Railway Sign Detection in Night Images

Gunho Sohn, Jungwon Kang, Kang Zhao

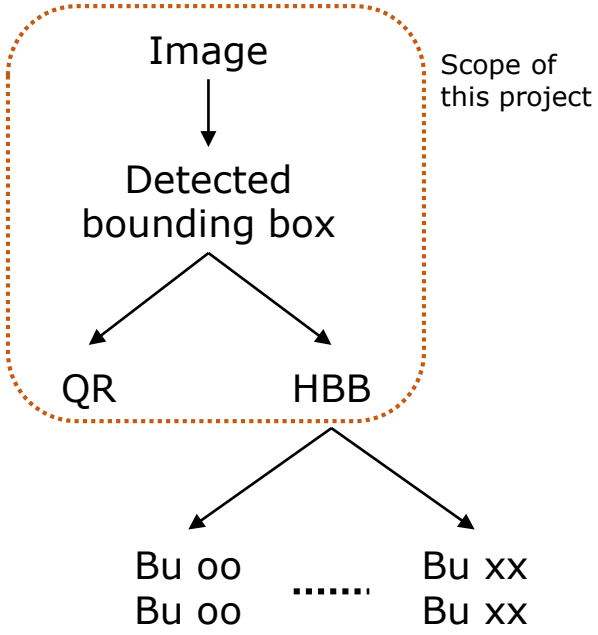
Feb 20 2018

Contents

- Overview
- Thales Train System
- (Raw) Thales Night Railway Image Set
- Task 0: Dataset Generation
- Task 1: Sign Detection
- Task 2: Sign Detection with Subsequent Deblurring
- Reference List

Overview

- Objective
  - Detecting two types (**QR** & **HBB**) of signs in night images, and deblurring the detected signs (in real time)
    * Recognition of the detailed sign contents is not included.



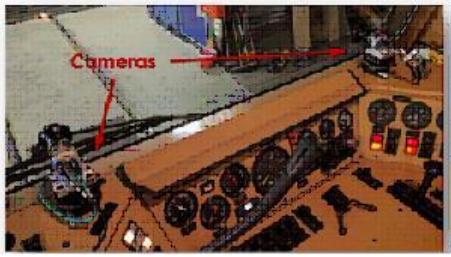
*HBB: HET-Bü-Bü

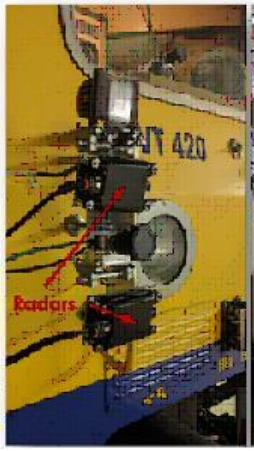
Thales Train System

POC3 Germany sensor suite

Redundant data logging and sensor cross-comparison

- 3 x IMU for redundant logging
- 2 x radar for odometry measurement
- 2 x camera for positioning and odometry
- 1 x LiDAR for positioning and odometry
- 1 x GNSS for positioning and odometry





(Raw) Thales Night Railway Image Set

- Image Set '**germany_2017-11-21**'
  - Raw images without annotation

Image set name	Number of Images	Status	Suitability for making training images
img_germany1/mono1 [germany_2017-11-21-16-26-44.bag]	1779	Calibration images	Not suitable
img_germany2/mono1 [germany_2017-11-21-16-34-23.bag]	1160	Just stationary	Not suitable
img_germany3/mono1 [germany_2017-11-21-16-36-39.bag]	389	Just stationary	Not suitable
img_germany4/mono1 [germany_2017-11-21-16-37-28.bag]	10309	Just stationary	Not suitable
img_germany5/mono1 [germany_2017-11-21-21-32-33.bag]	**20570**	**Train normally moving**	**Suitable**
img_germany6/mono1 [germany_2017-11-21-22-14-05.bag]	**40180**	**Train normally moving**	**Suitable**
img_germany7/mono1 [germany_2017-11-21-23-32-27.bag]	239	No sign included	Not suitable
img_germany8/mono1 [germany_2017-11-21-23-32-58.bag]	**5206**	**Train slowly moving**	**Suitable**
img_germany9/mono1 [germany_2017-11-21-23-43-01.bag]	**4701**	**Train slowly moving**	**Suitable**

(Raw) Thales Night Railway Image Set

- Signs in Image Set '**img_germany5/mono1**'

QR sign (Total 390 images)

Starting frame	Ending frame	Number of images
510	680	171
785	887	103
19851	19966	116

HBB sign (Total 497 images)

2675	2700	26	6490	6510	21	14994	15009	16
2850	2866	17	11810	11823	14	15214	15227	14
3130	3150	21	11975	11995	21	15416	15429	14
3535	3550	16	13344	13368	25	15497	15507	11
3670	3692	23	13448	13477	30	15626	15637	12
3755	3773	19	13943	13968	26	16056	16075	20
3955	3978	24	14731	14758	28	16440	16460	21
4205	4235	31	14904	14916	13	16707	16740	34

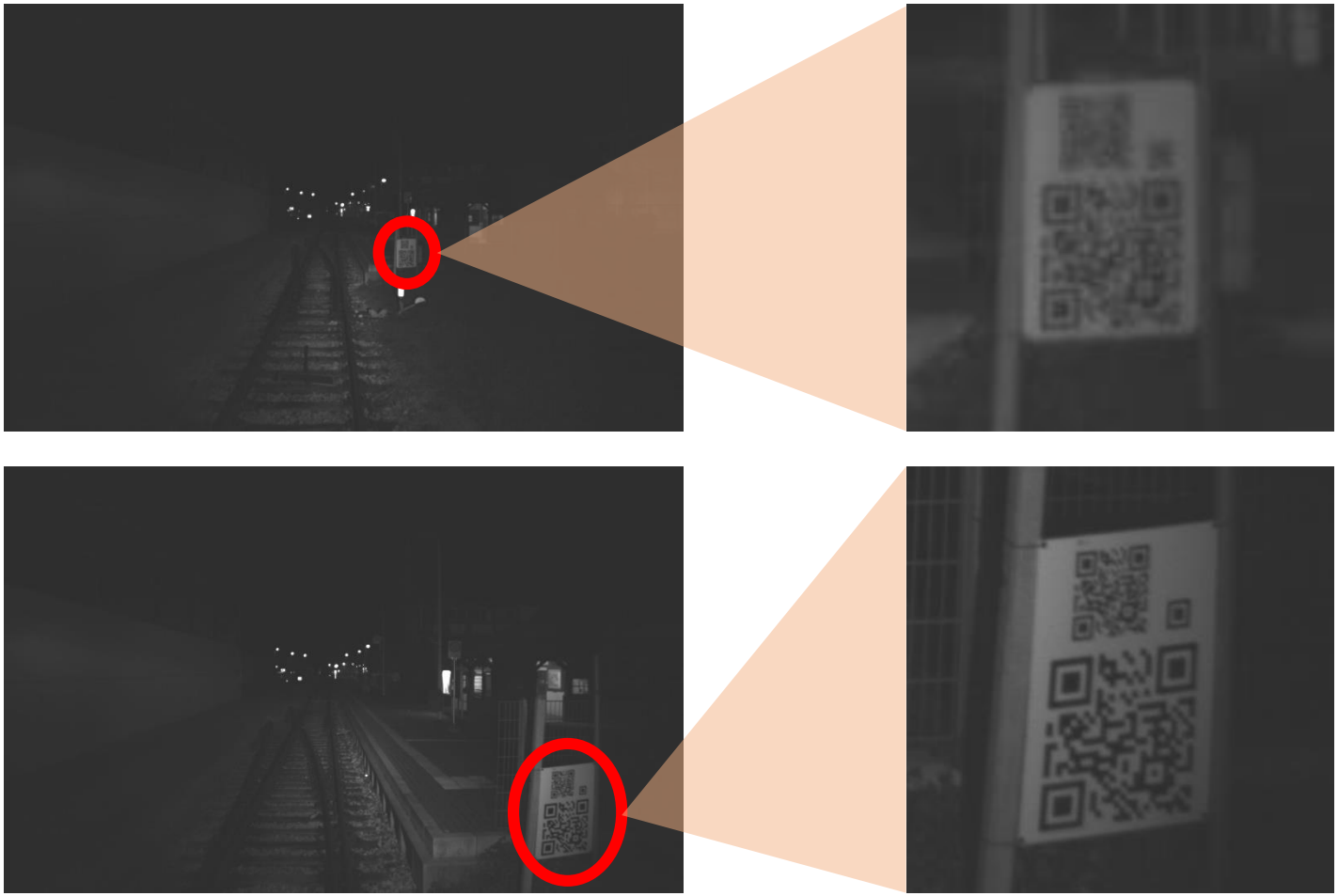
*HBB: HET-Bü-Bü

(Raw) Thales Night Railway Image Set

- Characteristics of Signs in Images
  - Having severe scale change
  - Having extremely illumination-dependent appearance
  - Showing substantial blur
    (when a sign is near to fast moving train)

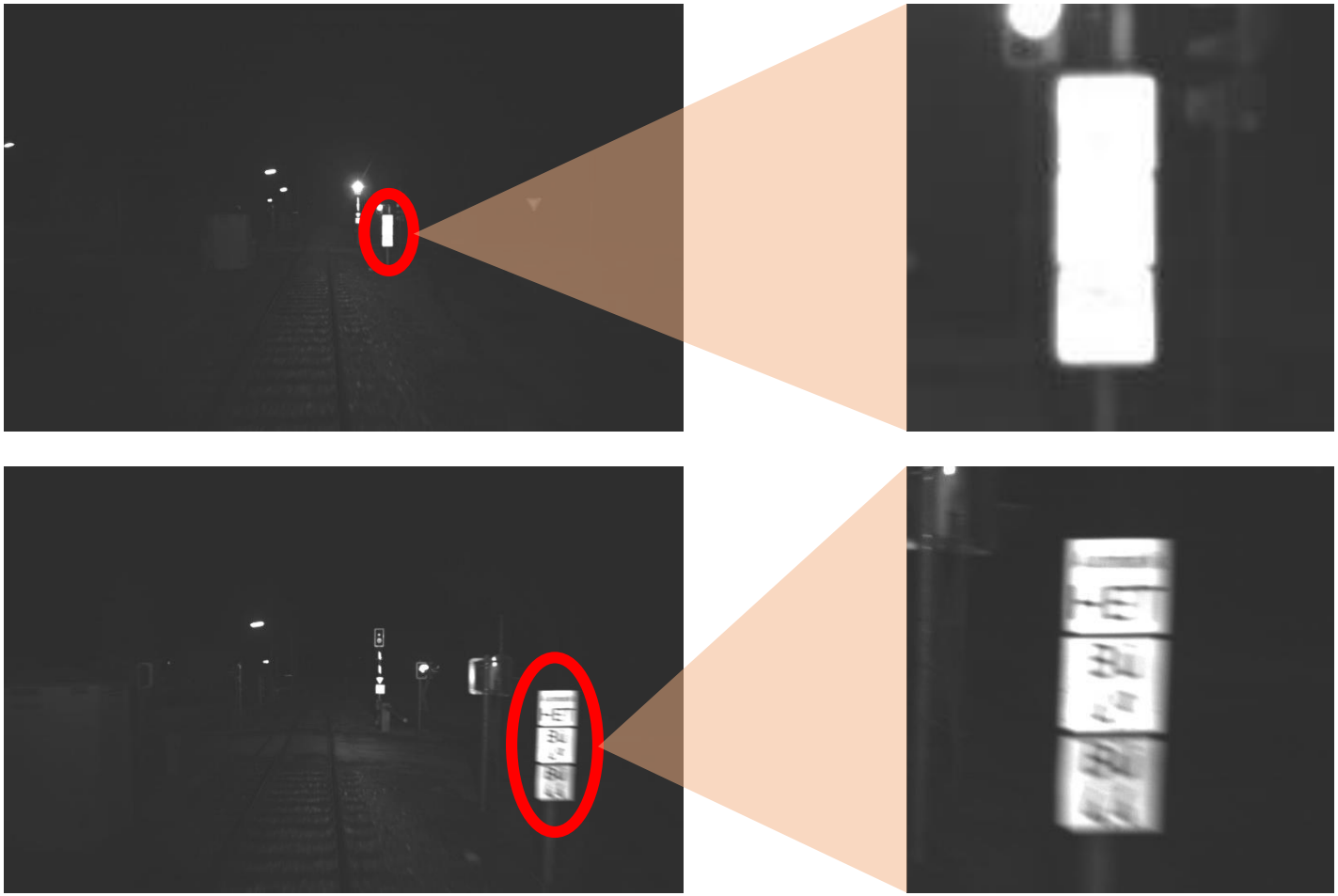
(Raw) Thales Night Railway Image Set

- Example of QR Sign



(Raw) Thales Night Railway Image Set

- Example of HBB Sign



Our Approach

- Severe Scale Change
  → Treating one object as multiple classes according to the scale
- Illumination-dependent appearance
  → Using preprocessing for illumination invariant transformation of images
- Not many real images for training
  → Generating virtual dataset and using both real and virtual dataset for training
- Substantial blur
  → Deblurring detected signs (for subsequent classification)

List of Tasks

- Task 0: Dataset Generation
  - Task 0a: From real images
  - Task 0b: From virtual environments
- Task 1: Sign Detection
- Task 2: Sign Detection with Subsequent Deblurring

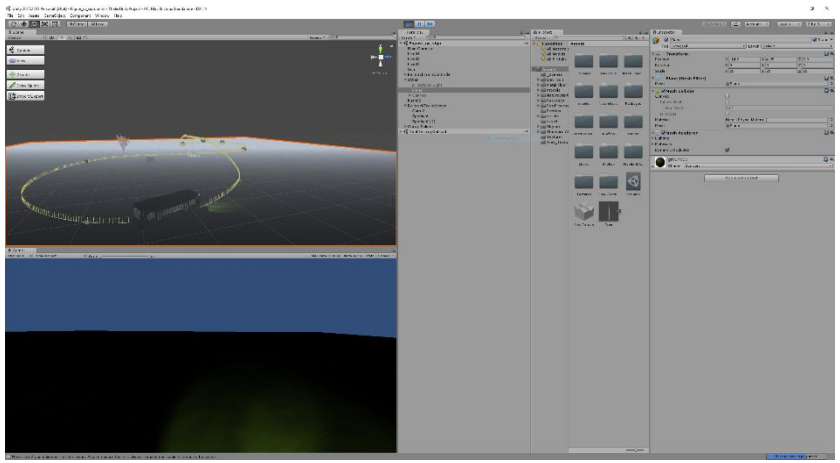
Task 0a: Dataset Gen. from Real Images

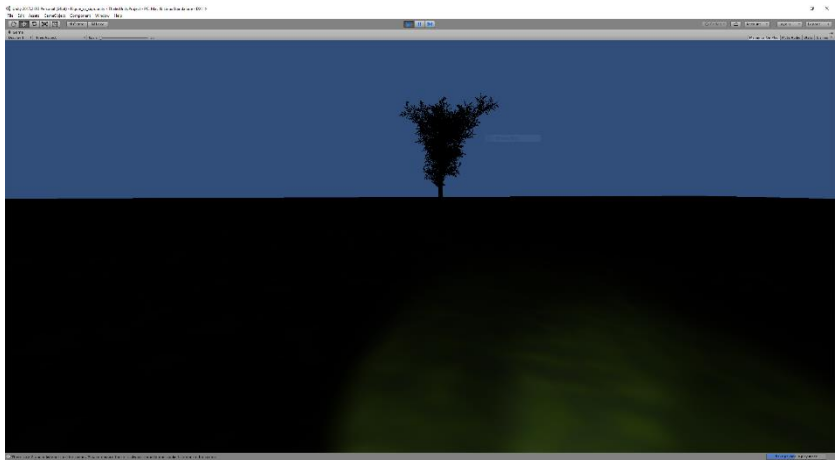
- Bounding box annotation
  - Alp's Labeling Tool (ALT)
    https://alpslabel.wordpress.com/2017/01/26/alt/

- Setting classes for QR & HBB signs
  - QR near / QR far / HBB near / HBB far, instead of QR / HBB

Task 0b: Dataset Gen. from Virtual Env.

- Parameters
  - Position and size of signs in 3D world
  - Camera intrinsic and extrinsic parameters
  - Background
  - Illumination
  - Train speed
  - Blur effect in images

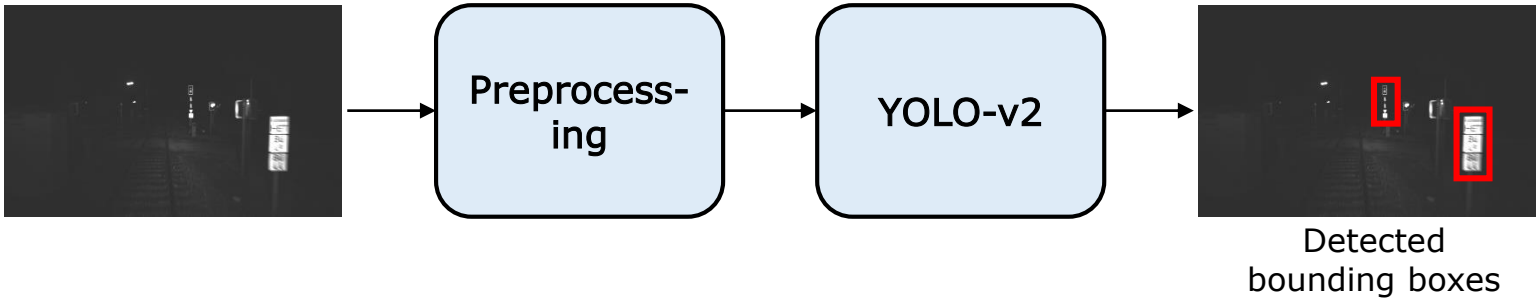




Screenshot of the unity program provided by Thales on Feb 7 2018

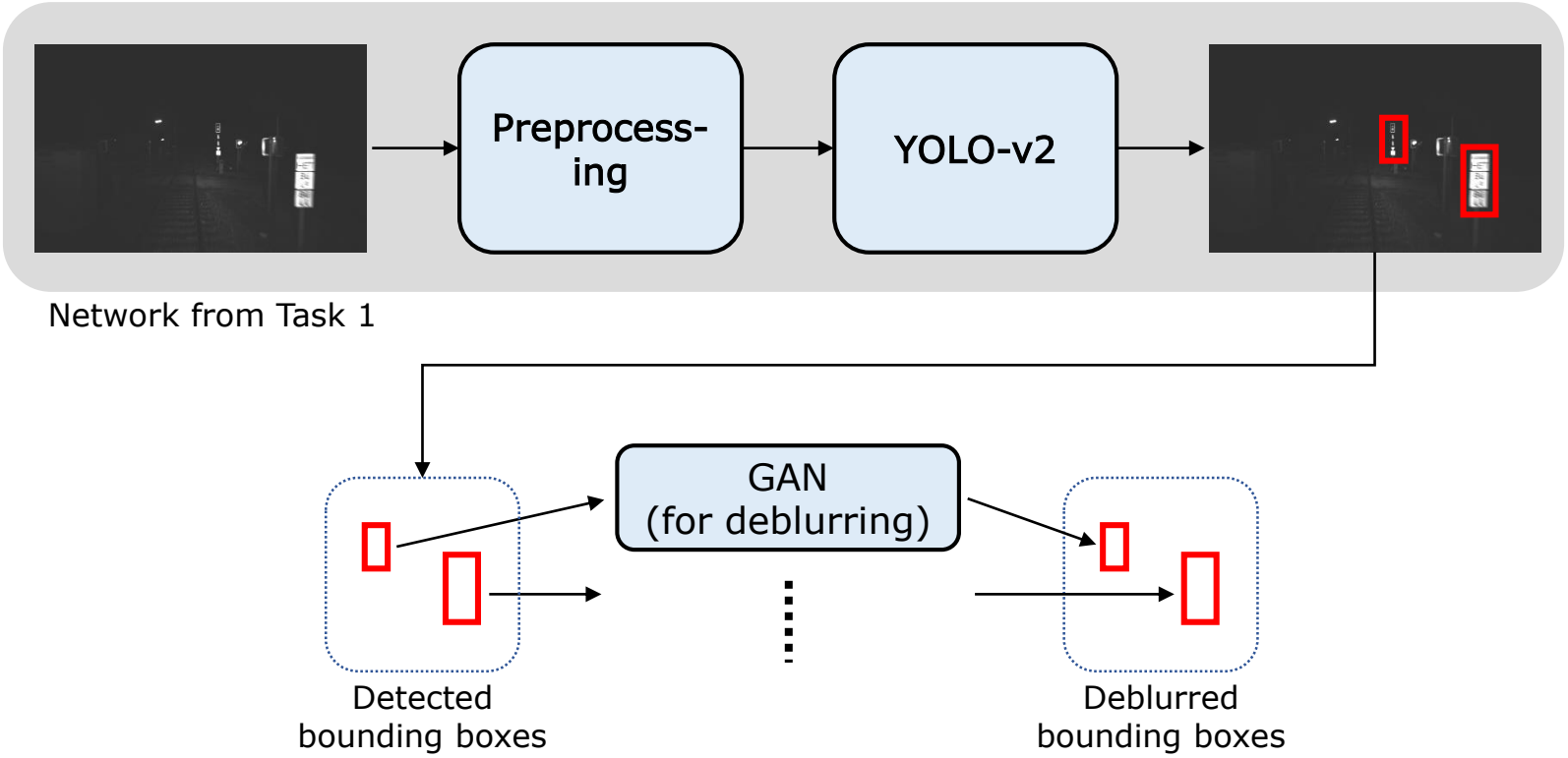
Task 1: Sign Detection

- Detecting Signs from Preprocessed Images
  - Just training YOLO-v2 with preprocessed images



Task 2: Sign Detection with Subsequent Deblurring

- Detecting Signs and its Deblurring
  - Having 'Bounding box + GAN' framework, as in [J. Li, CVPR 2017]



Reference List

- Traffic sign detection in night time
  - M. A. Garcıa-Garrido, "Fast Traffic Sign Detection and Recognition Under Changing Lighting Conditions", ITSC, 2006
  - K. Lim K, et al, "Real-time traffic sign recognition based on a general purpose GPU and deep-learning", PLoS ONE 12(3): e0173317. doi:10.1371/journal. pone.0173317, 2017
- Use of mixture of real & virtual images
  - Y. Tian, "Training and Testing Object Detectors with Virtual Images", arXiv:1712.08470v1 [cs.CV] 22 Dec 2017
  - S. Huang, "Expecting the Unexpected: Training Detectors for Unusual Pedestrians with Adversarial Imposters", CVPR 2017
- Object detection + GAN
  - J. Li, "Perceptual Generative Adversarial Networks for Small Object Detection", CVPR 2017
- Illumination-invariant image transform
  - W. Maddern, "Illumination Invariant Imaging: Applications in Robust Vision-based Localisation, Mapping and Classification for Autonomous Vehicles", ICRA 2014
- Deep learning-based deblurring
  - O. Kupyn, "DeblurGAN: Blind Motion Deblurring Using Conditional Adversarial Networks", arXiv:1711.07064 [cs.CV], Nov 2017
  - S. Nah, "Deep Multi-scale Convolutional Neural Network for Dynamic Scene Deblurring", arXiv:1612.02177 [cs.CV], Dec 2016