

# Log detection based on deep convolutional neural networks

## Abstract

- Autonomous forest machinery for log loading/unloading
- Objective: To detect logs using convolutional neural networks (CNN) from RGB images
- CNN can detect 91% of logs, and 81% of log regions

## Objective

- Autonomous technology for rise productivity
- Previous researches: mainly driving  
Not focused on loading/unloading
- No technology for log detection for autonomous loading
- Deep convolutional neural networks (CNN)  
Not adapted for autonomous log loading for forest machinery
- **Objective: To detect logs using CNN from log color images**

## Results



Fig. 1: Results of detection

## Materials and Methods

Experiment date: Sep, 18-19, 2018

Location: Forest mechanization center  
(Gunma Pref., Japan)

RGB stereo camera (Zed, Stereolabs) was set in front of grapple loader (CT-500, Iwafuji)

Fresh and 3-years-old log stack (30-40 years

Sugi (*Cryptomeria japonica*), Hinoki (*Chamaecyparis obtusa*), and Momi (*Abies firma*)) images

Trained by Yolo v3 (Redmon et al., 2018) with GPU (GTX1080Ti, NVIDIA)

Treatments: No augmentation,  
Augmentation by image processing,  
Augmentation by image composition

No augmentation    Img processing    Img composition



Original images



(Original + Gamma conversion  $\times 4$  + Gaussian filter  $\times 9$ )  $\times$  Horizontal flip



Background swap, background collected from Flickr

Index: Intersect of union (IoU),  
mean average precision (mAP)

$$IoU = \frac{\text{Area of overlap}}{\text{Area of union}} = \frac{\text{Object} \cap \text{Detection box}}{\text{Object} \cup \text{Detection box}}$$

Table: Results of detection in each data augmentation

	Precision	Recall	IoU	mAP	Num. of images
No augmentation	0.93	0.44	0.78	0.53	3088
Image processing	0.95	0.80	0.81	0.81	86464
Image processing & composition	0.96	0.95	<b>0.82</b>	<b>0.91</b>	176064

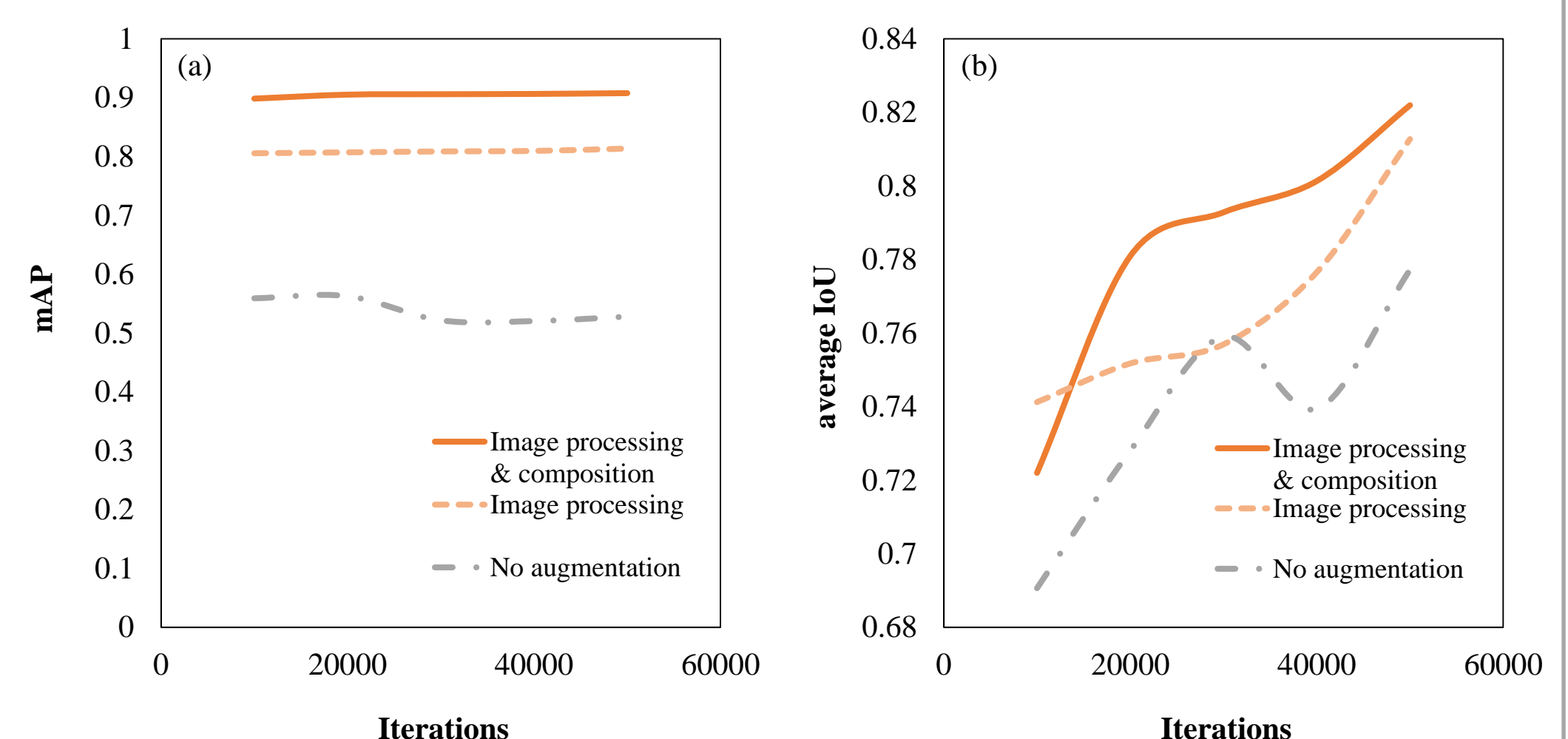


Fig. 2: mAP (a) and IoU (b) during training in each data augmentation

- Adapted CNN to log detection  
**max IoU 82%, mAP 91%, high accuracy**
- Confirmed to increase mAP and IoU by data augmentation
- Ensured robustness from the small amount of data by combination with image processing and image composition

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### References

Redmon, J. & Farhadi, A. (2018) YOLOv3: An Incremental Improvement. arXiv.

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