Tremplin Recherche 2025/2026 – Project Proposal

Project title
Talking Devices: Using Sound for Communication and Distance Measurement Between Smartphones

Laboratory / Institution
AME- GEOLOC Laboratory – Université Gustave Eiffel (Nantes campus)

Supervisor (name and email)
Dr. Pavel PASCACIO DE LOS SANTOS – pavel.pascacio-de-los-santos@univ-eiffel.fr

Targeted students
Level: E5 (M2)
Specializations:
Intelligent Electronic Systems
Artificial Intelligence & Cybersecurity
Data Science & Artificial Intelligence

Possibility of continuation as internship
Yes — a 6-month internship in our laboratory is offered from February 2026.

General presentation of the topic
Acoustic signals, beyond voice and music transmission, can be used for positioning by correlating signal propagation with the distance between transmitter and receiver. They also enable the transmission of positioning data using encoding techniques such as Frequency Shift Keying (FSK) or Phase Shift Keying (PSK).

Acoustic-based positioning can achieve centimetre-level accuracy in line-of-sight (LOS) conditions [1], avoids identity disclosure (e.g., MAC addresses), and leverages existing mobile devices, reducing infrastructure needs. This makes it a promising method to enhance positioning accuracy for navigation systems, i.e., based on Pedestrian Dead Reckoning (PDR. However, challenges remain: certain audible frequencies and encoding techniques may cause noise disturbances, synchronization issues arise in multi-device networks, and accuracy degrades over distance. Moreover, environmental noise and non-line-of-sight (NLOS) conditions [3] further reduce reliability.

This project will study and address these challenges by implementing a minimal communication protocol and a baseline for distance estimation using acoustic signals and machine learning to explore possible mitigation strategies.

Project objectives
Baseline development:

– Implement a minimum baseline for offline distance estimation using acoustic signals and machine learning, generating diverse signals and analyzing their accuracy under LOS and NLOS conditions.

Protocol implementation:
– Develop a minimal offline acoustic-based data communication protocol in Python, focusing on multi-device synchronization and low audible noise.

Work plan:

1. Review encoding/decoding techniques and acoustic distance estimation.
2. Design, implement, and evaluate acoustic-based ML distance estimation.
3. Design, implement, and evaluate the communication protocol.
4. Document result

Expected learning outcomes:
– Machine learning for acoustic positioning.
– Acoustic distance estimation techniques.
– Digital data transmission over audio.
– Experiment design and evaluation methodology.

Bibliography

[1] Tan, Caiming, et al. "A low-cost centimetre-level acoustic localisation system without time synchronisation." Measurement 78 (2016): 73-82.
[2] Mita, Yukiya, et al. "Geometric Sound Profile: Multipath-Time-of-Flight Fingerprint for High-Accuracy Acoustic Localisation." IPIN 2024. IEEE, 2024.
[3] Gu, Yanying, Anthony Lo, and Ignas Niemegeers. "A survey of indoor positioning systems for wireless personal networks." IEEE Communications Surveys & Tutorials 11.1 (2009): 13-32.