UNIVERSITATEA POLITEHNICA BUCUREȘTI

FACULTATEA DE AUTOMATICĂ ȘI CALCULATOARE

DEPARTAMENTUL CALCULATOARE

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PROIECT DE DISERTAȚIE

Titlul proiectului de diplomă (ex: Șablon proiect de diplomă)

Subtitlu (ex: versiunea 2018)

Enache Andrei-George

**Coordonator științific:**

Șl. dr. ing. Rădoi Emilian

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2023

UNIVERSITY POLITEHNICA OF BUCHAREST

FACULTY OF AUTOMATIC CONTROL AND COMPUTERS

COMPUTER SCIENCE DEPARTMENT

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MASTER THESIS

Diploma Project Title (eg: Diploma project template)

Subtitle (eg: 2018 version)

Enache Andrei-George

**Thesis advisor:**

Șl. dr. ing. Rădoi Emilian

BUCHAREST

2023

**CUPRINS**

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# Sinopsis

Sinopsisul proiectului are rol de introducere, conținând atât o descriere pe scurt a problemei abordate cât și o enumerare sumară a rezultatelor și a concluziilor. Se recomandă ca sinopsisul să fie redactat într-un limbaj accesibil unei persoane nefamiliarizate cu domeniul, dar în același timp destul de specific pentru a oferi rapid o vedere de ansamblu asupra proiectului prezentat.

Sinopsisul proiectului va fi redactat atât în română cât și în engleză. Ca dimensiunea recomandată aceasta secțiune va avea maxim 200 de cuvinte pentru fiecare variantă. Împreună, ambele variante se vor încadra într-o singură pagină.

# Abstract

The abstract has an introductory role and should engulf both a brief description of the issue at hand, as well as an overview of the obtained results and conclusions. The abstract should be formulated such that even somebody that is unfamiliar with the projects’ domain can grasp the objectives of the thesis while, at the same time, retaining a specificity level offering a bird’s eye view of the project.

The projects’ abstract will be elaborated in both Romanian and English. The recommended size for this section is limited to 200 words for each version. Together, both versions will fit in one page.

# IntroDUCTION

Indoor localization represents the capability of detecting objects or people inside covered buildings, places where in most cases the GPS signal is weak or non-existent [1], it being limited to outdoor areas where the signal strength of the satellites is stronger, thus having good enough coverage only in open spaces. This is why people had to come with new ideas of detecting objects without the need of GPS, so additional technologies have started to emerge.

## Context

Indoor localization is achieved using multiple indoor positioning systems (IPS), those being passive or active, consisting of networks of interconnected sensors and devices that generate data that can be used to estimate the position of an item in the real world relative to predetermined fixed points.

Some of the main areas where this type of navigation could improve our lives are:

* Smart workplaces – using this technology, the employees could find each other with ease or could find key points in the building (meeting rooms, utilities, their colleague’s location), in this way enhancing the company’s productivity and security. Also, the companies could create floor heatmaps of the most popular places to improve the quality of the work environment (additional disinfection, improving or remodeling the areas with poor traffic);
* Airports – using indoor localization, travelers could easily find points of interest that might otherwise be harder to find (luggage lanes, available check-in points, shops, restaurants, bathrooms) and they could also be guided effectively to their designated gateway, thus avoiding mistakes, and lowering the probability of missed flights caused by the plane departing from other lanes than the initial ones;
* Retail stores – with the help of indoor localization, customers could easily find the target stores that they want to reach, and they can also access a personalized route depending on their shopping preferences/habits. Stores could also introduce personalized ads based on the users once they are approaching them or are nearby. In addition, in the case of malls, they could also implement customized strategies based on the flow of people and the areas most visited by them, thus being able to optimize the resources allocated to increase profits;
* Assistance systems for people with disabilities – through an indoor navigation system, people with special needs could have it much easier to find different areas or products, without the need of a special person to guide them, it would also lower the effort needed to establish the surrounding environment;
* Universities – with the help of indoor localization systems, it would be much easier to students who are not yet familiar with the university’s layout to find their classrooms and laboratories, being especially helpful for persons who must be in different places within short timeframes. It could also help visitors to find the important attractions in case of events like tech fairs or job finding events organized by companies;
* Other locations and events with many people, where finding others is difficult due to the lack of an exact positioning in space (festivals, concerts, sport events).

Taking into consideration the tremendous advancements of the smartphone devices, with their integrated sensors and processing power, but also their high availability to a majority of the population, many new technologies and algorithms have emerged in order to resolve the issue at hand and it’s multitude of possibilities, making mobile devices the perfect tool for indoor positioning applications.

## Problem

Due to the inability to provide an accurate position inside buildings with the help of global positioning systems, it is necessary to use other types of technologies that can be implemented for indoor localization, such as radio frequencies, light waves, acoustic waves, images, or internal mechanical systems (Figura 1) [2].

Diagram

Description automatically generated

Figura 1. Categorization of the technologies used for idoor positioning, image taken from [2]

Each of the technologies shown in Figure 1 has it’s own unique characteristics, capabilities and restrictions, their usage being highly influenced by several factors, such as the element to be located, the device that verifies the location, the size of the area checked, etc. Considering all those factors, many devices and services are developed in order to make location based applications perform as highly accurate as possible, ranging from mobile helper robots in factories to product searching applications inside retail stores.

While this is a highly researched domain and great efforts have been made in order to increase the precision of the indoor positioning, especially for smartphone-based applications, there are still not enough large scale high accuracy localization algorithms that could be easily implemented in different types of locations and dynamic environments without extensive data mapping or adding new infrastructure.

## Objectives

This paper aims to present the research of a smartphone-based deep learning interior localization algorithm that uses the data from its integrated inertial and Wi-Fi sensors. We will analyze the effectiveness and performances of deep learning algorithms for the issue at hand, will compare and evaluate the accuracy and the reliability of the used algorithms in the context of indoor positioning and will enhance the presented models in order to achieve a higher result accuracy.

To validate the proposed algorithms against existing state-of-the-art approaches for indoor positioning and highlight their advantages and potential improvements.

With this objective in mind, we will present the used data and its processing, but also the algorithms used to estimate the user’s position, their implementation and the final results.

By doing this, we hope to further advance the research for a future highly-accurate, reliable and easy to implement smartphone-based indoor localization method that could help humans eliminate the constraints of indoor positioning systems.

## Structure

This paper is organized as follows. In Chapter 2 we will present the State of the art for the indoor localization field

# RELATED WORK

Acest capitol va analiza cerințele produsului din prisma potențialilor clienți și a scenariilor de utilizare preconizate, urmând a fi generată o lista de funcționalități.

# METHOD

Ce soluții similare există pe piață? Care sunt limitările lor / pentru ce cazuri de utilizare sau pentru ce tip de clienți produsele existente pe piață nu răspund cerințelor? Care sunt indicatorii pe baza cărora sunt evaluate aceste produse, de către potențiali clienți, și unde sunt lipsurile/ care este oportunitatea generată de lipsurile acestea?

# IMPLEMENTATION

Ce soluții similare există pe piață? Care sunt limitările lor / pentru ce cazuri de utilizare sau pentru ce tip de clienți produsele existente pe piață nu răspund cerințelor? Care sunt indicatorii pe baza cărora sunt evaluate aceste produse, de către potențiali clienți, și unde sunt lipsurile/ care este oportunitatea generată de lipsurile acestea?

# RESULTS

Acest capitol trebuie să răspundă, în principiu, la **2 întrebări** și să se încheie cu **o discuție** a rezultatelor obținute. Cele doua întrebări la care trebuie sa se răspundă sunt:

# Concluzii

În acest capitol este sumarizat întreg proiectul, de la obiective, la implementare, si la relevanta rezultatelor obținute. În finalul capitolului poate exista o subsecțiune de „Dezvoltări ulterioare“.  
Criterii pentru calificativul *Nesatisfăcător*:

# Bibliografie

|  |  |
| --- | --- |
| [1] | M. Chelly și N. Samama, „New techniques for indoor positioning, combining deterministic and estimation methods,” în *ENC-GNSS 2009: European Navigation Conference - Global Navigation Satellite Systems*, Naples, Italy, 2009. |
| [2] | S. Subedi și J.-Y. Pyun, „A Survey of Smartphone-Based Indoor Positioning System Using RF-Based Wireless Technologies,” *Sensors,* nr. 2020, 17 December 2020. |

# Anexe

Anexele sunt opționale.

Ce poate intra în anexe:

* Exemplu de fișier de configurare sau compilare;
* Un tabel mai mare de ½ pagină;
* O figura mai mare mai mare de ½ pagină;
* O secvență de cod sursa mai mare de ½ pagină;
* Un set de capturi de ecran („screenshot”-uri);
* Un exemplu de rulare a unor comenzi plus rezultatul („output”-ul) acestora;
* În anexe intră lucruri care ocupă mai mult de o pagină ce ar întrerupe firul natural de parcurgere al textului.