WiFi Localization Using Simulated Annealing

Neşat Dereli, MS Student, Department of Systems and Control Engineering

Introduction

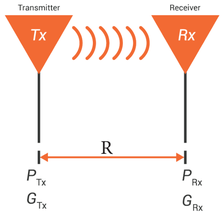
This project aims to localize a client which has locations and signal strengths of WiFi Access Points. As a solution Simualted Annealing method is chosen. Since interior walls and objects affects on signal strength, a simulation will be used. In the 2D simulation output power of each AP antenna will be assumed to be equal.

Motivation

- Wifi localization is a common and live topic
- Monte Carlo methods are a good match for the problem
- This work can also be used for different localization techniques such as GPS

Friis Equation

Friis Equation is fundamental formula, which is used to calculate received power on a wirelles communication. Friis formula assumes the area is a free space and there are no walls, no objects other than trasmitting and receiving antennas.



$$P_R = \frac{P_T G_T G_R c^2}{(4\pi R f)^2}$$

Calculations

- PtGt is assumed to be 20dBm which is maximum legal value for 2.4GHz Pint-to_MultiPoint set by European Telecommunications Standards Institute
- Gr is assumed to be 0dBi
- c/f is -9dB where c is speed light and f is assumed to be 2.4GHz for 1 m distance
- 1/(4π) is -11dB
- dBm(Pr) = dBm(PtGt) + dBi(Gr) + 2dB(c/f) + 2dB(1/(4π)) + 2dB(1/R), R is in meters unit
- dBm(Pr) = 20dBm - 18dB - 22dB + 20log(1/R) = -20 dBm + 20log(1/R) dB

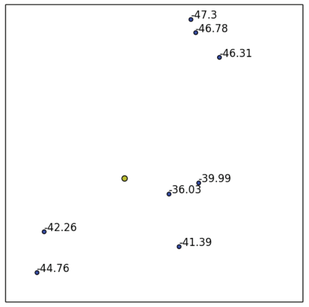
Data

Generated data is used to simulate 8 wifi routers and a client in each application. An area is initialized as 40m x 40m. Wifi routers are placed randomly but client is placed near to center to have a more realistic data.

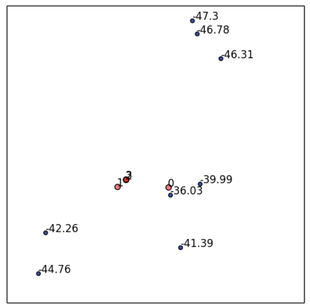
Simulated Annealing

Simulated Annealing method is used to solve the mentioned problem. Simulated Annealing method is used to minimize the distance between client and each router. Inverse temperature parameter is chosen as 1.01 for each iteration.

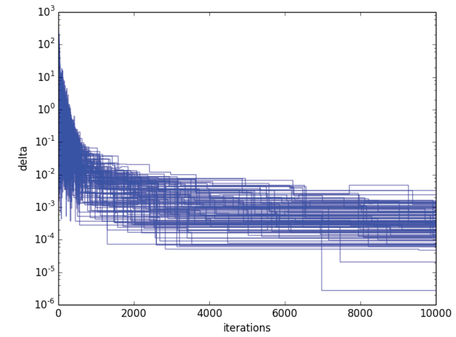
Localize Client Result



Blue dots represent routers and their signal rate
Yellow dot represents real location of the client

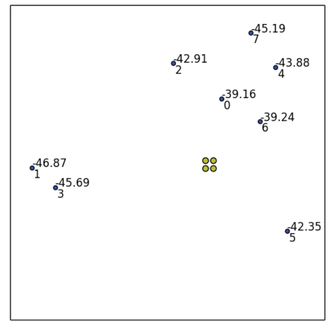


Red dots are estimation of client and its number represents iteration number

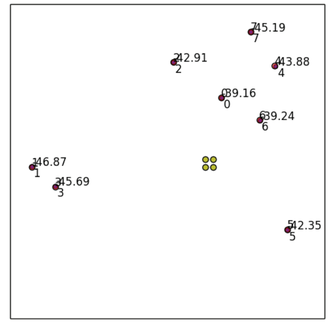


This graph shows distance from real client position

Localize Router Result



Blue dots represent routers and their signal rate
Yellow dot represents real locations of the client
4 differen sample is taken using 4 different location



Red dots are estimation of router and its number represents router identifier

Conclusion

The results show that Simulated Annealing method can be used to solve wifi localization problem. However, adding noise to the signal decrease the performance. To apply this method for real world problem, further improvements should be done.