**Programming Assignment 3: Indoor Localization Readme**

**Group 6**

**TASK 1:**

<Insert data and analysis> - Nelson

**TASK 2:**

<Insert elaboration on algorithm used>

**TASK 3:**

**<INSERT RADIO MAP HERE>**

***Vivocity, Level 2***

**Question 1**

**Part I: What is the estimated localization error for this floor (in meters)?**

From the radio map that we created for Vivocity Level 2, it can be seen that we have a total of 30 points spanning the 140,000 m2 of gross floor area. Using the assumptions that the length and width of the mall is 1:1 (which will not be accurate but provides ease of calculation for this approximation), we will have:

* 1 point for every 140,000/30 = 4,666.67m^2
* With the assumption that length == width, 1 point is found every 4,666.67 ^ (0.5) = 68 meters
* Therefore, the estimated maximum localization error for this floor will be ½ \* distance between points = 34 meters. <insert diagram here for clarity>

However, we know that from our radio map, the points gathered are mostly around the perimeter of the floor since the floor plan is designed in such a way that a large portion the middle area of the floor is empty space. Therefore, we would expect the localization error to be proportionately minimized alongside this decrease in the available floor space. <insert another diagram here again>

**Part II: Will the accuracy increase as more fingerprints are collected (e.g., the floor is covered by more walking rounds)?**

It depends on what does accuracy mean in this case.

We would say that the localization is more accurate in the sense that by having more fingerprints per point on the radio map to compare with the set of fingerprints obtained by the user’s phone at his/her location, the algorithm will be able to more precisely choose the most suitable point on the radio map as his/her location.

On the other hand, the localization error is not minimized since the number of points does not increase when more rounds are made to obtain more fingerprints per point. Hence, if “accuracy” is based on this criterion, then we think that accuracy does not increase.

**Part III: Do all locations in this floor have same localization errors?**

No, the localization error is not consistent across all locations in this floor. This can be seen from our generated radio map that the points where we collect fingerprints from are not consistently spaced. Hence, certain locations with a lower density of points will have a larger localization error as compared to locations on radio map with a higher density of points.

**Question 2**

We think that localization accuracy is affected by a combination of three factors:

1. Density of points on the radio map, which affects localization errors.   
   Since the precision of the obtained user’s location heavily depends on the available points to select his/her location from. <See figure>
2. Number of fingerprints per point on the radio map.  
   The number of fingerprints available for comparison in each point of the radio map to the set of fingerprints obtained by the user’s phone at his/her location determines how accurately the algorithm will be able to calculate the most likely point on the radio map that the user is closest to.
3. The localization algorithm used in determining which point the user is closest to.

As seen in Part 2 of this Programming Assignment, we can see that the algorithm used in localization plays a very significant role in making use of the available data to find the closest possible point on the radio map.

**Question 3**

With our answer for question 2, our group thinks that the localization accuracy can be increased by:

1. Increasing the density of the radio map, which allows the minimization of localization error
2. Increasing the number of fingerprints per point on the radio map by walking more rounds during mapping process.
3. Have a more effective localization algorithm that will be able to find the closest possible point on the radio map based on the fingerprints collected by the user’s phone and those available in the nearby points around the user’s location.
4. Ensuring that the points on the radio map are uniformly distributed as much as possible, so that the possible localization error is kept consistent across all locations in the floor