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A Survey on Road Detection for Autonomous Vehicles

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Abstract: The road detection technique and navigation of vehicle is challenging in different road scenarios in the real urban environment, particularly only when perceptions sensors and lasers were used without position information. Several methods have been used to derive this concept in real time application where illumination of light is invariant. These methods present a novel real-time optimal drivable region and this methods are robust to shadows and lighting variations. Their system uses a multisensory scheme to cover the most drivable area in front of the vehicle. A colour based tracking system is used to get the optimal region on an unmarked road. This methods hold true in different environments and weather conditions. Using a stereophonic vision system of 3D parameters they propose a fast road detections from colour images. It is simple and can be applied on real time scenario. They propose system successfully which handles both structured and unstructured roads. They get better understanding of this concept to produce a result of better understanding following numeroustests.

Keywords: Road detection, 3D image processing, Unmarked Roads, marked roads, HSI colour model, Lane detection, Navigation, Invariant lights.

• INTRODUCTION

The main problem is elaborate in this work which deals with unmarked and marked roads for autonomous vehicle driving. The concept of autonomous vehicle is to detecting optimize area for driving through the road without collision and misjudge lane. In present conditions the road detection methods are individually based on low level features with simple scenarios. They generally consider the structured roads, road homogeneity and uniform lighting conditions for their experiments. Development can be possible if they consider the typical roads condition in real urban environment.

There should be enormous methods like using camera, sensor, and laser spectrum may also use in this methods etc. a number of techniques are resolved in this paper to collaborate information needed. Although this technique can't say as completely reliable for road detection as so many other factors like misaligned lane marking, ambient sunlight and shadows may affect the result. Vision sensors completely works on the principle that they provide useful information without consuming time. It contain information like colour contrast, negative images, depth of that colour. With this survey there are several other vision based approaches. Also research tells that road detection is a straightforward approach which provides information for path planning also it detects obstacle in the path and finds proper road profile estimation. Ideally lane marking are white lines on dark pavement. Thus, the first step is usually based on image edges, defined as extreme of the gradient magnitude along the gradient direction.

• RELATED WORK

2.1 A Sensor Fusion Drivable-Region and Lane-Detection System for Autonomous Vehicle Navigation in Challenging Road Scenarios:

In this paper it has been shown that real time optimal drivable region and road detection and ranging LIDAR and vision data.
They have considered structured and unstructured roads arriving on path alternately this scientifically is quite difficult task. Pavement structure cannot occur regularly in this field, there are many interrupts such as, heavy shadows. Dirt and puddles. Weather conditions also matter in road detection as they frequently changes.

Experiments and Results:

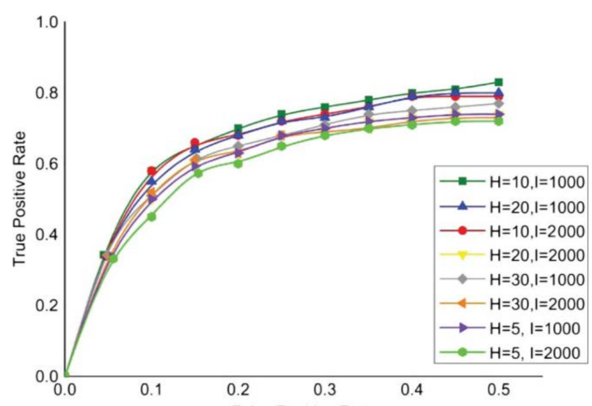

Fig.1 ROC of curb point detection by the ANN with different numbers of hidden nodes and iterations. The labels of the curves

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are sorted by the true positive rate at a false positive rate of 0.5. [1]

Table 1
Drivable-area detection results

	True area	Positive area	Accuracy
Data sequence 1	2300	2098	91.2%
Data sequence 2	1650	1537	93.2%
Data sequence 3	2600	2461	94.7%
Structured road	3584	3376	94.2%
Unstructured road	2966	2720	91.7%
Total	6550	6096	93.1%

The graph shows (Fig.1) a curb point detection results considering maximum 1000 points for 300 positive points and 700 negative points, collected from given data sets. A graph shows mapping of this points for true-false positive rate.
Additionally, result table for optimal drivable region has considered three sequence points where the accuracy is calculated from true and positive area of the road. The optimal drivable area tested 6550 frames and apart from that 2966 frames of unstructured roads and 2584 frames of structured road with an accuracy of 94.2%.

2.2Road Detection Based on Illumination Invariance:
In Paper [2] this paper properly works on light illumination variance in autonomous vehicle, because illumination invariance is a real major problem in this topic. A spectral power distribution and the spectral sensitivity of illuminations gives the proper image formation. It has the RGB colour features which may or may not be involves shadows spectrum. They convert the given RGB into shadow free HIS colour model. It is not constrained to specific road shapes. The likelihood-based classifier is build onlineadapted to each frame. Modelling of the background is not required. This does not affect its work because of road shapes and other restriction. Method is robust to shadows and lighting variations. Histograms are required here to fix the numbers, also they join the similar one and eliminates the odd ones. Each and every frame produces a new histogram so it is not a straightforward process. When the traffic is more then there is most probable chance of having mistaken in detection. Difficult to apply with complex road shapes crossing or when the road borders are not clearly visible. The demonstration of light is shown in fig 1 below.

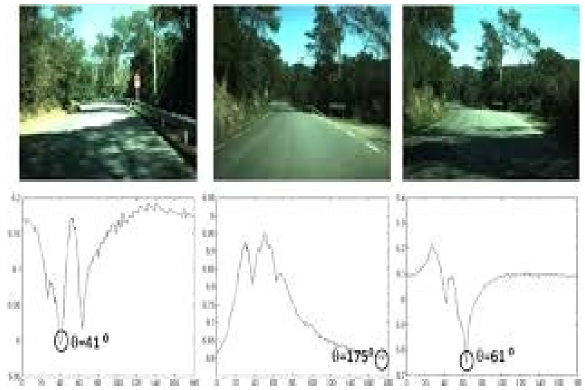


Fig. 2. Great challenges for monocular vision-based road detection are the treatment of shadows and the presence of other vehicles. [2]

In this fig.2, they shown that light is invariance in daylight .Shadows may affect the light detection system. A graph is plotted for every frame and it fluctuates for several instance of frame during the shadows and sunlight.

Experiments and Results:
Table 2
Light invariance result

	Shadows	No shadows or dim ones	Total
Close vehicles	10%	40%	50%
No vehicles or further away ones	34%	16%	50%
Total	44%	56%	100%

Table 2 shows variance of light in different situation with closed vehicles and far vehicles in consideration with shadows, no shadows and dim once etc.

2.3 A Colour Vision-Based Lane Tracking System:
In Paper [3] this system deals with the development of a road model which is accurate, distinct, and clear to viewerwith stability in autonomous driving. The process is convenient in both structured and unstructured roads for deriving the width of road and forming the specific edges accordingly. Method holds true for different environmental and weather conditions**.** This algorithm holds true only when if there is no direct incidence of rays on camera, that is it has some drawbacks when there is sunrise or sunset. The conversion of RGB to HIS is given below shown in fig 4.

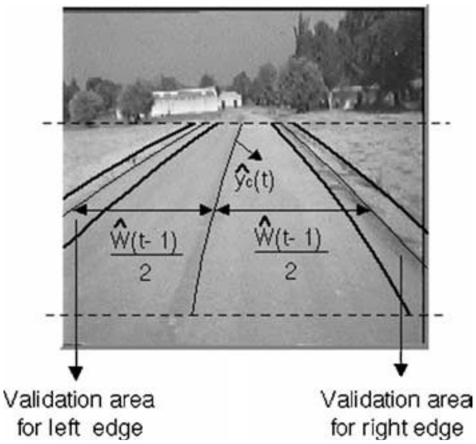


Figure 3.Validation areas for edge measurements. [3]

We consider random fig of road to calculate the road area, width of road and another several factors. Road width estimation is essential parameter. It can be calculated from following few formulas.

$$w_i = \hat{y}_r(t)|_{x=x_i} - \hat{y}_l(t)|_{x=x_i}$$

, Where yr (t),yj(t) are the edges from fig 3.

$$\begin{bmatrix} I \\ V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} \frac{1}{3} & \frac{1}{3} & \frac{1}{3} \\ \frac{-1}{\sqrt{6}} & \frac{-1}{\sqrt{6}} & \frac{2}{\sqrt{6}} \\ \frac{1}{\sqrt{6}} & \frac{-2}{\sqrt{6}} & \frac{1}{\sqrt{6}} \end{bmatrix} \cdot \begin{bmatrix} R \\ G \\ B \end{bmatrix}$$

$$H = \arctan\frac{V2}{V1} \qquad S = \sqrt{V_1^2 + V_2^2}$$

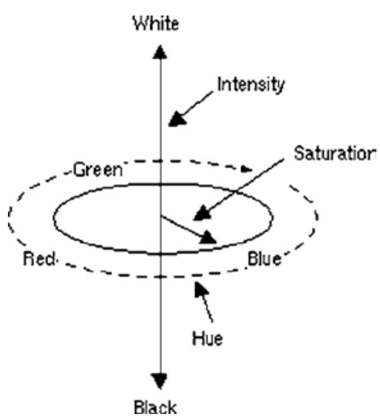


Fig 4. Mapping from the RGB cube to the HSI color space. (Paper 3)

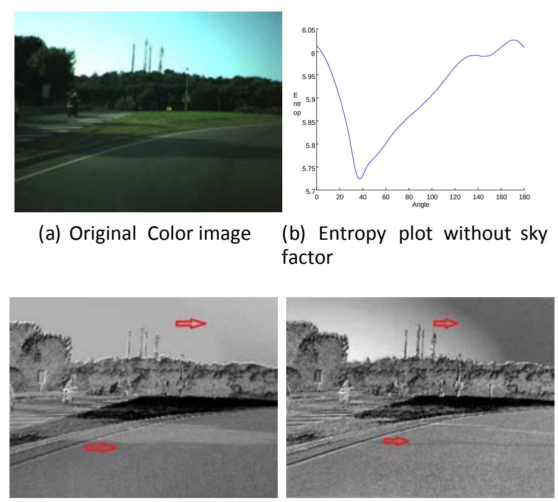
2.4 Fast road detection from colour images:

In Paper [4] in a typical road surface where a stereo vision based 3d parameters are invariant to the shadows and other lighting conditions. A function named as sky removal function is to removes the negative images and other unconditional data in sky light.They do not scatter the information and bound it to one function.It is simple method and works in real time and on line computations. It is independent from prior knowledge of road conditions and temporal constraints. Integration of stereo vision not only improved detection precision but also can provide a reliable platform for obstacle detection with binocular information. There should be difference in light intensity in morning, evening even in afternoon so sensibility is very low when shadows occurs. The sky light with similar effect collaborate and its result finding the threshold value on classifier to segmentation of light.

Algorithms involve:
[1] Axis calibration algorithm
[2] Stereo vision approach for road extraction

This algorithms are basically performs various operations to calculate different terms related to colour of an image. Which are very much significance in this road detection concept.
Maximizing the value, availing multi resources and minimizing errors are essential work for this algorithm.

Experimental result:



(a) Original Color image (b) Entropy plot without sky factor

(c) Gray image by whole image (d) grayscale image get by sky

Fig.5[4]

Fig 5 shows the conversion of main image to gray scale images including the sky image. This lead to calculate more info, more dataset has to be filter and normalize. Entropy of image without considering the sky factor is given in fig5 (b). It is more accurate when we do not consider sky image.

Illumination may lead to a mixture of self-shadow and cast shadow which is more complex to separate their optical features.

Table 3

Dataset	Dataset1		Dataset2	
Measure (log-chroma)	Robust mean	Standard deviatio n	Robust mean	Standard deviation
Normal	56.3°	17.19°	49.67°	3.88°
Geometric mean	43.4°	16.09°	34.33°	2.17°

Table I: Comparison of normal and geometric mean chromaticities

• CONCLUSION

The techniques used for road detection in real urban environment are specifically implemented for getting optimal path. We got several new ideas for getting our results more precise. These techniques have offered us future execution scope on our project.

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