CIS6930/4930: Deep Learning For Computer Graphics - Project III

Small-Object Sensitive Segmentation and Quantitative Analysis of Hard Drive Disk

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1. Background

A large number of images appear and interests in understanding images.

1. Background

Semantic segmentation aims to set a categorical label to each pixel in an image, and it plays a vital role in image understanding.

1. Background

Two challenges in CNN-based semantic segmentation networks:

- Consecutive pooling or striding causes the reduction of the feature resolution.
- The networks are not aware of small objects.

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2. Introduction

- Hard Drive Disk (HDD) is the experimental object.
- Introduce a data preprocessing module to mark each component of an HDD.
- Design deep learning architectures to classify each component.
- Propose multi-region deep convolutional neural networks (CNNs) to predict semantic segmentation results.

Final results: The semantic segmentation information of the HDD dataset and the accuracy of multi-region segmentation.

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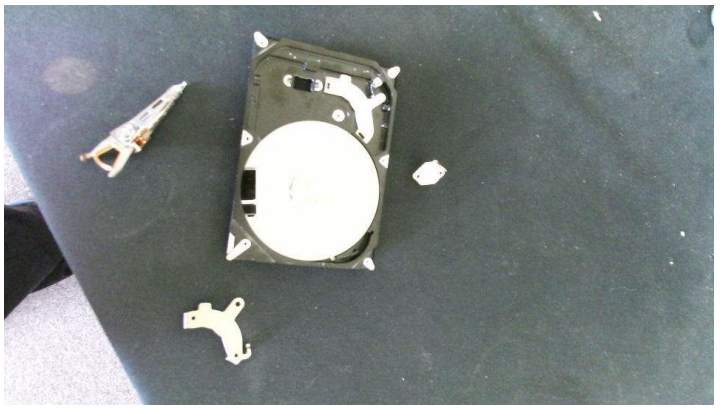
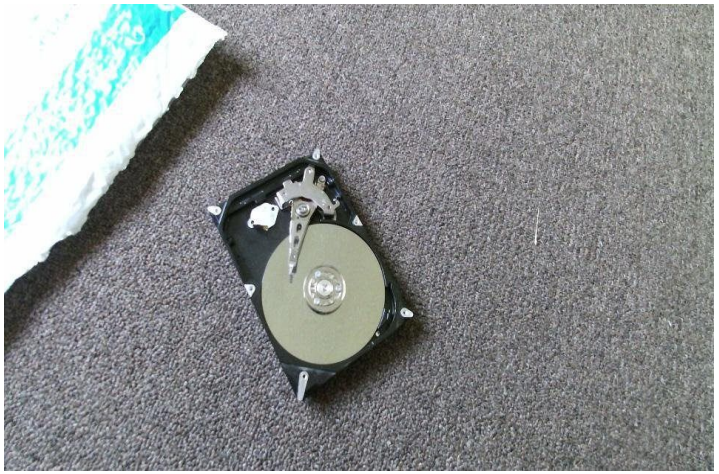
3. Methodology - Dataset Preprocessing

The original HDD dataset: 75 RGB images.



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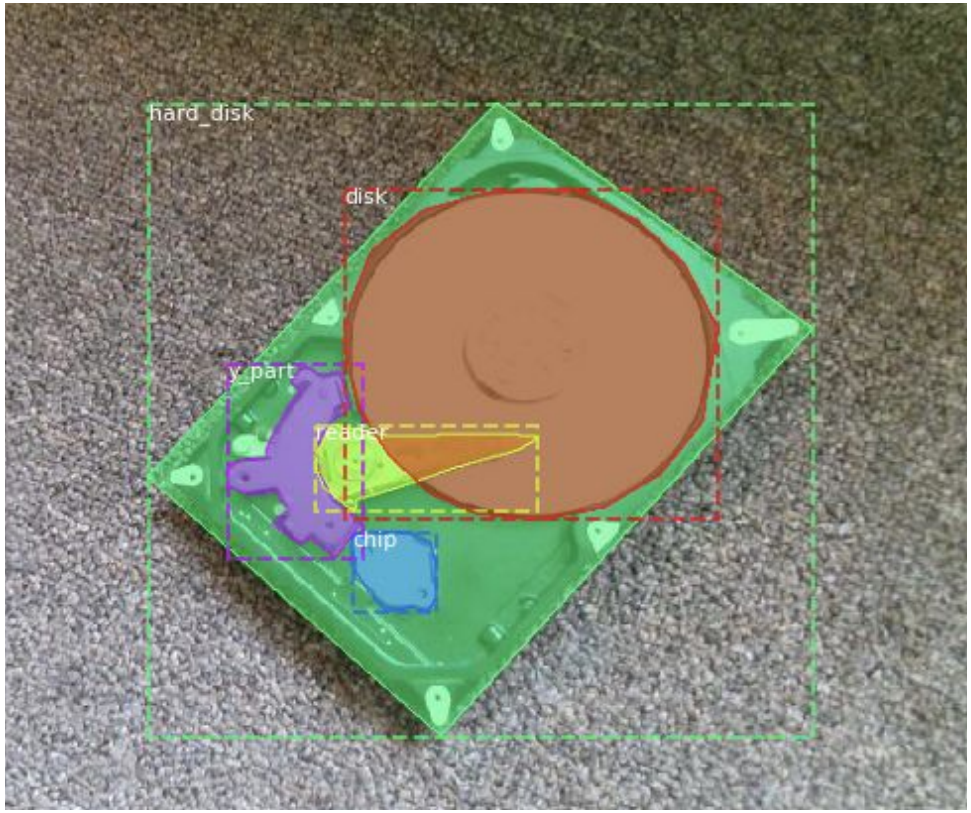
3. Methodology - Dataset Preprocessing

Separate an HDD into five parts, including hard_disk, disk, y_part, reader, and chip.



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3. Methodology - Dataset Preprocessing

Build a network to obtain the segmentation ground truth.

hard_disk

disk

y_part

reader

chip

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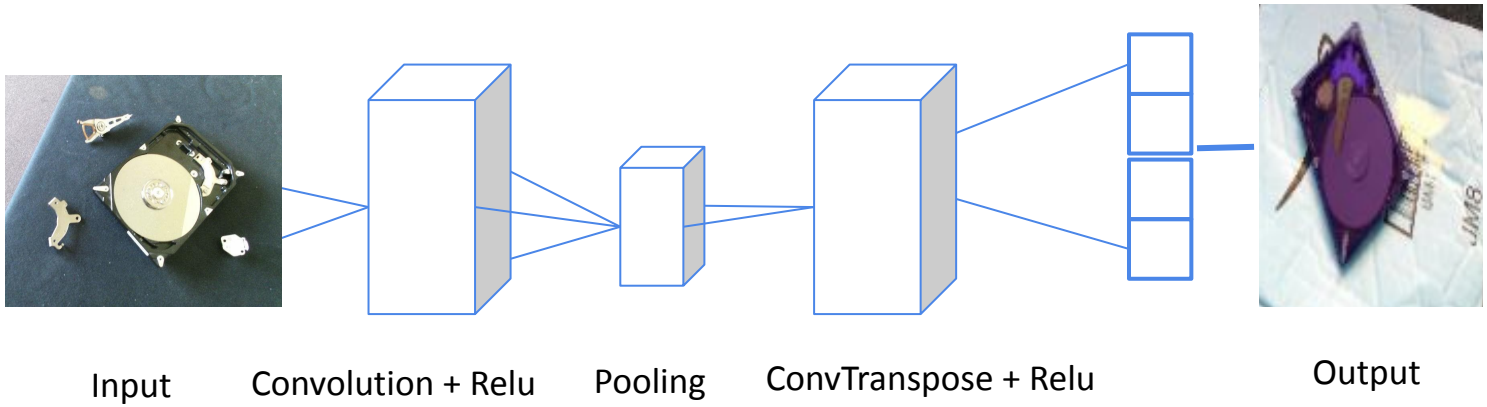
3. Methodology - Classification Architectures

Classify the label of each component by GoogLeNet and ResNet50:

- Data augmentation: resize, horizontal flip, normalize.
- Train: transfer pretrained model after training parameters 100 epochs for both architectures.
- Test: classify each HDD component individually.
- Result: predict classification accuracy and plot confusion matrices.

3. Methodology - Semantic Segmentation Model



- Convolution layer: Conv2d(kernel_size=3, stride=1, padding=1)
- Pooling layer: MaxPool2d(kernel_size=2, stride=2)
- Transposed convolution layer: ConvTranspose2d(stride=2, padding=1)

5 Convolution layers: channels from 3 to 256.

5 Transposed convolution layers: channels from 256 to 6.

3. Methodology - Semantic Segmentation Model

Quantify segmenting results through classification GoogLeNet and ResNet50 architectures:

- Input: apply output mask images from the segmentation components.
- Train: transfer pre-trained parameters of GoogLeNet and ResNet50.
- Test: predict the probability of exploring multi-region segmentation accuracy.

```
Resnet50 prediction:
hard_disk with prediction0.9965 probabilities
disk with prediction0.9987 probabilities
chip with prediction0.987 probabilities
reader with prediction0.9798 probabilities
y_part with prediction0.96 probabilities
GoogLeNet prediction:
hard_disk with prediction0.8514 probabilities
disk with prediction0.9375 probabilities
chip with prediction0.7505 probabilities
reader with prediction0.8085 probabilities
y_part with prediction0.4647 probabilities
```

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4. Conclusion - Results

The training and testing classification results of each component for two architectures:

Model	Parts	Training Accuracy	Testing Accuracy
GoogLeNet	chip	0.99	1
	disk	0.81	1
	hard-disk	0.93	1
	reader	0.76	1
	y-part	0.67	1
ResNet50	chip	0.91	1
	disk	0.85	1
	hard-disk	0.76	1
	reader	0.75	1
	y-part	0.76	1

4. Conclusion - Results

The results of segmented prediction:

```
Resnet50 prediction:
hard_disk with prediction0.9965 probabilities
disk with prediction0.9987 probabilities
chip with prediction0.987 probabilities
reader with prediction0.9798 probabilities
y_part with prediction0.96 probabilities
GoogLeNet prediction:
hard_disk with prediction0.8514 probabilities
disk with prediction0.9375 probabilities
chip with prediction0.7505 probabilities
reader with prediction0.8085 probabilities
y_part with prediction0.4647 probabilities
```

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4. Conclusion - Discussion

- Develop a preprocess network that yields a customized region representation capable of labeling in different colors.
- Apply regional mask images on two deep learning architectures for the multi-label image classification.
- Show how the segmentation model works and how to significantly quantify the segmentation capability.

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