Research Article

An Automatic Turn Signal System In Four Wheelers

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ABSTRACT: This paper aims at developing the new automatic technology in the field of Automobile. Not pre- warning of the vehicle's lane departure is the precursor to crashes. Especially during the driver's idleness and wrongly turning on the turn signals ON and OFF during the lane change. Hence the idea proposed is about indicating the turn-lights automatically during the lane change, which helps in the reduction of accidents. Photo frames from the camera are captured and processed for lane detection and tracking the position of the vehicle between the lane that helps the controller which hold an algorithm to put the turn signal to left or right. As future possibilities, this field of work can be used in self-driving cars.

Keywords - Partially Autonomous Vehicle, Lane Detection, Turn signal System.

I. INTRODUCTION

Industry 4.0 develops a trend in the wide usage of Automation and data transfer. The advancements in these technologies in the Automobile Industry leads to the development of Autonomous car or commonly called as a self-driving car [1]. Autonomous car or partially autonomous car is a car that functions without or with partial human intervention. Eventually, still, there is no legally operating, a fully autonomous vehicle in real circumstances. However, there are partially autonomous cars that function in Autonomous emergency braking system, cruise control, etc. These are highly independent, self-driving prototypes.

Like those systems, an idea of "Self-turn on the turn signal system", that turns on the turn signal ON and OFF during the lane change. The Root causes that lead to this idea are, the driver doesn't pre-warn the nearby driver for his lane departure, sometimes causing car crashes. And especially, driver's idleness or laziness to move his hand to put the turn signals ON and OFF. Also, wrongly turning on the turn signal to the left or right and moving in the opposite direction confuses the behind or adjoining lane car driver causing an accident. Efforts made up to help the drivers to assist in lane departure to turn on those turn signals automatically to the left or right depending on the departure on the left or right. Here in this system, a dash camera is used to take photo frames at certain Frames per Second (FPS). Theoretically explaining, FPS is maintained according to the car speed, as speed increases FPS increases. If FPS is less at high speed, missing of lane line and wrong tracking of vehicle position happens. Each Frame is image processed by an algorithm to detect the lane and it's Top-Down Point (TDP). Using the TDP, the position of the vehicle in between the lane is tracked. Here, the vehicle's track width matters as it varies for a different vehicle. Finally, tracking the vehicle helps in taking the decision toturn on the turn signal to the left or right side and turn off the turn signal after a certain duration when it arrives at the next lane after departure from the previous lane.

II. LITERATURE SURVEY

One of the most challenging tasks in developing autonomous or partially autonomous vehicle is the road that uses machine vision techniques for road segmentation, lane detection, obstacle, and pedestrian detection [2]. One effective lane detection system will results with good accuracy in the detection of roads in alltypes of conditions like, straight or curvy lane line, single or double broken or solid lines that may be in white oryellow colour and finally that should able to detect hard environment conditions like shadow, fog, stains [3].

Jae-Hyun Cho et al. [4] discussed on Lane recognition that uses a Hough Transform on polar coordinates. The algorithm discussed is used to fit only straight lane lines and not curved lane lines that produce poor lane recognition rate. It uses optimized accumulator cells in its multi-channel Region of Interest (ROI) in parallel that detects a straight line with approximately 90% accuracy.

Chan Yee Low et al. [5] discussed an idea of using ROI as the continuous lane markings don't change significantly from the driver's perspective. So, Selection of a certain region of an area just in-front the moving vehicle will help in separation of non-road part and road part that contains the road marking for easy lane line recognition. Defined ROI at a particular area may have some absence of road markings that affects the lane detection at that time thus decreasing the efficiency of recognition rate.

Dajun Ding et al. [6] discussed the Adaptive ROI determination algorithm using the data fromvanishing points attained from line segments. The vanishing point is defined as a point when two parallel lines diminish on the horizon line. The unnecessary information is rejected, and computation time is reduced when the process is done within the selected ROI. As the ROI is adaptive the accuracy of, presence of road marking the selected region is high.

Wang Fan et al. [7] discussed a technique on image pre-processing that showed up high resistance to noise and retain better edges for the thresholding from the image's different colour space. In Image Processing, RGB channel converted to grayscale image and feature is extracted. But the grayscale image contains noise that affects the feature in the image. So, image is converted to different colour space namely, LAB, HSV, HSL, CMYK, which are widely used. Each of the channels is analyzed to detect both yellow and white lane lines on the road and further thresholding or edge detection operation is carried out. This study specifically uses the LAB model. Addition of this pre-processing technique produces better quality output than using traditional algorithms.

Xiangjing Jainwen at al. [8] discussed a method of robust lane detection which involves two steps in the algorithm. The first step involves taking an input image and estimating the road parameters through astraight line fit using the Hough transform. The second step involves fitting a second order polynomial curve through a search algorithm and perspective projection helps in easy fitting the curve.

III. PROPOSED SYSTEM

Lane detection is a module that already exists in the auto-field, but the proposed system takes it furthermore to the core application. This chapter proposes a real-time system, which aims to automate things in the automobile field. Thus leading to the development of a system that automatically turns ON and OFF the turnsignal to the left or right, in accordance with the developed decision-making algorithm.

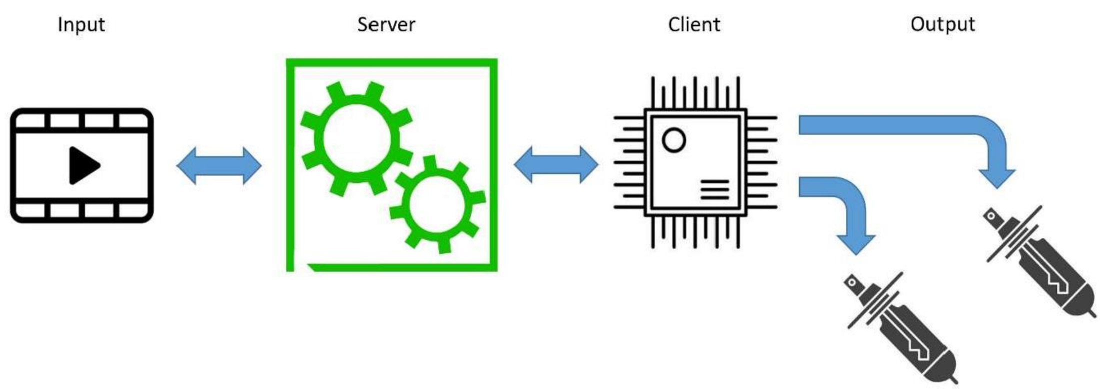


Figure1. System General Workflow Process

The proposed system has the sequential workflow process that is discussed below as follows Input, Server, Client, and Output.

I) Input – The Frames are captured from the dash camera and are encoded and compressed to AVI format. And finally, the compressed format video is logged into the file storage.

II) Server – A Server is a computer device or a computer program that accepts the request and respond to those. Meanwhile, it provides a centralized resource or service to another device or program, generally called client. For the demo purpose, the laptop serves the function of a server and processes the image requested by the client for lane detection and tracking of the vehicle.

III) Client – A Client is a workstation or a computer device that obtains the requested and calculated data from the server. Here the Microcontroller, Arduino Nano, acts as a client and receives the response from the server, Laptop. The output text data is serially transmitted between the client and the server.

IV) Output – The client then using the correct logic output data, controls the turn signal, an output device, to turn ON and OFF to the desired direction of Left or Right.

To describe figure1, the client (MCU) continually request data from server (Laptop) for the required operation. The image frames are processed by the server, meanwhile, the decision taken data is retrieved back tothe microcontroller and stored. The text data stored in the microcontroller is taken by the logic algorithm and switches ON and OFF the turn signals to left or right.

The system further classified as the system on the server and the system on the client and are discussed below.

SYSTEM ON SERVER

The comprehensive module is organized as following that the logical algorithm is written a python code for the implementation of the objective of Lane detection and tracking of the vehicle in between the lane lines thus helping the controller to take the decision of setting up turn signal to turn ON and OFF to the left or right side. This is completely a computer vision process which takes in some images as input and is pre-processed forthe feature quality enhancement. Then finally, the feature is extracted, and the decision is taken.

The Algorithm is described in three stages as follows Pre-processing stage, Lane detection stage and Vehicle tracking stage.

I) Pre-processing stage –Firstly, this stage involves resizing the image to 640x360 like as shown in the figure 2 and below this, it will cause the data loss. Then, the image is taken to smoothing and blurring operation like as shown in the figure 3, which results in reduced noise. The image then split into different colour space channel like RBG into LAB and HSV like as shown in the figure 4and analyzed for the best channel, which is the V-channel, and taken for further processing.

Figure 2. Resizing of the image.

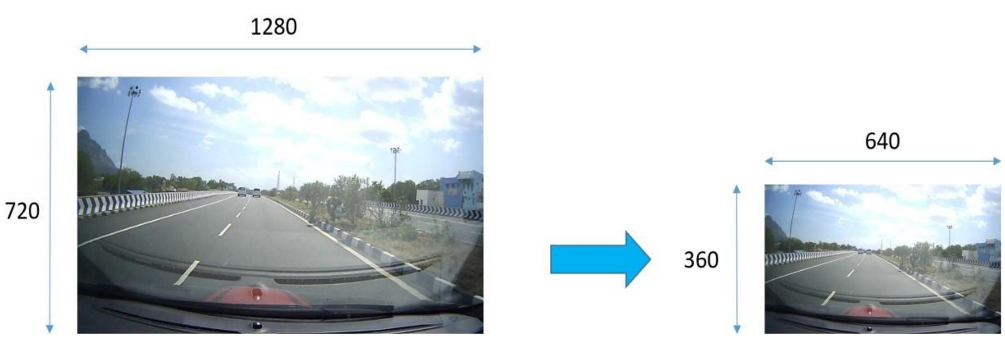


Figure 3. Smoothing and Blurring Operation

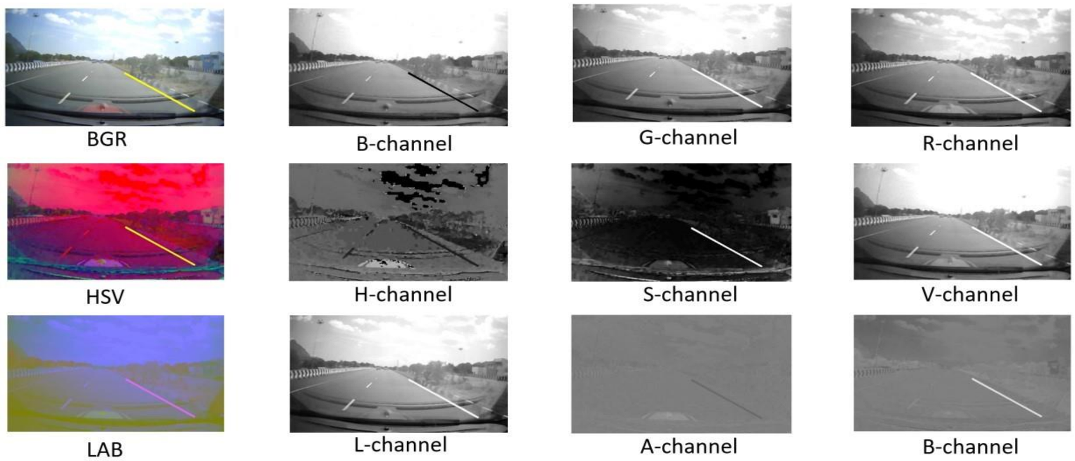


Figure 4. Colour space analysis.

II) Lane Detection stage – First part of this process involves the binarization of an image which is done by colour thresholding and gradient thresholding like as shown in the figure 5, thussegmenting the lane part. Then, as shown in the figure 6, the perspective is changed to the bird's eye view to converting the converging lane line at vanishing point into the two parallel lines which makes detection of lane easier. Vertical summation of the pixel points, which is a histogram like as shown in left side image of the figure 7, which is a plot for detection of the starting point of the lane. Then finally, like as shown in right side image of the figure 7, a sliding window is fit to trace the lane line through a second order polynomial and lane is detected, as shown in figure 8.

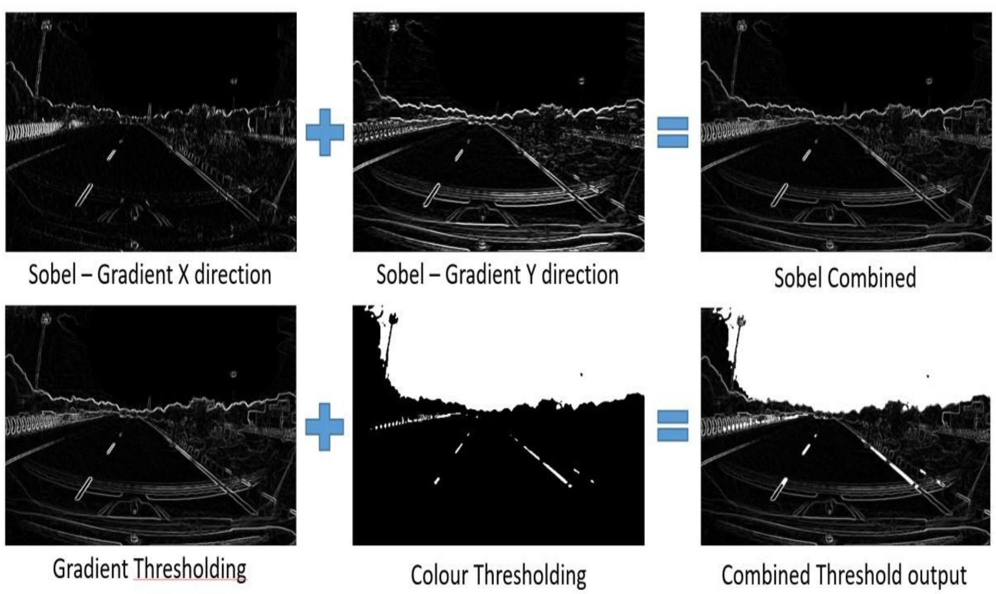
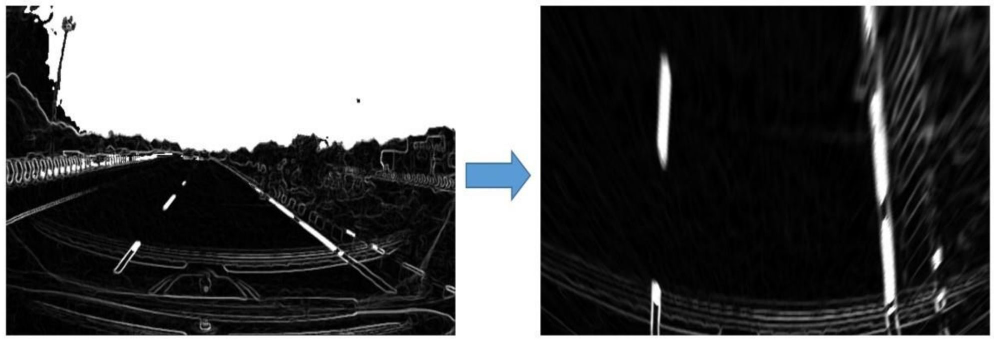


Figure 5. Gradient and Colour Thresholding.

Figure 6. Bird's eye view perspective.



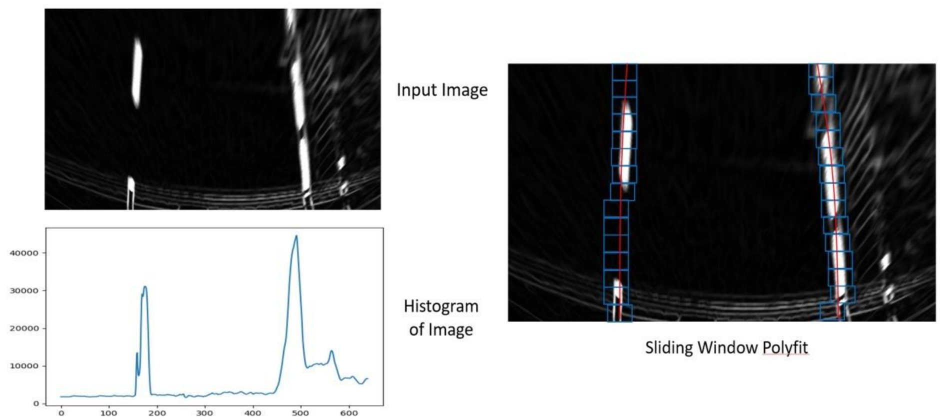


Figure 7. Histogram of image on left and sliding window polyfit on right.

Figure 8. lane detection

III) Vehicle tracking stage – This stage involves hard arithmetic calculation. Using the two top-down points, the two circles in the left side image of the figure 9, which is the starting point of the lane lines, and the mid-point of the lane which is the red line in the right side image of the figure 8, the position of the centre point of vehicle, which is the blue line in the right side image of the figure8, in between those two top-down points is estimated in percentage. Finally, the data values depictthe departure of the vehicle on the left or right lane.

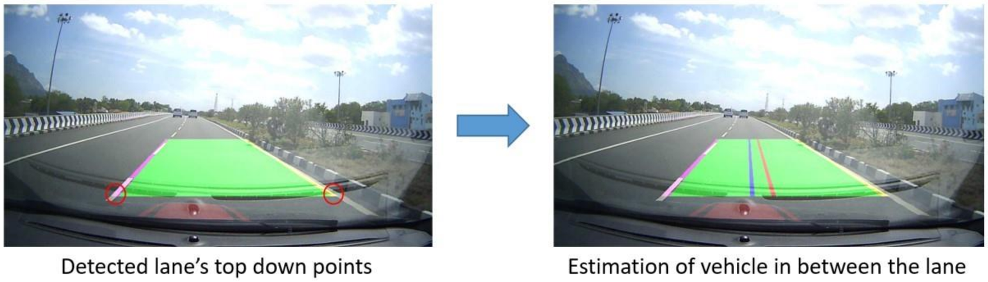


Figure 9. Estimation of the vehicle in between the lane.

SYSTEM ON CLIENT

This section describes how the hardware components are linked together to make up a system for self-turning on the turn signal. The Figure below shows the hardware system block diagram.

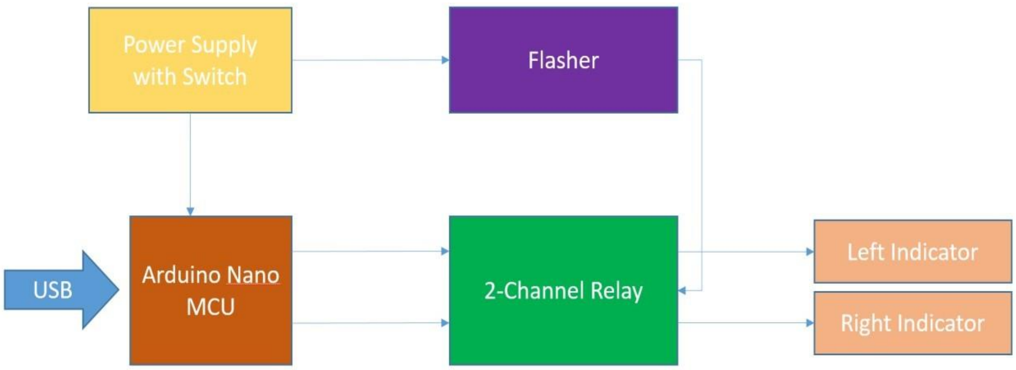


Figure10. Hardware System Block Diagram

The departure data, which is left or right, is sent serially to the MCU via serial port, according to which the turn signals are turned ON. And then after 3 seconds, the turn signal is turned OFF. Physical Hardware of the proposed system is shown in the figure below.

Figure 11. Physical hardware front view on left and top view on right

III. EXPERIMENTAL RESULTS

The image processing modules are implemented with OpenCV library and Python, under the environment of Windows, using Intel Core i7 CPU and 16GB RAM and the control modules are implemented with Embedded C under the environment of Arduino. The test-bed used for the experiment is shown in Figure

12.

Figure 12. Interior side view of the car showing the dash cam placed at the centre of the vehicle

The real-life video is collected by taking the Punto Abarth car to the test drive in the Indian national highways with the dash camera turned on. The video data is logged in the 16 GB class 10 memory card. The road conditions are different vehicles over-taking at a different speed. The captured test picture is shown in Figure 13.

Figure13. Captured test picture from dash camera

The Observation is made on two kinds of captured video. One is a slow-moving car that slowly departures to left and back to the right lane. Another one is a fast moving car that quickly departures to the left and back to the right lane. Below given table 1 is the video specification of the test video logged.

Specification	**Test Video 1**	**Test Video 2**
Length	00:20 sec	00:20 sec
Frame width	1280	1280
Frame Height	720	720
Frame rate	30	30
Colour space	YUV	YUV
Car Speed	Slow	Fast
Departure Time	Slow	Quick

Table 1. Video Specification OBSERVATION AND INFERENCE ON TEST VIDEO 1

The below-shown two figures are the output obtained when working with the Test video 1. In the left side image, when the car tries to approach the left lane, it is detected and the left turn signal is turned ON. In right side image, when the car tries to approach the right lane, it is detected and the right turn signal is turned ON. The condition that the output results at car speed and departure time is slow. In this, the drawn lane line is fit exactly on the real lane line.


Figure 14. Switching of left indicator Figure 15. Switching of right indicator

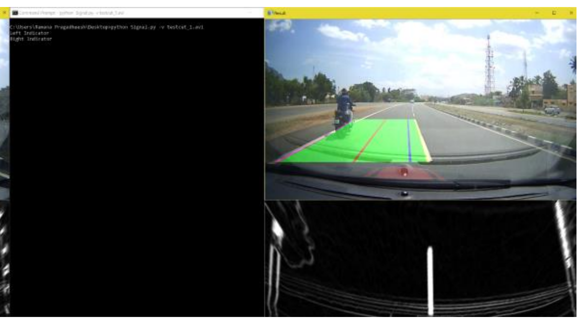



Figure 14a. Output showing vehicle departing left Figure 15a. Output showing vehicle departing right

OBSERVATION AND INFERENCE ON TEST VIDEO 2

The below-shown two figures are the output obtained when working with the Test video 2. In the left side image, when the car tries to approach the left lane, it is detected and the left turn signal is turned ON. In right side image, when the car tries to approach the right lane, it is detected and the right turn signal is turned ON. The condition that the output results at car speed and departure time is fast and quick. In this, the drawn lane line is not fit exactly on the real lane line and somehow it tries to manage to turn ON the turn signal on time.

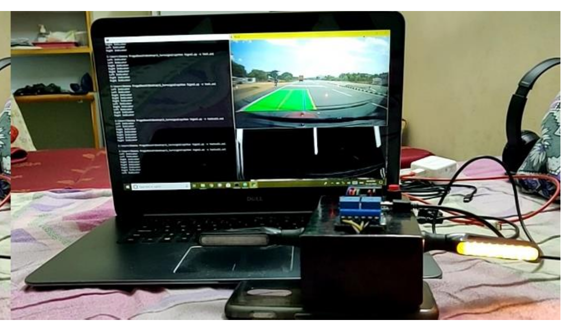



Figure 16. Switching of left indicator Figure 17. Switching of right indicator

Figure 16a. Output showing vehicle departing left

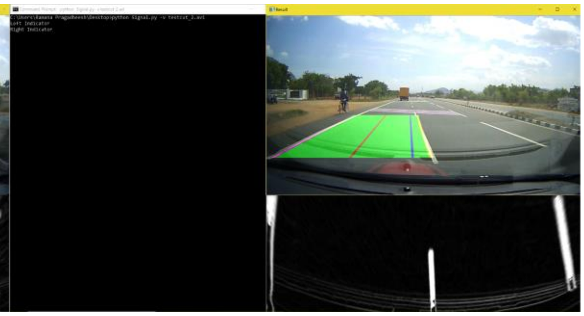


Figure 17a. Output showing vehicle departing right

OBSERVED ERROR CASE SCENARIO ON TEST VIDEO 2

The program is developed using Test video 1 and observed from the Test video 2. The Figures below shows the wrong detection of the lane line on Test video 2.

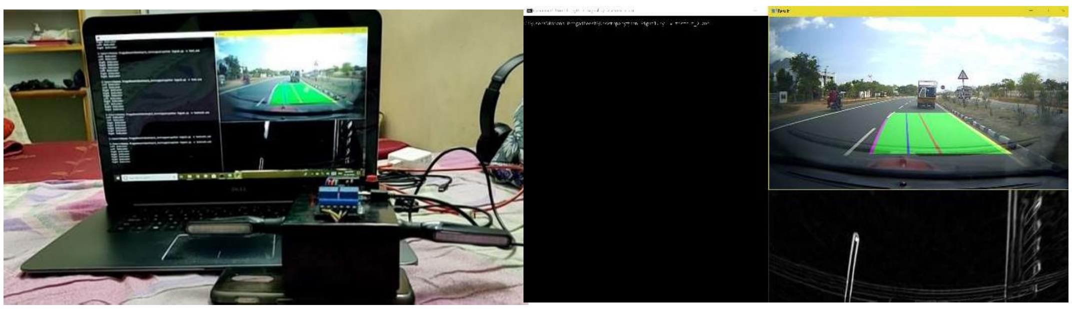


Figure 18. Misalignment of lane line

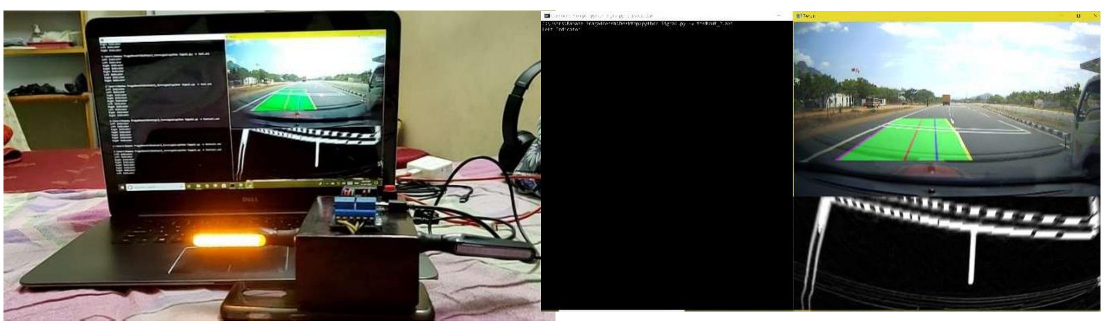


Figure 19. Misalignment of lane line

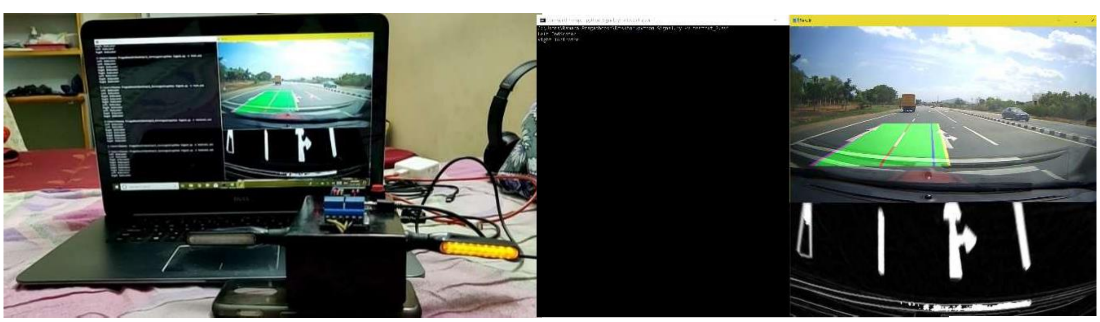


Figure 20. Wrong lane line detection

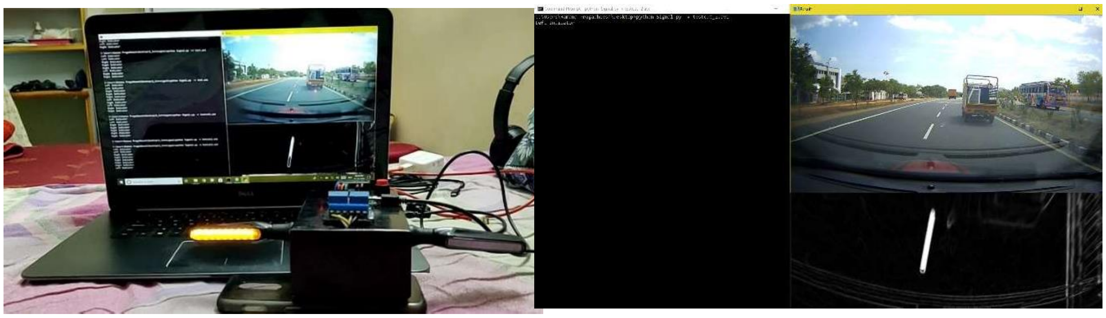


Figure 21. Absence of lane line

IV. CONCLUSION

The goal of this proposed work was to develop a system that uses the computer vision for automation. The task was to evaluate how the system responds to the developed algorithm on different condition as described in the previous section. According to the results, it is concluded that the developed system has a complex in memory management in the calculation of values thus making the system slower than the result required at the instant of the vehicle, creating the failure of lane detection at some cases. But, this system somehow it tries to manage the situation to correctly turning ON the turn signal at the correct time required. Thecoordinative function of all components, server, client and input-output device, are the main building block the system. If one fails, the whole system fails. The input data inside is much well pre-processed and prepared to obtain the quality output. Thus making the system more efficient and robust. Thus the system is developed by gathering the required components, software and gathering data from previous projects and surveys.

As of this writing, the proposed work has returned encouraging results; and in future work it is expected to reinforce previously returned results along with additional valuable design insights upon completion. Based on some recent trends of machine learning and deep learning the technique in computer vision is elevated to the next level. This method takes in the input-output data from the above-depicted algorithm and tries to learn about the lane line more precisely and accurately. Hence by using its weight vectors, that remove the traditional formula calculation, the lane is detected quickly and the system is made to work fast. Lee Kim et al. [9] discussed the method for robust lane detection that uses the deep convolution neural network and John et al. [10] discussed the road scene segmentation using deep learning techniques.

The problem of road lane detection and applications trying to solve it have great potential for daily use. Every technique used in this application could be a subject of further improvement by different approaches or bytaking advantage of new hardware.

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