

PhD. Thesis

Travel assistance for visually impaired people based on computer vision

Summary

- Subject: “Travel assistance for visually impaired people based on computer vision”
- Keywords: Assistive Technologies, Visual Impairment, Computer Vision, Image Captioning, Ambient Systems
- Research Unit: Lab-STICC (UMR CNRS 6285)
- Team: RAMBO - Robot interaction, Ambient system, Machine learning, Behaviour, Optimization
- Location: IMT Atlantique, Brest site
- Start: October November 2022
- Duration: 3 years
- Supervision: Christophe Lohr, Panagiotis Papadakis

Project Description

The objective of this thesis is to develop a technical solution to help visually impaired people move around. Two aspects will be explored: on the one hand, computer vision problems and, on the other hand, problems of open cooperation between ambient and robotic systems.

The first part of the study deals with the problem of *image captioning*. This computer vision discipline aims to automatically construct a textual description from an image [2]. It includes various AI paradigms such as image segmentation and pattern recognition. This problematic will be linked to issues of embedded machine learning, running on constrained hardware. The ambition is that, thanks to the developed system, a visually impaired user visiting a place of interest can obtain a description of the scene around her/him, with a level of precision and chosen point of interest [1, 3]. The level of description provided should enable the user to consciously choose his destination, where she/he can go by managing the path in the usual way.

A needs analysis can guide the scope and areas to study: indoors, outdoors, points of interest to be made explicit (type of obstacles, terrain, signs and directions, etc.), interaction methods to be provided (e.g. vocalization, level of speech and vocabulary according to the domain of use, etc.), the type of equipment to be envisaged (e.g. equipment carried by the user or a companion robot). The aim is therefore to contribute to these AI issues, and to pay particular attention to the targeted use cases. The overall ambition is to provide a technical aid that promotes the autonomy of people having a partial or total visual impairment. Also, time for exchange with user representatives is planned throughout the project, whether in the needs definition phase or for functional validation and acceptability tests.

The second part of the study focuses on knowledge sharing in the context of machine learning, in this case the description of a scene, between an embedded vision system and a connected building. To speed up and streamline the service provided, the vision system can obtain from ambient devices (e.g. a database on the local area network of the place visited) descriptions of the place that have already been developed in the past by previous users' systems, and contribute to this in turn. By open collaboration, we mean here that these different devices belong to disjointed systems, without prior mutual knowledge, and without presuppositions about the level of reliability of the deposited information. It

will be necessary, on the one hand, to propose mechanisms for versioning the information provided by each of them and, on the other hand, to adapt the image captioning algorithms to take account of uncertain information to be confirmed.

Research Environment

Assistive technologies can be a response to the desire of frail (elderly, disabled) people to frail people (elderly, disabled) to regain more autonomy in their daily lives. In this context, the RAMBO team of the Lab-STICC carries out a variety of work within the Maintain at Home Chair (MaD), co-founded with ENSIBS. These include solutions for the interoperability of home automation equipment, algorithms for the recognition and analysis of human activity recognition, the development of mobile robotic devices, mapping and navigation for robots, artificial intelligence, etc. This work has been the subject of prototypes and experiments within our living lab Experiment'HAAL, a privileged place to develop and validate our proposals.

The Handicap Innovation Territory project (HIT) aims to develop technical, social and organizational measures to promote the integration of people with disabilities handicap in the territory of Lorient agglomeration. Winner of the call for national projects Territories of Innovation, this project developed over 8 years (2020-2027) is managed by Lorient Agglomeration in collaboration with the Kerpape Functional and Rehabilitation Center and Biotech Santé Bretagne and brings together 87 partners, including IMT Atlantique. The thesis project proposed here is Operation 4.2.5 of the HIT project.

Application

The candidate must hold (or is about to obtain) a Master Degree in Computer Science with theoretical and practical skills in AI algorithms and associated tools (e.g. Pytorch), and a good background in Computer Vision. The candidate should be fluent in English (working and publishing main language), but French speaking is an advantage (meetings with end-users representatives).

A detailed application will be addressed to Christophe.Lohr@imt-atlantique.fr and Panagiotis.Papadakis@imt-atlantique.fr, including a cover letter, an up-to-date CV, transcripts of grades (last two years) and reference letters if any.

References

- [1] Pierre Dognin et al. “Image Captioning as an Assistive Technology: Lessons Learned from VizWiz 2020 Challenge”. In: *J. Artif. Int. Res.* 73 (May 2022). ISSN: 1076-9757. DOI: 10.1613/jair.1.13113. URL: <https://doi.org/10.1613/jair.1.13113>.
- [2] Virendra Kumar Meghwal, Namita Mittal, and Girdhari Singh. “Image Captioning Methodologies Using Deep Learning: A Review”. In: *Electronic Systems and Intelligent Computing*. Ed. by Pradeep Kumar Mallick et al. Singapore: Springer Singapore, 2020, pp. 507–512. ISBN: 978-981-15-7031-5.
- [3] Chinmayi Rane et al. “Image Captioning based Smart Navigation System for Visually Impaired”. In: *2021 International Conference on Communication information and Computing Technology (ICCICT)*. 2021, pp. 1–5. DOI: 10.1109/ICCICT50803.2021.9510102.