講演番号	083

文献番号	20226083

A Performance Analysis of Training Models for a Deep Learning-Based Object Detection Method to Detect Motorcycles with an Onboard Camera

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KEY WORDS: electronics and control, **image recognition system**, **intelligent**, motorcycle, conspicuity (E1)

In object detection methods based on deep learning, the detection accuracy can be affected by giving training images to a training model. In this paper, we use YOLO[(1)] as the object detection method, and prepare the following six types of training image datasets and evaluate the object detection models training with these datasets.

- motorcycle-COCO dataset（2842 images）: The images with Label "motorcycle" (3085 images) were extracted from the COCO dataset, commonly used in YOLO. We eliminated the images of motorcycles that are not in the traffic environment.
- motorcycle-5000 dataset（5810 images）: Extracted images on drive-recorder videos that include motorcycles.
- motorcycle-3000 dataset（2842 images）: A subset of motorcycle-5000, to match the number of images in motorcycle-COCO.
- motorcycle-8000 dataset（8652 images）: All images of motorcycle-COCO and motorcycle-5000.
- 4 types dataset（8652 images）: The same images as motorcycle-8000, and they are divided into four motorcycle type classes: sports with cowl; adventure; naked; scooter.
- 4 directions dataset（8652 images）: The same images as motorcycle-8000, and they are divided into four direction classes according to the shooting angle: front, right, back, and left.

Using the proposed training models and test videos, we evaluated the distance from which motorcycles can be detected with commercially available equipment and technology. An onboard visible light camera takes the test videos in a four-wheeled vehicle approaching a stationary motorcycle on a traffic test road at the Japan Automobile Research Institute (JARI), which simulates a real traffic environment. We set the following four environmental conditions.

- indoor: In the indoor facility with ceiling lights on at JARI Specific Environment Area
- foggy: Adding to "indoor", generating fog with a visibility of 30m
- backlight: Adding to "indoor", with a solar radiation device that illuminates a camera from the front as if against the sun
- outdoor: at an open-air multipurpose city street in clear weather in JARI Versatile Urban Area

In this environment, we shot a motorcycle in four different compositions: following, opposing, from right, and from left.

Table 1 shows the motorcycle detection distance by each training model and each environment condition. The training model based on our prepared images from drive-recorders, closer to real-world conditions than the COCO dataset, improved the detection distance. The proposed four-type and four-direction classification might be practical to a small extent, but the effects were not as significant as the former. The above results' detection distance of about 15 to 30 meters may not be sufficient for preventing motorcycle accidents. However, we have confirmed that detecting a motorcycle with a commercially available onboard camera can be practical other than under poor conditions such as fog or backlight from the sun.

Table. 1 The Detection Distance in Each Condition and Composition [m]

condition	composition	COCO	motorcycle -coco	motorcycle -3000	motorcycle -5000	motorcycle -8000	4 types	4 directions
indoor	following / opposing	– / 13	– / 12	16 / 14	16 / 12	– / 11	16 / 16	– / 10
	from right / from left	16 / 18	21 / 26	25 / 24	28 / 25	24 / 23	28 / 25	24 / 25
foggy	following / opposing	– / 7	14 / 8	20 / 9	20 / 8	19 / 6	16 / 1	17 / 5
	from right / from left	– / –	– / 12	– / 11	– / 10	– / 12	– / 10	– / 11
backlight	following / opposing	– / 11	– / 12	– / 12	– / 13	– / 12	– / 16	– / 11
	from right / from left	6 / 7	21 / 14	25 / 12	28 / 12	24 / 14	28 / 12	24 / 12
outdoor	following / opposing	– / 16	13 / 16	18 / 18	16 / 20	16 / 16	16 / 16	16 / 16
	from right / from left	24 / 18	24 / 18	28 / 34	30 / 31	26 / 31	26 / 31	23 / 18

Acknowledgements: This research was supported by the JARI-commissioned research project "Identification of Motorcycle Issues in ITS/AD Environments and Investigation of Responses" for FY2019-2021.

References: (1) YOLO: `https://github.com/AlexeyAB/darknet` (2022.7.15).