ML5G-PS-006: Location Estimation Using RSSI of Wireless LAN in NLoS Environment

Team: KIT-labs

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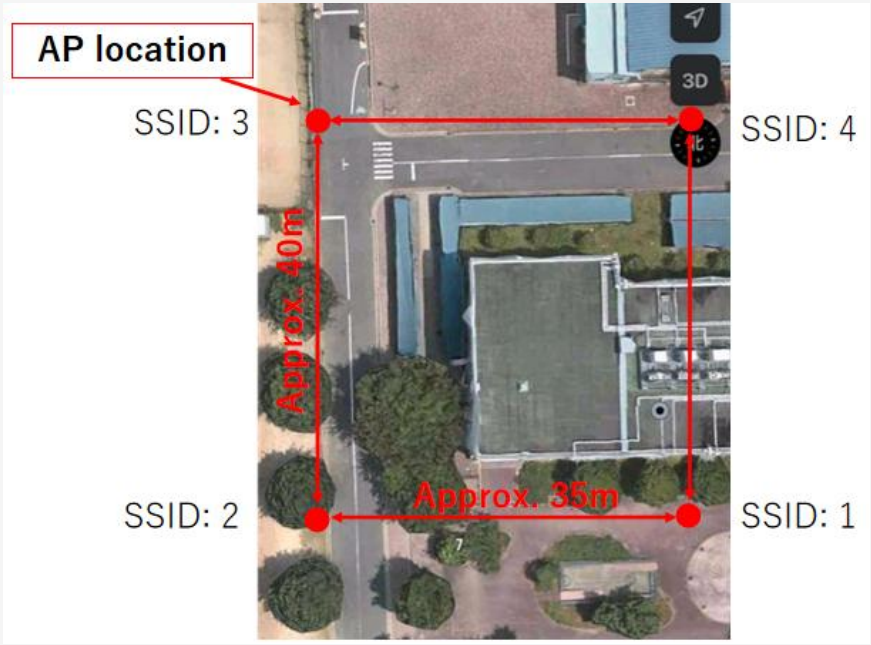
Task

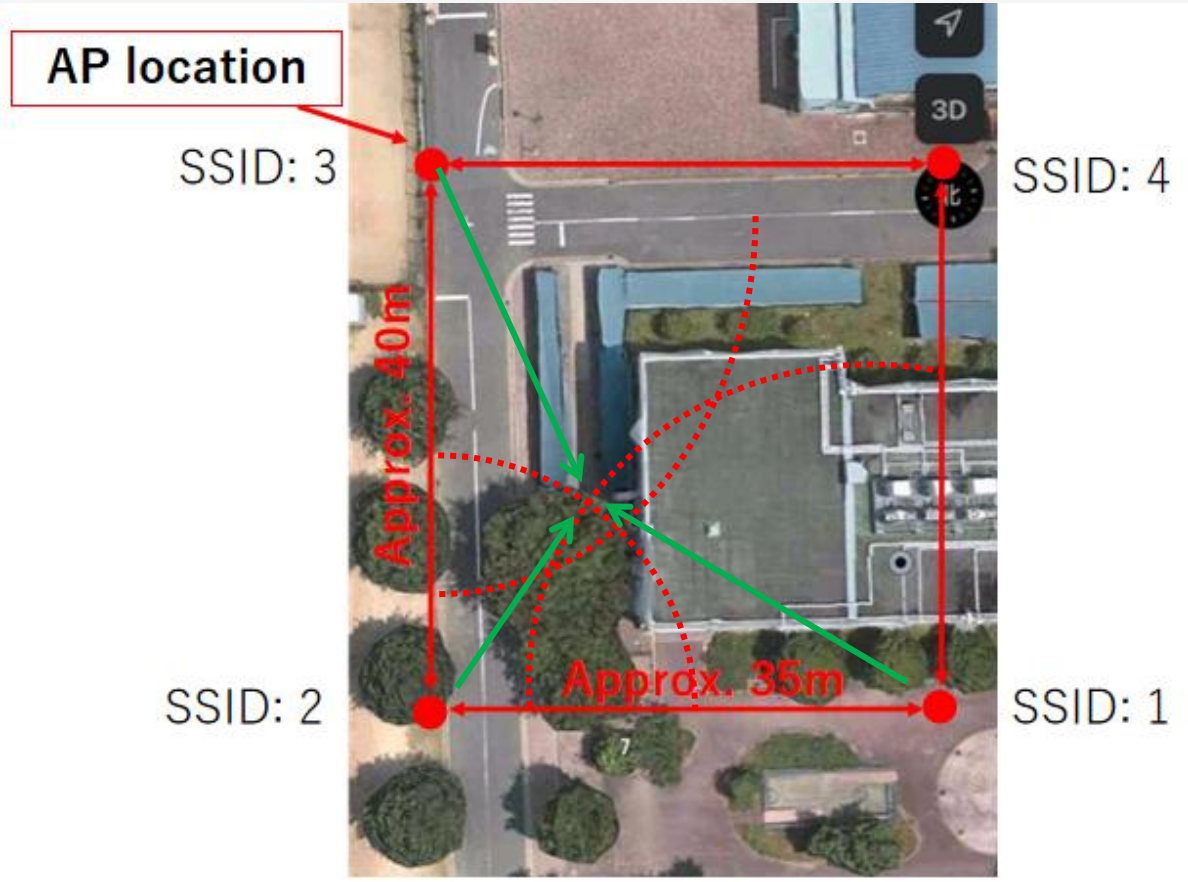
- Location Area within 4 APs
- Location estimation by RSSI
  - Difficult
  - Especially when obstacles are added to the area

- Use AI/ML tools to improve the accuracy of location estimation



Consideration

- To estimate the location, Trilateral positioning method is effective.



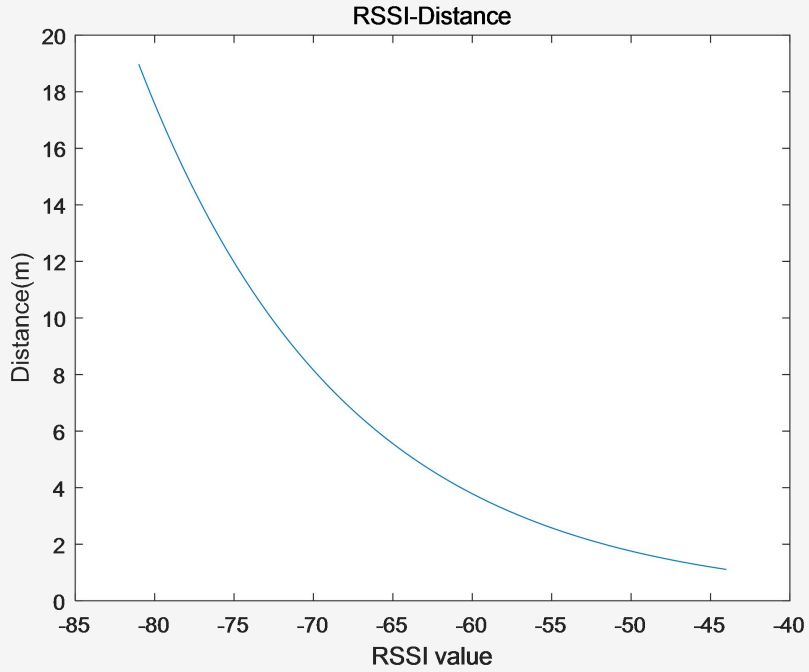
- Trilateral positioning is quiet accurate in this case(40m x 35m area)
  - if the distance data is adequate and precise

Proposed Method

- RSSI is directly related to distance
  - $PL(d) = PL(d_0) - 10nlg\frac{d}{d_0} - N_0$

- However, there is no distance data and available RSSI data is very little
  - Get the distance corresponding to each RSSI value
    - To acquire the complete data of RSSI-Distance and the problem will be solved
    - All given RSSI data are integers and belong to [45,80](absolute value)
    - those over 80 can be consider to error or because of obstacles

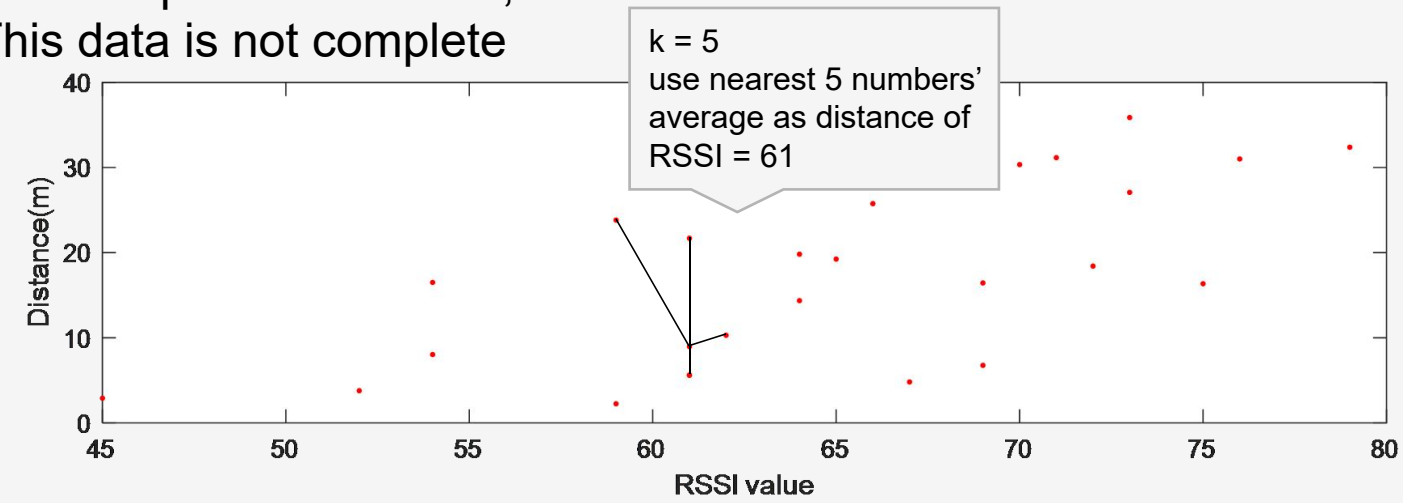
ideal result



- We use KNN(K-nearest neighbor) model to predict the distance data which are not provided
  - e.g. When we need the distance data of RSSI values of 62, which we don't have, but we do have data of 61, 64 and 65 It's possible to predict the data of 62 with those near data

KNN Model

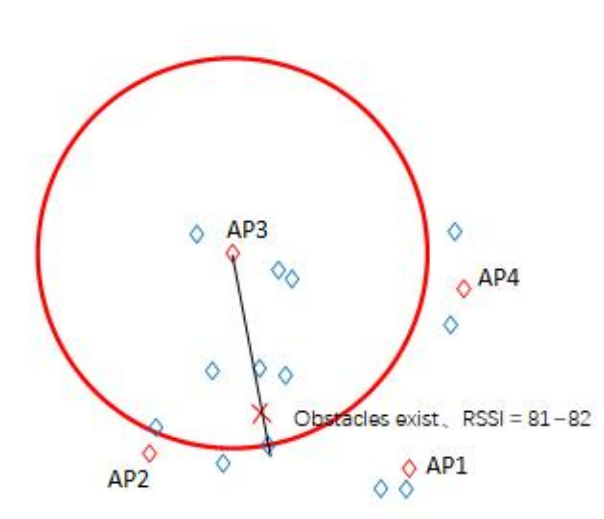
- We counted all the samples and got distance data
  - For multiple RSSI values, the distances are different
  - This data is not complete



- Use KNN to complete this chart
  - use nearest k numbers to predict one
  - Training to get optimal k for every RSSI value
    - k from 1 - 10, 36 RSSI values, 10^36 iterations
      - Not enough time, we reduced the iteration
      - As a result, if the RSSI is 60 to 69, the K value is 5, and in other data, when the K value is 2

Solutions of obstacles

- By analysising the traning sample, we found at least 3 obstacles
  - through the RSSI data of AP2, AP3 and AP4



- when one RSSI value is very high, the target might be behind of obstacles
- Then other 2 RSSI values can help judge the reason that abnormal high RSSI is because of obstacles or just long distance

- judging by RSSI values to different APs, we can estimate the approximate location of obstacles
- there is only one data in every sample which includes obstacles

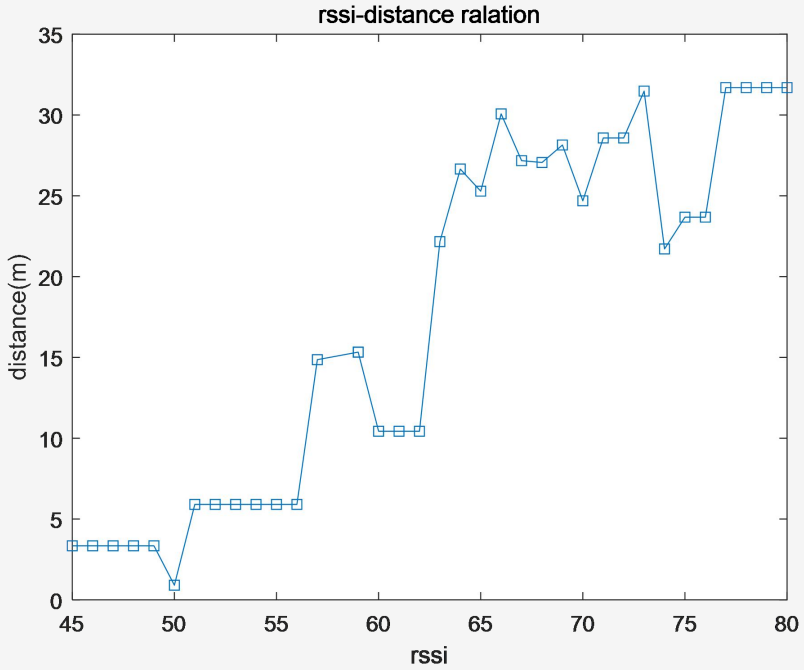
$$d_{obstacle} = \begin{Bmatrix} D2 = 45.3124, RSSI\_2 > 63, RSSI\_4 < 45 \\ D4 = 36.6082, RSSI\_4 > 75, RSSI\_2 < 65 \\ D3 = 26.9626, RSSI\_3 > 75, RSSI\_1 < 65, RSSI2 < 70 \end{Bmatrix}$$

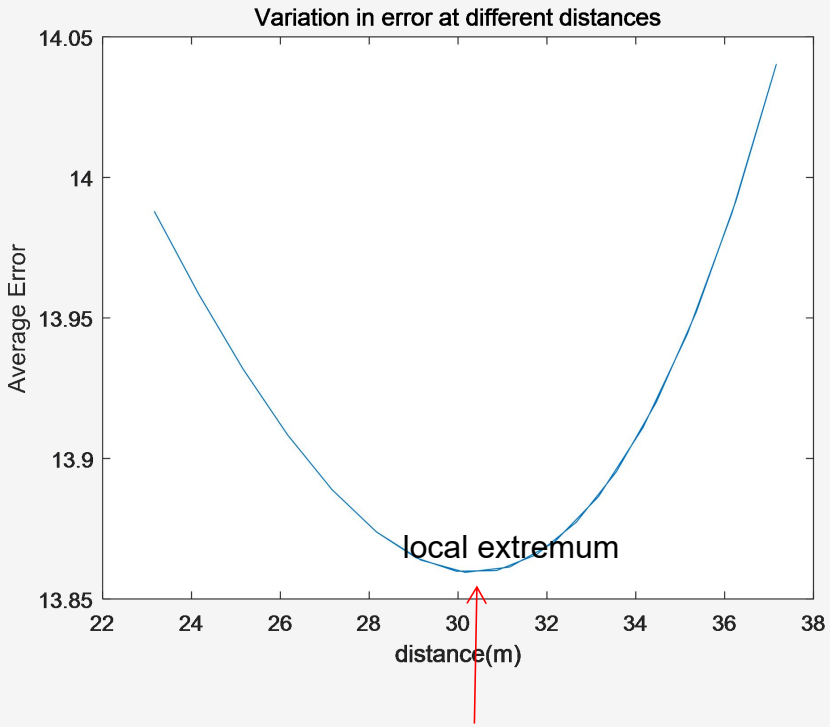
- When the conditions are met, there are obstacles between the target and the certain AP
  - we use fixed distance under this circumstance in trilateral positioning

Results optimization by

- Using KNN model, we get a sketchy result. But clearly it is not the best.

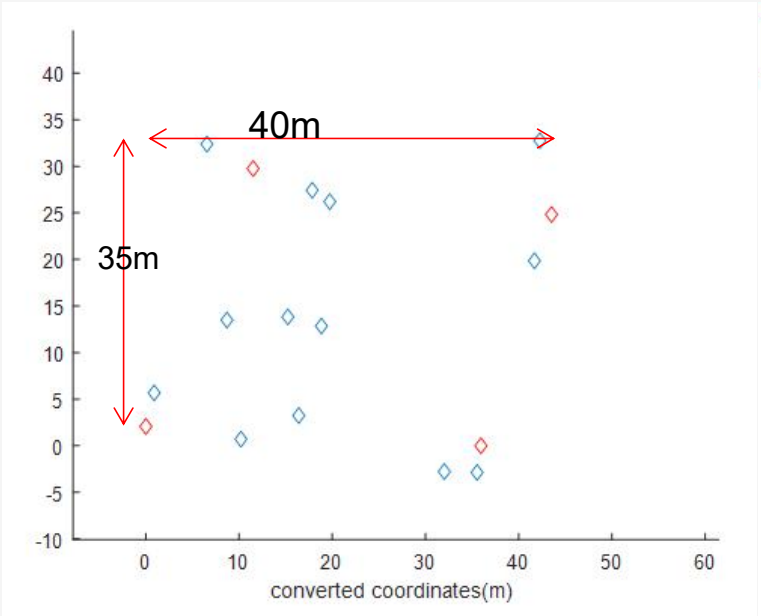
- We could use another machine learning to Improve accuracy even further
- Make those scatters closer to the real curve
  - nonlinear regression problem
  - DNN with gradient descent

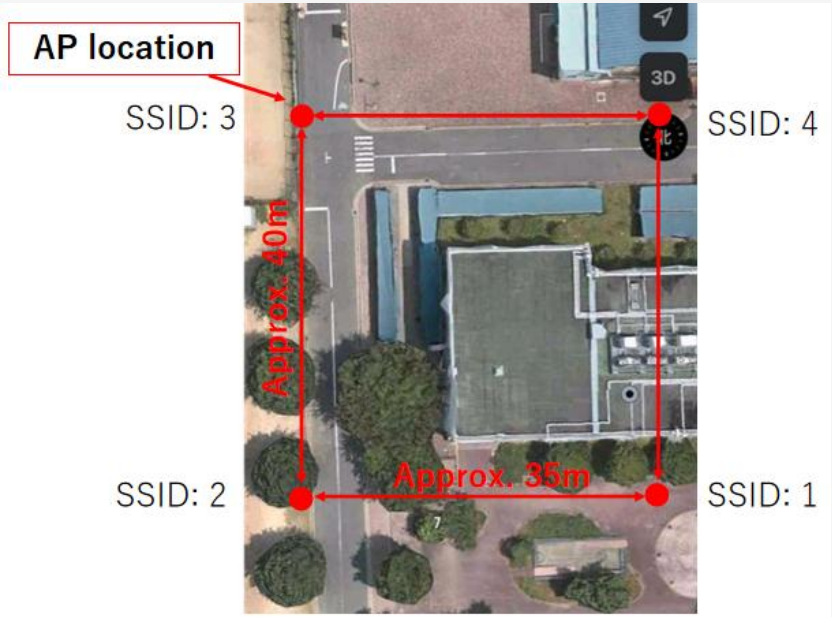




Results

- Verification Data set:





Results without DNN		Results with DNN	
Average Error	15.6255218 m	Average Error	14.3342028 m
Maximum Error	24.7557955 m	Maximum Error	18.730044 m

Discussion

- The step change of gradient descent wasn’t set
  - that could improve the results
- We only found one of the local extremum
  - Maybe there’s other value that could make the error smaller