

ICCE-Asia 2023

‘Crop & Match: RoI-Cropping and Feature Matching for Segmentation of Small Objects’

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Introduction (1/2)

Objective: Detect disease in aerial field images using segmentation



* Green: plant / Yellow: disease

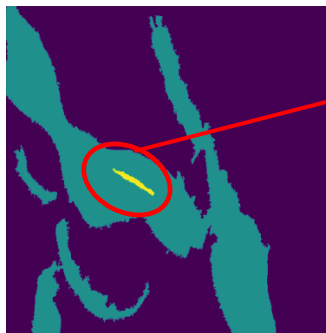
Disease class is small RoI area

- Recognizing small object is challenging task in DL
- The small size of disease area becomes even more prominent
→ need to improve the performance of small RoI objects

Motivation: Predicting small objects accurately



Image



GT

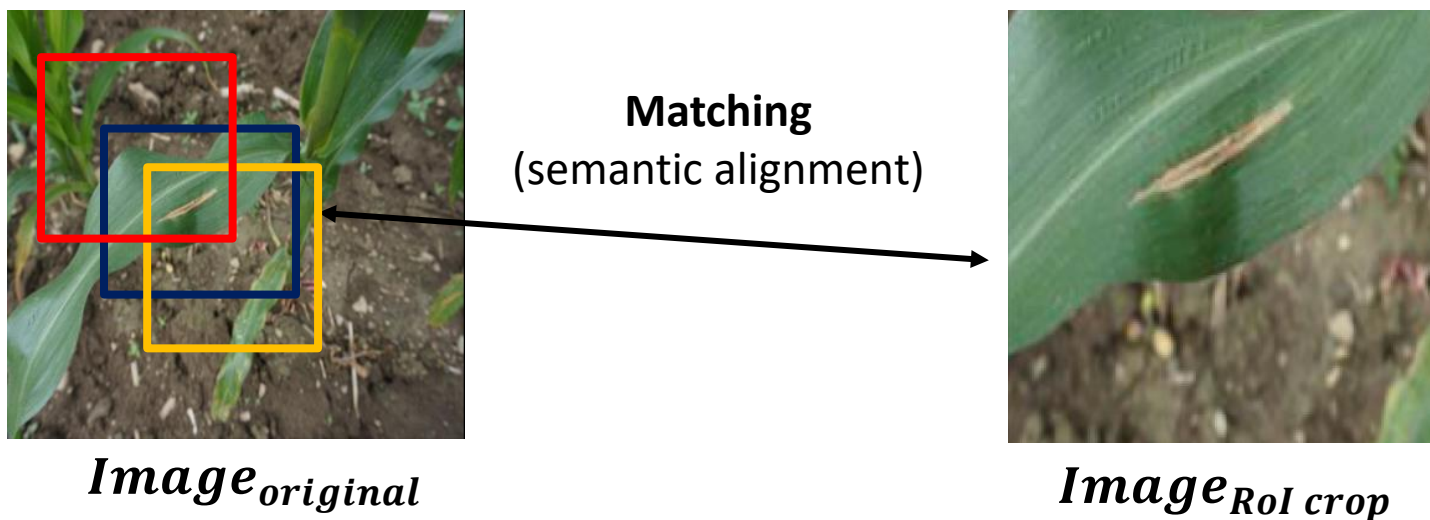
RoI region (disease class)

- RoI areas, which are our main concern, are mostly small in size
- Small RoI areas make accurate predictions difficult

Introduction (2/2)

Proposal: novel data augmentation & optimization methods to improve the performance of small objects

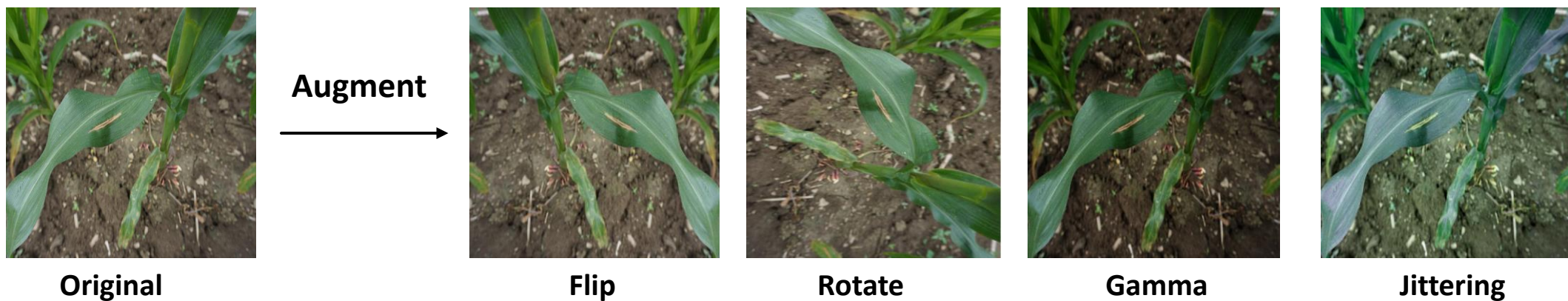
- ① **RoI-Cropping** : method of cropping image in a way that highlights the RoI area
→ makes the network **pay attention to RoI area**
- ② **Feature-Matching Loss**: maximize the cosine similarity between the features of input and its RoI-cropped version
→ enhance the **model's consistency** between different views



Enhancing model's robustness while leveraging the advantages of RoI-emphasized image

Proposed Methods ① - RoI-Cropping (1/2)

Traditional data augmentation methods are not suitable for small RoI object detection



Geometric & color transformation fail to emphasize the small RoI area



Random-Cropping might exclude the RoI area

Proposed Methods ① - RoI-Cropping (2/2)

RoI-Cropping can provide diverse view-points of an image while emphasizing the RoI regions



Original

Augment



RoI-Cropping (red box)



Random-Cropping (blue box)

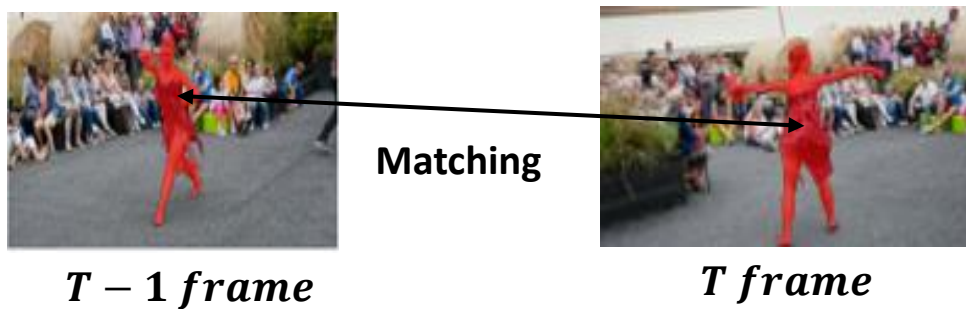
* Cropped regions should include RoI area to some extent

- **RoI-Cropping makes the network to focus on the small RoI area**
- It is suitable for calculating feature matching loss

Proposed Methods ② - Feature Matching (1/3)

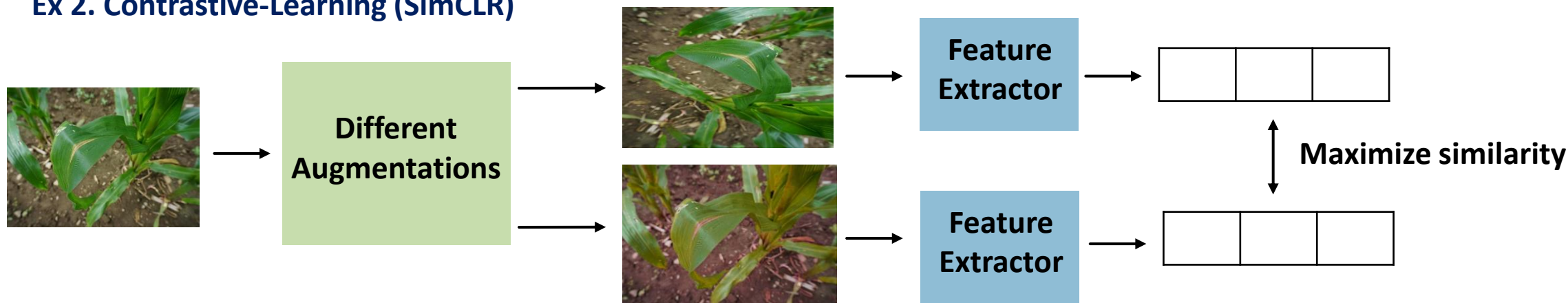
- Motivation of feature matching comes from video-object segmentation & contrastive learning

Ex 1. Video-object Segmentation



- RoI class: red masked person
- Features corresponding to RoI class should be similar (matched)

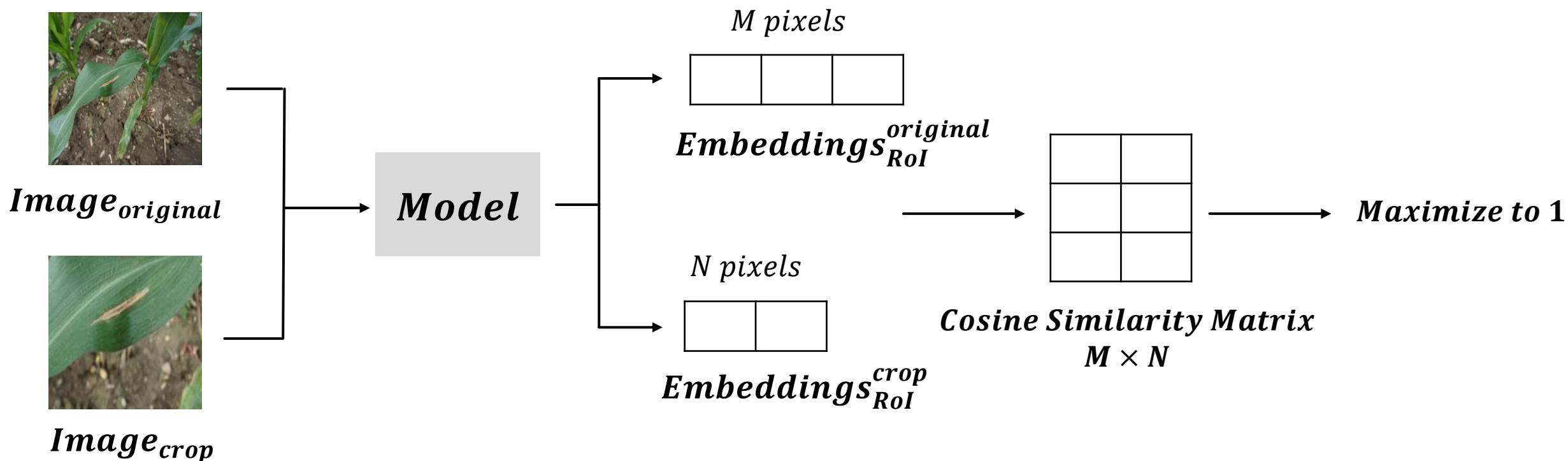
Ex 2. Contrastive-Learning (SimCLR)



The objective is to strengthen inter-image consistency at feature level

Proposed Methods ② - Feature Matching (2/3)

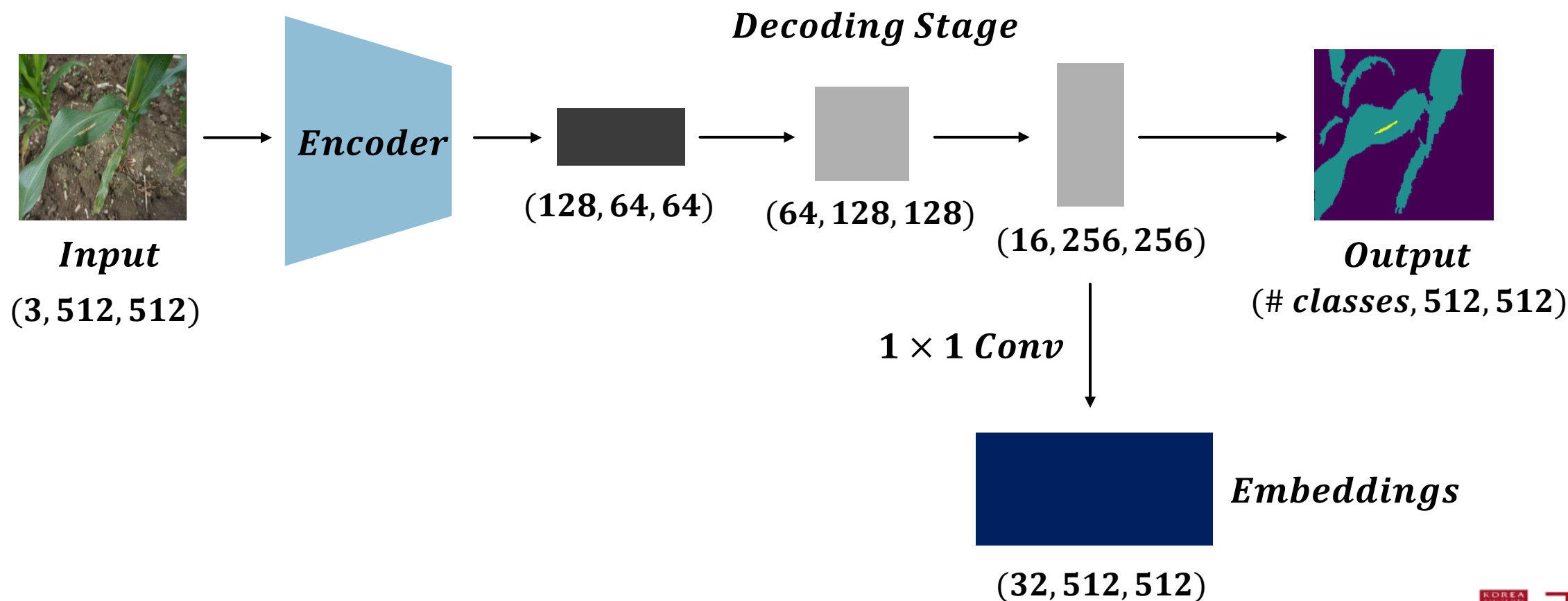
Maximize the cosine similarity between the feature of input image and its augmented(RoI-Cropped) version



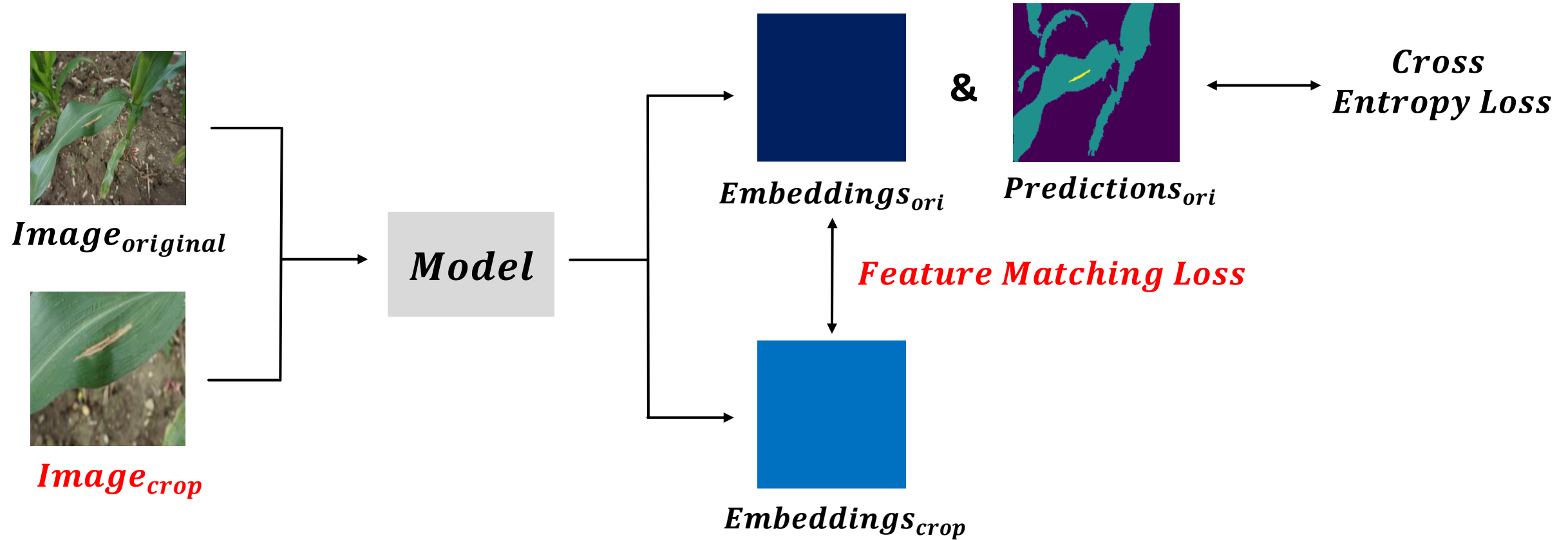
The robustness of the network regarding RoI areas can be strengthened

Proposed Methods ② - Feature Matching (3/3)

- High-dimensional feature embeddings to be matched are from decoding stage of the model
- Only additional 1x1 conv was added to the original ERFNet structure



Proposed Methods – Overall Network (1/1)



Experiments & Results (1/2)



Input

Prediction

GT

Experiments & Results (2/2)

The proposed Crop & Match shows the effectiveness in improving the performance for small RoI class

Method	Plant IoU	Disease(RoI class) IoU
Crop & Match	0.841	0.437
Cross-Entropy Loss	0.838	0.372
OHEM Loss	0.831	0.381

→ Enhancing inter-image consistency of model is effective for improving the performance on small objects

RoI-Cropping is more effective for matching loss than other augmentation methods

Method	Plant IoU	Disease(RoI class) IoU
Crop & Match (RoI-Cropping O)	0.841	0.437
Only Match (RoI-Cropping X)	0.837	0.413

→ RoI-Cropping is more suitable for enhancing the inter-image consistency than traditional augmentations

Thank you