

Review of dissertation thesis

Author of the Thesis: **Tomas Bravenec**

Title of the Thesis: **Exploiting Wireless Communications for Localization: Beyond Fingerprinting**

Reviewer of the Thesis: **Maria Cristina Rodriguez Sanchez, Universidad Rey Juan Carlos, Ciencia e Ingeniería de los Materiales y Tecnología Electrónica (Spain)**

Theoretical framework and bibliography:

The bibliographic review and the theoretical framework are correct, covering different works to contextualize the objective of the thesis adequately.

Novelty of the topic:

The thesis focuses on privacy in IPS, especially on non-cooperative tracking of users through regular Wi-Fi wireless communications, highlighting the identification capability even with common MAC address randomization practices.

The thesis presents an algorithm for estimating room occupancy based on passive "eavesdropping" of Wi-Fi management frames, using received signal strength (RSSI) as an indicator. The usefulness of this approach for smart building energy regulation is highlighted.

In addition, methods for reducing the computational requirements of machine learning and indoor positioning algorithms are explored. A significant reduction in the memory requirements of neural networks is achieved through changes in the data type of the weights, and interpolation techniques are investigated to improve the accuracy of fingerprinting methods in IPS.

The work concludes with the availability of data sets and tools for future research, improving the reproducibility of the study. In summary, as a conclusion, the research provides a comprehensive overview of non-cooperative user tracking, presence detection, and occupancy estimation, along with optimizations in machine learning algorithms and indoor positioning by RSSI fingerprinting.

Methodology:

The methodology and work seem adequate. But always in this type of work, I wonder why only WI-FI is evaluated, and other methodologies such as BLE, UWB, and even other low-power communication technologies are not evaluated in parallel. Also, it would be interesting to take into account factors related to the environmental conditions of the surroundings, environmental pollution, presence of smoke, and other factors that could affect the signals.

It would be interesting to identify whether the results would facilitate the integration of the location to generate routes based on that location.

Regarding the issue of statistical type data analysis, if only the training data set is used for training and the evaluation is performed exclusively on the test set, there is no risk of overfitting, because if good predictions are made, they are based on observations that it has never seen before (i.e., these

data have not been used to minimize error). If the predictions are not good, it is clear that the model generalizes poorly. The risk of overfitting arises when adjusting the hyperparameters to perform well on the training set, which could lead to poor generalization. However, this information is available from evaluations on the test set.

On unbalanced data: this does not apply in this case because there are no categorical variables. An example would be to predict something for "people" and in the data between.

Relevance of the results:

There are several scientific publications with impact index. Some are in highly relevant congresses, but of the papers presented, there is one of high percentile, another one also from the SENSORS journal, and the last one from the last quartile. The articles are of great interest for the topic of indoor positioning, and being a doctoral thesis that has taken a period so tight and so well profiled, I can value as very positive these results and the ability of the doctoral student to take them to publication during this period that has lasted his doctoral thesis.

He emphasizes from the publications that the work team has always been very similar, which reflects that he has a great capacity to work with the same team to carry out the results of the evaluation and dissemination of his thesis.

It would be appreciated if the contribution of the main author (the doctoral student) and the other authors of these publications could be explained in some way. It would also be interesting if you could indicate which stays have resulted in these publications, if so.

Evaluation:

The thesis comprehensively addresses several crucial aspects in the field of indoor localization and associated privacy, presenting significant contributions in presence detection, room tracking and occupancy, as well as optimizations in machine learning and indoor positioning algorithms. The inclusion of community-accessible datasets and tools reinforces the reproducibility and continuity of research in this field.

Another analysis of the study comprehensively addresses the influence of interpolation on the accuracy of an indoor positioning system based on neural networks. The choice of a simple NN and the evaluation of several alternatives provide a comprehensive overview. The discussion of quantization and interpolation highlights the importance of considering the trade-off between accuracy and efficiency in the implementation of positioning systems.

I would also like to highlight that the work addresses crucial issues in machine learning and indoor positioning such as exploring accuracy reductions in ML models by providing useful insight on how to balance hardware requirements with model accuracy. In addition, optimizations in radio map construction demonstrate practical approaches to improve efficiency in data collection and location inference in indoor environments. Overall, the work presents valuable contributions and effectively answers the research questions posed.

Regarding future lines, it would be interesting to consider delving into future lines related to risk or emergencies. Exploring how indoor location technology can play a crucial role in emergency scenarios, such as rescues or evacuations, could offer practical applications and significant benefits for public safety. Furthermore, investigating stress measures in rescue situations, or specific contexts such as exam preparation, could broaden the application of the proposed solutions to more diverse situations.

Additionally, considering the integration of technology in the monitoring of rehabilitation therapies could be a valuable line of research. Exploring how indoor location systems can contribute to monitoring and support in rehabilitation processes, especially in home settings, could have a significant impact on the healthcare field.

These suggestions could further enrich the relevance and applicability of the research, broadening its scope into key areas such as emergency safety and personal well-being in stressful situations.

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Place and Date

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Signature