



International Research Centre

Innovative Transportation and Production Systems

MSc Research Internship Proposal

« Specialization and multimodal adaptation of YOLOv8 for road detection:
Application to short wave infra-red imaging (SWIR) »

Keywords: SWIR, robotics, artificial perception, computer vision, transfer learning, knowledge distillation

Informations

Laboratory: Université Clermont-Auvergne, Institut Pascal (UMR 6602 CNRS/UCA/SIGMA), ISPR research group (Images, Perception Systems and Robotics). Computer Vision Research Team (ComSee)

 Campus Universitaire des Cézeaux, 4 Avenue Blaise Pascal, 63178 Aubière, France

Supervision: Mathieu Labussière (Associate Professor), Romuald Aufrère (Full Professor), and Alexandre Riffard (PhD Student).

Start of the internship: February/March 2026

Duration: 6 months

Funding: The position is fully funded by the International Research Center (CIR) "Innovation Transportation and Production Systems" (ITPS) of the I-SITE CAP 20-25.. *Monthly gratification is approximately 750€.*

Scientific context

Road detection is critical in many domains: autonomous driving, surveillance, environmental monitoring, infrastructure maintenance. Traditional sensors (visible-light, radar, LiDAR) work well under many conditions but have limitations (lighting, weather, scattering, glare). SWIR (short-wave infra-red) imaging (~900-1700 nm depending on definition) offers advantages: better penetration through haze/fog; improved contrast under certain conditions; less sensitivity to visible light variations. Using SWIR for road detection may improve robustness in adverse conditions.



Fig. 1 - YOLO detections on a SWIR Image

Deep learning models, especially YOLO series, are state of the art for object detection and road-scene tasks. YOLOv8 is among the latest, more efficient and flexible. But most YOLOv8 training is on visible-spectrum datasets. To deploy YOLOv8 on SWIR (or multimodal with SWIR + visible) [1] there is need for **specialization**: adapting the model to the SWIR domain via *fine-tuning, domain adaptation, distillation etc.*

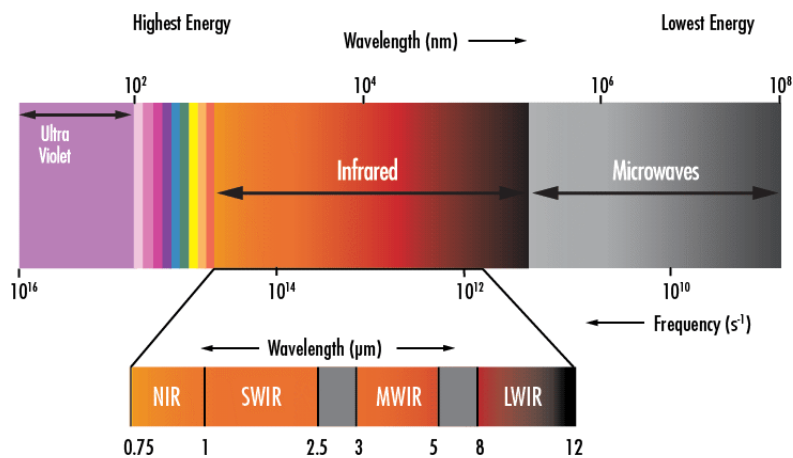


Fig 2. - Electromagnetic Spectrum Illustrating the SWIR Wavelength Range¹

Research Objectives

The internship will focus on the specialization and adaptation of the YOLOv8 model [2] for object detection in road environments, combining RGB and SWIR (Short-Wave Infrared, 0.9–1.7 μm) modalities. The main objective is to improve the robustness of perception systems for autonomous driving under adverse conditions such as night, fog, or rain, where conventional RGB sensors show limitations [1].

This work follows preliminary works conducted on SWIR in the research team and complements the PhD thesis entitled “*Exploitation of a Short-Wave Infrared (SWIR) Sensor in a Fusion Architecture for the Perception of Mobile Robots in Unstructured Environments and Challenging Weather Conditions*”, currently on-going.

The focus will be on adapting YOLOv8n, a real-time object detection model, first to SWIR images and then to fused SWIR+VISIBLE images, addressing challenges related to the scarcity of annotated data and the domain gap between RGB and SWIR [1].

The experimental approach will consist of three main steps:

1. **Reviewing the state of the art** on model specialization methods and analyzing results from the previous internship (e.g., Transfer Learning and Fine-Tuning, Domain Adaptation, **Knowledge Distillation**, etc.)
2. Fine-tuning models using synthetic images and the public RASMD dataset [3] to optimize performance on SWIR data, and
3. Applying knowledge distillation to transfer capabilities from a foundation model such as GroundingDino [4] to the SWIR (and later SWIR+VISIBLE) domain, with a focus on YOLOv8n for embedded deployment.

Complementary techniques such as data augmentation, SWIR image preprocessing, and synthetic image generation may also be explored to enhance robustness. This internship will contribute to the advancement of multimodal perception systems for autonomous vehicles and driver-assistance systems by exploring reliable detection solutions under challenging conditions. The work will also open perspectives for deeper integration of RGB and SWIR modalities within computer vision architectures.

¹ Source: <https://www.edmundoptics.fr/knowledge-center/application-notes/imaging/what-is-swir/>



The student may also take part in the acquisition and creation of multimodal datasets (GNSS, IMU, LiDAR, radar, cameras, SWIR, odometry, etc.) using the EquipEx ROBOTEX and EquipEx+ TIRREX platforms available at the Institut Pascal laboratory (notably PAVIN, EZ10, and ZOE).

The expected deliverables are:

- A specialized YOLOv8n model on SWIR, and on SWIR+RGB;
- A comparative evaluation on RGB vs SWIR;
- A benchmark under degraded conditions.

The results may lead to a publication in *IEEE Transactions on Intelligent Vehicles (T-IV)*.

Bibliography.

[1] Mehra, Rohan et al. "Would SWIR modality help for detection and segmentation in harsh weather conditions? An experimental study." *Proceedings of the IEEE/CVF International Conference on Computer Vision (ICCV) Workshops*. 2025.

[2] Jocher, Glenn, et al. "YOLOv8." In: <https://github.com/ultralytics/ultralytics>, Ultralytics, 2023.

[3] Jin, Youngwan, et al. "RASMD: RGB and SWIR Multispectral Driving Dataset for Robust Perception in Adverse Conditions." *arXiv preprint arXiv:2405.12944*, 2024.

[4] Liu, Shilong, et al. "Grounding DINO: Marrying DINO with Grounded Pre-training for Open-set Object Detection." *European Conference on Computer Vision*, 2024.

Information and contact

Required skills. Ongoing M.Sc. student (or Diplôme d'Ingénieur) in Robotics / Automatics / Mechatronics / Electronics / Signal Processing / Computer Vision. Strong background in Robotics and Computer Vision, and curiosity to work with sensors in experimental situations. Experience with machine (deep) learning would prove to be valuable (e.g., PyTorch, Tensorboard, etc.). Strong skills in programming would be an advantage (e.g., python, C++, jupyter-lab). A good level of English is required (Level B2+ or C1) along with strong communication skills. A minimal level of French would be helpful.

Contact. If you are interested, please send a **CV**, a **motivation letter**, grades, ranking, and **recommendation letter(s)** to Mathieu Labussiere by email at mathieu.labussiere@uca.fr (and/or to Alexandre Riffard at alexandre.riffard@uca.fr).
