Fully Convolutional Network

(FCN)

In Autonomous Vehicle

Overview of AV and FCN(Semantic Segmentation)

Autonomous Vehicles are capable of drive a vehicle by itself without an human interface from starting place to predetermined destination. That has 0 - 5 levels of Autonomous vehicle. In that the 5th level is fully autonomous there is no human intervention might be present.

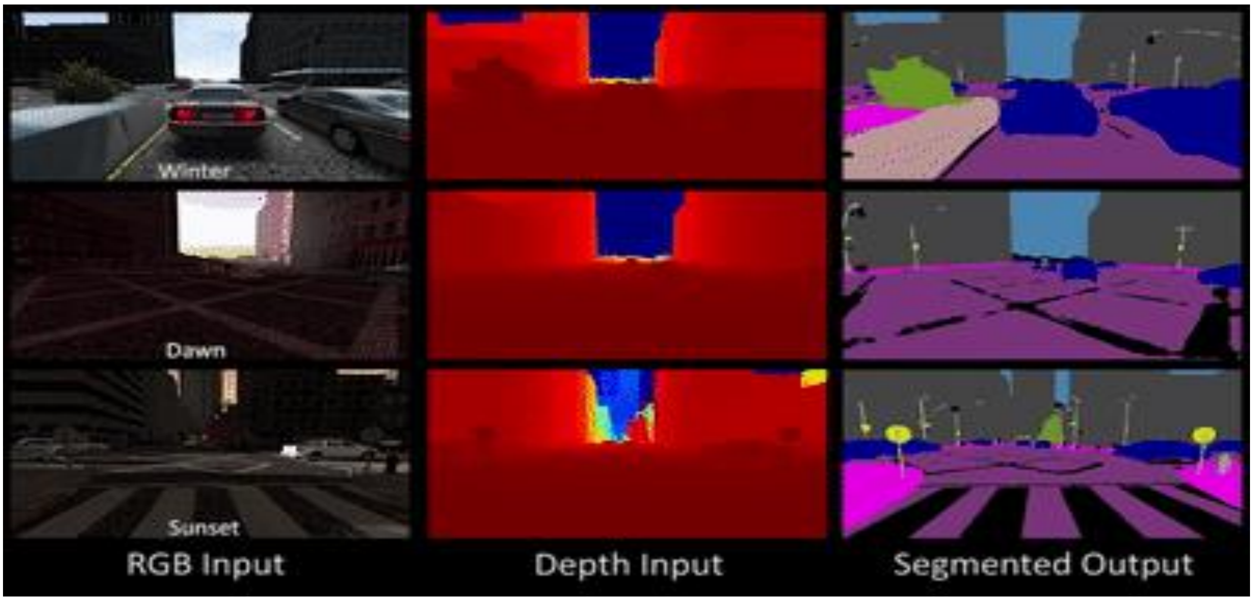
It has the following stages to produce a complete autonomous vehicle,

1. Perceiving the Environment
2. Planning how to reach from point A to point B
3. Controlling the vehicle

Fully Convolutional Network was used to training the real-world data to recognize what is in-front of the vehicle. FCN classifying the objects class for each pixel value in captured image to clarifies what is inside of the vehicle.

There are many situation that must be learned. To know the locations of the objects around autonomous vehicles.

The process of determining the locations of the objects in the image can be realized by detecting (getting into the bounding box) or segmenting.



In this document discussed about Perceiving the Environment

Perception

Identification and understanding motion

AI Helps:

- use sensor data to **paint the scene**
- Identify **signs** & **road rules**
- **Learn** continuously to improve **safety and performance**

Goals

- **Road & lane markings**
- **Curbs(off-road,slide)**
- **Traffic light**
- **Road signs**
- **Construction sign & obstruction**
- **Vehicle and Pedestrain detection**

Challenges

- **Robust detection & segmentation**
- **Sensor uncertainity (While raining, fog)**

- **Occlusion & Reflection(While sunlight)**
- **Illuminance,lensflare**
- **Weather**
- **precipitation**

How to Perceiving the Environment?

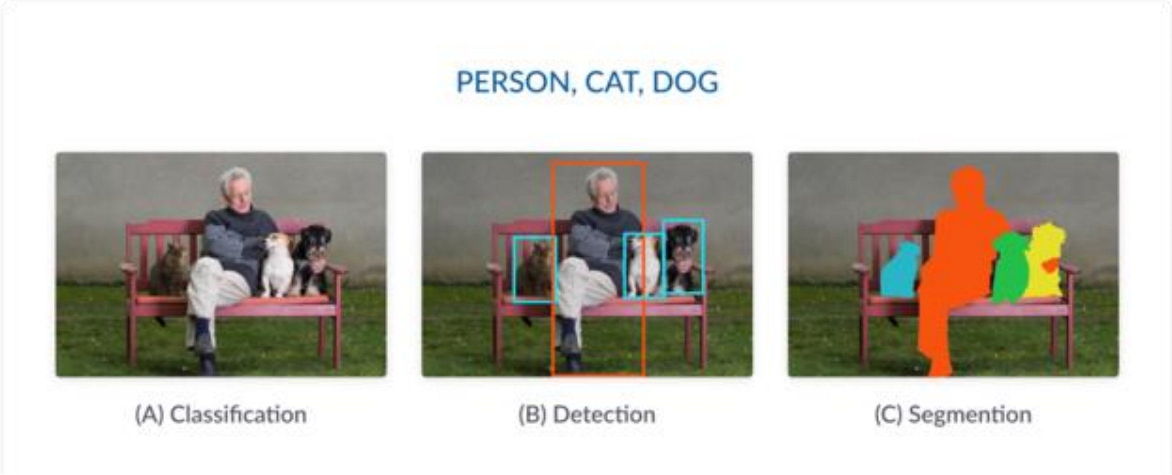
In this process is used to understand how the vehicle see the real world Environment and Everything fully done by computer based operation. Perceiving the environment with the help of

1. Sensors
2. LIDAR
3. RADAR
4. Camera

ComputerVision plays vital role in understanding the environment. In that semantic segmentation is important to do it correctly.

Methods

1. Image Classification
2. Object Detection
3. Semantic Segmentation(FCN)
4. Instance Segmentation



Compare semantic segmentation with other methods:

Image Classification	**Object Detection**	**Semantic Segmentation**	**Instance Segmentation**
Classifying the object or recognizing the object classes within the image itself	Detect and classify the objects within image and show bounding boxes bounded by the object in that class , position, size is used	Classifies the **object class for each and every pixel** within the image. **Here each pixel has its own label.**	Hybrid of object detection and Semantic Segmentation

FCN

FCN or Semantic Segmentation is a classifies the object class for each pixel.

Image segmentation is the operation of separating images into unique groups that shows similar and labeling each pixel in an image as belonging to a given semantic class.

Semantic Segmentations are achieves a fine-grained inference by making of dense prediction & inferring labels for every pixel &

each pixel will labeled with the class of its enclosing the object of region.

Encoding input image into low-dimensions and recovering it with a orientation invariance capabilities of the decoder. This generating a segmented image in the decoder end.

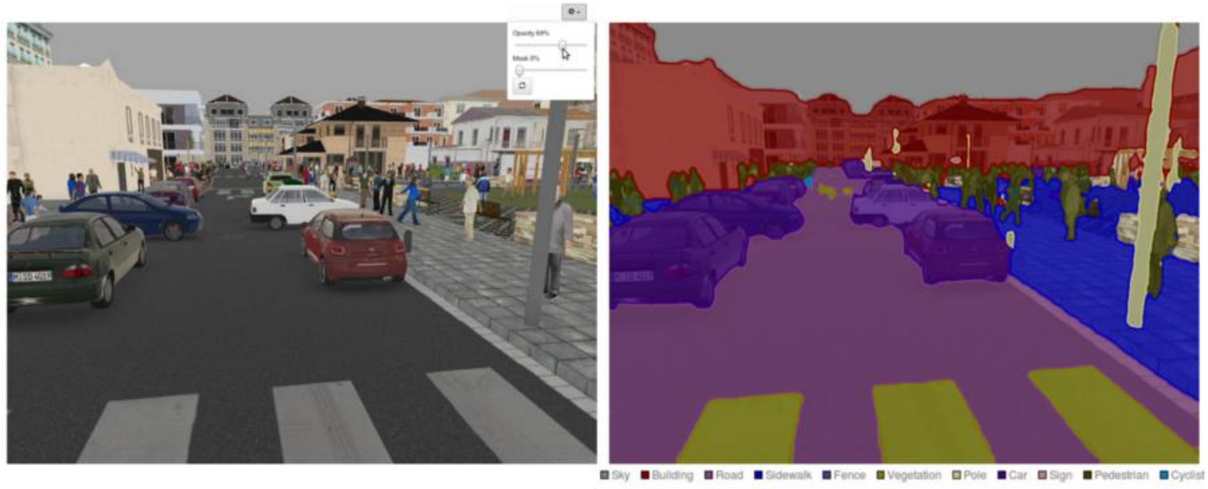
The classes represent an urban scene that is important for self driving vehicle;

1. traffic signs
2. cars
3. pedestrians
4. street lamps or sidewalks.
5. Tree
6. Lane line etc

Operations

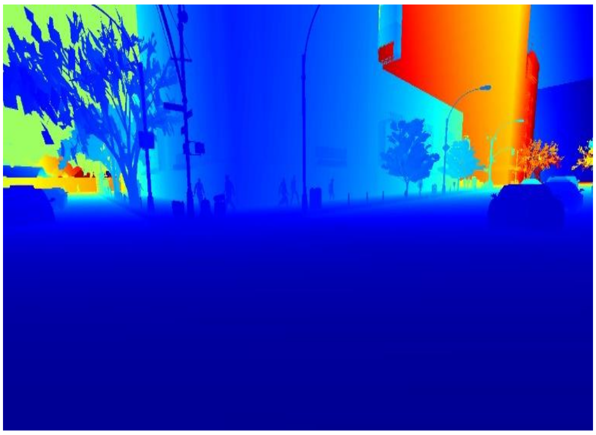
1. Lane line Detection
2. Traffic sign classifier
3. Traffic Light classifier
4. Behavioural cloning
5. Vehicle detection

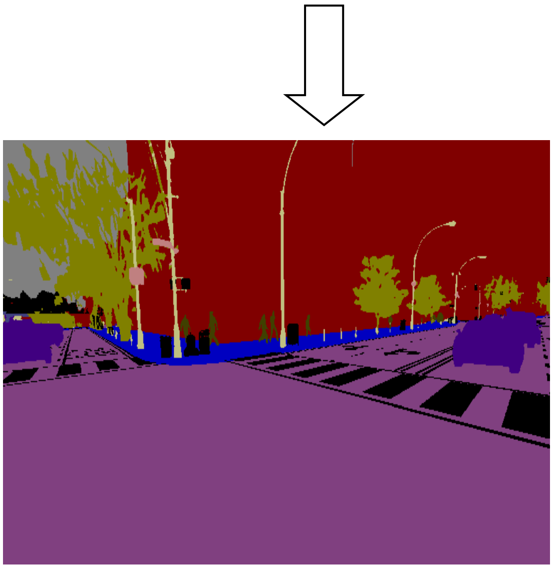
Examples



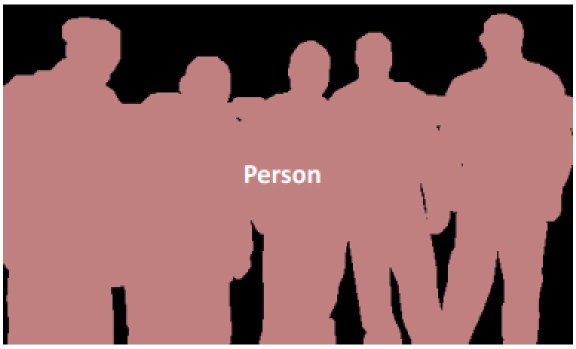
INPUT IMAGE

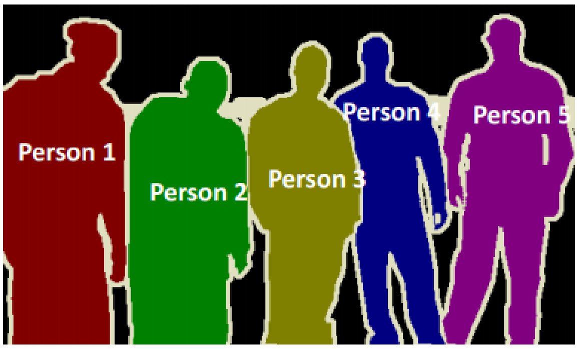
SEGMENTED IMAGE





Segmented output





Semantic Segmentation

Instance Segmentation

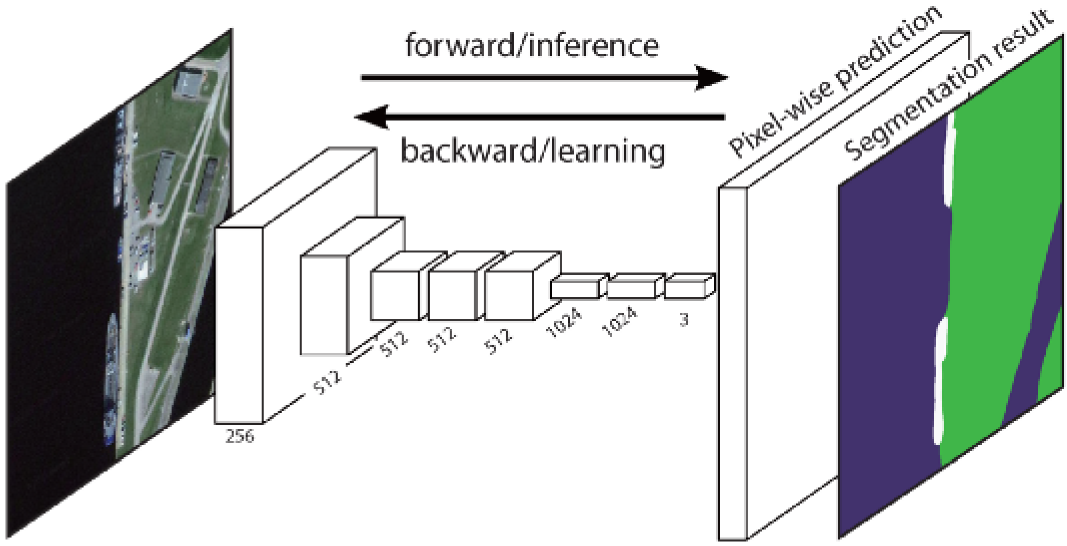
CNN for Segmentation

Semantic Segmentation have more CNN Architecture layers, non-linear activations, batch normalization, polling layers.

FCN pipeline is extension of the classical CNN. Idea to make the classical CNN take as input arbitrary-sized images.

The restriction of CNN is to accept ,produce labels only for specific sized inputs comes from the fully-connected layers are fixed.

FCNs only have convolutional and pooling layers that are give them   ability to make predictions on arbitrary-sized-inputs.



One issue in this specific FCN was that by propagating through several alternated convolutional and pooling layers, the resolution of the output feature maps is down sampled.

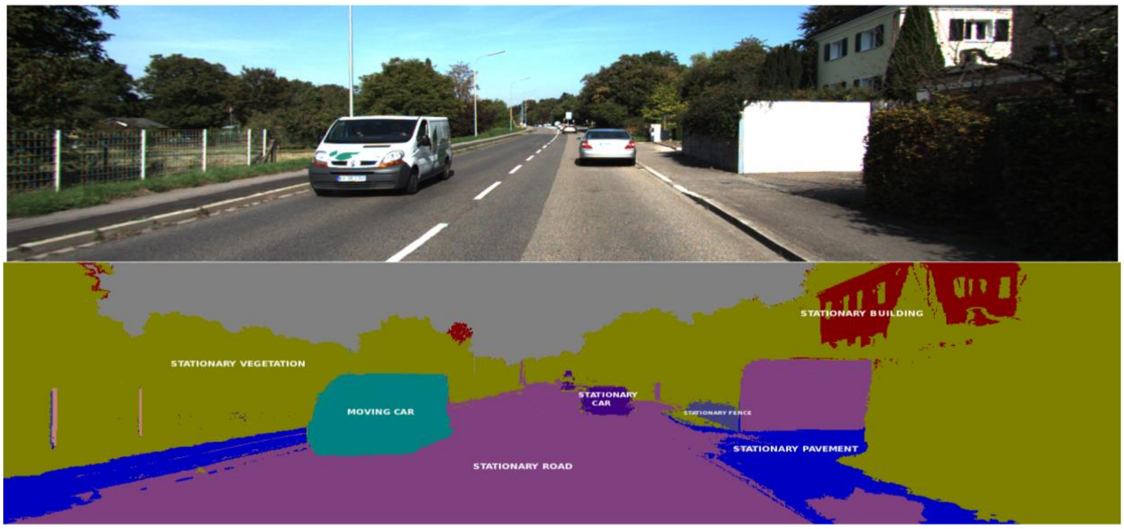
A variety of advanced FCN based approaches had been proposed to address this issue, including DeepLab-CRF ,SegNet , Dilated Convolutions.

Lane Detection using FCN

Lane detection need some algorithms to extract pixel features of the lane line, & pixel fitting algorithm is used to complete the lane detection.

To obtaining lane line points using Sobeledge or Canny edge extraction algorithm and lane feature detection done by Hough transform , but operations are based on manual feature extraction.

The research is based on deep neural network to make dense predictions instead of artificial feature extractions. In order to enable the model to adapt to more road scenes, by analyzing the structure of classic convolutional neural networks and **semantic segmentation**,using two-branch network and custom function network to convert the lane line detection problem into an **instance segmentation** problem detection, and then each lane line forms its own instance.



Two branch networks contain lane segmented & embedded branch that can be trained end-to-end.

The Lane segmentation branch outputs backgrounds or lane lines, and lane pixels are divided into different lane proportion by decomposing lane embedding branch . So that the function of lane segmentation can be fully utilized without having to assign different classes to different lanes.

The Lane embedding branches trained with the clustering loss function assign lanes to each pixel from the lane segmentation branch, ignoring background pixels.

A blockchain based edge offloading method is used to ensure integrity and real-time in the data transmission process. For real-time processing and feed- back, edge computing, as a new computing paradigm,has a better ability to solves one problems such as hightrans- mission delays,high bandwidth expenditures, and privacy leaks.

Lanefitting

The lane instance is estimated by determine which pixel belongs to which lane, we need to convert each of them into a parameter description.

Use a widely used fitting algorithm.the widely used lane fitting models are mainly cubic polynomials, spline or arc curves.

To transform the image into a “bird’s-eye view” to improve the quality of the fitting while main- taining the computational efficiency, and then adopt the method of curve fitting by Inverse perspective transformation.

The transformation matrix on a single image calculated by the inverse perspective transform and can remain fixed, but if the road plane changes, the fix is no longer valid, causing

Apply an inverse perspective transformation to the image before fitting to the curve to solve this situation, and uses a customized loss function for the lane fitting problem to optimize it.

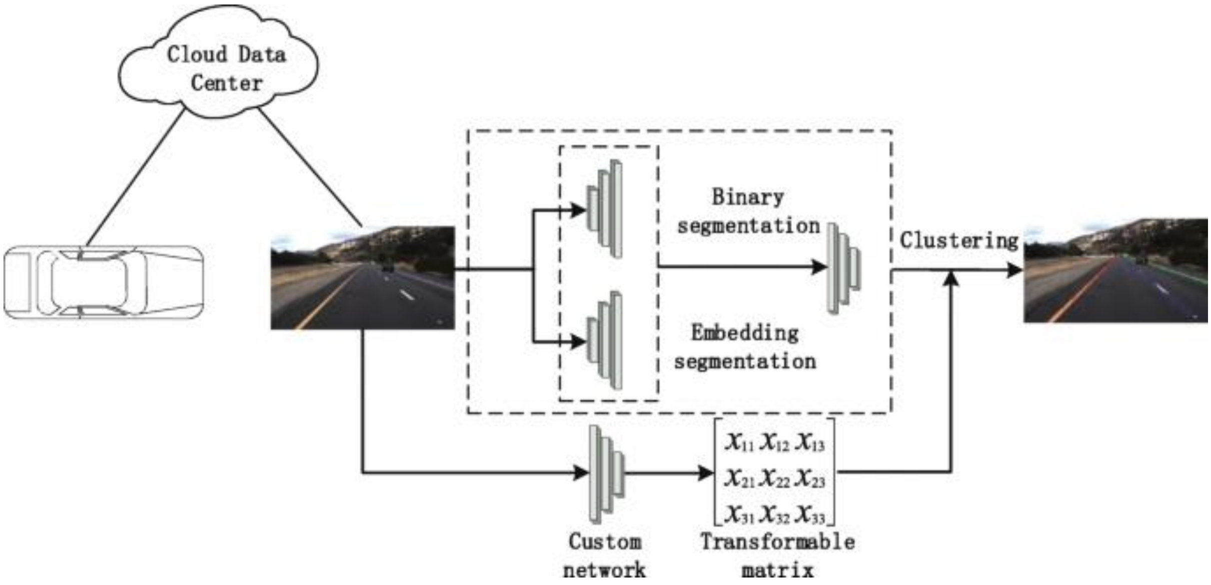
A custom function net- work is used to generate a transformable matrix and transform the lane pixels, then use curve fitting polynomials toper form pixel fitting on the converted pixels, & finally the input image fitted to the converted pixels.

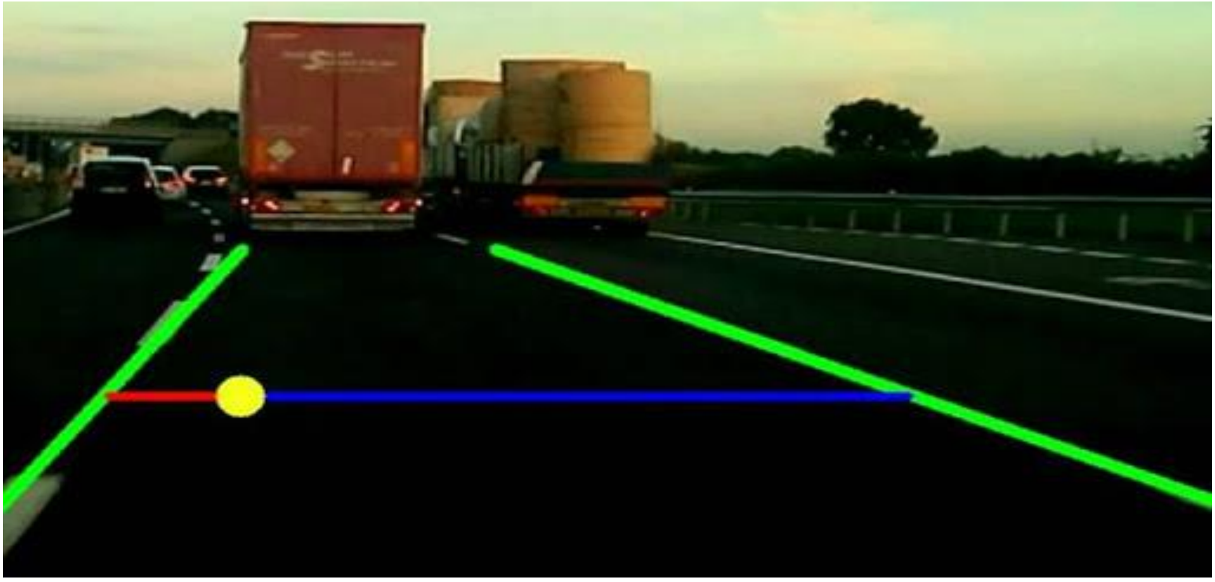
The advantage is detection algorithm can fit the pixels of distant lanes with good robustness whenever the road surface changes& adapt to lane changes.

Method

Binary segmentation used to save computing resources & to binarizing the image.

The two-branch network outputs a binary segmentation map, which divides the laneline and non-laneline parts. At the high imbalance between lane and background, and lane pixel segmentation used to bounded inverse class weighting.





Lane line detection after instance segmentation