

Bachelor's Thesis

Classifying WiFi FTM with the help of channel state information

Abstract

The WiFi standard IEEE.802.11.mc introduces the FTM (Fine Time Measurement) method to measure distances based on round trip times. This standard aims to close the gap in indoor localisation, where GNSS fails because of shadowing of ceilings and walls. With FTM we can set up an indoor localisation service and can use the same hardware for communication. However, FTM hardware is still rarely deployed. The ESP32 microcontroller become cheap FTM hardware, too. So far, indoor experiments reveal, that FTM comes with a high position depended error due to multipath. Classification of the FTM measurements would help to skip measurements outliers. However, due to the constant positional error it is not possible to detect these outliers from the FTM data itself. Here, the channel state information might help.

Content

The goal of this thesis is to improve the FTM measurements by classification of the measurement data based on CSI values. Therefore, a mixed system with FTM and CSI measurements has to be created in our lab. In a next step, both type of data has to be collected and analysed. Additionally, statistical methods have to be applied on this data.

Requirements

* microcontroller programming (esp32) * interests in experiments * interests in data analysis and statistics * scientific work * Linux skills

Literature

Vales, Valentín Barral, et al. "Fine Time Measurement for the Internet of Things: A Practical Approach Using ESP32." IEEE Internet of Things Journal 9.19 (2022): 18305-18318.

Horn, B.K.P. Doubling the Accuracy of Indoor Positioning: Frequency Diversity. Sensors 2020, 20, 1489. <https://doi.org/10.3390/s20051489>

Horn, B.K.P. Indoor Localization Using Uncooperative Wi-Fi Access Points. Sensors 2022, 22, 3091. <https://doi.org/10.3390/s22083091>

Gentner, C., Ulmschneider, M., Kuehner, I., & Dammann, A. (2020, April). WiFi-RTT indoor positioning. In 2020 IEEE/ION Position, Location and Navigation Symposium (PLANS) (pp. 1029-1035). IEEE.

Notes



Lab Rules

As the lab is shared among all of us we ask you to follow one simple rule. Failing that, we will restrict access to the lab and our resources.

0. Make sure that your working in/with the lab does not negatively impact other people's work.

To give some examples:

1. Do not change the hardware configuration or unplug any cables.
Feel free to connect your Laptop to a monitor if there is an unconnected VGA cable on the desk.
However you must not disconnect any peripherals of any Lab computer in the room.
When leaving make sure you select the right input mode of the monitor such that it again shows the screen of the Lab computer.
2. Do not execute code you did not write.
This not only extends to binaries downloaded from the Internet, but also source code, scripts, command lines, etc. We will be happy to supply you with any software you might need. Please ask your supervisor.
3. Do not execute the sudo or su command.
4. Do not shut down or reboot computers.
If a computer crashed please inform our administrators.
5. Do not monopolize resources.
A good rule of thumb is to not use more than max. 6 CPU cores and max. 8 GB memory per machine, so fellow users can still log in.
6. Do not print more than you need.
If you print something, be sure to pick it up from the printer.
7. Do not take hardware out of the lab without permission.
If you need to take hardware home, please check this equipment out with HaJo Kraus.
8. Do not leave the lab (nor your machine) unlocked when you leave.
We are not responsible for any theft.
9. Do not litter.
Clean up after yourself.

Thank you!

Paderborn, 22 May 2018

wiki pages. * After a settling-in period of 2 months (Bachelor thesis) or 3 months (Master thesis), the student and their supervisor(s) can agree on working together on the topic. This agreement is formalized when the thesis proposal is accepted by the supervisor. However, both parties reserve the right to withdraw from further cooperation before the final submission of the proposal. Once the proposal is accepted by the supervisor, it has to be registered with the examination office, otherwise the thesis will be canceled. * Submission is possible before the official deadline of the examination office, but not before 50% of the official time. * <https://www.tu.berlin/en/studying/organizing-your-studies/study-and-examination-regulations/>

Log

We assume there will be a meeting between you and your supervisor at least every two weeks. In the meantime, please indicate your progress by email. If there is no log entry for more than one month, we have to assume the thesis is to be canceled.

- YYYY-MM-DD: <what happened in the last week(s), outcome of discussions within the meetings, plans for the next week, deliverables...>

End-of-thesis Checkpoints

Once you are finished with your thesis, collect all of your simulation output files (.sca, .vec) in `scratch-shared/` and remove all of the output files which are not used in the final written thesis. Create a `README.txt` documenting the points below.

task

Add thesis to our BibDB

Final git commit (hash) for the developed simulation code/model. Create a branch called `thesis-final`

Final git commit (hash) for the scripts used to parse the raw data to obtain the csvs; include the command for starting the scripts; Cr

Directory location and structure of the result files and parsed files (if applicable)

Final SVN commit for the written thesis, the final presentation

Final git commit (hash) for the scripts used for plotting in the final written thesis; Create a branch called `thesis-final`

Copy all documents (proposal, thesis, pptx) to SVN:/theses/tkn/<year>.<thesis-type>.<bibtexkey>

After fulfilling the tasks, report the information to your supervisor via email and they will update the status column.

For the supervisor: Check *After the thesis is submitted* point in How to supervise a thesis page