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Center for Sustainable Future Mobility (CSFM)

LROD: Long-range obstacle detection for railway driver assistance systems

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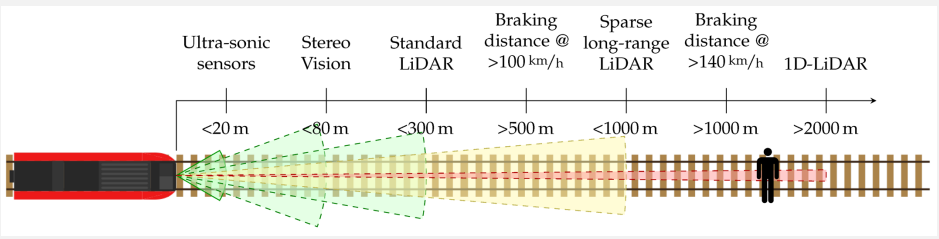
1 Introduction

Increasing demand for transportation by rail necessitates the expensive construction of new tracks or the development of new modes of operation for a denser usage of the railway network. In combination with rising rail vehicle speeds, this requires new and more advanced safety systems to ensure the safe and reliable operation of the network. Obstacle detection aims to prevent collisions with humans, infrastructure, trees or other objects on the tracks.

2 Related Work

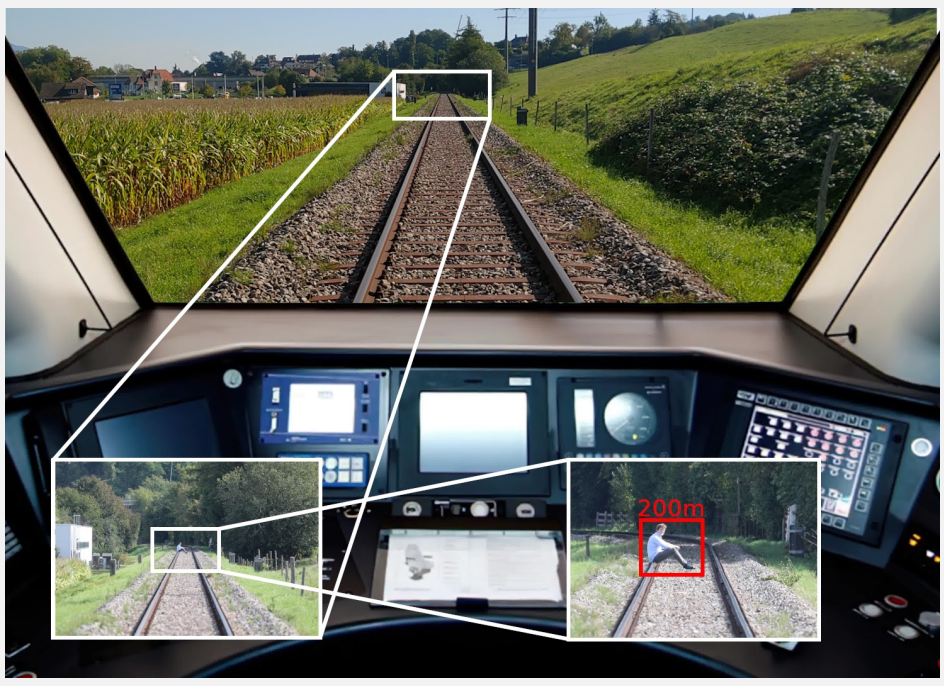
Existing methods[1,2], for example known from the automotive industry, fail to provide the required range for the operation on the train. Further, sensor modalities such as Radar do not provide the required resolution or suffer from low reflectivity off of non-metal objects.



1. Durrant, D. R., Haseeb, M. A., Emami, D., & Gräser, A. (2018). Multimodal Sensor Fusion for Reliable Detection of Obstacles on Railway Tracks.
2. Haseeb, M. A., & Gräser, A. (n.d.). Long-range obstacle detection from a monocular camera.

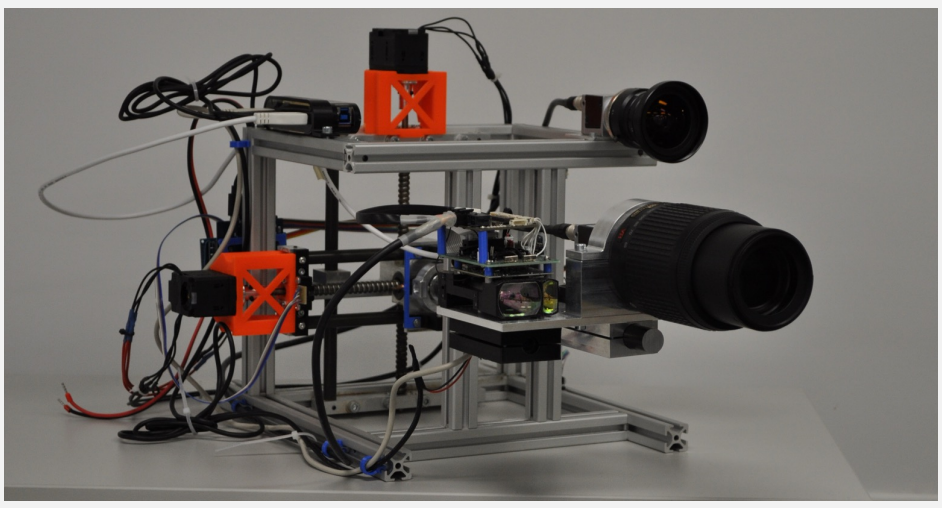
3 Method

Through high-focal length optics, long-range LiDAR and an actuated sensor mount, we search for, detect and locate obstacles on the track ahead.



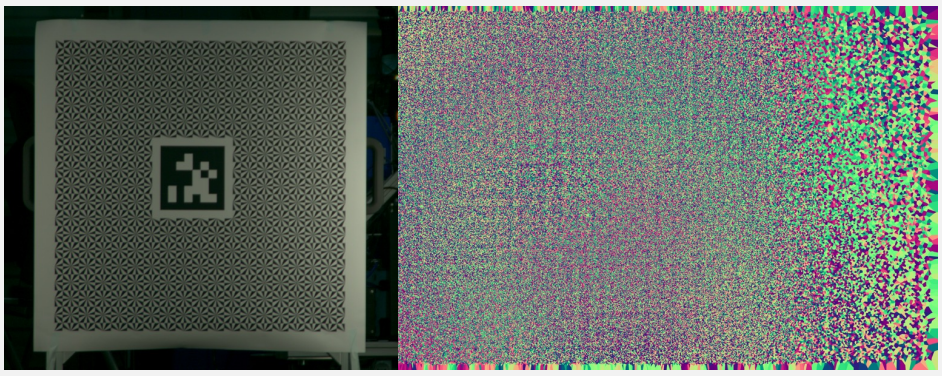
4 Hardware

The developed sensor setup consist of a fixed overview camera, a high-focal length detail camera and a long-range 1D LiDAR, both of which are mounted on a custom high-precision gimbal to precisely position obstacles even at high range.



5 Calibration

Accurate calibration of all system components is crucial for long-range operation. Even minor angular misalignments lead to missed detections at the relevant operation ranges. Generic camera models[3] (as depicted below) are utilized in combination with further novel sensor calibration methods to accurately calibrate the entire sensor setup. Infrastructure elements in the railway environment can further be used to continuously adjust and validate parts of the current system calibration.



3. Schops, Thomas, et al. "Why having 10,000 parameters in your camera model is better than twelve." *Proceedings of the IEEE/CVF CVPR*. 2020.

6 Conclusion

- Long-range obstacle detection requires the fusion of various sensor modalities to provide the range required for save operation.
- High-precision actuation and sensing mechanisms have been developed for this task.
- Novel methods have been developed to accurately calibrate sensor systems for the railway domain.

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