technische universität dortmund

Communication Networks Institute

Master Thesis

RF Fingerprinting Positioning Based on Massive Crowd-Sensing Data

Localization methods are being progressively improved. Especially with the introduction of 5G New Radio (NR) networks, various localization functions have been introduced or improved compared to predecessor networks going down to the order of magnitude of millimeters in some case [1].

However, novel and future localization features may compromise user privacy and are becoming increasingly complex. Thus, this thesis aims to evaluate an alternative approach to user equipment (UE) localization that does not depend on network operator location services.

Based on continuously performed crowd-sensing-based and systematic measurement campaigns, a semi-dense radio environmental map(REM) consisting of various reference signals (RSs) is constructed. Additionally, the UE, which shall be localized, measures passive RSs of the connected and neighboring cells. In the second step, this data is used to match the RSs measured by UEs to a location on the REM. This process may be done with the help of machine learning (ML). Its performance and computational cost shall than be compared to other existing localization methods.

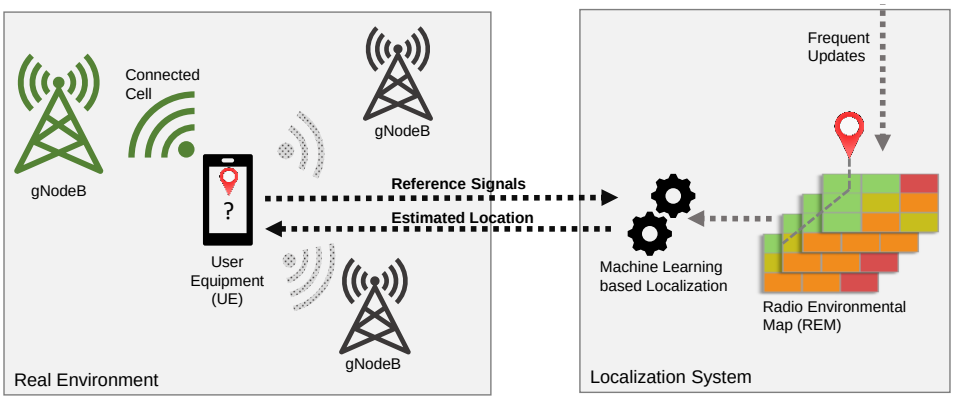

Figure 1: Scenario Overview of radio fingerprinting based localization.

The main advantages of this method may be the independence of mobile network operator (MNO) based localization methods and a possible open-source implementation. Compared to e.g. satellite-based localization, a reduced positioning latency may be accomplished. Furthermore, this method should improve the user's privacy and reduce the energy consumption of the positioning process, as mainly passive RSs need to be utilized.

Further evaluations could include the localization of base stations by multiple sets of locations and reference signal tuples measured by UEs [2,3]. These could form the base for the UE localization process, by providing base station locations. Furthermore, techniques used to localize gNodeBs could be applied to UE localization.

Requirements

- Interest in 5G Mobile Networks
- Participation in MDK, MFN/MRN (and other CNI lectures) are a plus
- Excellent English skills; highly desirable: Willingness to write thesis in English
- Python and basic LaTeX/TikZ skills

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References

[1] S. Häger, S. Böcker, S. Jamali, T. Reinsch, and C. Wietfeld, “A Novel System Architecture for Small-Scale Motion Sensing Exploiting 5G mmWave Channels,” in 2021 IEEE Globecom Workshops (GC Wkshps), Dec. 2021, pp. 1–6. doi: 10.1109/GCWkshps52748.2021.9682166.

[2] L. Eller, P. Svoboda, and M. Rupp, “Bayesian Inference of Sector Orientation in LTE Networks based on End-User Measurements,” in 2021 IEEE 94th Vehicular Technology Conference (VTC2021-Fall), Sep. 2021, pp. 1–6. doi: 10.1109/VTC2021-Fall52928.2021.9625548.

[2] L. Eller, V. Raida, P. Svoboda, and M. Rupp, “Localizing Basestations From End-User Timing Advance Measurements,” IEEE Access, vol. 10, pp. 5533–5544, 2022, doi: 10.1109/ACCESS.2022.3140825.