Pi2 project proposal

Hugo ALATRISTA-SALAS / Sonia DJEBALI

# Analyzing Indoor Movement Patterns via Raspberry Pi Network

## 1 Motivation and objectif

Understanding how people move through physical spaces is becoming increasingly valuable in the age of ubiquitous connectivity and intelligent systems. Whether students navigate the halls of a university or customers browsing a shopping mall, their journeys tell a story that can inform design, improve services, and create more efficient environments.

This project focuses on developing an indoor circulation graph using Internet of Things (IoT) devices. A circulation graph is a dynamic graph that models the flow or movement of entities through a network over time. In the context of indoor spaces, nodes represent physical locations (e.g., hallways, classrooms, or stores), and edges represent detected transitions or movement flows between these locations.

The objective of this Pi2 project is twofold. First, to develop a Raspberry Pi-based network of sniffing devices for capturing Wi-Fi and Bluetooth packets. Second, to design and implement a Python-based prototype capable of analyzing and visualizing spatio-temporal behavioral patterns extracted from a circulation graph constructed using data from the sniffing devices. This system will enable the identification of high-traffic zones and reveal the temporal dynamics of movement between key areas.

## 2 Methodology

The first step in this exploration will be to turn Raspberry Pi devices into sniffers capable of detecting Wi-Fi or Bluetooth signals from nearby smartphones [**?**, **?**]. Using Python and libraries such as *scapy* or *Pi Sniffer*, students will develop a prototype that listens to ambient wireless traffic and logs anonymized data about device presence. This data will include elements like MAC addresses (anonymized or hashed), timestamps, and the identity of the sniffer that captured the packet.

Once the basic functionality is in place, the system must be tested in a controlled environment. This phase will allow students to assess the effective range of detection, the impact of obstacles, and the consistency of data capture [**?**]. This step is crucial for understanding the limitations and practical realities of passive sniffing.

With validated sniffers in hand, the next challenge will be scaling up. Then, students will work to design and deploy a network of these devices across selected indoor locations, for example, in classrooms in a university building or corridors in a mall. The devices will need to communicate with each other or a central server. Time synchronization will be critical to maintaining network coherence, so NTP can be used to align clocks across devices.

Data obtained by the sniffer should then be stored in a centralized database (like *SQLite3* or *MySQL*), a *MongoDB* database, or even a cloud-based solution. The proposal should be able to store raw packets, as well as derived transitions between sniffers (indicating user movement). From this structure, the circulation graph will begin to take form.

The graph will be built using Python-based graph libraries such as *networkx* or *igraph*. Each zone a sniffer covers will be a node in the graph, and edges will represent detected movements [**?**, **?**]. With this structure in place, students will have a powerful tool to explore mobility patterns [**?**].

# 3 Summary

- Title: Analyzing Indoor Movement Patterns via Raspberry Pi Network.
- Project duration: ∼6 months.
- Supervisor(s): Hugo ALATRISTA-SALAS / Sonia DJEBALI
- Tools to be used: Python, Sqlite3/MySQL/MongoDB, Raspbian or Kali OS etc.
- Place where the project will be carried out: Pôle Universitaire Léonard de Vinci / STARCS research team.

# References


[1] Sudarshan Anand, Krishnendra Shekhawat, Karan Agrawal, et al. Automated generation of circulations within a floorplan. *AI EDAM*, 39:e9, 2025.

[2] Arash Bahrehmand, Alun Evans, and Josep Blat. A computational metric of the quality of circulation in interior spaces. In *2014 International Conference on Information Visualization Theory and Applications (IVAPP)*, pages 130–137. IEEE, 2014.

[3] Jin-kook Lee, Charles M Eastman, Jaemin Lee, Matti Kannala, and Yeon-suk Jeong. Computing walking distances within buildings using the universal circulation network. *Environment and Planning B: Planning and Design*, 37(4):628–645, 2010.

[4] Yan Li, Johan Barthelemy, Shuai Sun, Pascal Perez, and Bill Moran. A case study of wifi sniffing performance evaluation. *IEEE Access*, 8:129224–129235, 2020.

[5] ABM Musa and Jakob Eriksson. Tracking unmodified smartphones using wi-fi monitors. In *Proceedings of the 10th ACM conference on embedded network sensor systems*, pages 281–294, 2012.

[6] Yusuf Turk, Onur Demir, and Sezer Gören. Real time wireless packet monitoring with raspberry pi sniffer. In *Information Sciences and Systems 2014: Proceedings of the 29th International Symposium on Computer and Information Sciences*, pages 185–192. Springer, 2014.