VISION BASED STATIONARY RAILWAY TRACK MONITORING SYSTEM

Related Work

Fig. 1: Rail and Obstacle Detection used by [1]

- Traditional Approaches (Computer Vision based)
  - Identifying rail track and its environment (e.g., based on Hough Transform [1])
  - Detecting Obstacles based on Optical Flow approach [3]

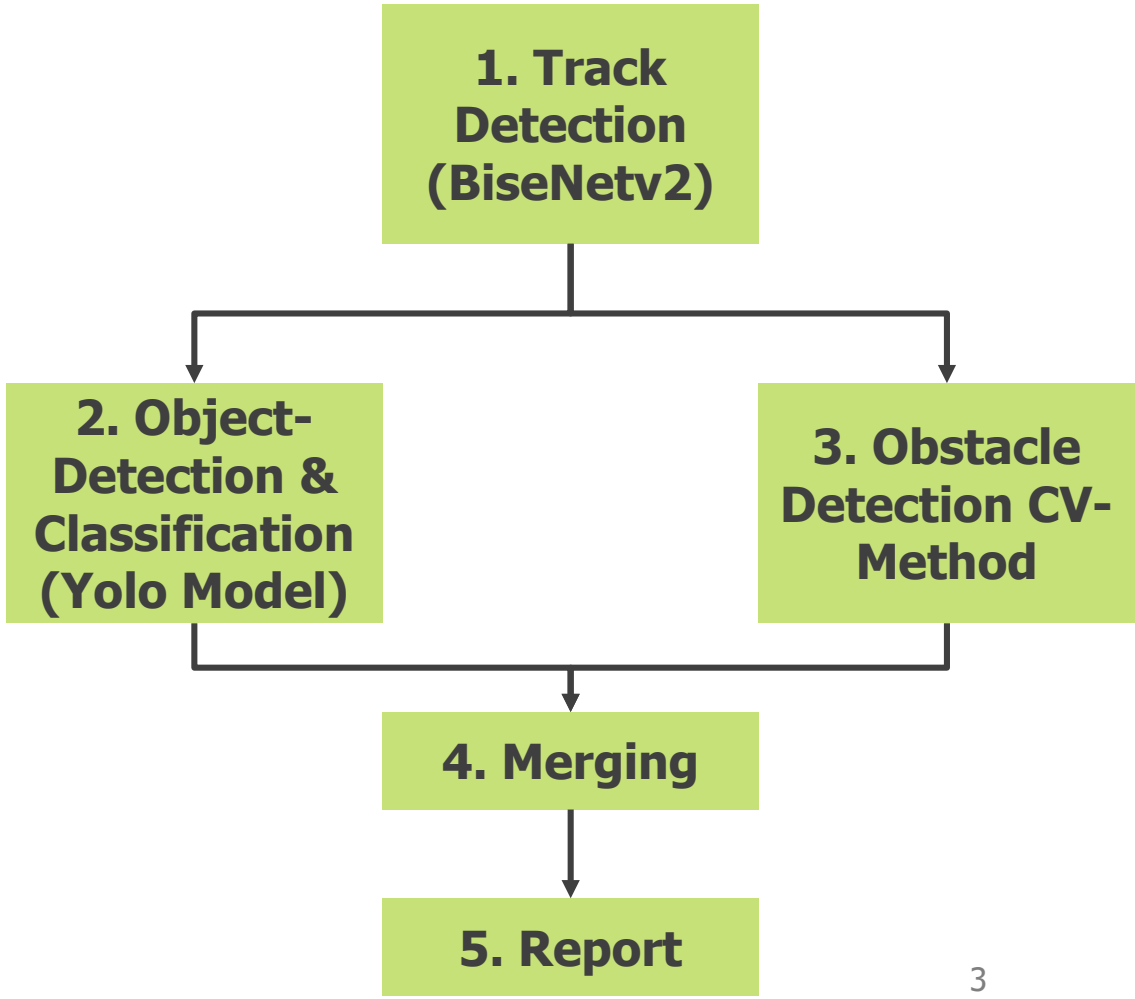
- AI based approaches
  - Identifying rail track and its environment (e.g., based on CNN [5]), a well working approach currently is BiSeNet V2 [4]
  - Obstacle detection focused on AI approaches based on YOLOx version [6] or predefined data sets with obstacles such as trains, people or animals [7]

- Very good recent survey is given in [2], focuses on obstacle detection, rail track detection, distance estimation (evaluated 49 papers) in 2021

Combined Approach: Track detection and Object classification

- Main differences of related work to our contribution:
  - Using YOLO and BiSeNet v2 for rail track detection and well known objects,
  - focusing on specific obstacles (mud, stones, trees, etc.),
  - classifying allowed objects and disallowed objects,
  - Providing a monitoring system for specific dangerous track areas and not a drivers eye system
  - Reference image comparison for obstacle detection including

- Approach split into 5 subtasks



1. Track Detection

- Using BiSeNet V2 [4] to create mask of region of interest

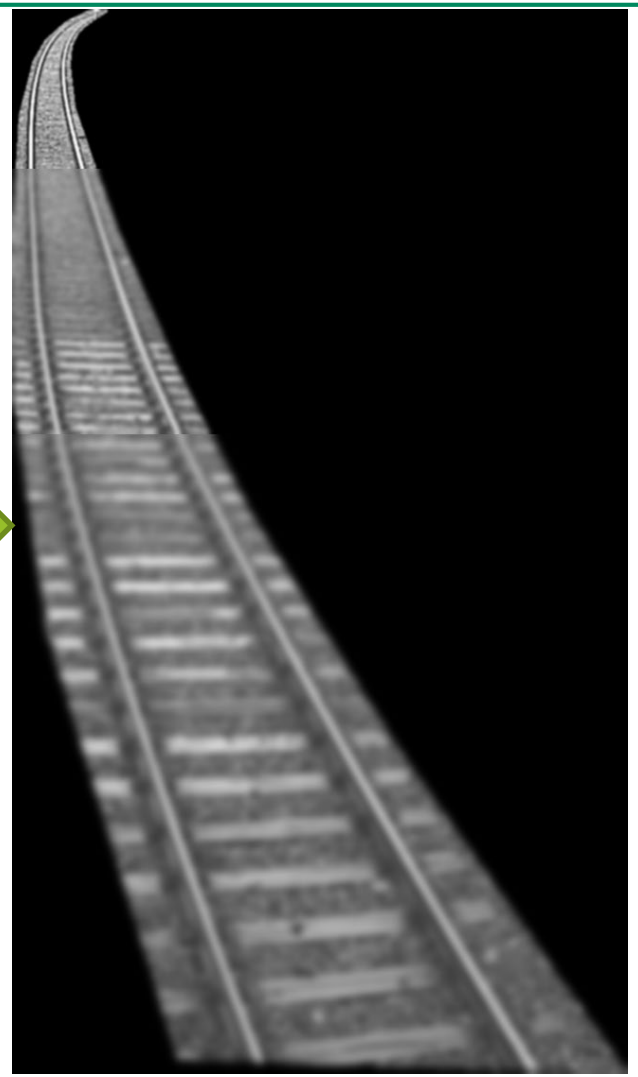
(a) (b) (c)

2. Object Detection & Classification:

- Using YOLOv5 to classify well known objects (people, car, train, etc.)
- Evaluated on RailSem Data set (https://wilddash.cc/railsem19 and Youtube videos)

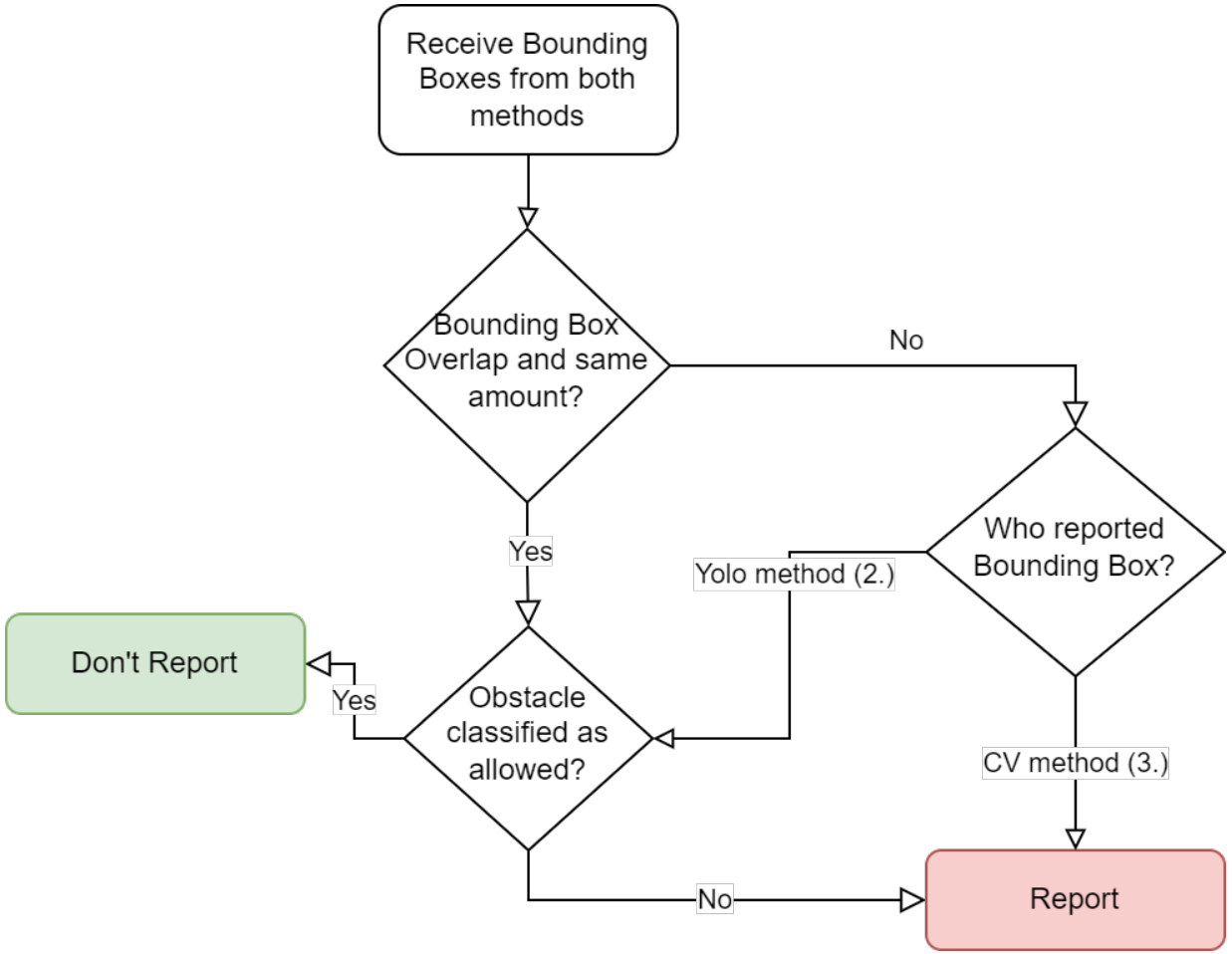
3. Obstacle Detection:

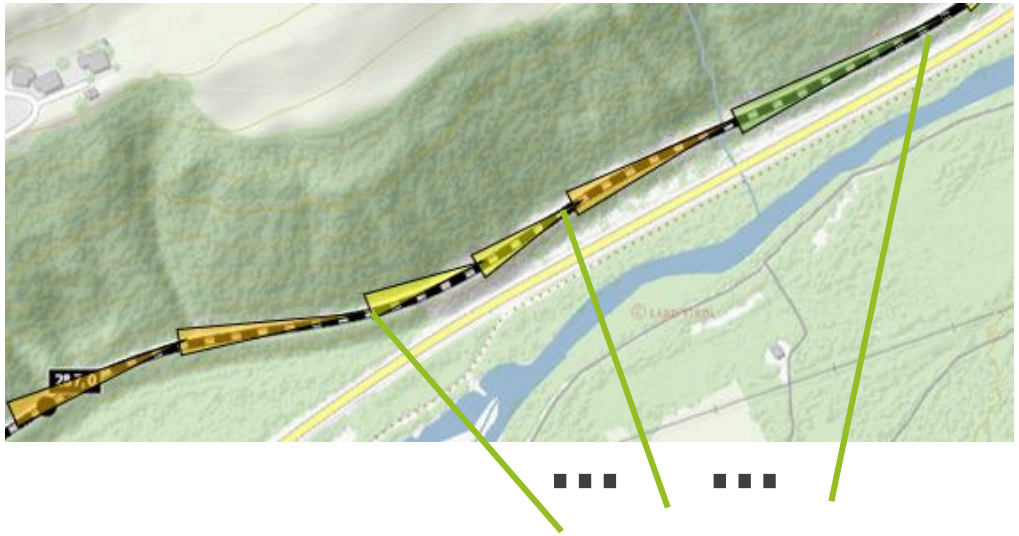
- Comparison of current track image with an empty track image
  - Preprocessing Steps:
    - Greyscaling
    - Adjusting Contrast and Brightness
    - Histogram Matching
  - Noise Removal by applying blur with different kernel size depending on distance from camera (closer parts of the image are blurred with a bigger kernel)
  - Pixel for Pixel Comparison of both images
  - Enlargen possible obstacles by applying dilation operation
  - Calculate area of obstacles → if bigger than threshold draw bounding box



4. Merging

» How to deal with different results from steps 2. and 3.?





Monitoring system
View of individual sensors

5. Report

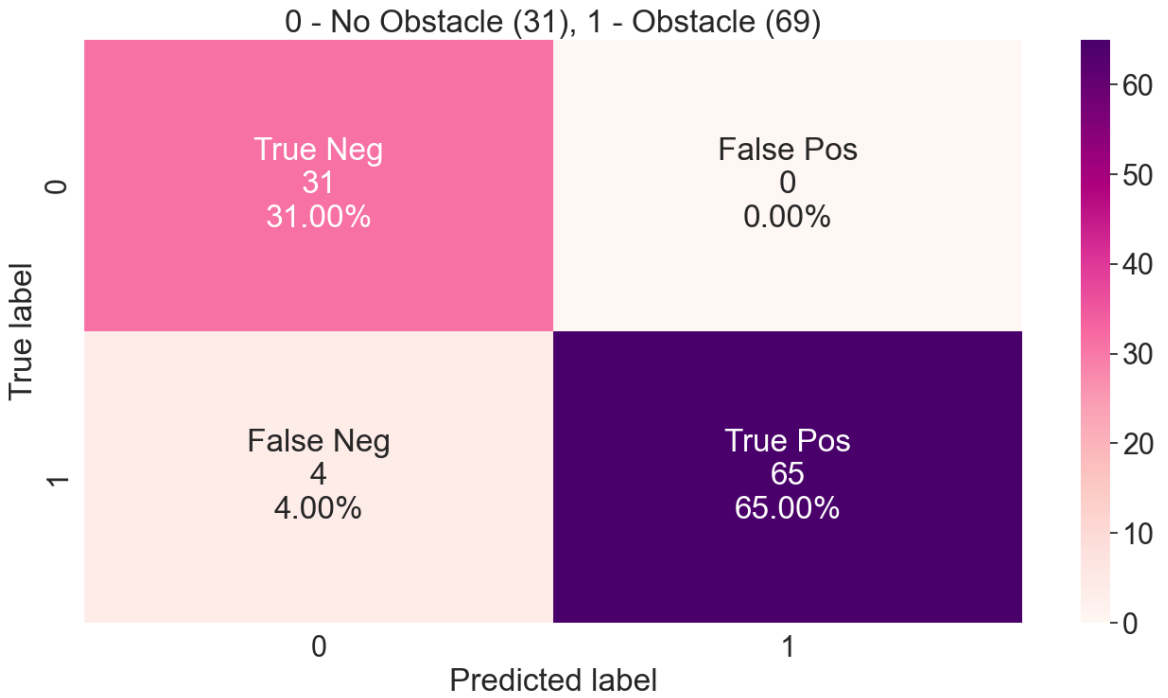
- Images with bounding boxes highlighting detected obstacles are reported
- Red areas are forwarded to the monitoring rail track system for human in the loop check

Our Test Data

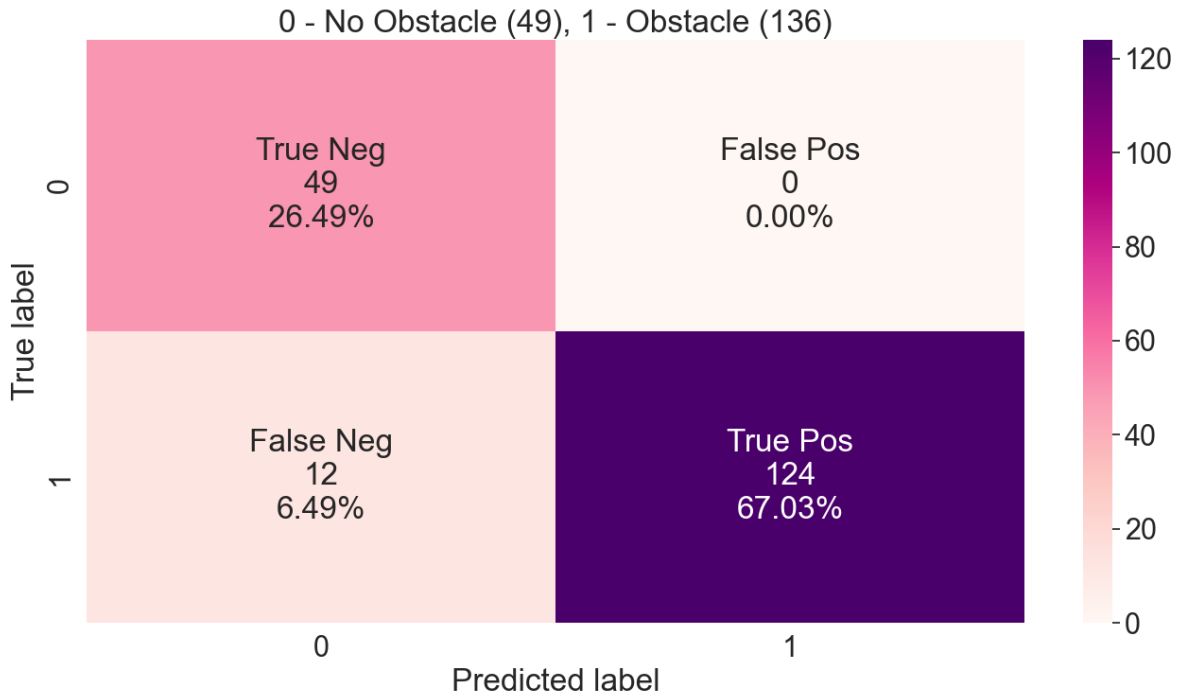
101 images under normal conditions on a fixed mounted camera
→ 69 with obstacles, 32 without

186 images under snowy conditions on a fixed mounted camera
→ 136 with obstacles, 50 without

Evaluation



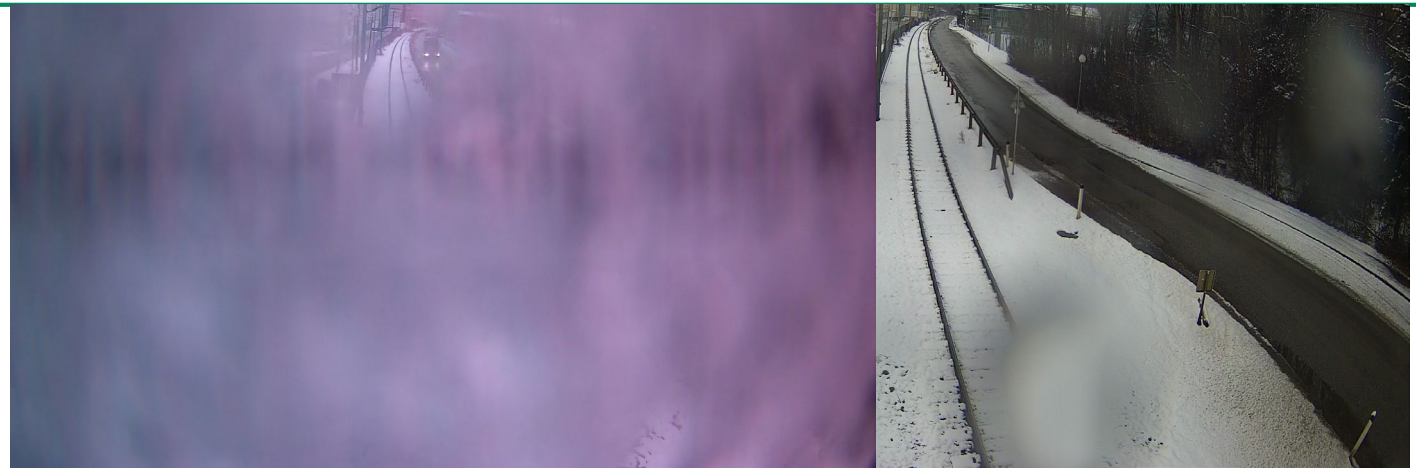
Images under normal conditions



Images under snowy conditions

Limitations & Outlook

- Limitations
  - Camera Lens Obstruction
  - Shadows being detected as obstacles (see yellow area)
  - Obstacle Detection during the night
- Outlook
  - Synthetic Data Generation for rare situations (mud, stones, trees, etc.)
  - Optimize Shadow-Detection during reference image selection



References

[1] L. A. Fonseca Rodriguez, J. A. Uribe, and J. F. Vargas Bonilla, "Obstacle detection over rails using hough transform," in Proceedings of the XVII Symposium of Image, Signal Processing, and Artificial Vision (STSIVA), 2012, p. 317–322.

[2] D. Ristic-Durrant, M. Franke, and K. Michels, "A review of vision based on-board obstacle detection and distance estimation in railways," vol. 21, no. 10, 2021

[3] J. A. Uribe, L. Fonseca, and J. F. Vargas, "Video-based system for railroad collision warning," in Proceedings of the IEEE International Carnahan Conference on Security Technology (ICCST), 2012, p. 280–285.

[4] D. Ristic-Durrant, M. A. Haseeb, M. Franke, M. Banic, M. Simonovic,´ and D. Stamenkovic,´ Artificial Intelligence for Obstacle Detection in Railways: Project SMART and Beyond. Springer, 2020.

[5] Z. Wang, X. Wu, G. Yu, and M. Li, "Efficient rail area detection using convolutional neural network," IEEE Access, vol. 6, p. 77656–77664, 2018.

[6] D. Ristic-Durrant, M. A. Haseeb, M. Franke, M. Bani´c, M. Simonovi´c, and D. Stamenkovi´c, Artificial Intelligence for Obstacle Detection in Railways: Project SMART and Beyond. Springer, 2020, iSBN: 978-3-030-58462-7.

[7] S. Ren, K. He, R. Girshick, and J. Sun, "Faster r-cnn: Towards real-time object detection with region proposal networks," in CoRR abs/1506.01497, 2015.