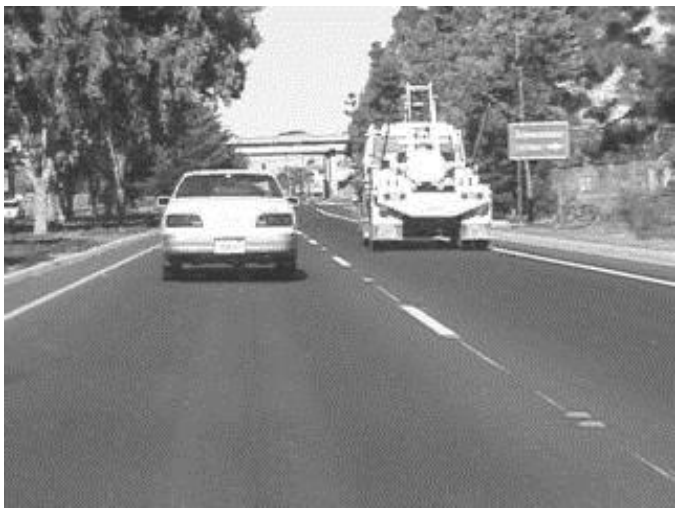
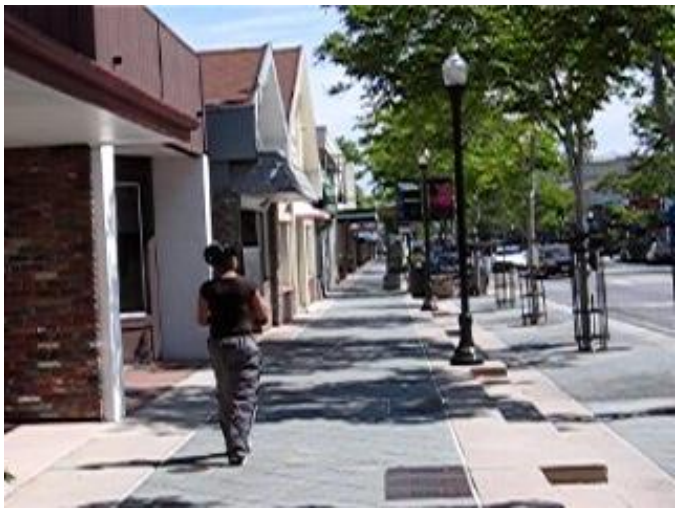
README

- Run the program.
- Choose a dataset to work with.
- We will only show the N largest segments on screen and print details. Select N.
- Evaluate the two segmentation result of k-means and classical threshold methods.
- Choose one.
- Results will be on screen and command window.
- After pressing any key, program rolls images forward and you can stop any time by pressing “p”.

EE 576 Final Project

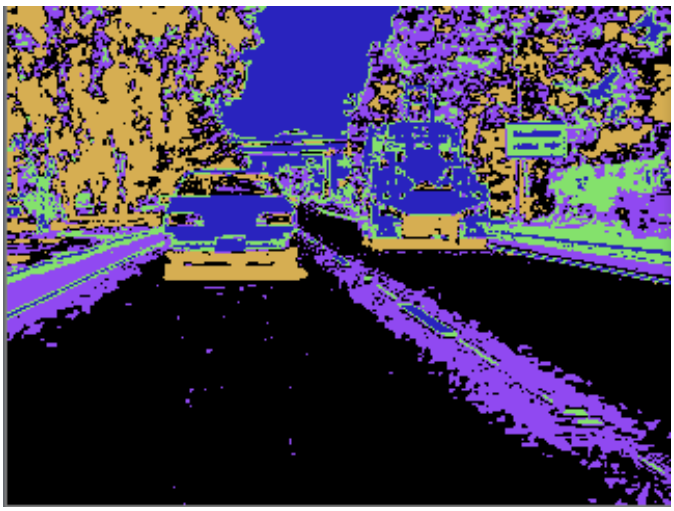


An image from “Car” dataset.



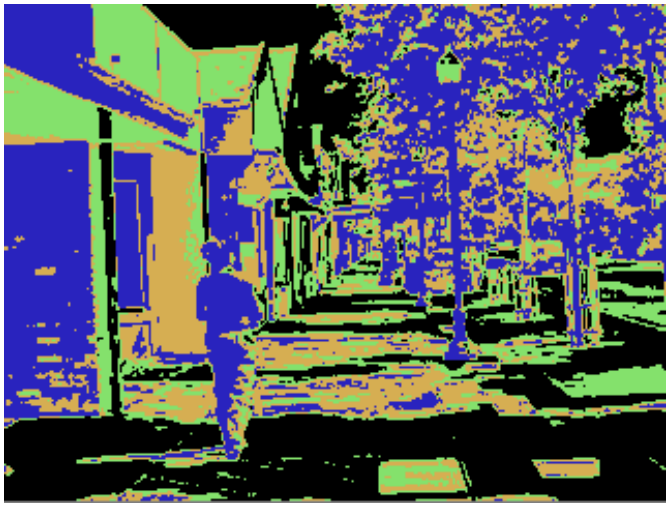
An image from “Human” dataset.

The aim of this project is combining segmentation and tracking. Our dataset contains time-varying images of a human walking on street and cars going on a highway. For segmentation, I tried Watershed Algorithm, Edge Based Segmentation, Thresholding, Region Based Thresholding, K-means Clustering, Connected Components Algorithm(CCA) and OpenCV Graph Based Segmentation Method. The two best method for our problem were K-means Clustering and Region Based Thresholding with post and pre-processing. Other applied methods aren’t applicable for good results while using our dataset. K-means algorithm was really successful without any enhancement to the images. Applying Connected Components Method to the results of k-means achieved very detailed segmentations. On the other side, Region Based Thresholding needed morphological operations to succeed.

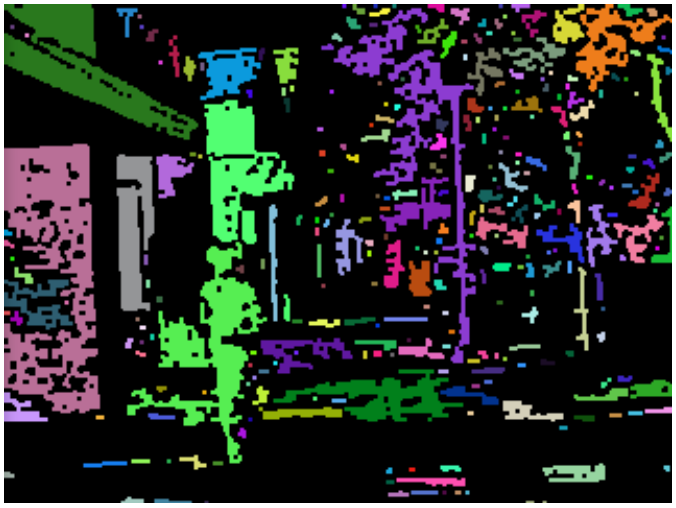


K-Means Segmentation before CCA

Pre and Postprocessed Adaptive Thresholding Segmentation



K-Means Segmentation before CCA

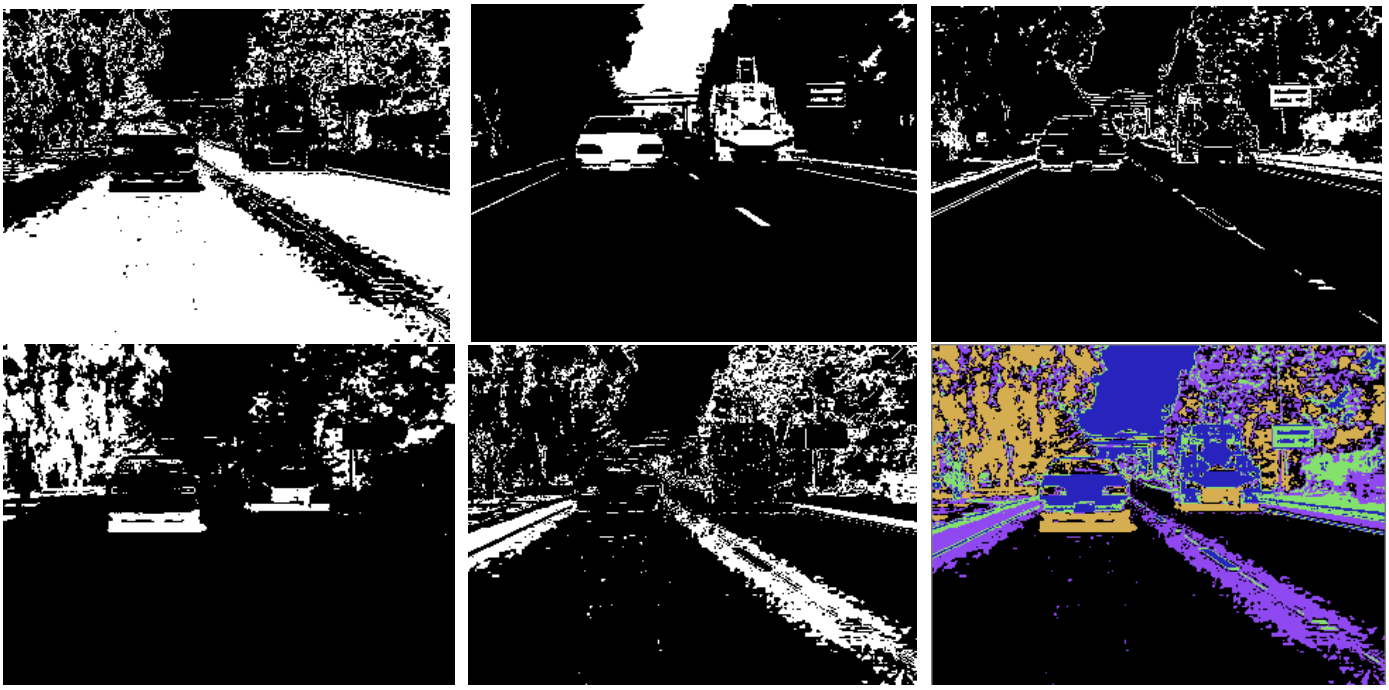


Pre and Postprocessed Adaptive Thresholding Segmentation

For thresholding, first histogram equalization is applied to the images to increase the contrast. Then, Median Blurring followed by Laplacian Filtering is applied and results extracted from the original image to help reducing the noise and to make clear the object borders. After applying Adaptive Thresholding image still wasn't perfect to be segmented thus "Opening" (erosion + dilation) is applied after thresholding. Resulted image is given to the Connected Components Algorithm and a successful segmentation is achieved.

Thresholding Process

K-Means algorithm only creates a definite number of labels. Increasing this number is computationally expensive and results in increased waiting time. Therefore, a suitable small "K" is selected for clustering and then supported with CC algorithm. Every K-means label send to CCA with their own binary image and at the end all segments added together for segmentation. Moreover, inspecting all output labels of K-means clustering individually gives some opportunities. For example, if needed, user can select disregarding any object other than cars and air and can only segment those selected objects as can be seen in below pictures. Also, at the initialization of the program, you can only see the K-means results pre-CC analysis that's because connected components created significantly increased amount of label and that is not preferred due to performance issues.

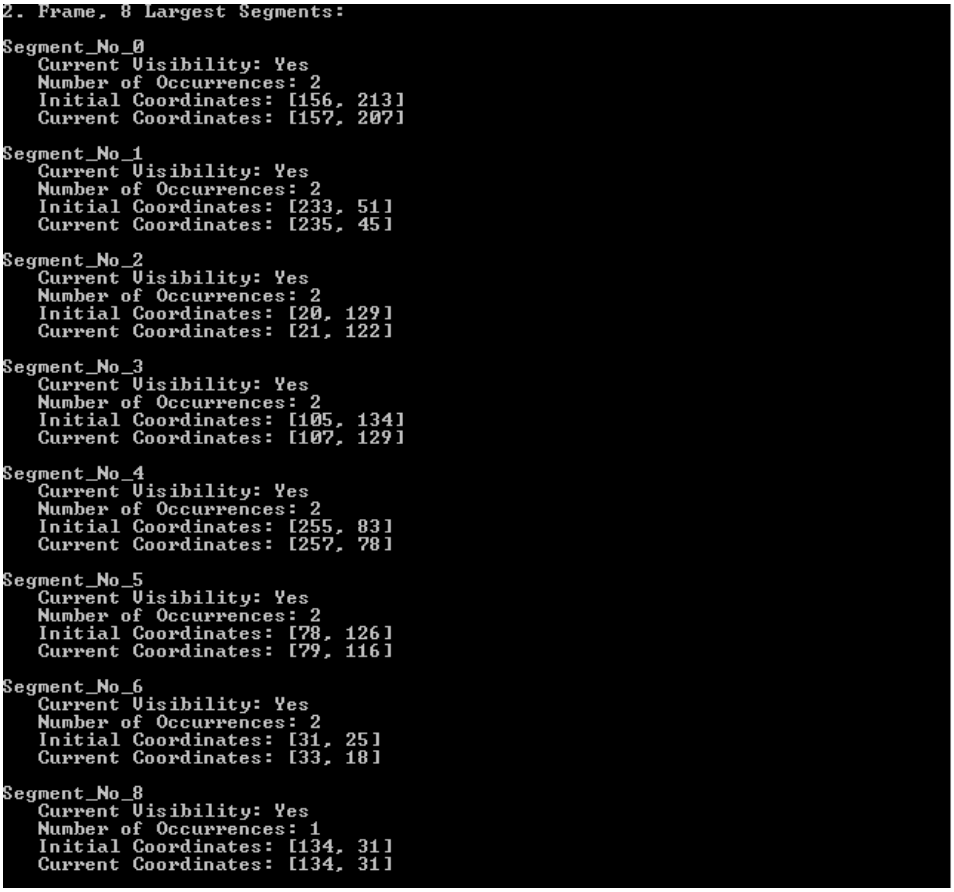


Separate Binarization of Every K-means Label

For tracing, Sparse Optical Flow Calculation is preferred. Lucas-Kanade method is used for the calculations. The downside of this choice was Optical Flow Calculation particularly works well with corner features, but our features was the centroids of our segments. This resulted with low tracking success, but we reinforced this weakness with a segment memory thus is was able to redetect most points it lost track off.

For each consecutive image pair, their N largest segments and their track arrows are displayed on the image. Also, segment id, current visibility, number of occurrences, initial coordinates and current coordinates of these segments are printed. Program also tries to remember detected segments through out the images and, names new segments identically if they are similar to previous one.

2 consecutive frame, segment centers and their orientation from past frame



Example results(Segment 7 is lost in the 2. Frame)

References

1) http://isl.ee.boun.edu.tr/courses/ee576/lectures/sunum/segPres.pdf
2) http://isl.ee.boun.edu.tr/courses/ee576/lectures/sunum/enhancement.pdf
3) http://isl.ee.boun.edu.tr/courses/ee576/lectures/sunum/TrackingPres.pdf
4) https://ijcsmc.com/docs/papers/May2014/V3I5201499a84.pdf
5) https://www.analyticsvidhya.com/blog/2019/04/introduction-image-segmentation-techniques-python/