TRAILBot
Real-Time Trail Segmentation

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Motivation

Baseline Solution

- TRAIL Lab robot to distribute treats to hikers
- Semantic segmentation of hiking trails
- Trained on PSPNet with custom dataset (~1000 images)

Limitations

- Dataset is overfit to 1 long trail
- PSPNet semantic segmentation model is no longer state-of-the-art
- Inconsistent results (mIoU)

Objectives

Robustness

Adaptability to perform effectively in various environmental/trail conditions

Speed

Ability to segment incoming video stream frames in real-time

Accuracy

Ability to correctly identify and label the trail boundaries

Methodology

Dataset Expansion

Collect and segment 400 images of various trails (asphalt, concrete, dirt, gravel)

Architecture Adjustment

Explore state-of-the-art segmentation models for optimal performance

Data Augmentation

Augment data using mirroring, scaling, cropping, and gaussian blurring techniques

Hyperparameter Tuning

Tune the highest performing architecture hyperparameters (epochs, learning rate, batch size)

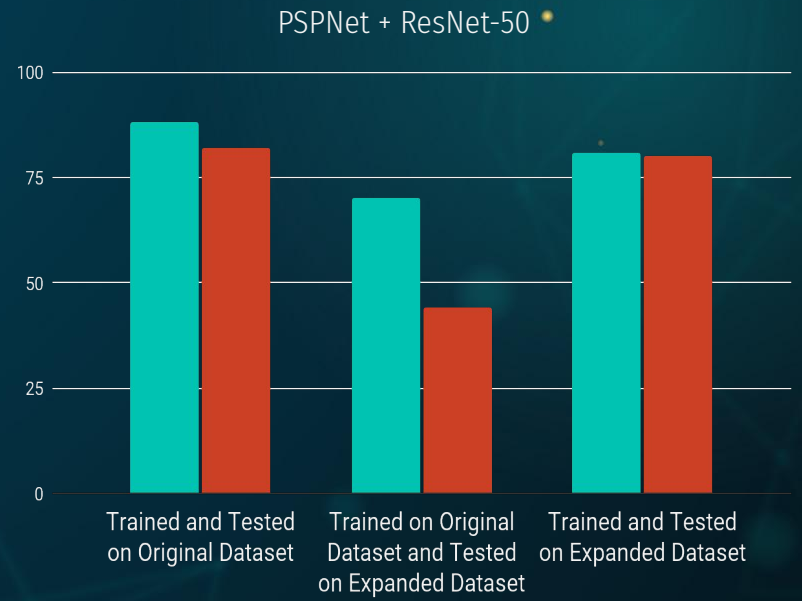
Dataset Expansion

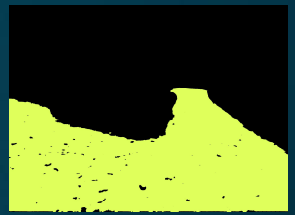
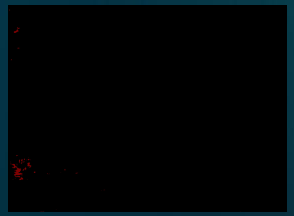
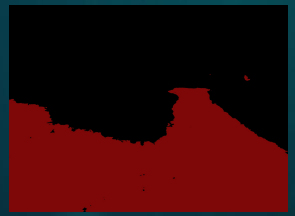
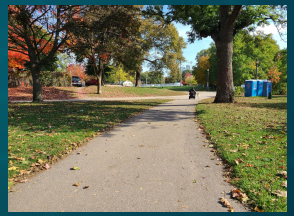
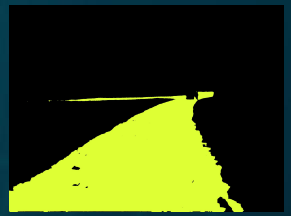
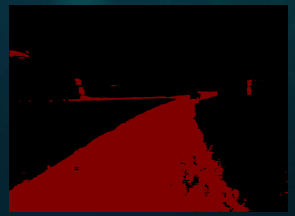
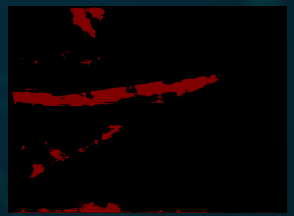
Pixel Accuracy

Percentage of pixels that are accurately classified in the image

mIoU

Percentage of overlap between the predicted segmentation and the ground truth segmentation



Trail	Ground Truth	Old Prediction	New Prediction
			
			
			
			

Data Augmentation

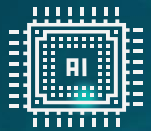
01 **Mirror**
Flip the image along its vertical axis

02 **Scale**
Resize the image while maintaining its aspect ratio

03 **Crop**
Extract a portion of the image

04 **Gaussian Blur**
Blur the image to reduce noise and suppress detail

Architecture Selection



Performance: How does the model perform on segmentation tasks with existing popular datasets (e.g. Cityscapes or COCO)?

Runtime: Is this approach appropriate for real-time online applications on mobile robot?

Computation Required: How many weights need to be optimized? Is this feasible with only 1 GPU?

PyTorch Compatibility: How complex is it to integrate these models with PyTorch? Are there licensing issues?

Model Results

A Lightweight Encoder-Decoder Network for Real-Time Semantic Segmentation

Hyperparameter Tuning

LEDNet + ResNet-50 (Before Tuning Hyperparameters)			
Learning Rate	**Batch Size**	**Epochs**	**Performance**
0.003	8	10	87.79%

LEDNet + ResNet-50 (After Tuning Hyperparameters)			
Learning Rate	**Batch Size**	**Epochs**	**Performance**
0.004	4	30	89.38%

Video Demo

THANKS!