Multi-sensor rail track detection in automatic train operations

Master's thesis in Data Science

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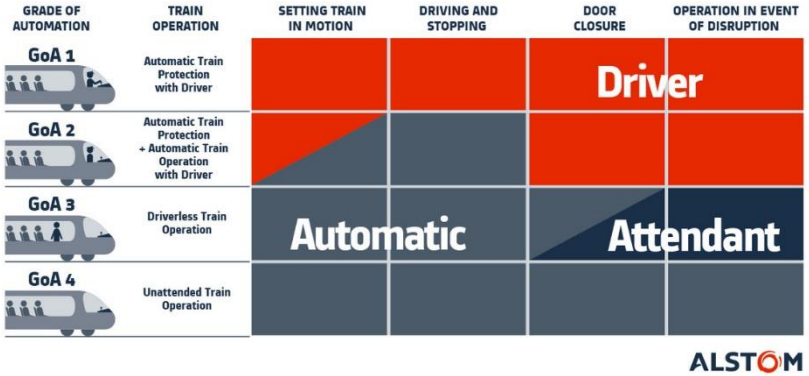
Introduction

- **What is Automatic train operations (ATO)?**
  → Technology is used to automate tasks that were previously performed by rail personnel (e.g., conductor)



- **Why ATO?**
  - Better utilization of infrastructure
  - Flexibility due to predictability (service on remote lines, automated parking)
  - Lower costs (e.g., maintenance)
  - Reduced energy
- **Challenges**
  - Sensors are already on a very high level
  - However, **application software** is still in the **early stages of development**

DB Cargo to develop fully automated shunting by 2024

- DB Cargo aims to develop a GoA4 (Grade of Automation) system as a retrofit solution
- Challenges
  - Positioning of locomotive: determine the locomotive's position in the marshalling yard without trackside installations
  - AI-based obstacle and signal detection: objects can be reliably detected → Up to now, no recognised approval processes have been available for AI-based object detection applications.

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https://www.railtech.com/rolling-stock/2021/10/28/db-cargo-to-develop-fully-automated-shunting-by-2024/

Openly available datasets for ATO applications

- In May 2023, Digitale Schiene Deutschland published the first freely available multi-sensor dataset OSDaR23
- Sensors:
  - 3 high resolution cameras
  - 3 medium resolution cameras
  - 3 infrared cameras
  - 3 long-range LiDARs
  - 1 mid-range LiDAR
  - 2 short-range LiDARs
  - 1 long-range radar
  - 4 inertial measurement units
  - 4 GPS/GNSS sensors

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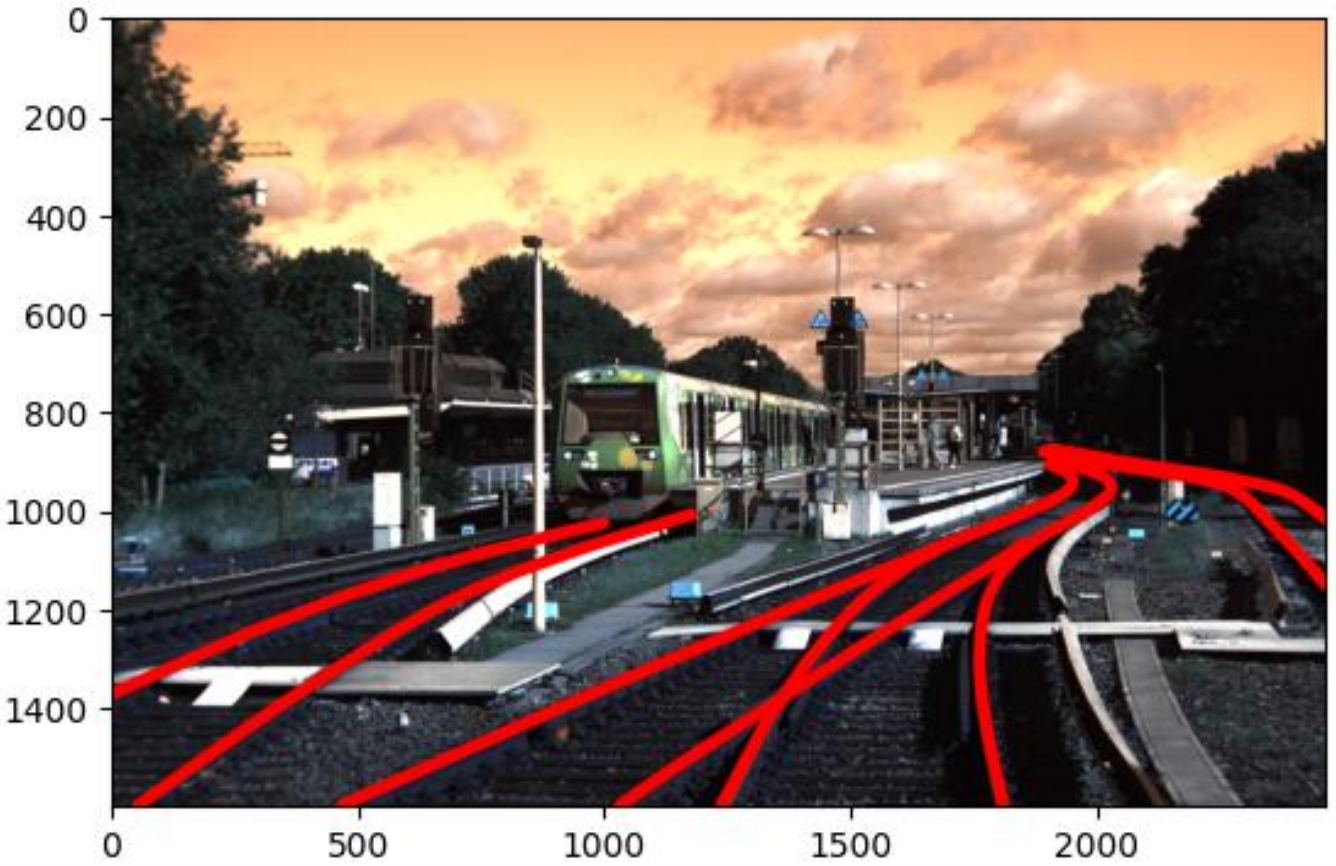
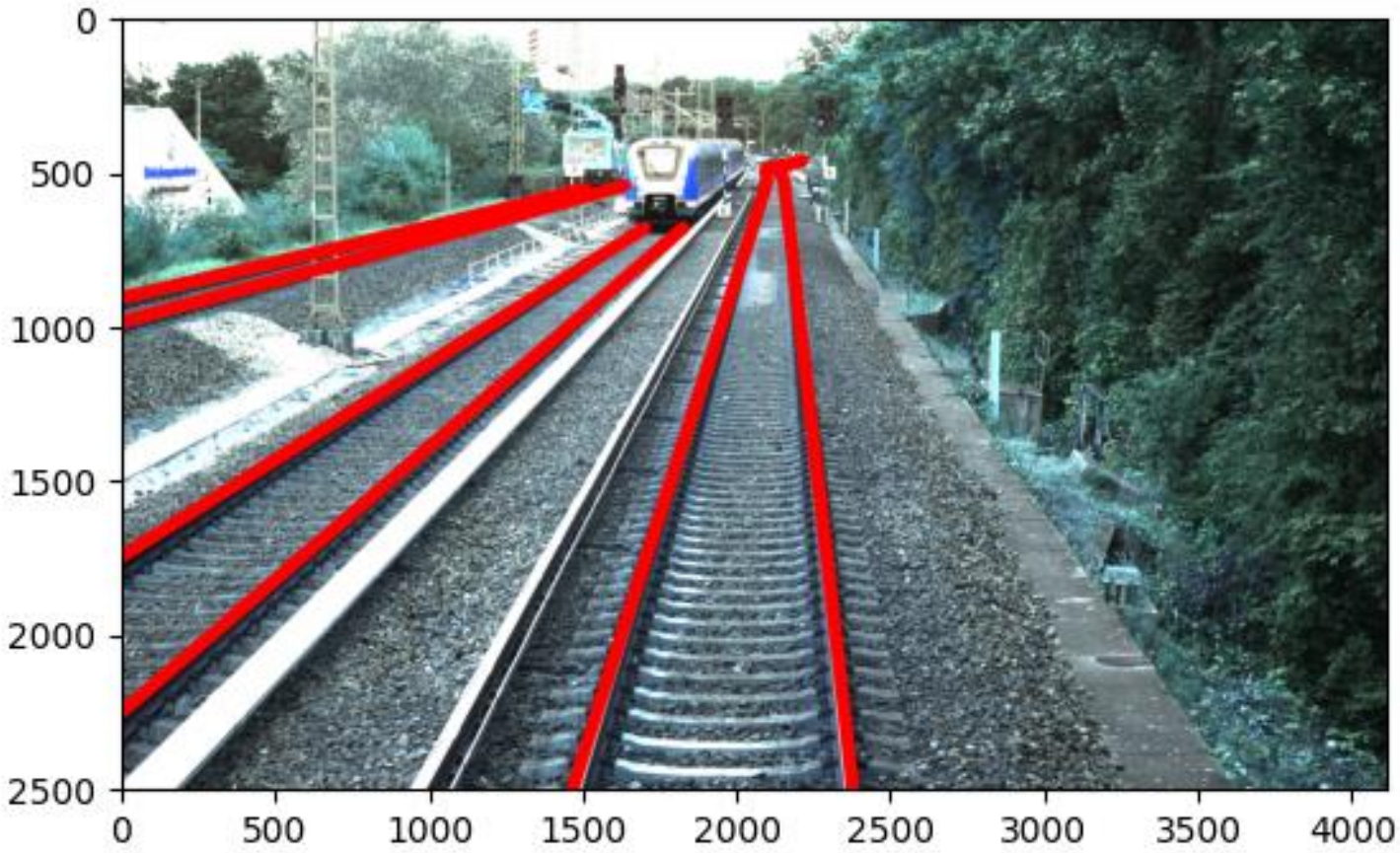
Sensor: RGB



Sensor: RGB-high-res



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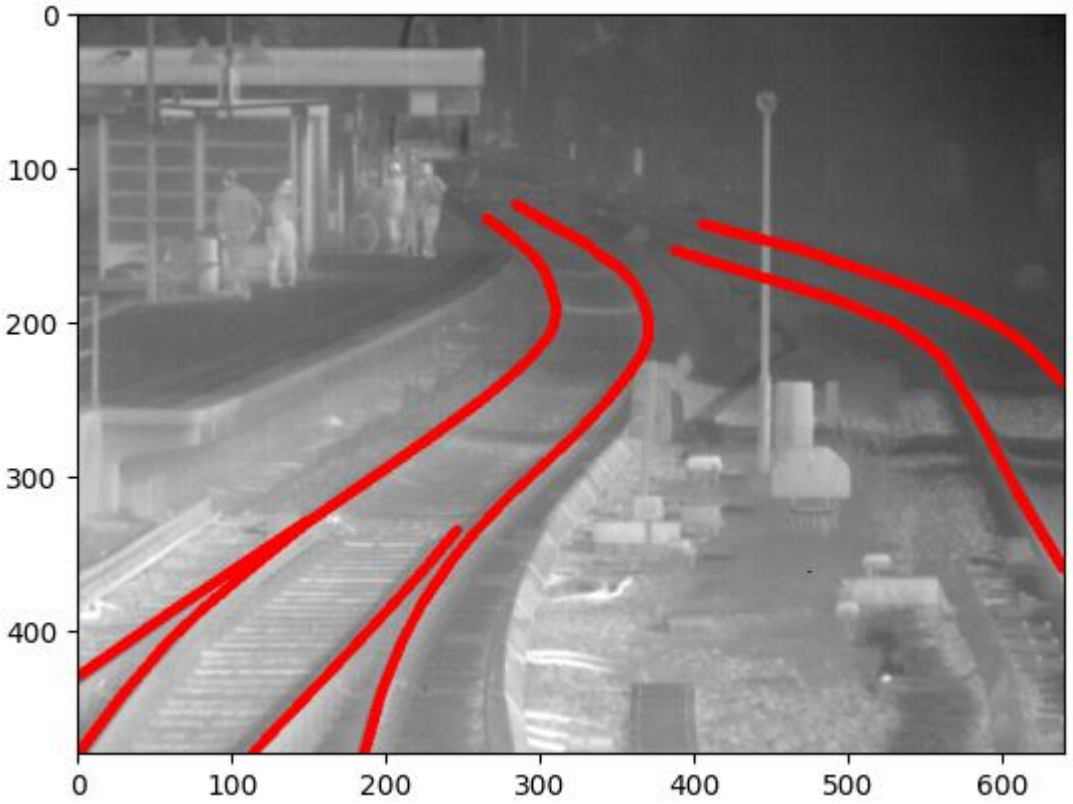
Sensor: Infrared



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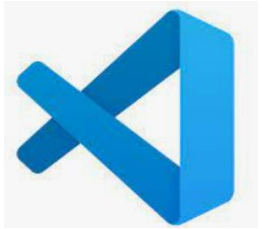
Goal of the master‘s thesis

- Investigate the effect of using different sensors on the ability to detect tracks in real-time
  - Focus on polyline detection, i.e., tracks, crossing tracks, neighboring tracks
  - Selection of a proper CNN model incl. training and finetuning on available dataset (one model per sensor)
  - Sensors: RGB, RGB-highres, IR
  - Results will be compared with existing approaches based on brightness gradient segment detection
  - Prototype: test models in real-time object detection in video stream

Technologies



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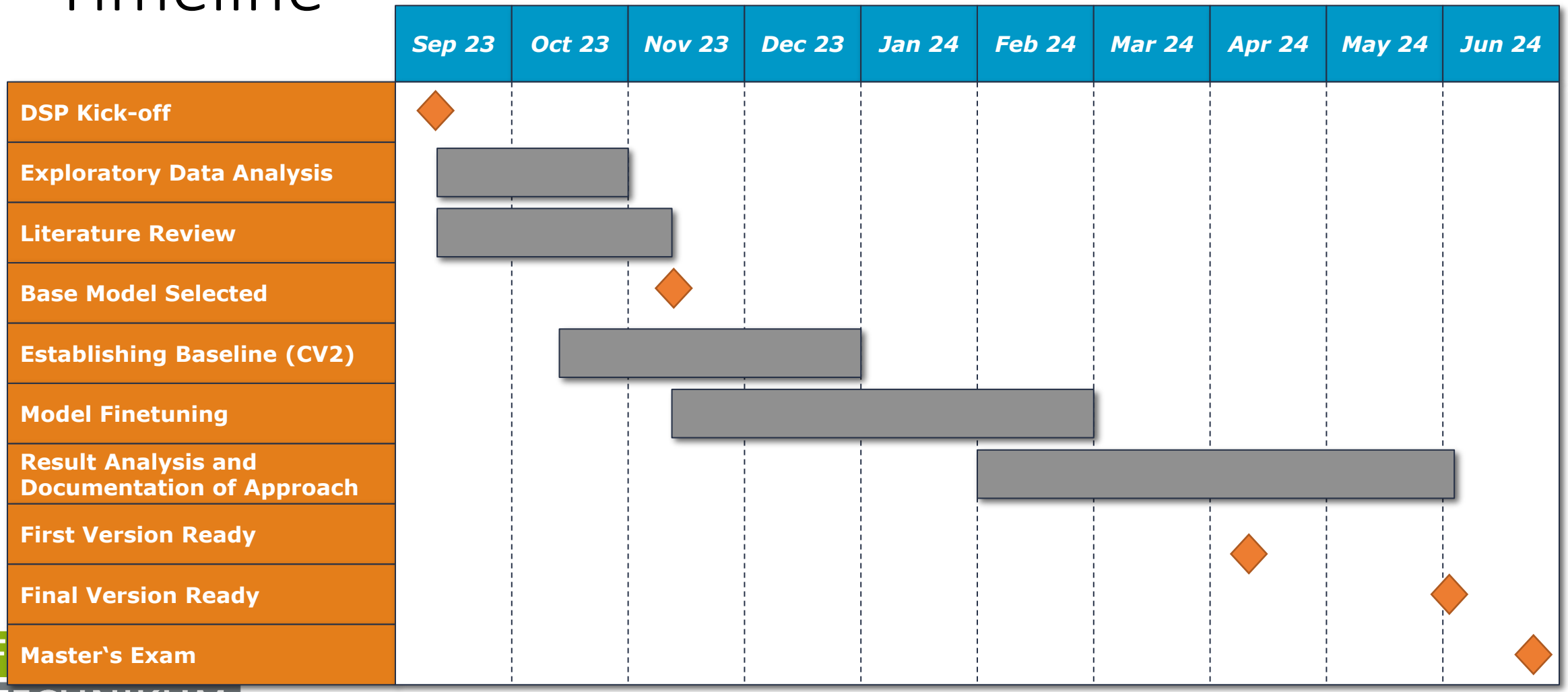
Timeline



Q&A

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