

**TITRE DE LA THESE : SUMMA-Sound**  
**Summarization of activities of daily living using sound-based activity recognition**

**Direction de thèse : Christophe Lohr**

**Co-encadrant·es : Andries Mihai,**  
**Plinio Moreno, Alexandre Bernardino (ULisboa)**

**Laboratoire(s) : Lab-STICC**

**Equipe(s) de recherche : RAMBO**

**Département(s) IMT Atlantique : Département Informatique**

**S'agit-il d'une thèse en cotutelle internationale ? Oui**

Si oui, organisme avec lequel la cotutelle est envisagée :

**Instituto Superior Técnico (Lisbonne, Portugal)**

**Le sujet proposé présente-il un caractère interdisciplinaire ? Non**

Si oui, expliquer brièvement pourquoi (2 ou 3 lignes) :

**La source du co-financement est-elle identifiée ? Oui**

Si oui, préciser quel co-financement est envisagé :

**Bourse Instituto Superior Técnico**

**Autres informations :**

Informations utiles que vous souhaiteriez communiquer (si pertinent) :

**Contexte ou état de l'art scientifique :**

*Décrire en 5 à 10 lignes le contexte de la thèse.*

**Scientific question:** How to collect and summarize domestic health-related data relevant for medical diagnosis, in a non-intrusive manner using audio information?

This research addresses the lack of existing practical tools for providing high-level succinct information to medical staff on the evolution of patients they follow for health diagnostic purposes. This research is based on the assumption that valuable diagnostic data can be collected by observing short- and long-term lifestyle changes and behavioural anomalies. It relies on the latest advances in the domains of audio-based activity recognition, summarization of human activity, and health diagnosis.

Research on health diagnosis in domestic environments has already explored a variety of sensors and modalities for gathering data on human health indicators [5]. Nevertheless, audio-based activity recognition is notable for its less intrusive nature. Employing state-of-the-art sound-based activity recognition models [2] to monitor domestic human activity, the thesis will investigate and develop

methods for summarization of human activity [3] in a human-understandable language, in order to produce easily interpretable data by doctors who, remotely, monitor their patients [4]. This work continues and fosters the research of the RAMBO team at IMT Atlantique on ambient systems, enabling well ageing at home for the elderly adults or dependent populations [1].

### **Objectifs de la thèse :**

*Décrire en 10 à 15 lignes les résultats attendus.*

**Expected social and economic impact:** We expect this thesis to provide technology likely to relieve the burden on gerontologists and elderly-care facilities, alleviate somehow the caregiver shortage by offering some automatic support to the task of monitoring elderly or handicapped people, enabling them to age-at-home while still being followed by medical specialists using automated means. With our partners from board and care homes for seniors and geriatric centers (Pôle gériatrie CHRU Brest, Liga Dos Amigos Da Terceira Idade Setubal, Residencia Senior de Belverde), we will be able to perform real-life validations of the developed activity recognition and summarization models. The thesis will be organised in the following steps: (1) Definition of pertinent sounds and activities for health diagnosis, (2) Hardware set-up, (3) Dataset constitution, (4) Activity recognition, (5) Diarization of activities, (6) Summarization, (7) Validation in a real environment.

**Scientific goals:** (1) Determine the set of human activities relevant for health diagnosis, (2) Implement a state-of-the-art model for audio-based activity recognition and validate its function by clinicians, (3) Develop a model for summarizing the evolution of human activity over time intervals of arbitrary duration (typically spanning from days to months and possibly years).  
Outcomes of the PhD: (1) A model for semantic summarization of human activity, based on sound recognition of activities of daily living. (2) A proof of concept for this model.

### **References**

- [1] Damien Bouchabou. “Human activity recognition in smart homes : tackling data variability using context-dependent deep learning, transfer learning and data synthesis”. Theses. Ecole nationale supérieure Mines-Télécom Atlantique, May 2022. url: <https://theses.hal.science/tel-03728064>.
- [2] Detection and Classification of Acoustic Scenes and Events (DCASE). url: <https://dcase.community/challenge2022/task-sound-event-detection-in-domestic-environments> (visited on 07/01/2022).
- [3] P Durga et al. “When less is better: A summarization technique that enhances clinical effectiveness of data”. In: Proceedings of the 2018 International Conference on Digital Health. 2018, pp. 116–120.
- [4] Akshay Jain et al. “Linguistic summarization of in-home sensor data”. In: Journal of Biomedical Informatics 96 (2019), p. 103240. issn: 1532-0464.
- [5] Mostafa Haghi Kashani et al. “A systematic review of IoT in healthcare: Applications, techniques, and trends”. In: Journal of Network and Computer Applications 192 (2021), p. 103164.

### **Compétences attendues du ou de la candidat·e :**

Lister les principales compétences nécessaires pour ce sujet de thèse.

- Programming and Software Engineering skills (Python, Git, Software Architecture Design)
- Data science skills
- Machine learning skills