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Fusion of Global-Local Features for Image Quality inspection of Shipping Label

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1. Introduction – Shipping label

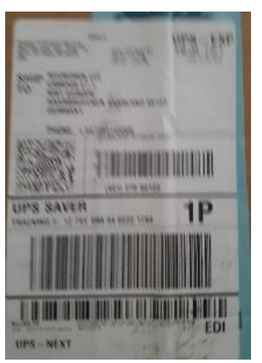
- Shipping Label
  - Contains barcodes and the address of sender and receiver
- Problematic labels lead to High-cost loss problem
  - such as undeliverable situations, returned products, and damages on seller's reliability
  - The annual costs are estimated at about 1.5 billion dollars for the postal service and 20 billion dollars for the mailing industry
- The performance of OCR engines and text detection engines is sensitive to image quality and defects on target objects.

1. Introduction – Image Quality Inspection of Shipping label

- To reduce the processing time and the accuracy of the inspection, bad quality images need to be detected.
- We define five classes; Normal, Unreadable, Contaminated, Handwritten, Damaged
- “Contaminated” class for preprocessing process, “Unreadable” class for bad image quality assessment, “Handwritten” class for OCR engine, and “Damaged” class for bad quality product inspection

Normal

Contaminated



Unreadable

Hand-written

Damaged

Normal

Contaminated

Unreadable

Hand-written

Damaged

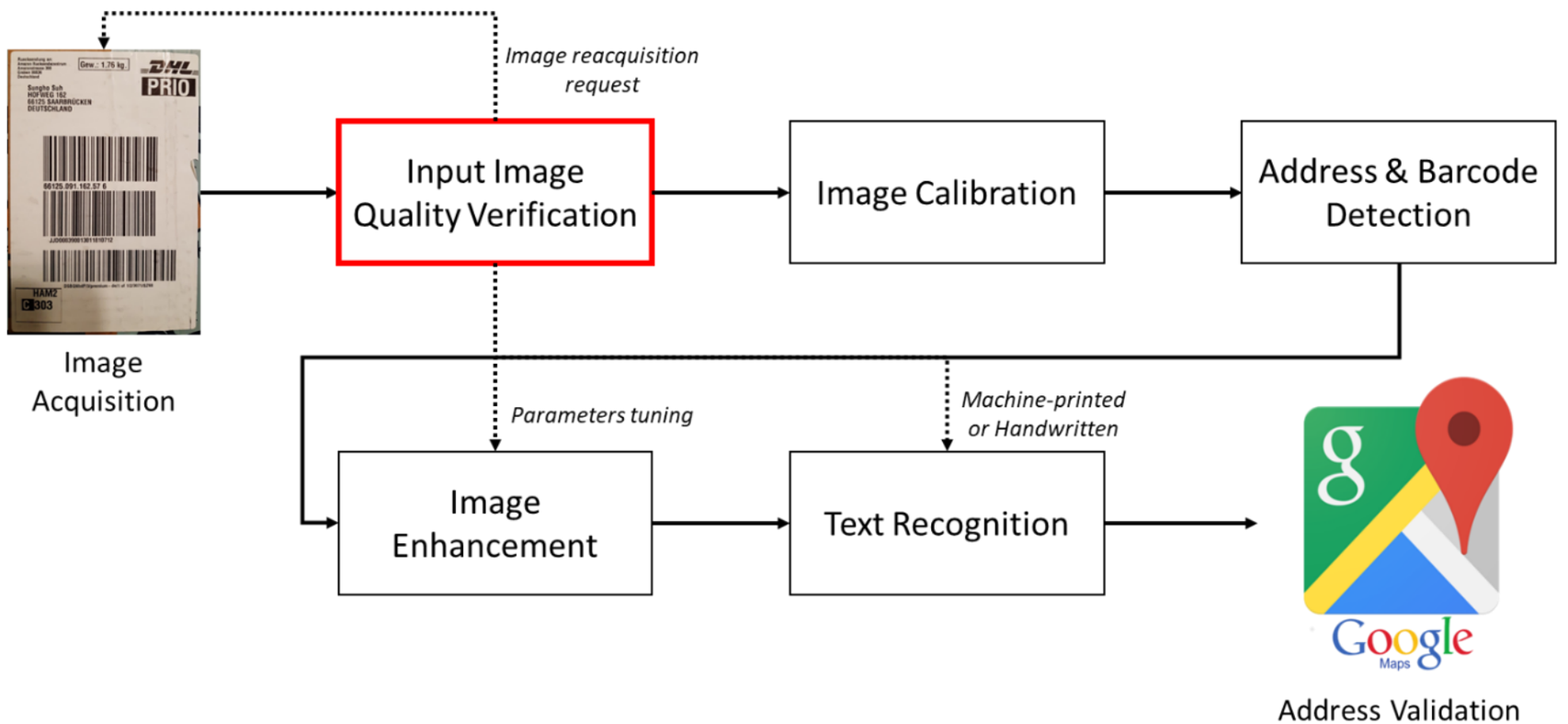
1. Introduction – Problems for classification based on CNNs

- Two problems for classification
  1. The varying aspect ratios and sizes of shipping label images
  2. Difficult to distinguish between contaminants in the address area and contaminants in other areas.
- General methods for handling input images of different sizes
  1. Resizing the input image while maintaining the aspect ratio in the padding space
  2. Using patches as inputs to the CNN to extract discriminative features
- Resizing the input images leads to increasing the ambiguity between normal and blurred images because of the loss of detailed features, making it difficult to detect defects in ROIs.
- Dividing an input image into patches can lead to the loss of global features, degrading the classification performance.

→ In this study, we propose an input image quality verification method using CNNs combining global and local features for shipping label inspection.

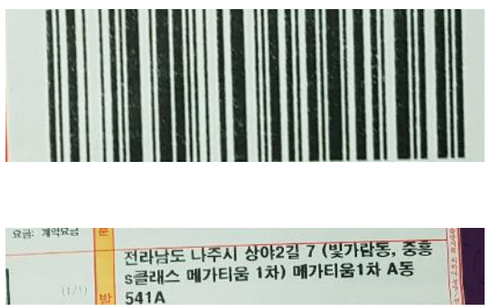
2. Proposed Method – The shipping label inspection system

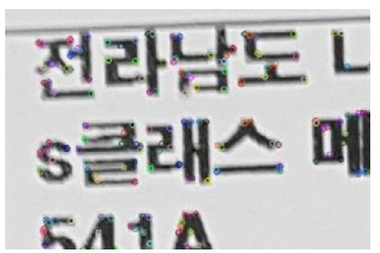
- The shipping label inspection system involves six steps
  1. Unreadable image and the damaged label → Image reacquisition request
  2. The contaminated and handwritten addresses → Parameter tuning for image enhancement and text recognition process

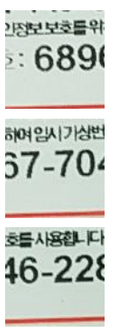


2. Proposed Method – Feature Localization

- Feature Localization by using YOLO and FAST
  - Address and Barcode detection by using YOLO: a fast general-purpose object detector using deep neural networks and achieved real-time detection, that is much faster than R-CNN and Faster R-CNN based methods.
  - Region localization by using FAST: a famous corner-detection algorithm that can be used to extract feature points.







Complete Image

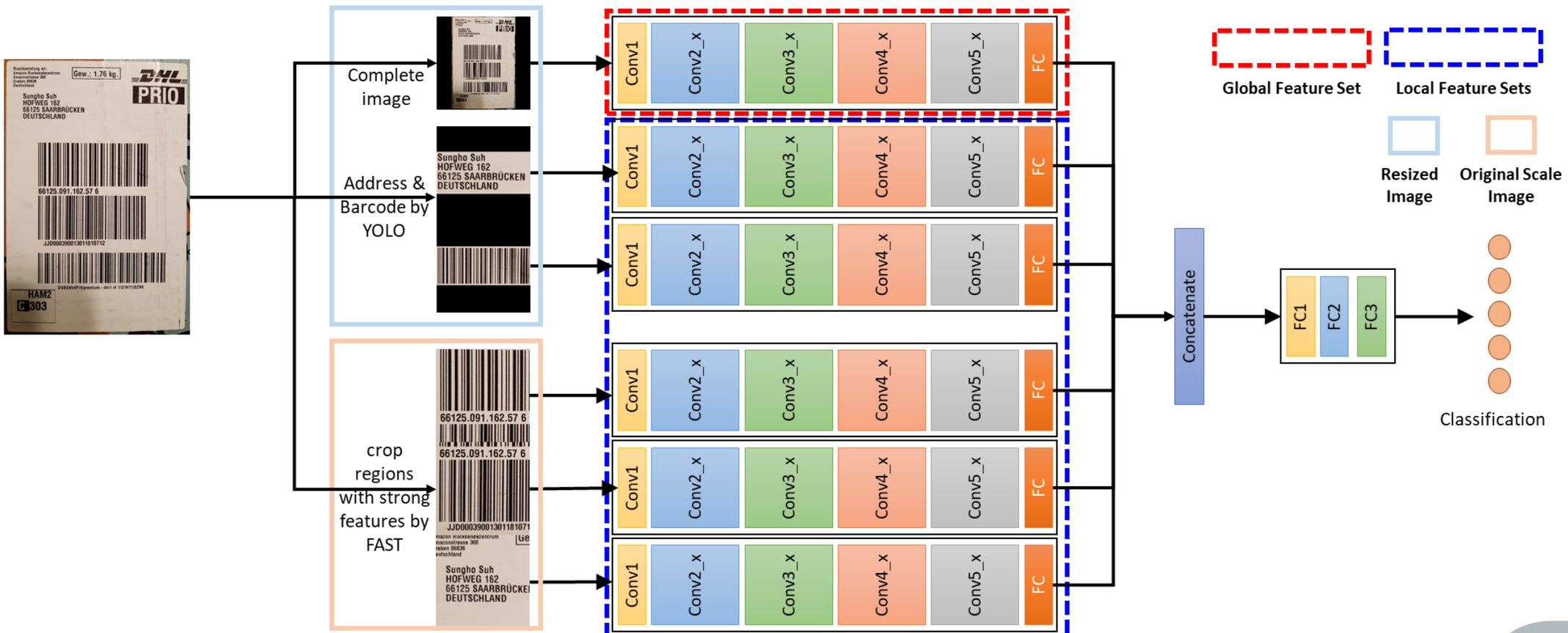
Address and Barcode area by YOLO

FAST results

Three strong feature areas

2. Proposed Method – Overall network architecture

- Global and Local Feature Fusion
  - Deployed ResNet-50 pre-trained on ImageNet for global and local feature extractions.
  - A stacked generalization ensemble was adopted to combine the global and local features.
  - To verify the proposed method, we compared the proposed ensemble models with majority voting and weighted majority voting algorithms.



3. Experimental Results - Dataset

- Generated and collected real shipping label dataset
  - We have generated and collected 5306 and 1092 images of different types and from various countries using smartphones.
  - Five people manually annotated the dataset with specific sorting criteria.

Defect Type	# of Images (Generated)	# of Images (Collected)
Normal	1283	660
Contaminated	1054	139
Unreadable	904	107
Handwritten	988	52
Damaged	1077	134
Total	**5306**	**1092**

- The performance of the detection by YOLO

Region	mAP (Generated)	mAP (Collected)
Address	0.9653 ± 0.1637	0.8907 ± 0.0215
Barcode	0.9976 ± 0.0018	0.9778 ± 0.0065
Total	**0.9814 ± 0.0085**	**0.9343 ± 0.0105**

3. Experimental Results – Classification Results

- Comparison of classification results on the generated dataset

Methods	VGG-19	ResNet-50
Only global features	95.98 ± 0.74 %	95.80 ± 0.38 %
Global-local fusion (majority voting)	96.40 ± 0.65 %	96.62 ± 0.43 %
Global-local fusion (weighted majority voting)	97.16 ± 0.43 %	97.02 ± 0.77 %
Global-local fusion (ours)	98.32 ± 0.49 %	**99.06 ± 0.66 %**

- Comparison of classification results on the collected real dataset

Methods	VGG-19	ResNet-50
Only global features	85.40 ± 2.43 %	86.00 ± 3.40 %
Global-local fusion (majority voting)	84.67 ± 2.27 %	86.40 ± 2.97 %
Global-local fusion (weighted majority voting)	85.00 ± 2.68 %	87.60 ± 2.70 %
Global-local fusion (ours)	87.80 ± 2.13 %	**89.26 ± 2.70 %**

- Accuracy of each class on the collected real dataset

Defect Type	Only global features	Global-local fusion (ours)
Normal	93.33 %	95.00 %
Contaminated	78.33 %	85.00 %
Unreadable	83.33 %	88.33 %
Handwritten	98.33 %	98.33 %
Damaged	76.67 %	79.31 %
Total	86.00 %	89.26 %

4. Conclusion

- We have presented an input image quality verification method using CNNs combining global and local features for shipping label inspection.
- As the four different poor conditions of captured images were successfully classified, the performance of the shipping label inspection system could be improved and the cost in logistics could be reduced.
- In future work, we plan to apply the proposed method to a packaging machine with an industrial camera and will test it in the logistics industry.
- We also plan to improve the image enhancement and text recognition process in the shipping label inspection system.

T H A N K Y O U

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