

Travail de Master / 2023

Computer Science - Cybersecurity

**Sound Source Localization and Distance Estimation in Open Environment using Simulation and AI**

Specification

22.02.2023 – Version 0.1

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| Supervisors:  Principal: | **Michael Mäder**  **Beat Wolf**  **ROSAS** |
|  | Logo  Description automatically generated with medium confidence |

**Versions table**

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| **Version** | **Publication Date** | **Author** | **Description** |
| 0.1 | 22.02.2023 | Denis Rosset | Draft of specifications |
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# Introduction

Within the framework of the research project "NPR Teleoperation", the engineers of the HEIA-FR have developed the first concept in Switzerland of a remote-controlled automated vehicle. However, teleoperation only makes sense if the vehicle is automated. There can be no teleoperation without automation (economic factors) just as there can be no automation without teleoperation (legal, technical, and social factors). ROSAS then created the Autovete (Automatisation de véhicules téléopérés) project, financed by HEIA-FR, to build up vehicle automation expertise.

For a vehicle to be fully autonomous, the detection of other emergency vehicles is mandatory. To solve this issue, V2V (Vehicle-to-Vehicle) communication can be used but is not currently used by the emergency vehicles. So, to be able to detect such emergency vehicle, two signals need to be processed: the sound of the emergency siren and the blinking lights of the vehicle. This project focusses only on the sound source distance estimation and localization.

Big improvements in sound source localization with the help machine learning are being made[[1]](#footnote-2) and can be used to reliably localize the origin of a sound using one or more microphone array (multiple microphones operating in tandem).

A non-negligible problem is that the number of real-world datasets with moving sources in open environment is limited or non-existing. A solution is to create the datasets in realistic sound propagation simulation.

To validate and use the model, it should also be tested to see how it react to adversarial attacks, understand how it can be used in a real environment and limit the attack vector, for finally improve the reliability of the system.



Figure 1 Perceptin: An Autonomous Vehicle

# Actors

The following actors are part of the project:

* Denis Rosset, Computer Science student, MSE
* Michael Mäder, Professor in Computer Science at HEIA-FR, Supervisor
* Beat Wolf, Professor in Computer Science at HEIA-FR, Supervisor

# Objectives

## Getting a dataset

Generating a dataset of sounds and relative position which can be used to train a neural network

## Creating a model

Creating a model to predict the position of the source of a sound

## Validating the model

* Test of the model in real life condition
* Analysis of the potential of adversarial attacks against it
* Propositions of improvements of the model to make it more secure and robust

# Tasks

The tasks are divided in three main categories. Data generation, model creation and model validation.

## Dataset generation

* Creation of a simulation to generate a dataset
* Creation of a tool to transform of a sound into a spectrogram
* Interpret and understand data

## Model creation

* Data preparation
* Feature extraction / modelling
* Evaluation
* Model improvement

## Model validation

* Understanding if the model reach objectives
* Analysis of the hardware for real life usage
* Test of the model in real life condition
* Testing the model against adversarial attacks

# Key dates

* 20.02.2023 – Start of the Master Thesis
* 07.07.2023 – Report deposit

# Planning

1. A SURVEY OF SOUND SOURCE LOCALIZATION WITH DEEP LEARNING METHODS (<https://arxiv.org/pdf/2109.03465.pdf>) [↑](#footnote-ref-2)