Lane Detection Methods Based on Semantic Segmentation

Min Nam, Jonghwan Lee (Kumoh National Institute of Technology)

International Conference on Innovation, Communication and Engineering 2023

Research Background

Traffic accidents are steadily increasing due to the malfunction of Advanced Driver Assistance System.

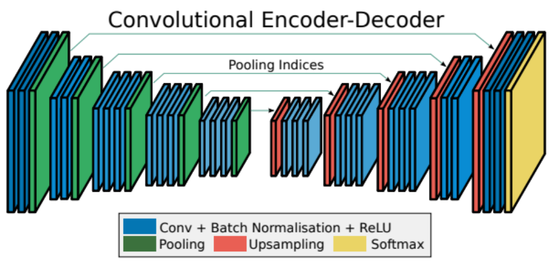
<Figure 1> Dump truck stopped because it recognized the shadow as an obstacle

<Figure 2> Blocking stick recognized by FCA as human

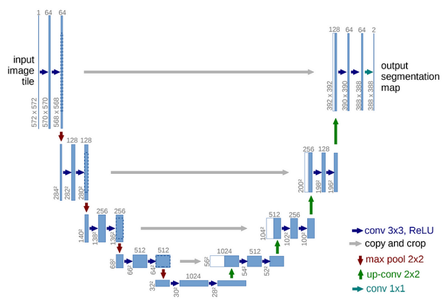
Semantic Segmentation

- Semantic Segmentation is a computer vision task in which the goal is to categorize each pixel in an image into a class or object.
- The goal is to produce a dense pixel-wise segmentation map of an image, where each pixel is assigned to a specific class or object.

SegNet vs UNet



<Figure 3> SegNet Architecture



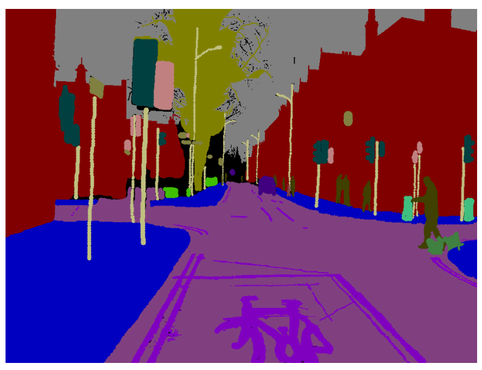
<Figure 4> UNet Architecture

- SegNet is a model released in 2016, designed for pixel-wise semantic segmentation of images taken while driving on the road.
- SegNet is characterized by being composed of Encoder - Decoder. It can operate efficiently in terms of memory and induction time.

- UNet is a model that appeared in the ISBI cell tracking challenge 2015.
- UNet is an artificial neural network that extracts the features of an image using both low-dimensional and high-dimensional information.

Data (CamVid)

<Figure 5> CamVid Image Data



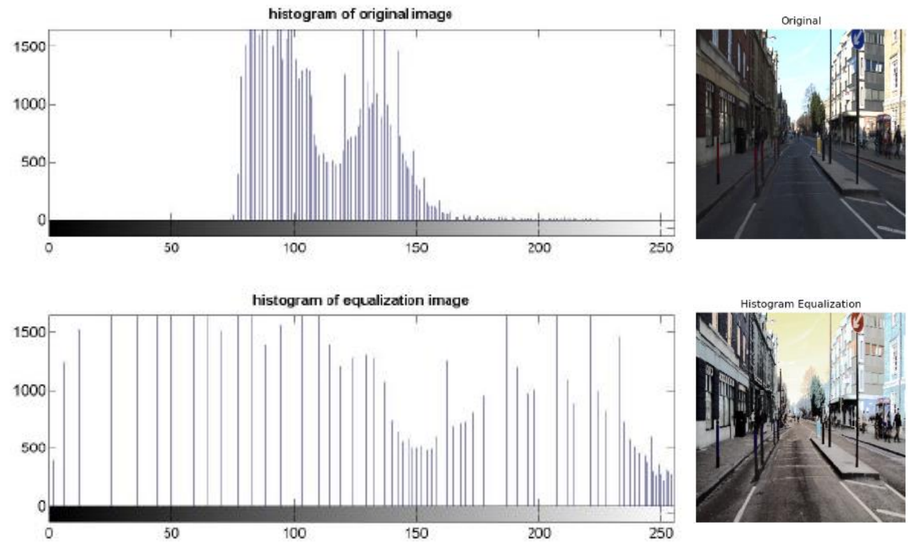
<Figure 6> CamVid Label Data

CamVid (Cambridge-driving Labeled Video Database) is a road/driving scene understanding database which was originally captured as five video sequences with a 960×720 resolution camera mounted on the dashboard of a car.

- Those stills were manually annotated with 32 classes:

void, building, wall, tree, vegetation, fence, sidewalk, parking block, column/pole, traffic cone, bridge, sign, miscellaneous text, traffic light, sky, tunnel, archway, road, road shoulder, lane markings (driving), lane markings (non-driving), animal, pedestrian, child, cart luggage, bicyclist, motorcycle, car, SUV/pickup/truck, truck/bus, train, and other moving object

Pre-processing



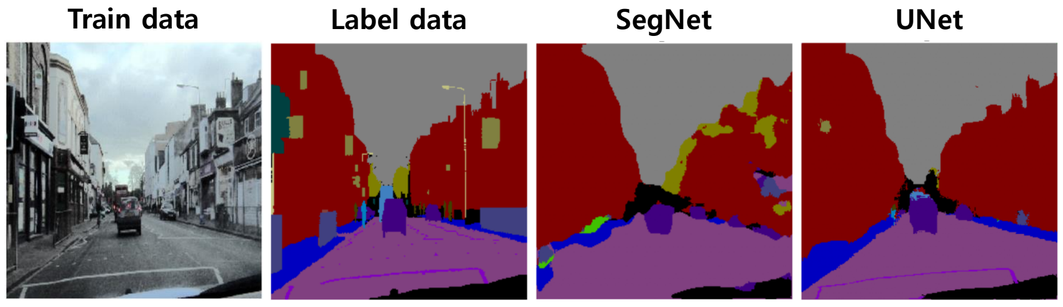
<Figure 7> Original Image vs Histogram Equalization Image

- By performing histogram equalization, an enhanced image can be obtained by distributing the brightness value of the image to have an even brightness value in the range of 0 to 255.
- With these advantages, histogram equalization is used as an image preprocessing process in technologies for obtaining specific information, such as image analysis and image recognition.

IoU & Inference Time

- Semantic Segmentation is a computer vision task that involves assigning a semantic label to each pixel in an image.
- In Real-Time Semantic Segmentation, the goal is to perform this labeling quickly and accurately in real-time, allowing for the segmentation results to be used for tasks such as object recognition, scene understanding, and autonomous navigation.

Results



<Figure 8> SegNet & UNet Prediction Results using Test Data

	SegNet	Unet
Accuracy	0.7714	0.8631
IoU	0.9429	0.9234
Inference	0.5040	0.5380

<Table 1> Comparison of SegNet and UNet Results

Conclusion

- SegNet has a shorter inference time than UNet in accuracy or prediction images. On the other hand, UNet had a long inference time instead of good performance.
- The model to be selected will depend on whether the model performance or inference time is weighted.
- In future research, it is necessary to consider “what is important” in model selection and upgrade.

References

- 한문철 TV. “18662회. 전방충돌보조(FCA) 장치의 오작동으로 갑자기 멈춰버린 트럭” YouTube, 2023. 4. 9., https://www.youtube.com/watch?v=ER9GLEtg4ic
- 블박맛집. “흔들리는 눈빛 그녀의 역주행, 중앙봉을 사람으로 인식 결함일까요, 자전거 사고 가해자에서 피해자로 | 블랙박스 모음 [블박맛집]” YouTube, 2023. 5. 5., https://www.youtube.com/watch?v=ig-IFeZNosg
- Badrinarayanan, V., Kendall, A., Cipolla, R.: ‘SegNet: A Deep Convolutional Encoder-Decoder Architecture for Image Segmentation’, IEEE Transactions on Pattern Analysis and Machine Intelligence, 2015, pp 99
- Ronneberger, O., Fischer, P., Brox, T.: ‘U-Net: Convolutional Networks for Biomedical Image Segmentation’. In MICCAI, 2015, pp 234-241