Wifi Deployment using Matlab

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1 Background & Purposes

Since the wifi-based indoor positioning system becomes more and more popular,many of the research focus on the accuracy of the system. On the one hand, we can search for an apropriate algorithm, which can get more accurate matching to the fingerprint,such as the KNN algorithm. On the other hand, the deployment of the wifi access points is also very significant for improving the accuracy of the positioning.

Normally we make a survey of the place and test, to get the appropriate position,which can reach a better network coverage or lower mislocalization. This will take a lot of time and energy. And here comes to the method, which use the mathematical model of the transmission of the signal in the indoor environment and the computer to help us to figure out the position of the access points.

2 Experment Principle

The following picture can give us a brief description of the algorithm.

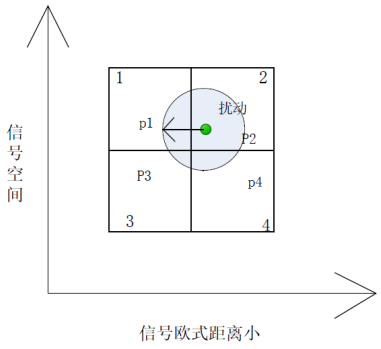

Figure 1 low Euclidean distance

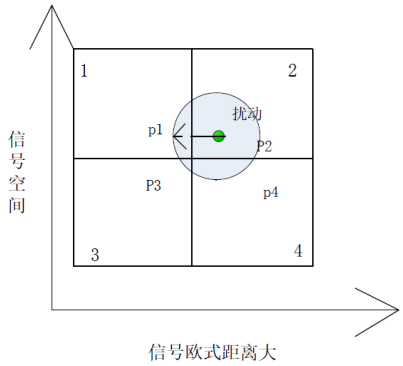

Figure 2 high Euclidean distance

We can see, The reference points is the center of the areas.we should judge the position is Number 1.If the signal have a disturbance,which is the circle on the picture, we could misjudge the position to 2,3,4.It is clear that when we increase the distance of the reference points,the area of the disturbance in the the misjudge of the position is smaller.

From the above analysis we use a more professional statement,that the error probability of positioning will decrease,if the Euclidean distance of the reference point increase within a certain range.

And the following we give the prove of the algorithm.The first step is to build the mathematical model of the signal. The ideal signal from AP is:

$$S(t) = Re[b(t)c(t)exp(2\pi j f_0 t)]$$

$b(t)$is the baseband data, $c(t)$ is spread spectrum sequence and $f0$ is carrier frequency. But after reflection,refraction,diffraction the signal will be as follows.

$$R(t) = \sum_{i=0}^{N} a_i(\tau_i)S(t-\tau_i) = \sum_{i=0}^{N} a_i(\tau_i)b(t-\tau_i)exp(2\pi j f_0 t)exp(-2\pi j f_0 \tau_i)$$

We treat $R(t)$ as a complex fuzzy stochastic process.When there is no optical route($a_0 = 0$),$R(t)$ can be representes as:

$$\left\{\begin{array}{l} \boldsymbol{R(t) = \sum_{i=1}^{N} c_i b(t-\tau_i)\exp(2\pi j f_0(t-\tau_i) - j\sigma_i)/4\pi(f_0+f)\tau_i} \\ \boldsymbol{X(t) = \sum_{i=1}^{N} c_i b(t-\tau_i)\cos(2\pi j f_0(t-\tau_i) - j\sigma_i)/4\pi(f_0+f)\tau_i} \\ \boldsymbol{Y(t) = \sum_{i=1}^{N} c_i b(t-\tau_i)\sin(2\pi j f_0(t-\tau_i) - j\sigma_i)/4\pi(f_0+f)\tau_i} \end{array}\right\}$$

Figure 3 expression of R(t)

Based on the central-limit theoremwe can get that he envelope of the signal $r = \sqrt{x^2+y^2}$,which is a Rayleigh distribution.its probability distribution function

is

$$f(r) = \frac{r}{\sigma^2} exp(-\frac{r^2}{2\sigma^2})$$

Then we can calculate the Pe,which can be expressed as:

$$p_e = \frac{1}{2}\Big(\int_{r_0^*}^{+\infty} \frac{r}{\sigma_1^2} exp(\frac{-r^2}{2\sigma_1^2})dr + \int_0^{r_0^*} \frac{r}{\sigma_2^2} exp(\frac{-r^2}{2\sigma_1^2})dr \Big)$$

The derivative of Pe shows that with the distance of the means increasing, pe will decrease.

3 Experiement

3.1 Process of programm

Based on the theory we can use matlab to find out the appropriate position. Normally we use the Genetic Algorithm.The process of the program is as follows.

1. set the objective function and the constraint condition
2. set the origion and the number of the reference points
3. $APnum = 0$
4. set the parameters of GA
5. set the initial population and coding
6. $AP = AP + 1$
7. calculate the value of he objective function
8. judgement,if it fits the requirement.
9. choose,crossover and mutation
10. replace the incommensurate parent
11. find the unit which have highest fitness value record all the value of the objective function,return to 6.
12. record the best individual and its value of objective function

3.2 Some results of the Experiment

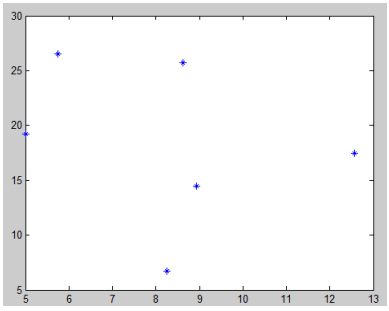

Figure 4 the loc when $APnum = 6$

4 Experience

Thanks for giving us this oppoturnity for deep learning by doing this project.

5 Reference

[1]Indoor-Positioning-Algorithm
[2]Indoor Access Points Location Optimization using differential Evolution