Measurement format description

Elena Simona Lohan

elena-simona.lohan@tut.fi

WLAN data was collected with a Windows Tablet in a 4-floor university building in Tampere, Finland. The Access Points MAC addresses were converted into indices from 1 to N_{AP}, where N_{AP} stands for the total number of MAC addresses heard in that building. We remark that several MAC addresses can come from the same physical location (e.g., in the case of Access points supporting multiple BSSIDs). The exact location of the Access Points is not known, but it can be estimated, for example as given in:

S. Shrestha, J. Talvitie, and E.S. Lohan "Deconvolution-based indoor localization with WLAN signals and unknown access point locations", in Proc. of IEEE ICL-GNSS, Jun 2013, Italy

The *FINGERPRINTING data* (FingerprintingData_*Building*mat) is given in the following format:

- N_floors = number of floors in the building

- floor_heights = a vector with the building floor heights in m

- WLAN_grid_synthpoint=is a cell of size 1 x $N_{AP.}$ Each element WLAN_grid_synthpoint{ap} is a N(ap) x 4 matrix, showing the coordinates of the points where that particular ap is heard and at which power (first column gives the x coordinates, second column the y coordinates and third column the z coordinates, while last column hows the RSS values in dB. N(ap) is the number of points which are hearing the ap-th Access point.
  Example:
  [-93.5000 11.5000 0 -91.0000
  -94.5000 15.5000 0 -89.0000
  -95.5000 17.5000 0 -81.0000
  -97.5000 23.5000 0 -73.0000]
  In this example, an AP is heard in N(ap)=4 points, all at the same floor.

- WLAN_data_per_synthpoint= is a Total_No_of_fingerprints x 2 cell, with Total_No_of_fingerprints=number of measurement points or fingerprints. WLAN_data_per_synthpoint{n,1} elements show the 3D coordinates (x,y,z) of the fingerprints and WLAN_data_per_synthpoint{n,2} elements show which APs and at which RSS are heard in each fingerprint.
  For example,
  WLAN_data_per_synthpoint{n,2}=
  [2 10 13
  -60 -80 -75]
  This means that in n-th fingerprint we hear 3 access points, indexed 2, 10 and 13, at

power levels -60, -80 and -75 dBm, respectively

- mapped_meas_positions = are the fingerprint coordinates (it's the same information that you find in the WLAN_data_per_synthpoint{nn,1} elements, but this time written as a matrix. The measurements were in fact mapped on a rectangular grid with grid step of 1m. If several measurements were mapped to exactly the same point, then their RSS mean was taken and stored as RSS value. This was done in order to allow a data storage which can easily grow when adding new measurements.

There are *several user tracks per building*, (UserTrack*Building *mat) and each has the following format:

- User_data_per_measpoint is a Nu x 2 cell, with Nu=the number of measurements for that track. The elements User_data_per_measpoint {nu,1} show the x,y,z coordinates of the track point and the elements User_data_per_measpoint {nu,2} show the AP indices and the RSS values (in dBm) heard in that particular point, with nu=1, …, Nu.
  Example:
  user_data_per_measpoint :

  [1x3 double] [2x12 double]
  [1x3 double] [2x17 double]

  user_data_per_measpoint{1,1}:
  -71.7800 28.8500 3.7000 -> it means that a measurement was done at the local coordinates x=-71.78m, y=28.85m and z=3.7m
  user_data_per_measpoint{1,2}
  [136 137 138 289
  -50 -49 -49 -88]
  -> it means that in the first measurement of the considered track, we heard 4 Access points (with indices 136, 137, 138 and 289) and with RSS values: -50, -49, -49 and -88 dBm respectively

  NOTE: The tracks are given in two forms: one by one, as collected by the user, but also merged into a single long track, UserTrack*ALL_LONG_UniversityBuilding*mat

  The data is given in 3 folders:
  1) BUILDING1 : it's a 4-floor university building in Tampere; the measurements were done during 2011
  2) BUILDING2: it's a 3-floor university building in Tampere; the measurements were done during 2011
  3) BUILDING1_NEW: it's the same 4-floor university building as in BUILDING1, but measurements were done in 2013, after a WLAN infrastructure change in the whole building. The Access Point indices from BUILDING1 and BUILDING1_NEW do not match; they should be considered independently of each other. Such measurements are useful for example to check the signal variability with a change of WLAN infrastructure, as done in:

S. Shrestha, J. Talvitie, and E.S. Lohan , "On the fingerprints dynamics in WLAN indoor localization", in Proc. of IEEE International Conference on ITS Telecommunications, Tampere, Finland, Nov 2013

Additional publications of the group related to RSS-based positioning studies:

1. H. Nurminen, J. Talvitie, S. Ali-Löytty, P. Muller, E.S. Lohan, R. Piché, M. Renfors, "Statistical path loss parameter estimation and positioning using RSS measurements", *accepted to* Journal of Global Positioning Systems , 2013.
2. E.S. Lohan, K. Koski, J. Talvitie, L. Ukkonen, "WLAN and RFID propagation channels for hybrid indoor positioning", in *Proc. of IEEE ICL-GNSS conference*, Jun 2014, Helsinki, Finland
3. J. Talvitie, E.S. Lohan, and M. Renfors, "The Effect of Coverage Gaps and Measurement Inaccuracies in Fingerprinting based Indoor Localization", in Proc. of *IEEE ICL-GNSS conference*, Jun 2014, Helsinki, Finland
4. P. Kasebzadeh, G. Seco-Granados, and E.S. Lohan, "Indoor localization via WLAN path-loss models and Dempster-Shafer combining", in Proc. of *IEEE ICL-GNSS conference*, Jun 2014, Helsinki, Finland.
5. S. Shrestha, J. Talvitie, and E.S. Lohan "Deconvolution-based indoor localization with WLAN signals and unknown access point locations", in Proc. of IEEE ICL-GNSS, Jun 2013, Italy
6. J. Talvitie, and E.S. Lohan , "Modeling Received Signal Strength Measurements for Cellular Network Based Positioning", in Proc. of IEEE ICL-GNSS, Jun 2013, Italy.
7. H. Nurminen, S. Ali-Löytty, R. Piché, J. Talvitie, E.S. Lohan, M. Renfors, "Statistical Path Loss Parameter Estimation and Positioning Using RSS Measurements in Indoor Wireless Networks", in Proc. of IPIN, Nov 2012, Australia.
8. H. Nurminen, J. Talvitie, S. Ali-Löytty, E.S. Lohan, R. Piché, M. Renfors, "Statistical path loss parameter estimation and positioning using RSS measurements", in Proc. of UPIN-LBS, Oct 2012, Finland.
9. S. Shrestha , E. Laitinen, J. Talvitie, E. S. Lohan , "RSSI channel effects in cellular and WLAN positioning", in Proc. of WPNC, Mar 2012
10. E. Laitinen, E. S. Lohan, J. Talvitie and S. Shrestha , "Access Point Significance Measures in WLAN-based location", in Proc. of WPNC, Mar 2012

More at: www.cs.tut.fi/tlt/pos