🎓 Master Thesis Overview

Title: *Acoustic Source Localization in Complex Environments Using Vehicle-Mounted Microphone Arrays*

Institution: Hamburg University of Technology (TUHH)
Research Partner: Valeo GmbH, Germany
Student: Amr Ahmed (M.Sc. Mechatronics Engineering)

🔍 Objective

The aim of this thesis is to develop a robust acoustic source localization framework capable of accurately identifying and tracking sound sources—such as emergency vehicle sirens—in highly complex and dynamic environments. These include **urban traffic conditions**, **reverberant fields**, and scenarios with **moving sources** and **low signal-to-noise ratios (SNR)**.

🧠 Key Contributions

- 📡 **Microphone Array Modeling**: Design and simulation of vehicle-mounted microphone arrays with optimal spatial resolution for urban deployment.
- 🌆 **Realistic Acoustic Modeling**: Modeling of **reverberant sound fields** using impulse response functions and mirror source techniques to reflect real-world conditions like buildings, vehicles, and surfaces.
- 🚗 **Doppler Compensation**: Integration of Doppler effect modeling and de-Dopplerization algorithms to eliminate frequency shifts caused by source motion.
- 🎯 **Advanced Beamforming**: Implementation of adaptive beamforming techniques, including **SC-DAMAS**, to enhance spatial resolution in low-SNR, reverberant environments.
- 🧪 **Experimental Validation**: Dual-phase simulation (indoor reverberation and outdoor motion) followed by physical testing to validate localization accuracy.

🧰 Tools & Technologies

- `MATLAB`, `Python`
- Signal Processing Toolbox
- Adaptive Beamforming Algorithms
- Simulation of Room Acoustics (Mirror Source Method)
- Frequency-Domain & Time-Domain Beamforming

📈 Application Areas

- Emergency siren localization for smart city traffic systems
- Urban noise monitoring and source identification
- Advanced driver-assistance systems (ADAS)
- Acoustic diagnostics for dynamic environments

🌐 Let's Connect

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Note: Full thesis details, methodology, and simulation results will be made public upon successful thesis submission.