Indoor localization based on RSS

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1 INTRODUCTION

Indoor localization has long been an popular research,which contains a large range of computing applications.Though various techniques has been used indoor localization,The received signal strength (RSS)is always a seminal way to induce indoor localizations systems.Most of the RSS based localization systems are implemented in the 802.11 wireless local area network (WLAN)environment,where the RSS measured for frames sent from different access points (APs).

In this paper,we present a general probabilistic model,we first generalize the assumption of the widely used Log-Normal Path Lose(LNPL) model to provide a more reasonable portrait of the RSS particularly in the indoor environment.Given the Gaussian function,the RSS is set to be a new random variable with the probability distribution function.So,the multi-dimensional can be transformed to a matrix of distance between the APs.With the Multidimensional scale(MDS),which is a form of non-linear dimensionality reduction. Then Choosing N=2 optimizes the object locations for a two-dimensional scatter plot.

2 MODEL

To determine the relationship between the intensity and distance of a signal, which requires an understanding of the wave propagation model. In the free space environment, no consideration for blocking and multipath propagation, the distance between the launch and receiver is d, and the receiving power P_r is represented as:

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

$P_t$is the launch power; G_t and G_r are emission and receive antenna gain; λ is the wavelength of the wave.

In the real environment, the transmission loss of radio is still relatively large due to the random factors such as multi-diameter, obstruction and diffraction. It is more reasonable to use the log-normal distribution model:

$$P_r(d) = RSSI = 10log\left[\frac{P_r(d_0)}{P}\right] + 20log\left[\frac{d_0}{d}\right] (general \ d_0 = 1)$$

3 RELATED WORK

In this report, we use HUAWEI E5 router to obtain the RSS.we choose an empty outdoor space for the strength test of the HUAWEI mobile wifi

and set at a distance of 1m to 10m,as the standard database. We obtained a Gaussian distribution for each integer position and did the matching between the distances.
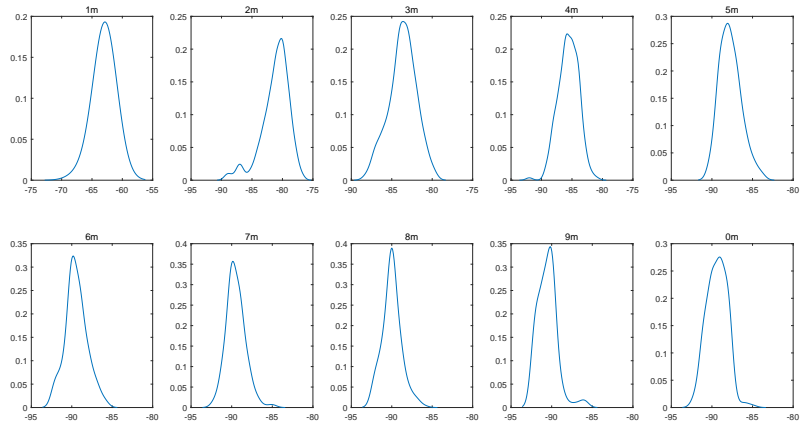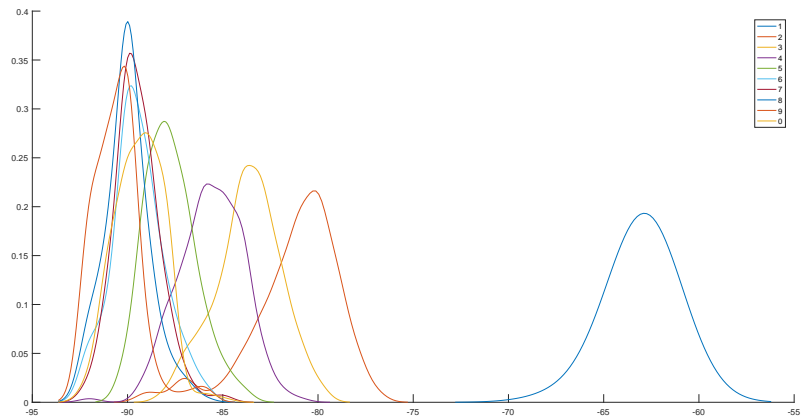

Figure 1: pdf of the HUAWEI router

Figure 2: subplot of pdf

4 ANALYSIS AND FITTING

For all the data,respectively,the standard deviation(std)and the mean has been measured,

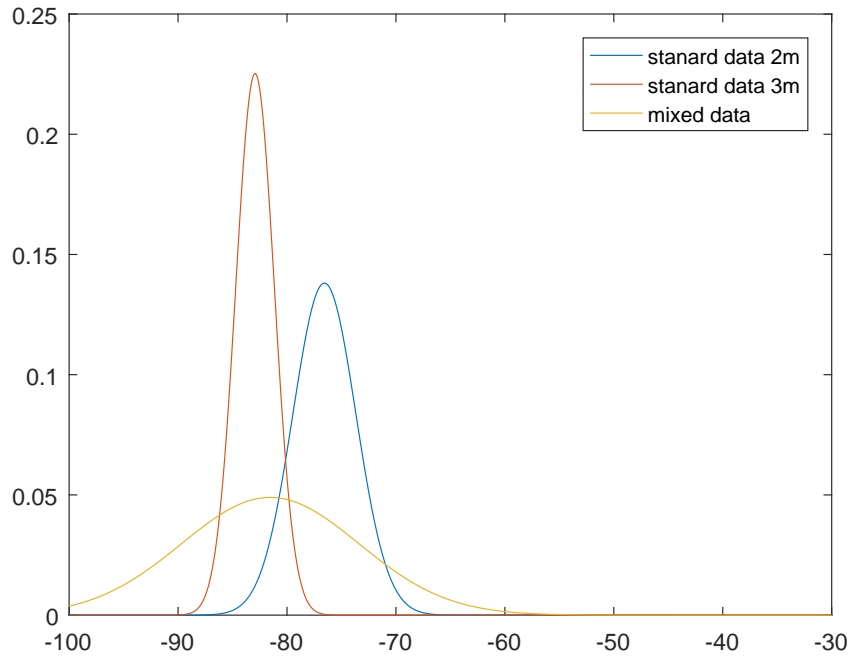Figure 3: moving recipients

First,we choose a set of data belong to the same distance, it is determined to which group it belongs.And then mix two sets of data to determine which it belongs to,and determine which side is closer.

Set a threshold at the integration value, As shown in the figure3,4, the moving recipients and the resting recipients maybe have the same mean value, but there is a difference from the integral value with the standard database.So that we can determine whether the receiver is in motion.

Then use the dichotomy to determine the separation point, first determine a boundary B, if the left closer to the right standard data, then move the border B to the right, on the contrary, to the left;Repeat the process,until the left data is referred to the left standard data ,the right data is referred to the right standard data.The border is the dividing line.

5   MDS

We could call MDS function directly in MATLAB to calculation. After that, we will reached a accurate position as Figure 5.
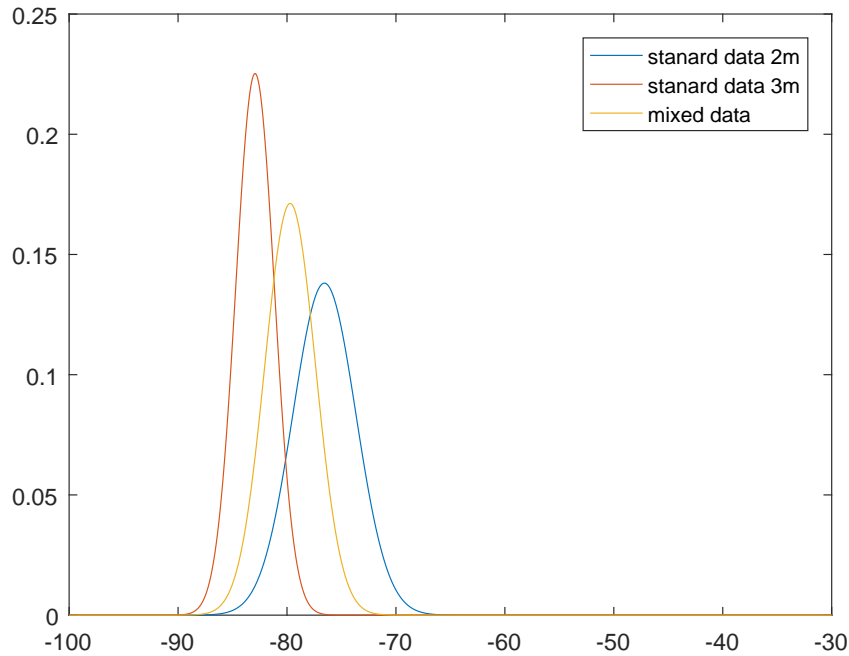
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Figure 4: resting recipients

MDS process:

Given the distance between all the network in a matrix, where is the distance between the coordinates of i and j, given by

$$d_{ij} = \sqrt{(x_i - x_j)^2 + (y_i - y_j)^2}$$

Now, we want to find the coordinates.

General forms of loss functions called Stress in distance MDS and Strain in classical MDS.

The strain is given by:

$$Strain_D(x_1, x_2, ..., x_N) = \left(\frac{\Sigma \left(b_{ij} - \langle x_i, x_j \rangle \right)^2}{\Sigma b_{ij}^2} \right)^{1/2}$$

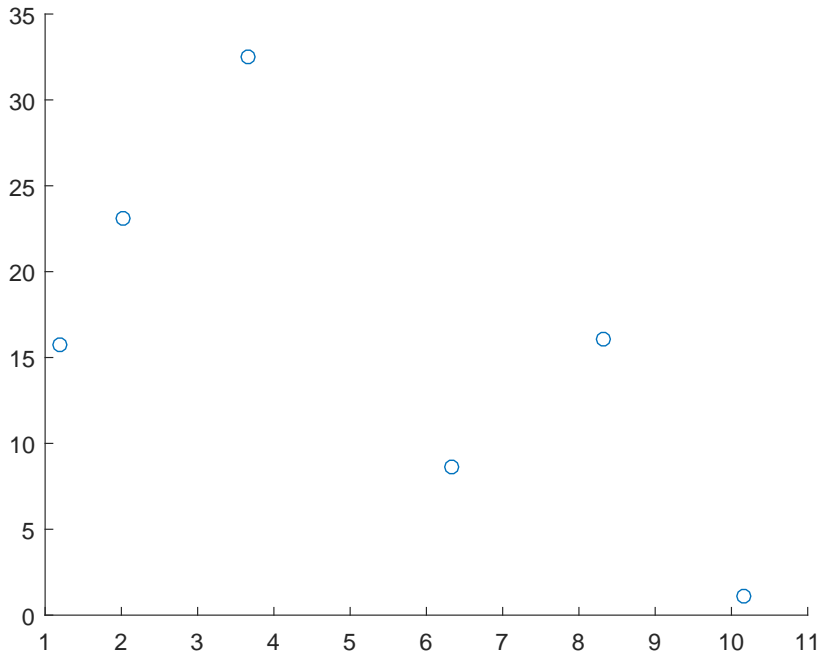Where b_{ij} are the terms of the matrix defined on step of the following algorithm.

Figure 5: MDS

Steps of a MDS algorithm :

Given the distance between all the network in a matrix $D = d_{ij}$,which the $d_{ij}$is the distance between the coordinates of$i$and$j$

1. Set up the squared proximity matrix $D = [d_{ij}]$

2. Apply double centering:$B = -\frac{1}{2}JDJ$ using the centering matrix $J = I - \frac{1}{n}11'$,where n is the number of objects.

3. Determine the m largest eigenvalues and corresponding eigenvectors of B (where m is the number of dimensions desired for the output).

4. $X = E_m A_m^{1/2}$,where E_m is the matrix of m eigenvectors and A_m is the diagonal matrix of m eigenvalues of B.