

Lane Detection based on Object Detection and Image-to-image Translation

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Background

Many vision-based lane detection methods have been proposed for advanced driver assistance system or autonomous driving system. Most of these methods detect lane markings such as white lines drawn on the road surface. However, traffic lanes are divided by various roadside objects. For example, curbs, grasses, walls and snow sidewalls. We propose the method to detect various types of lane markings and road boundaries simultaneously from a monocular camera image.

Outline of the proposed method

Lane markings and road boundaries are detected in IPM image obtained by the Inverse Perspective Mapping of input images since these are close to vertical lines in the IPM image.

1. In the IPM image, bounding boxes including a lane marking or a road boundary are detected by the object detection network.
2. In each bounding box, lane marking boundaries or road boundaries are drawn by the image-to-image translation network

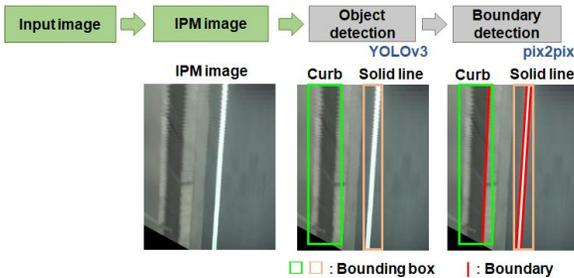


Fig.1 Processing flow

Object detection network

YOLOv3

Darknet: Conv layer + residual block
 Detection: Conv layer + Upsampling
 Conv layer: filter + Batch Normalization + Leaky ReLU

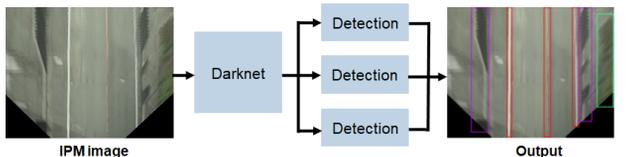


Fig.2 Outline of YOLOv3

- ※ 8 categories are identified by the object detection network
- Lane marking: Solid line, Dashed line, Zebra line
- Road boundary: Curb, Grass, Guardrail, Sidewall, Snow sidewall

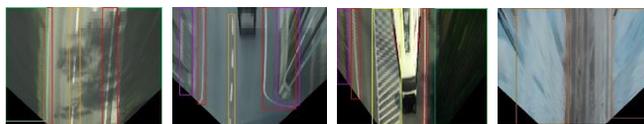


Fig.3 Examples in datasets for object detection

Boundary generation network

- In each bounding box, boundary lines with lane markings or roadside objects are generated by pix2pix.
- Different generators are created for each category.
- Boundaries are generated using a generator that corresponds to the category of the bounding box
- Datasets (a pair images)
- Original image A: a bounding box image obtained by object detection network
- Boundary image B: an image adding line borders to an original image manually

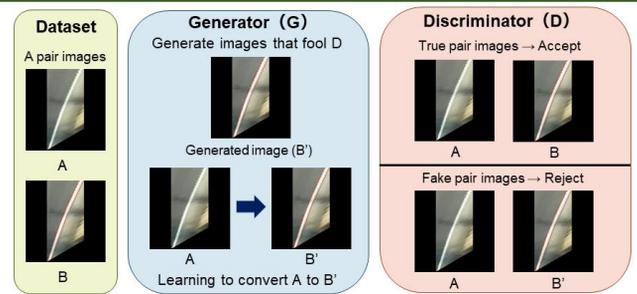


Fig.4 Outline of pix2pix

Experiments

(a) Detection of lane boundary object

(1) Datasets

- IPM images annotating bounding boxes around the lane markings and road boundaries.
- Image size: 720x560 pixels → 608x608 pixels (resize)
- Train: 3,240 images, Test: 1,172 images

(2) Quantitative evaluation

- True positive (IoU > 0.5 and Category reliability > 0.25)

Table 1 Accuracy

	curb	grass	guardrail	sidewall	snow sidewall	white line	white line (dashed)	white line (zebra)	mAP
train	98.9	99.2	98.2	98.5	99.1	99.5	99.1	99.7	99.0
test	91.7	97.1	93.3	87.2	92.4	95.4	96.4	82.8	92.0

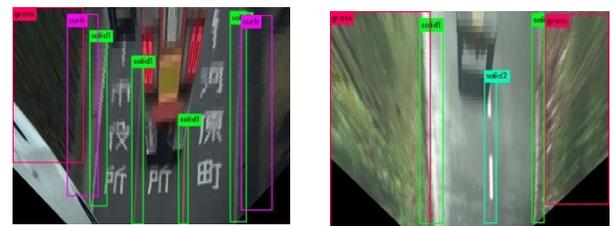


Fig.5 Results of object detection

(b) Boundary generation

Generators for a curb, grass and a white line (solid line and dashed line) were created and evaluated.

(1) Datasets

- Curb: train 1,000 images, test 110 images
- Grass: train 800 images, test 100 images
- White line: train 3,200 images, test 1,060 images
- Image size: 256x256 pixels

(2) Quantitative evaluation

[White line: solid line and dashed line]

- The degree of overlap between white line area of the ground truth and white line area of the generated image are evaluated by IoU.
- F-measure: 99.3% (IoU > 0.3), 96.4% (IoU > 0.5)

[Curb and Grass]

- When the average error in the horizontal direction between the generated boundary and the ground truth is less than about 5 pixels, It's determined as the true positive.
- 80% of 110 images for curb, 93% of 100 images for grass

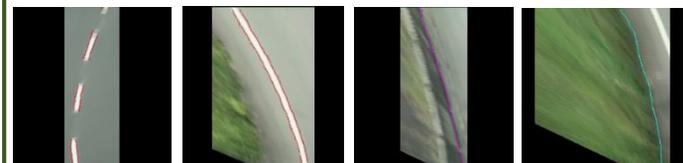


Fig.6 Results of boundary generation