their constants for their ranging function.

Chart, histogram

Description automatically generated

Figure : Graphing tool used to approximate the distance-rssi-tx\_power relation. The x axis is distance in meters and the y axis is RSSI values.

Chart

Description automatically generated with medium confidence

Figure : Data table. Full table is available in the [excel sheet](Average_locations_plus_rssi_distance_table.xlsx) in the zipped folder.

Part 5:

Table

Description automatically generated

Figure : We used a trilateration approach using 3 scanned beacons whose values for each test along with the coordinates are tabulated here. The actual sheet is present in the [excel workbook](Average_locations_plus_rssi_distance_table.xlsx) in the zipped folder.

For SAHB1, the average coordinates we obtained were (12.476, 15.425)

For SAHB2, the average coordinates we obtained were (49.076, 16.378)

For SAHB3, the average coordinates we obtained were (22.874, 20.672)

For SAHB4, the average coordinates we obtained were (44.206, 12.897)

For SAHB5, the average coordinates we obtained were (38.459, 23.750)

However, while all other locations had some line-of-sight beacons, SAHB 5 did not have a single line-of-sight beacon, and we believe this shows its impact on the coordinates.

For all the testing rounds, the values were never quite agreeing with each other very accurately. We believe this is because of the tuning parameters we used for our range function, the hardware specs being different for the iBeacons and the microbit, in addition to environmental effects like multipath to some extent.