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Project 1 | Lane Detection

Dataset

Figure 1. Individual frame of provided video

The dataset is provided as a .mp4 video. In order to proceed with analysis, the video is broken into individual still frames.

Region of Interest

Figure 2. Trapezoidal ROI; where processing will be applied

A polygonal region of interest (ROI) is selected for universal use across all subsequent frames. The chosen ROI serves to ignore noise from irrelevant portions of the image. Additionally, the trapezoidal nature of the region will serve to introduce perspective when unwarping.

Projective Warping

Figure 3. Trapezoidal ROI applied with projective transformation

The four points from the ROI selection is used to develop a homography matrix; when mapped to points of a rectangular region, this projective transformation will give off the appearance of unwarping.

Processing

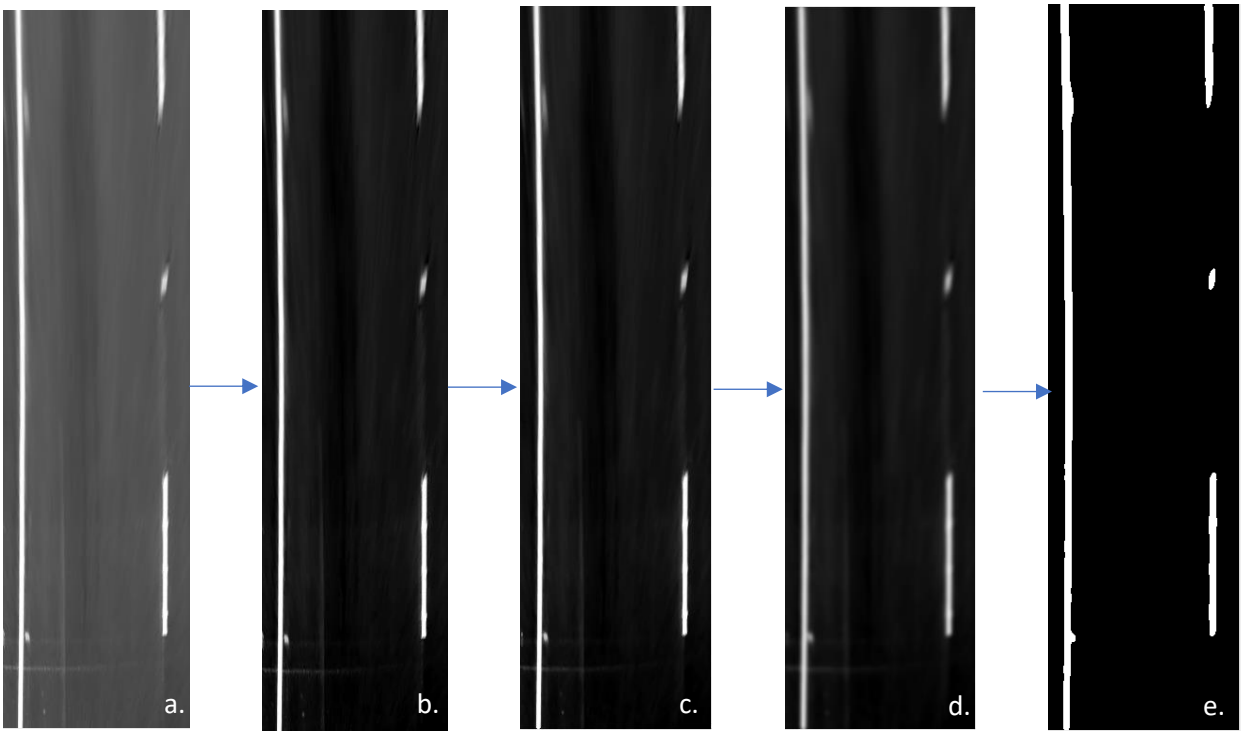
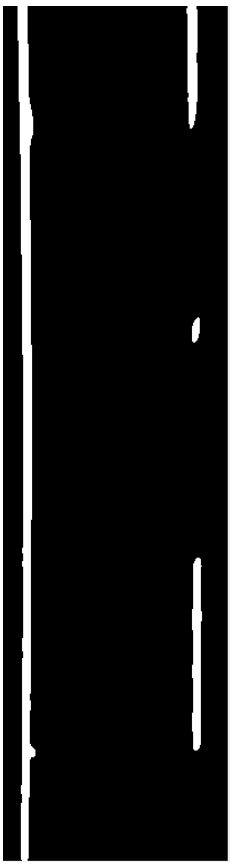
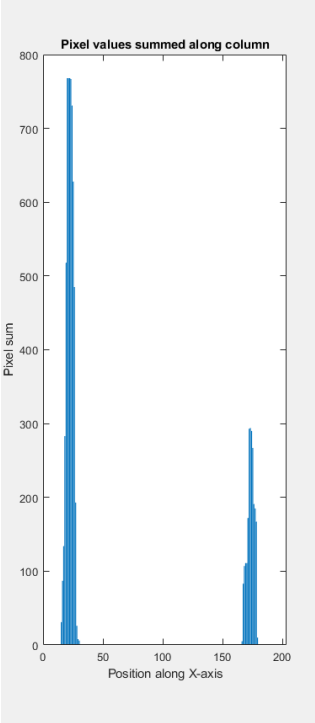


Figure 4. Unwarped region applied with image processing techniques in tandem: a) red channel extraction; b) histogram equalization; c) median filtering; d) gaussian blur; e) image binarization

Image processing is used to isolate the known features of interest whilst balancing signal to noise ratio. The red channel is initially extracted from the RGB image because the lanes are already clearly differentiable from the dark asphalt; this extraction is fast relative to techniques such as Hue-Saturation-Lightness conversion. Histogram equalization continues to improve contrast of the lanes. Median filtering removes the majority of random noise spikes in the image array. The gaussian blur smoothens the image to further reduce noise and minute detail. Finally binarization converts the two-dimensional image array into a logic array.

Peak Seeding





The binarized image is summed along respective columns to provide a starting seed of likely lane centers. A peak finding function can be applied to the resulting vector to find x-location of starting seeds.

Figure 5. Column-wise summation of binarized image

Sliding Window

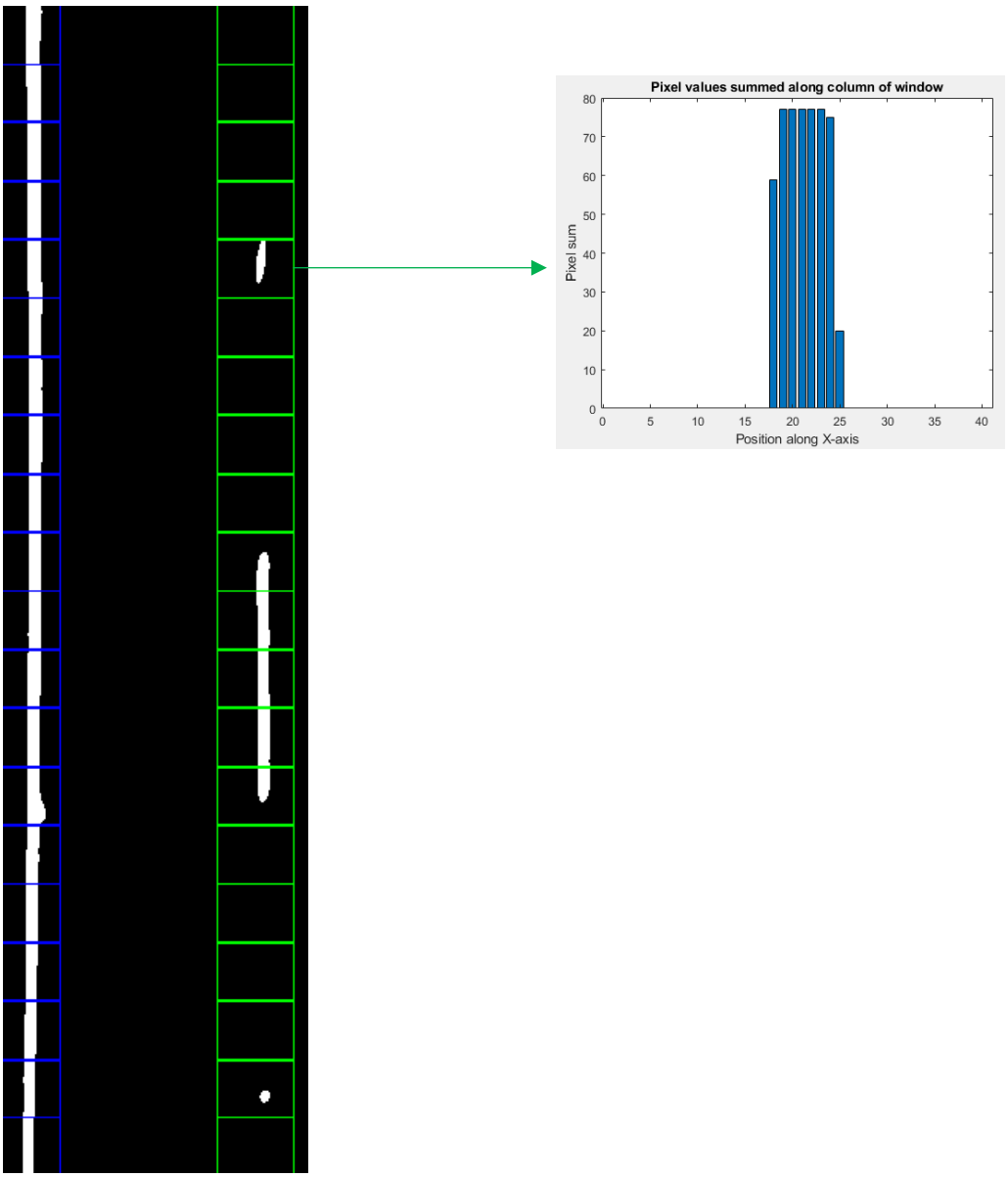


Figure 6. Sliding window scheme; used to refine centers of potential features

Several windows can be adapted from the initial seed to search along the column for additional candidates for lane features. In order to extract window-based centers: the window is cropped, the image array is summed along the column, peak localization is applied, and the coordinate is selected in context of the original image.

Point Detection

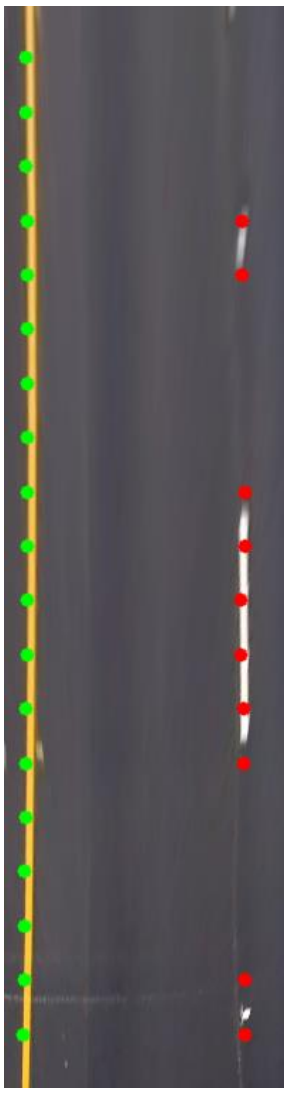


Figure 7. Point indicators along lane features

Coordinates from the window search are plotted on the ROI projective transformation.

Projective Unwarping

Figure 8. Point indicators applied to original image

Projective transformation is used to generate an inverse homography matrix to warp the image and accompanying lane point indicators.

Lane Detection and Shading

Figure 9. Left and right lanes indicators on original frame, along with lane region

Polynomial fitting is executed to fit all y-coordinates in the defined unwarped region to x-coordinates in the same region. When projective transformation is subsequently executed, the fit lines overlay the lane features. Using the corner points of the polynomial fit lines, a dynamic lane region mask can be developed.

Curve Detection

Figure 10. Curve prediction based on slope of center region vector

A line is extended in the unwarped space and its respective slope is monitored; when the slope falls within pre-defined thresholds a message will display the camera's bearing.