TOSHKENT SHAHRIDAGI INHA UNIVERSITETI
INHA UNIVERSITY IN TASHKENT

Requirements Analysis Document

Capstone Design (SOC4150)

Comprehensive Assignment
(Line Detection)

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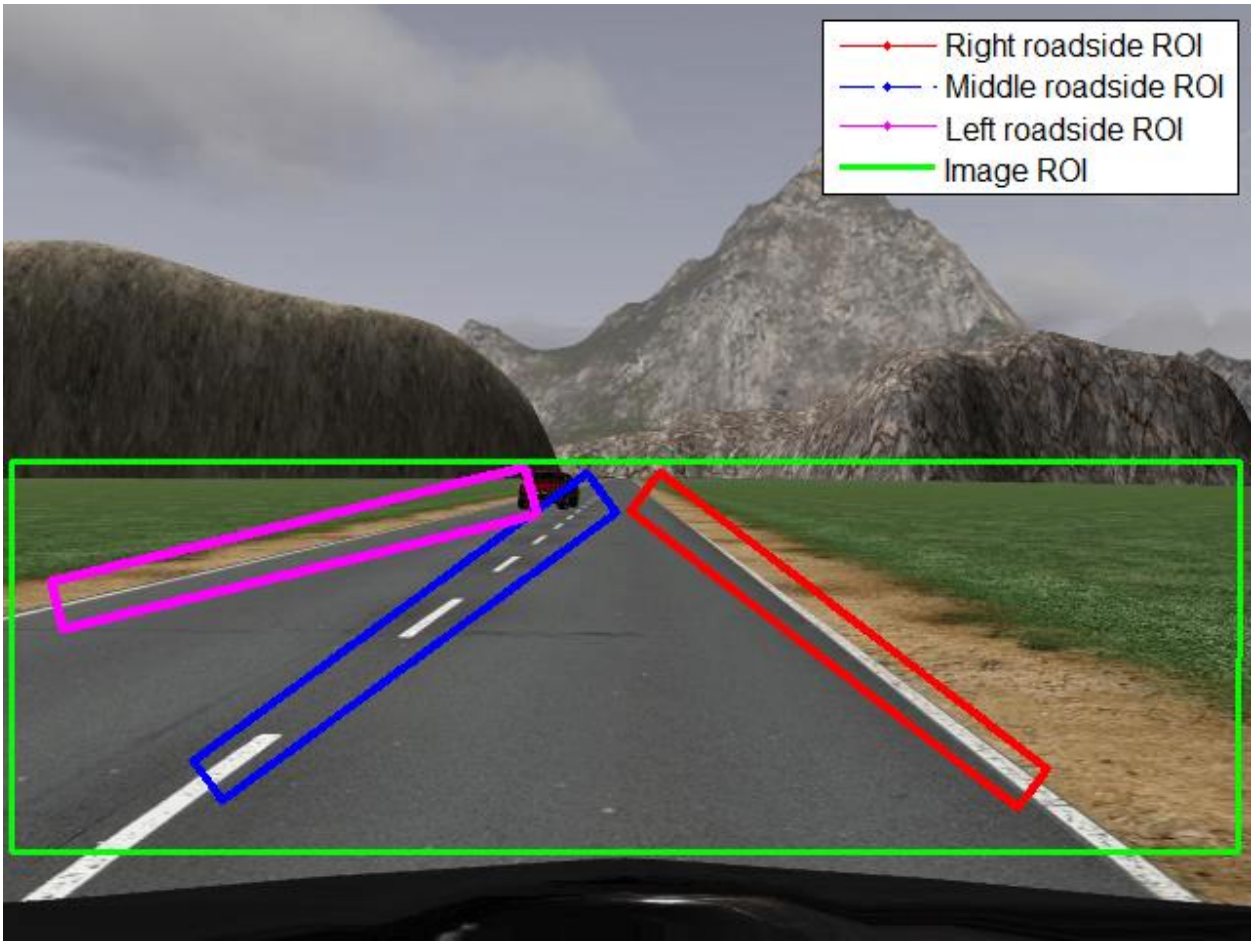
1.Introduction

Driver support system is one of the most important features of the modern vehicles to ensure driver safety and decrease vehicle accident on roads. It is known, the road lane detection is the complex and one of the most challenging tasks. It includes the localization of the road and the determination of the relative position between vehicle and road. The system gets the front view using a camera fixed on the vehicle and detects the lanes by applying few processes. The lanes are extracted using Hough transform through a pair of hyperbolas which are fitted to the edges of the lanes. The proposed lane detection system can be applied only on painted roads as well as curved and straight road in different weather conditions. The proposed system does not require any extra information such as lane width, time to lane crossing and offset between the center of the lanes.



2. Proposed system

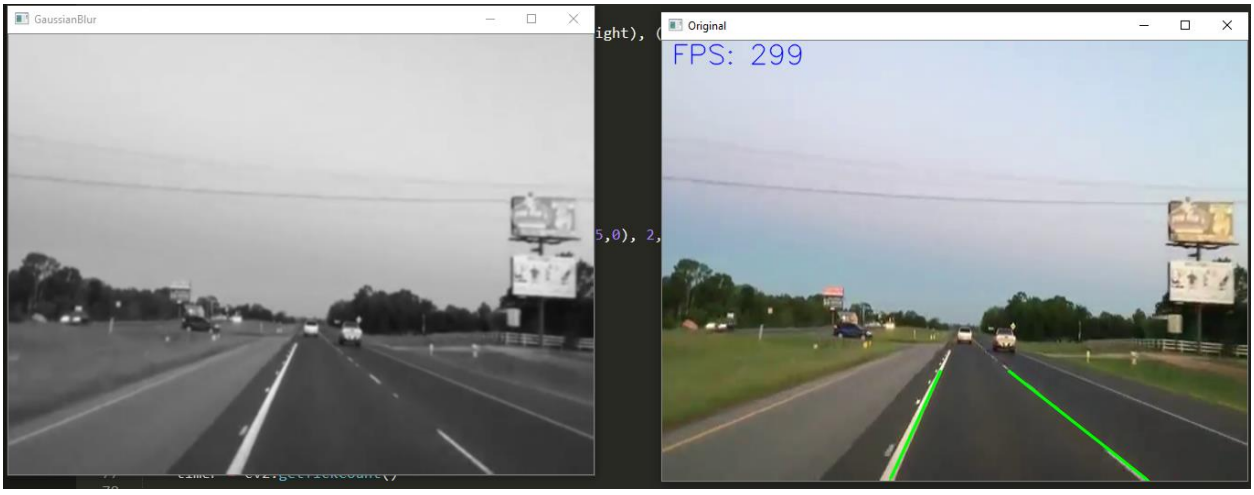
Lane detection is one of the most important component of vision-based driver assistance systems (DAS), lane detection and tracking methods are challenging in present intelligent transportation systems and intelligent vehicle applications. It is however very

difficult as the road is in an outdoor scenario recorded from a moving car. in this project, we suggest and implement an effective algorithm of real-time line detection. The proposed algorithm consists of two phases, In the first phases the road is isolation from the image, so, the proposed algorithm in this phase will detect the edges on the road using image processing techniques. The second phase in this research, is for how to follow the lines to take the angles of the neighborhood of each pixel on the line, to be able to know the road is straight or rotate. Lane-detection algorithm which is simple, robust, and efficient and also suitable for real-time image and video processing. The main objective of this project is to implement an effective lane detection and following system, the approach presented here was tested on video downloaded from https://drive.google.com/file/d/1RMq9j_-mxkqPX_C4OYdoJmdfnp15ef0S/view?usp=drivesdk . All the detection and tracking programs developed using the python programming language.

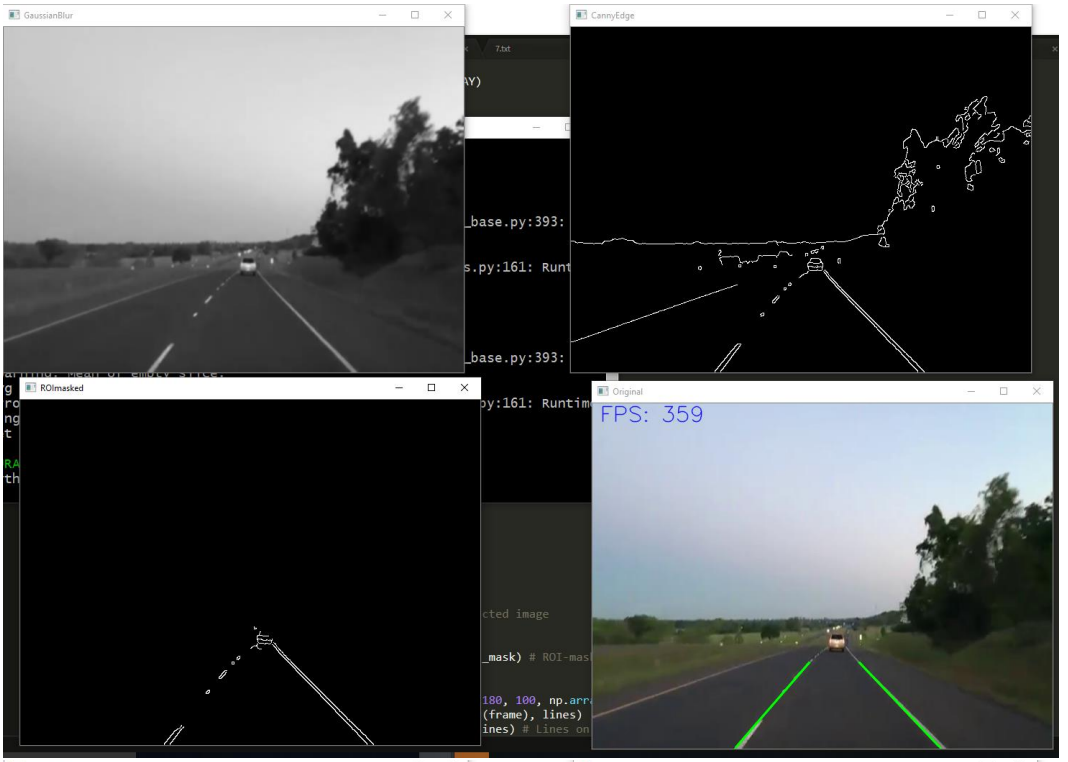
3. Edges detection

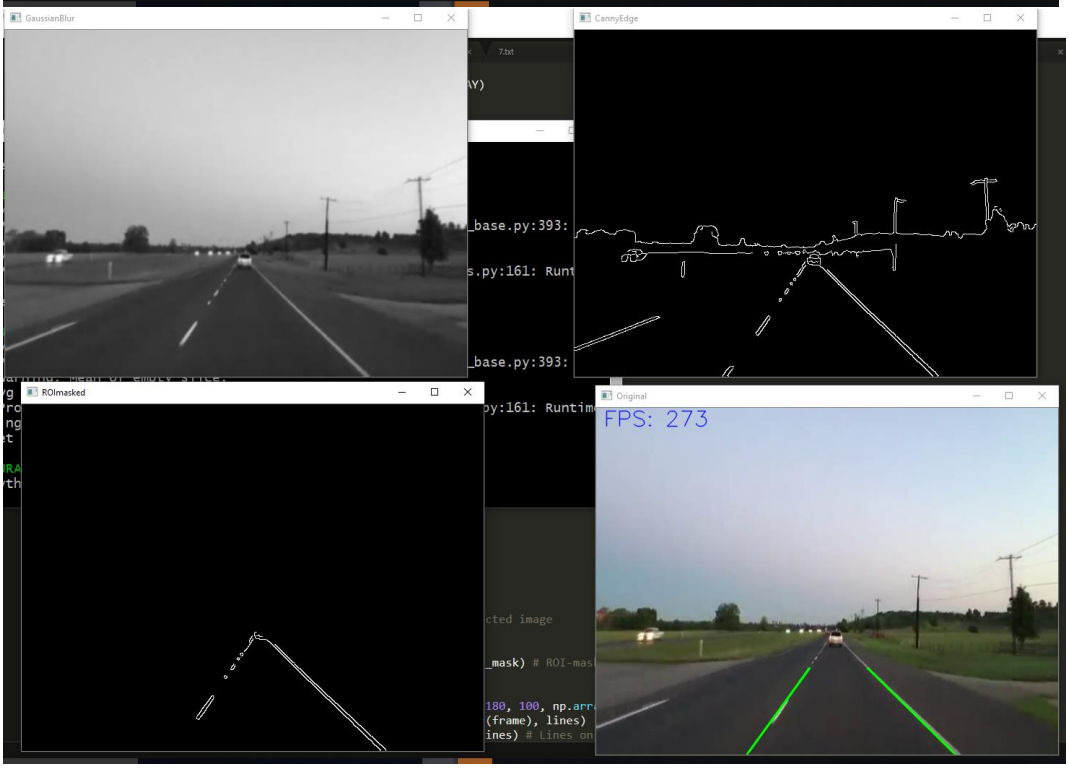
Road boundaries detection is the most difficult and important task that an intelligent vehicle should perform. They are often defined by the sharp contrast between the road asphalt and painted lines. The pixels, with high gradient values, are the image edges, where some of them correspond to road side-lines. To determine those edges, there are several edge detectors that could work like Prewitt, zero cross, Roberts, Laplacian of Gaussian, and Canny. Nevertheless, Canny edge detector is still the one which provides the best edged frames, and it is globally described by two steps:

a— Smoothing the ROI by convolving a Gaussian mask with the image.



b— Getting the region of high contrast with a first derivative operator.





In order to keep the autonomous vehicle on the road, the frame's edges should be classified to hyperboles or to straight lines according to the relative vehicle's position and direction — to predict the future road lanes parameters.

4. Functional requirements

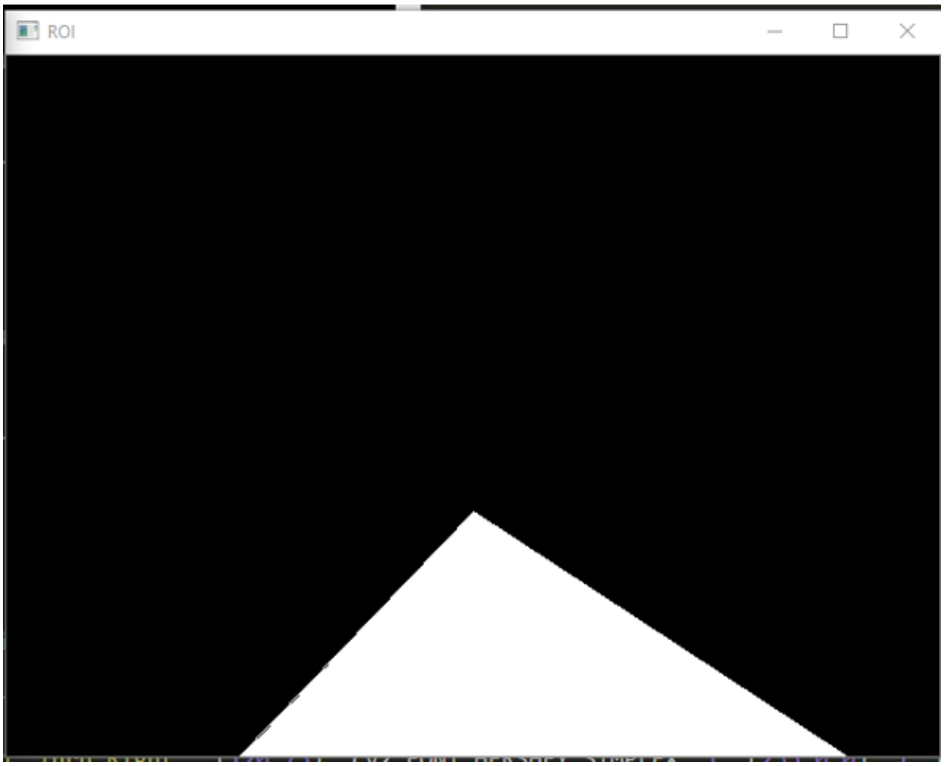
There are multiple different steps we should take to achieve a better line detection:
-Image denoising, for which we used Gaussian Blur and edge detection from binary image

A digital image is represented by a matrix that stores the RGB/BGR/HSV(whichever color space the image belongs to) value of each pixel in rows and columns.

The first thing we are going to do is to find the gradient of the grayscaled image, which allow us to find edge-like regions in the x and y direction. The gradient is, in fact, multi-variable generalization of the derivative. While a derivative can be defined on functions of one variable, for functions of several variables, the gradient takes its place.

The gradient is a vector function, as opposed to a derivative, which is scalar. Like the derivative, the gradient represents the slope of the tangent of the graph of the given function. Moreover, the gradient points in the direction of the greatest rate of increase of the function, and its magnitude is the slope of the graph in that specific direction.

-Image masking, highlighting the region of interest

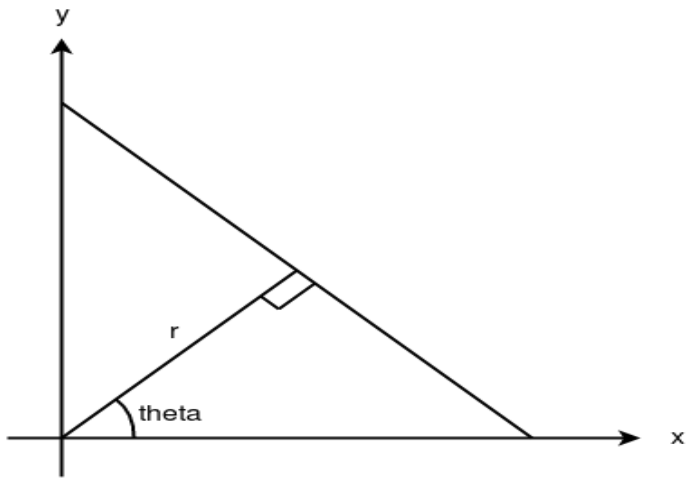


-Hough lines detection

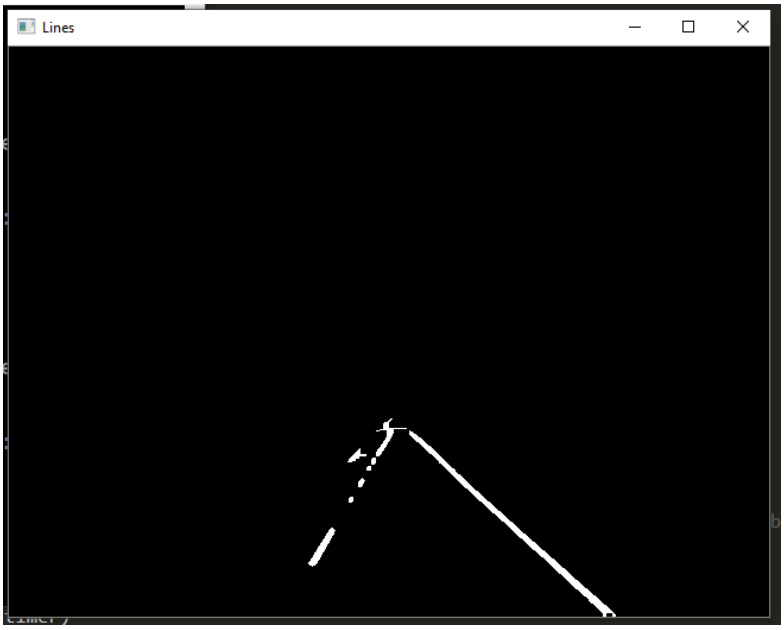
The Hough Line Transform is a transform used to detect straight lines. The Probabilistic Hough Line Transform is used here, which gives output as the extremes of the detected lines

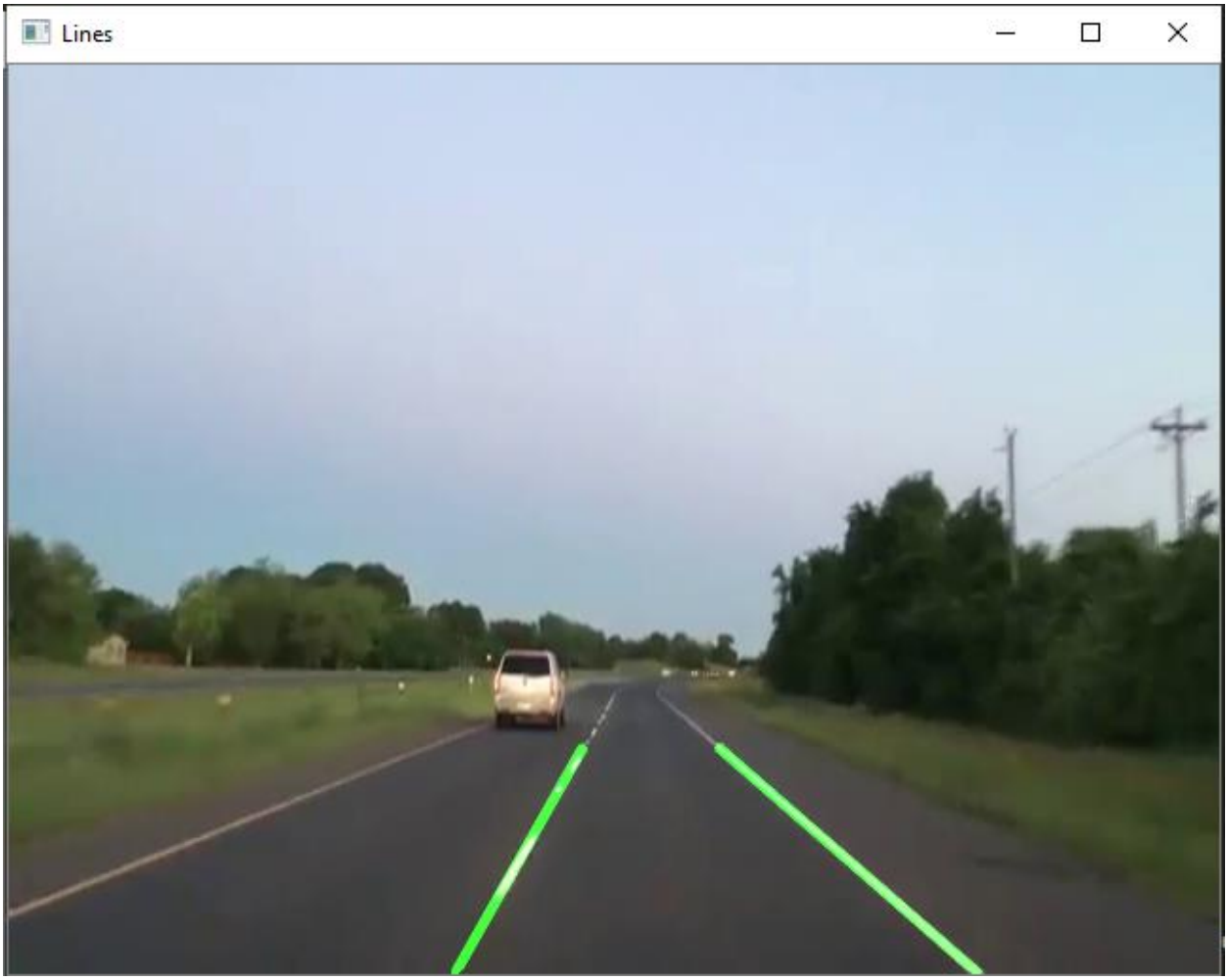
-Left and right lines separation

A line can be represented as y = mx + c or in parametric form, as r = x*cos(θ) + y*sin(θ) where r is the perpendicular distance from origin to the line, and θ is the angle formed by this perpendicular line and horizontal axis measured in counter-clockwise



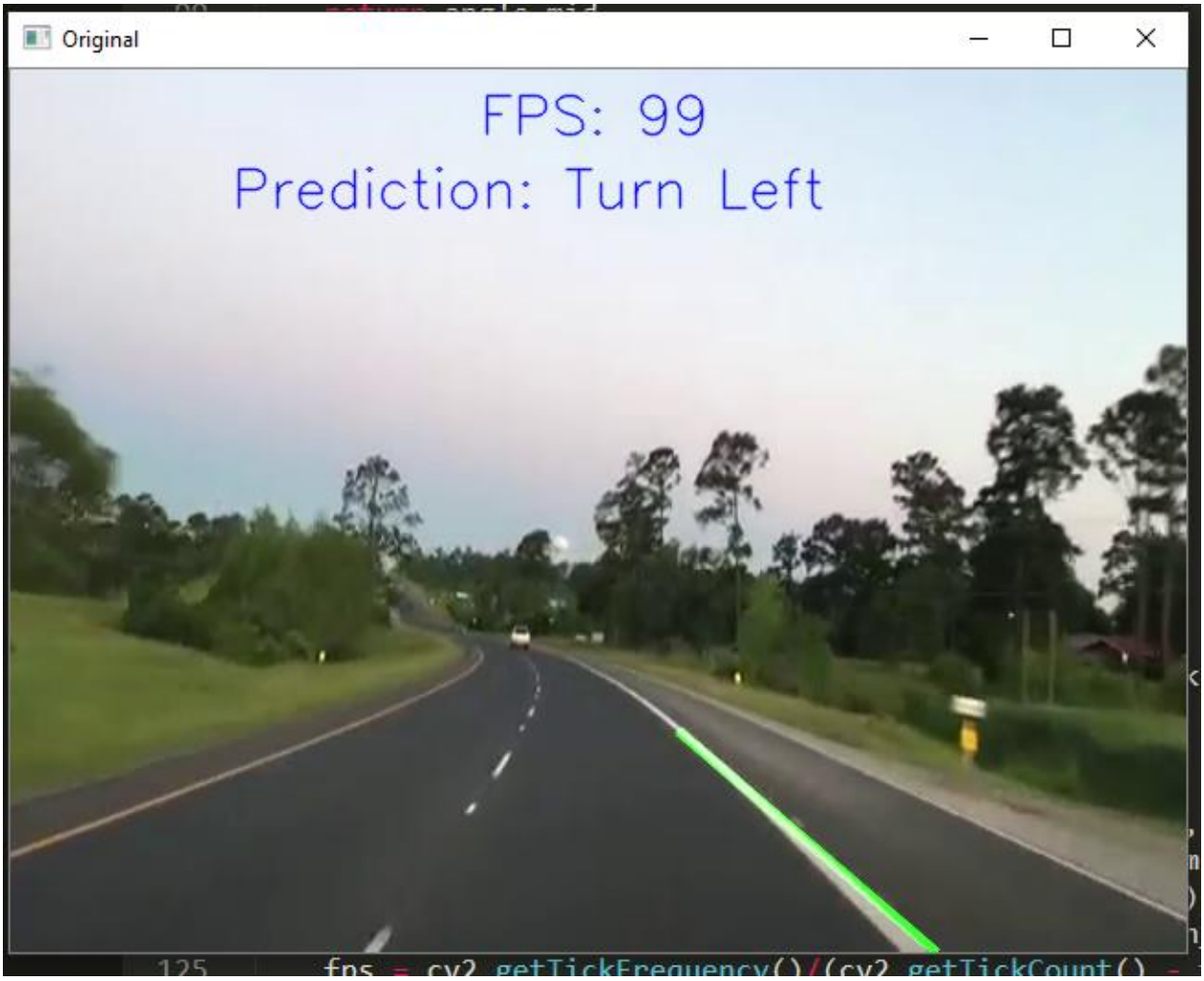
Therefore, any line can be represented with these two terms, (r, θ).





-Predict the turn

For turn prediction purposes, we need to find incline/decline angle of the lines. Initially, we extract the height and width measurements from original image. Height is needed to find y-offset, which would always be the half of the height. Width would be needed to find horizontal middle boundary, which we took as the half of width. X-offset is a difference number between right and left lines of detected lines



5. Environmental Variability

In addition to the intended application of the vision-based lane detection system, it is important to evaluate the various types of conditions that are expected to be encountered. Roads can be marked by well-defined solid lines, segmented lines, circular reflectors, physical barriers, or even nothing at all. The road surface can be comprised of pavements or combinations of multiple asphalt components. Some roads are relatively simple scene with both solid lines and dashed lines lane markings. Lane position in this scene can be considered very easy because of the well-defined markings and uniform road material. But in other complex scene in which the road surface varies and also consist of circular reflectors as well as solid lines, the lane detection would not be relatively easy task.

6. Conclusion

In this project, real time vision-based lane detection system was proposed. Image segmentation and removing the shadow of the road were to be processed. Multiple algorithms were used to detect edges that represent road lanes or road boundaries. A hyperbola-pair road model used to deal with the occlusion and imperfect road condition. Multiple experiment showed that the lanes were detected using Hough transformation with restricted search area and the projection of their intersection will form the last scan point called the horizon. Furthermore, to search out for the left and right vector points that represent the road lanes, the lanes can boundary phase use the edge image and the left and right Hough lines and the horizon line as inputs. That was demonstrated by two hyperbola lines. The first program results showed that the system is able to achieve a standard requirement to provide valuable information to the driver to ensure safety.

REFERENCES

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[3] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6679325/