

Project Summer Semester 2018

Channel State Information for In-Door Localization and other Use Cases

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1 Indoor Localization Methods for Location-Based Services

Location-aware services are information systems that depend on the information about the location of people or electronic devices in order to control their features. Targeted and mobile advertising, location-based recommending systems, assistive health-care systems and smart-home automation are only a few application examples where location-aware services can be deployed.

WiFi is a ubiquitous wireless technology for computer connectivity referring to the IEEE 802.11 set of media access control (MAC) and physical layer (PHY) specifications for implementing wireless local area networks (WLAN). WiFi signals can also serve for positioning at the additional benefit of requiring little or no additional infrastructure. Remarkably, although certain commercial indoor positioning systems exist, there is still not a standardized indoor localization system similarly to the GPS technology, primarily because of the coarse localization performance of these available products. This fact renders scientific work in this area of significant importance. Recently, indoor localization using the Channel State Information (CSI) of WiFi transmissions is actively researched. CSI essentially is information characterizing the the state of a communication link from the transmit source(s) to the receiver source(s). It is particularly useful in the context of MiMo (Multiple Input Multiple Output) involving multiple antennas as the information can be exploited to gain information about the location.

Currently, we have a running localization service based on sensing WiFi signal strength in place. The service is supported by a SW-engineering group (Mobile Campus Applications MoCa). In addition, the research group, whose team members, Mrs Elpiniki Tsakalaki and Mr Joel Stein will support you, too, is doing research on CSI data and try to utilize this data primarily to improve the localization accuracy, but see other use cases below.

Thus, if you want to learn current research involving advanced methods including machine learning techniques and computer simulation, this project is for you!

2 Research Topics to be covered

The primary research areas of this project are as follows:

1. indoor localization using the Channel State Information (CSI) of WiFi
2. (passive) user (gesture) and motion recognition – useful for ambient assisted living applications and surveillance – using Channel State Information (CSI) of WiFi

2.1 Available Projects/Research Topics

The following sub projects are available to students

1. Geometric Localization via CSI: Experimentation and Testing – Test the WiFi indoor localization based on real experiments. The test will analyze different algorithms for detection of Line of Sight (LoS), number of sources etc., see e.g. [KJBK15]
2. Fingerprinting CSI test data – Planning and carrying out experiments with fingerprinting CSI data. This involves various machine learning algorithms including (deep) neural networks (convolution networks based on TensorFlow), see e.g. [WGMP17]
3. Analyzing CSI data for motion and gesture recognition as described in the overview paper [YND⁺17]

3 Required Skills

Students should be able to program (any language) and should not fear mathematics – you do not have to do any math, but you should be able to understand research papers including math. Students should be curious and eager to learn – we will help you with the math and any other difficulties arising. In addition we will coach you with the tools, e.g. Matlab etc. A command of python is helpful for TensorFlow.

4 Further information

We will publish recent project documentation and preparatory material under these urls

- <http://www.informatik.fb2.frankfurt-university.de/~jschaefer/> and
- <http://www.informatik.fb2.frankfurt-university.de/~jschaefer/index.atom>.

In addition, feel free to contact me (jschaefer@fb2.fra-uas.de) and ask for a consultation hour before making your choice!

References

- [KJBK15] Manikanta Kotaru, Kiran Joshi, Dinesh Bharadia, and Sachin Katti. Spotfi: Decimeter level localization using wifi. *SIGCOMM Comput. Commun. Rev.*, 45(4):269–282, August 2015.
- [WGMP17] X. Wang, L. Gao, S. Mao, and S. Pandey. Csi-based fingerprinting for indoor localization: A deep learning approach. *IEEE Transactions on Vehicular Technology*, 66(1):763–776, Jan 2017.
- [YND⁺17] Siamak Yousefi, Hirokazu Narui, Sankalp Dayal, Stefano Ermon, and Shahrokh Valaee. A survey of human activity recognition using wifi CSI. *CoRR*, abs/1708.07129, 2017.