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Abstract

The problem

Our proposal

State of the art approaches for fingerprints collection use neural networks, Bayesian and Kalman filtering, human step prediction and other complex techniques.

The abstract is a short summary of your dissertation, usually about 150–300 words long. You should write it at the very end, when you've completed the rest of the dissertation. In the abstract, make sure to:

- State the main topic and aims of your research
- Describe the methods you used
- Summarize the main results
- State your conclusions

Although the abstract is very short, it's the first part (and sometimes the only part) of your dissertation that people will read, so it's important that you get it right. If you're struggling to write a strong abstract, read our guide on how to write an abstract. <https://www.scribbr.com/dissertation/abstract/>

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Introduction

In the introduction, you set up your dissertation's topic, purpose, and relevance, and tell the reader what to expect in the rest of the dissertation. The introduction should:

- Establish your research topic, giving necessary background information to contextualize your work
- Narrow down the focus and define the scope of the research
- Discuss the state of existing research on the topic, showing your work's relevance to a broader problem or debate
- Clearly state your research questions and objectives
- Give an overview of your dissertation's structure

Everything in the introduction should be clear, engaging, and relevant to your research. By the end, the reader should understand the what, why and how of your research. If you need more help, read our guide on how to write a dissertation introduction.

Objectives

We want to create a framework for collecting database of fingerprints (magnetic, WiFi, BLE and others).

Because the approach is SLAM, it may be considered from both sides: as a mapping tool and as a localization product. We have to satisfy criteria for both of them.

Criteria for the system proposed:

- can be implemented locally
- no special hardware for operation
- positioning accuracy enough for operation (1-2m depending on requirements)
- cost, complexity, accuracy, time of development

Hypotheses:

1. Current systems on the market (WiFi, BLE) are not suitable for standalone applications in common use-case.
2. Competitive technology of magnetic field navigation may be implemented and fine-tuned for several common use-cases.

Literature review / Theoretical framework

Indoor navigation solutions are a wide range of products and services. While "indoor routing" functionality that guides people through the buildings is important, there are lots of services that support it, such as content management system, mobile and web applications, indoor and outdoor localization, social networks, data analytics, and many others.

Indoor positioning systems is a growing industry with hundreds of applications. Different applications from security applications and assets tracking in business and manufacturing to the proximity advertising in retail. From fully protected to broadcast solutions, from cheap high range proximity to high precision solutions in robotics.

Different applications have different technologies behind it. Over 15-20 different working technologies are known. Only 3 of them are widely used now (WiFi, Bluetooth Low Energy, Image-Based).

Table 1. technology comparison

IPS Technology	Type	Accuracy, m	Scalability	Complexity	Cost
Geomagnetic	fingerprinting	2	Low	Low	Very Low
Photo	camera	1-10	Low	High	High
Barcodes	camera	1-10	Medium	Low	Low
Video, AR	camera	1-10	Low	High	High
Bluetooth Low Energy (BLE)	Radio	1-3	High	Medium	Medium
RFID, Active	Radio	1-10	Medium	Medium	Medium

RFID Technology	Type	Accuracy, m	Scalability	Complexity	Cost
Wi-Fi	Radio	5-10	High	Medium	Low
Ultra Wide Band (UWB)	Radio	0.15-0.5	Low	Medium	Medium to Low
Zigbee	Radio	3-5	Low	Low	Low
FM		2-4	Low	Low	Low
Lighting-Based – Infrared LED	Lighting	0.15-3	Low	Low	Low
Lighting-Based – Visible LED	Lighting	0.3-3	Low	Low	Low
Audible	sonic	0.5	Low	Low	Low
Ultrasound	sonic	0.05-0.25	Low	Medium	Low to Medium
Inertial	supplementary		Low	Low	
Pressure	supplementary				
GPS	supplementary	6-10	Low	High	

Relevant publications:

- RinQ Fingerprinting: Recurrence-Informed Quantile Networks for Magnetic Resonance Fingerprinting https://link.springer.com/chapter/10.1007/978-3-030-32248-9_11
- Scene-LSTM: A Model for Human Trajectory Prediction <https://arxiv.org/pdf/1808.04018.pdf>
- Magnetic Resonance Fingerprinting using Recurrent Neural Networks <https://paperswithcode.com/paper/magnetic-resonance-fingerprinting-using>
- Multicompartment Magnetic Resonance Fingerprinting <https://arxiv.org/pdf/1802.10492.pdf>
- Magnetic resonance fingerprinting https://mrquestions.com/uploads/3/4/5/7/34572113/mr_fingerprinting_nature11971.pdf

- Collecting sources (e.g. books and journal articles) and selecting the most relevant ones
- Critically evaluating and analyzing each source
- Drawing connections between them (e.g. themes, patterns, conflicts, gaps) to make an overall point

develop a coherent structure and argument that leads to a clear basis or justification for your own research. For example, it might aim to show how your research:

- Addresses a gap in the literature
- Takes a new theoretical or methodological approach to the topic
- Proposes a solution to an unresolved problem
- Advances a theoretical debate

- Builds on and strengthens existing knowledge with new data

The literature review often becomes the basis for a theoretical framework, in which you define and analyze the key theories, concepts and models that frame your research. In this section you can answer descriptive research questions about the relationship between concepts or variables.

TODO

define and analyze the key theories, concepts and models that frame your research

Methodology / theoretical framework

- A statement of the methodology for the thesis project that defines the specific design of the procedures, data collection, analysis, and (or) interpretation. Illustrate how the method you have chosen best allows you to fulfill the purpose of the thesis project.
- A description of techniques to be used for the development of the thesis product, including specific software tools, programming languages, or other appropriate techniques.

Preparation landscape research

First, we define the current state of the art, we build the model for existing technologies, analyze products on the market, list key players and IP owners, create Pareto frontier. This part is intended to make a visible and understandable landscape of this technology segment.

Procedures list

- Collection of magnetic fingerprints database with smartphone sensors: Gyroscope, compass, IMU.
- Implementation of localization model
- Experiments using model, estimation of accuracy
- Implementation of possible techniques, benchmarking
- SLAM model development, re-localization technique, map-merging
- Fine-tuning of SLAM model
- Comparison to other products, interpretation of results

There are several enhancements of technology we want to implement:

- Relocalization technique (air imaging approach) >> improve mapping
- Kalman filters for the dead reckoning (extended Kalman filter) >> improve stability
- Bayesian methods of user coordinate prediction >> improve localization
- Smartphone-based magnetic fingerprinting (usual approach) >> infrastructure-free navigation system

We use data of Microsoft competition as a starting reference (D. Lymberopoulos, J. Liu, X. Yang, R. Choudhury, V. Handziski, S. Sen, F. Lemic, J. Buesch, Z. Jiang, H. Zou, H. Jiang, C. Zhang, A. Ashok, C. Xu, P. Lazik, N. Rajagopal, A. Rowe, A. Ghose, N. Ahmed, and P. Hevesi, "A realistic evaluation and comparison of indoor location technologies: Experiences and lessons learned," 04 2015.).

Results

Discussion

Conclusion

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