Assignment-1

Parthasaradhi Reddy N 2024JRB2028

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1 Algorithm

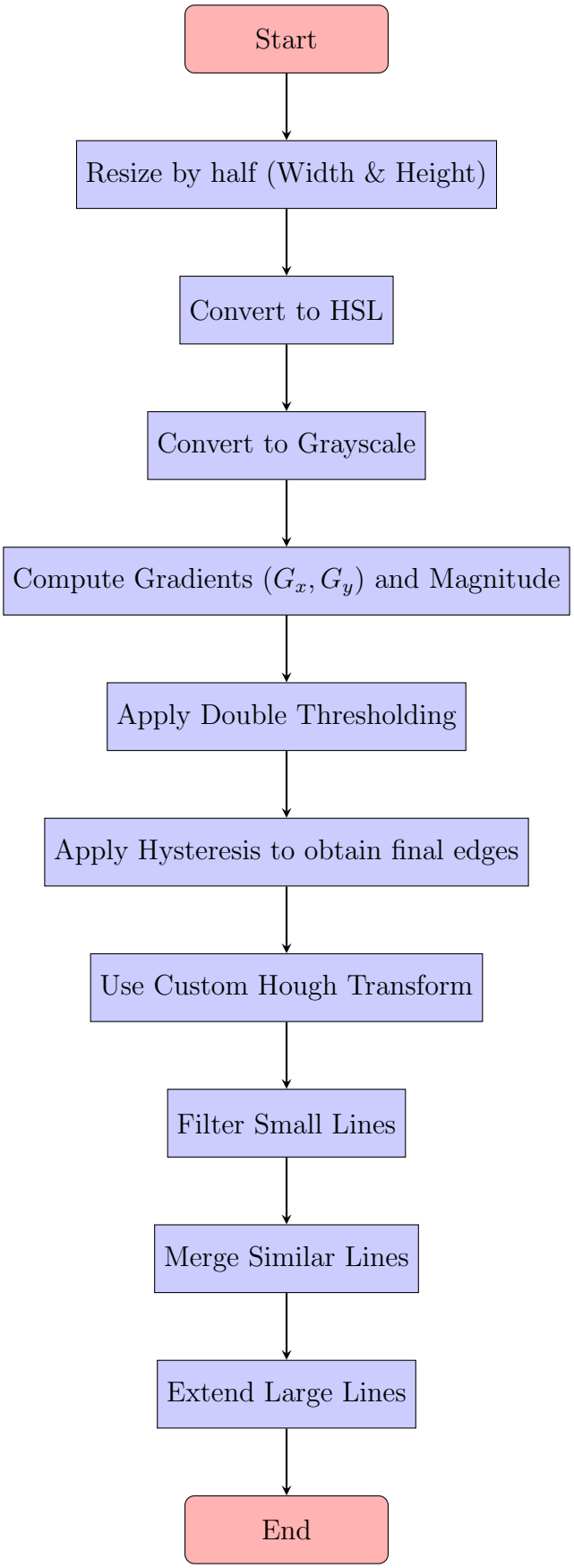
Used Canny Edge Detector Algorithm and Hough Tranform based straight line fitting method

Steps

The steps for the algorithm are as follows:

1. Preprocess the image
   (a) Resize by half of width and height
   (b) Use HSL colour Transform
   (c) And then use Gray colour tranform
2. Apply edge detection using a custom Canny algorithm.
   (a) Use Sobels to get Gradients Gx,Gy then found Gmagnitude
   (b) Then on this apply Double thresholding
   (c) On the resulting edges use Hysterisis method to get the final edges
3. Using custom Hough transform based method find the significant straight lines
4. Extract lane/path structures from detected edges.
   (a) Filter small lines
   (b) merge the similar lines
   (c) if lines are bigger than certain length extend them.
5. For Part 2:Identify intersection points of detected lines.
6. Compute centroid of intersections and sum of the distances of points from centroid.
7. Save results in a CSV file.

2 Flowchart


Start
Resize by half (Width & Height)
Convert to HSL
Convert to Grayscale
Compute Gradients (G_x, G_y) and Magnitude
Apply Double Thresholding
Apply Hysteresis to obtain final edges
Use Custom Hough Transform
Filter Small Lines
Merge Similar Lines
Extend Large Lines
End

3 Formulas and Matrices

Gaussian Blur

$$\text{kernel} = \frac{1}{16} \cdot \begin{bmatrix} 1 & 2 & 1 \\ 2 & 4 & 2 \\ 1 & 2 & 1 \end{bmatrix}$$

Sobel

$$G_x = \begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix} \quad G_y = \begin{bmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ 1 & 2 & 1 \end{bmatrix}$$

RGB to HSL

$$\begin{aligned} C_{\max} &= \max(R, G, B) \\ C_{\min} &= \min(R, G, B) \\ \Delta &= C_{\max} - C_{\min} \\ L &= \frac{C_{\max} + C_{\min}}{2} \\ S &= \begin{cases} 0 & \text{if } \Delta = 0 \\ \frac{\Delta}{1 - \lvert 2L - 1 \rvert} & \text{if } \Delta \neq 0 \end{cases} \\ H &= \begin{cases} 0 & \text{if } \Delta = 0 \\ 60^\circ \times \left(\frac{G-B}{\Delta}\right) & \text{if } C_{\max} = R \\ 60^\circ \times \left(\frac{B-R}{\Delta}\right) + 120^\circ & \text{if } C_{\max} = G \\ 60^\circ \times \left(\frac{R-G}{\Delta}\right) + 240^\circ & \text{if } C_{\max} = B \end{cases} \end{aligned}$$

$$H_{\text{output}} = \frac{H}{2}, \quad S_{\text{output}} = S \times 255, \quad L_{\text{output}} = L \times 255$$

Gray scale conversion formula

$$Y = 0.2989H + 0.5870S + 0.1140L$$

4 Hough Transform based Straight line fitting Algorithm

I have written simple version of Hough Transform using the core idea of it.So this will have two parameters, threshold and minimum number of points.Here threshold is value of minimum intensity to allow.And the function will take Gradient magnitude image as one of the input. The steps are as follows:

1. Defined all the pairs of image edge points
2. Defined an parameter min_number_of_points

3. Using gradient magnitudes and predefined minimum number of points and threshold, if the number of points on the line are greater than the defined value then add that line to final lines list using the endpoints.

Conclusion:Part-1

In most of the images the applied techniques and algorithms are giving potential lane lines.But in some images small parts of the lines were detected.This is mostly due to curvyness in those few images.So curve fitting and more tuning might help to achieve more perfect lane lines.

Conlusion:Part-2

In the grass images, as there are some parallel lines the values are so high.If these are properly filtered, then it may reduce to some good value.

Other methods

1. Used different filters like median filter and mean filter but does not gave good results
2. Used different preprocessing techniques like changing brighness and also used differnt colour transforms.But results are not good.

Sample Outputs