**Road Lane Detection**

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**Abstract**

Lane detection is a challenging problem. It has attracted the attention of the

computer vision community for several decades. Essentially, lane detection is a

multifeature detection problem that has become a real challenge for computer vision

and machine learning techniques. Although many machine learning methods are

used for lane detection, they are mainly used for classification rather than feature

design. But modern machine learning methods can be used to identify the features

that are rich in recognition and have achieved success in feature detection tests.

However, these methods have not been fully implemented in the efficiency and

accuracy of lane detection. In this paper, we propose a new method to solve it. We

introduce a new method of preprocessing and ROI selection. The main goal is to use

the HSV colour transformation to extract the white features and add preliminary

edge feature detection in the preprocessing stage and then select ROI on the basis

of the proposed preprocessing. This new preprocessing method is used to detect the

lane. By using the standard KITTI road database to evaluate the proposed method,

the results obtainedare superior to the existing preprocessing and ROI selection

techniques.

**Introduction**

With the rapid development of society, automobiles have become one of the

transportation tools for people to travel. In the narrow road, there are more and more

vehicles of all kinds . As more and more vehicles are driving on the road, the number

of victims of car accidents is increasing every year. How to drive safely under the

condition of numerous vehicles and narrow roads has become the focus of attention.

Advanced driver assistance systems which include lane departure warning (LDW),

Lane Keeping Assist, and Adaptive Cruise Control (ACC) can help people analyse

the current driving environment and provide appropriate feedback for safe driving or

alert the driver in dangerous circumstances. This kind of auxiliary driving system is

expected to become more and more perfect. However, the bottleneck of the

development of this system is that the road traffic environment is difficult to predict .

After investigation, in the complex traffic environment where vehicles are numerous

and speed is too fast, the probability of accidents is much greater than usual. In such

a complex trafficsituation, road colour extraction and texture detection as well as

road boundary and lane marking are the main perceptual clues of human driving .

Lane detection is a hot topic in the field of machine learning and computer vision and

has been applied in intelligent vehicle systems . The lane detection system comes

from lane markers in a complex environment and is used to estimate the vehicle’s

position and trajectory relative to the lane reliably . At the same time, lane detection

plays an important role in the lane departure warning system. The lane detection

task is mainly divided into two steps: edge detection and line detection. Qing et al.

proposed the extended edge linking algorithm with directional edge gap closing. The

new edge could be obtained with the proposed method. Mu and Ma proposed Sobel

edge operator which can be applied to adaptive area of interest (ROI) . However,

there are still some false edges after edge detection. These errors will affect the

subsequent lane detection. Wang et al. proposed a Canny edge detection algorithm

for feature extraction .The algorithm provides an accurate fit to lane lines and could

be adaptive to complicated road environment. In 2014, Srivastava et al. proposed

that the improvements to the Canny edge detection can effectively deal with various

noises in the road environment . Sobel and Canny edge operator are the most

commonly used and effective methods for edge detection. Line detection is as

important as edge detection in lane detection. With regard to line detection, we

usually have two methods which include feather-based method and model based

methods. Niu et al. used a modified Hough transform to extract segments of the lane

profile and used DBSCAN (density based spatial application noise clustering)

clustering algorithm for clustering . In 2016, Mammeri et al. used progressive

probabilistic Hough transform combined with maximum stable extreme area (MSER)

technology to identify and detect lane lines and utilized Kalman filter to achieve

continuous tracking . However, the algorithm does not work well at night. In this

paper, we propose a lane detection method that is suitable for all kinds of complex

traffic situations, especially as driving speed in roads is too fast. First, we

preprocessed each frame image and then selected the area of interest (ROI) of the

processed images. Finally, we only needed edge detection vehicle and line detection

for the ROI area. In this study, we introduced a new preprocessing method and ROI

selection method. First, in the preprocessing stage, we converted the RGB colour

model to the HSV colour space model and extracted white features on the HSV

model. At the same time, the preliminary edge feature detection is added in the

preprocessing stage, and then the part below the image is selected as the ROI area

based on the proposed preprocessing. Compared with the existing methods, the

existing preprocessing methods only perform operations such as graying, blurring, X-

gradient, Y-gradient, global gradient, thresh, and morphological closure. And the

ways to select the ROI area are also very different. Some of them are based on the

edge feature of the lane to select the ROI area, and some are based on the colour

feature of the lane to select the ROI area. These existing methods do not provide

accurate and fast lane information, which increases the difficulty of lane detection. In

this paper, experiments show that the proposed method is significantly better than

the existing preprocessing method and ROI selection method in lane detection.

**Methodology**

The Road Lane detection techniques discussed are Preprocessing, Colour

Transform, Basic Preprocessing, Adding Edge Detection in Preprocessing, ROI

Selection, Edge Detection, Lane detection, Lane Tracking Using Extended Kalman

Filter.

**Preprocessing:**

Preprocessing is an important part of image processing and an important

part of lane detection. Preprocessing can help reduce the complexity of the

algorithm, thereby reducing subsequent program processing time. The video input is

a RGB-based colour image sequence obtained from the camera. In order to improve

the accuracy of lane detection, many researchers employ different image

preprocessing techniques.

**Colour Transform:**

Colour model transform is an important part of machine vision, and it is also

an indispensable part of lane detection in this paper. The actual road traffic

environment and light intensity all produce noise that interferes with the identification

of colour. We cannot detect the separation of white lines, yellow lines, and vehicles

from the background. The RGB colour space used in the video stream is extremely

sensitive to light intensity, and the effect of processing light at different times is not

ideal. In this paper, the RGB sequence frames in the video stream are colour

converted into HSV colour space images. HSV represents hue, saturation, and

value.

**Basic Preprocessing***:*

A largenumber of frames in the video will be preprocessed. The

images are individually gray scaled, blurred, X-gradient calculated, Y-gradient

calculated, global gradient calculated, thresh of frame, and morphological closure . In

order to cater for different lighting conditions, an adaptive threshold is implemented

during the preprocessing phase. Then, we remove the spots in the image obtained

from the binary conversion and perform the morphological closing operation. The

basic preprocessed frames cannot be very good at removing noise. It can be seen

from the results after the morphological closure that although preliminary lane

information can be obtained, there is still a large amount of noise.

**Adding Colour Extraction in Preprocessing:**

In order to improve the accuracy of lane detection, we add a feature

extraction module in the preprocessing stage. The purpose of feature extraction is to

keep any features that may be lane and remove features that may be non lane. This

paper mainly carries on the feature extraction to the colour. After the graying of the

image and colour model conversion ,we add the white feature extraction and then

carry out the conventional preprocessing operation in turn.

**Adding Edge Detection in Preprocessing***:*

This paper has carried out edge detection two times successively; the

first time is to perform a wide range of edge detection extraction in the entire frame

image. In the second, the edge detection is performed again after the lane detection

after ROI selection. This detection further improves the accuracy of lane detection.

This section mainly performs the overall edge detection on the frame image, using

the improved Canny edge detection algorithm. The concrete steps of Canny operator

edge detection are as follows: First, we use a Gaussian filter to smooth the image

(preprocessed image), and then we use the Sobel operator to calculate the gradient

magnitude and direction. Next step is to suppress the nonmaximal value of the

gradient amplitude. Finally, we need to use a double-threshold algorithm to detect

and connect edges.

**ROI Selection:**

After edge detection by Canny edge detection, we can see that the

obtained edge not only includes the required lane line edges, but also includes other

unnecessary lanes and the edges of the surrounding fences. The way to remove

these extra edges is to determine the visual area of a polygon and only leave the

edge information of the visible area. The basis is that the camera is fixed relative to

the car and the relative position of the car with respect to the lane is also fixed, so

that the lane is basically kept in a fixed area in the camera.

In order to lower image

redundancy and reduce algorithm complexity, we can set an adaptive area of

interest (ROI) on the image. We only set the input image on the ROI area and this

method can increase the speed and accuracy of the system. In this paper, we use

the standard KITTI road database .We divide the image of each frame in the running

video of the vehicle into two parts, and one half of the lower part of the image frame

serves as the ROI area. The images of the four different sample frames have been

able to substantially display the lane information after being processed by the

proposed preprocessing method, but not only the lane information but also a lot of

non lane noise is present in the upper half of the image. So we cut out the lower half

of the image (one-half) as the ROI area.

**Lane Detection:**

The lane detection module is mainly divided into lane edge detection and

linear lane detection. This section implements the basic functions of lane detection

and performs lane detection based on improved preprocessing and the proposed

ROI selection.

**Edge Detection:**

Feature extraction is very important for lane detection. There are many common

methods used for edge detection, such as Canny transform, Sobel transform, and

Laplacian transform . We have selected Canny transform which is better.

**Lane Detection:**

Feature based Methods: To detect the colour and edge features of Lanes in

order to improve the accuracy and efficiency of lane detection

Two Methods:

**1)Hough Transform:** used to extract lane line parameters in each frame of the

Image sequence for lane detection

**2) Self-Programming:** ROI area is traversed to perform line detection for a specific

range of angles

**Lane Tracking Using Extended Kalman Filter** :

After completing the lane detection, the next step is to track the lane,

which is also a key technology for smart and automated vehicle (SAV). Image edge

detection technology and linear lane detection are technologies used to detect lane;

then EKF is used to track these parameters one by one . In this way, the tracking of

lane lines is converted into the tracking of lane line parameters, which not only

improves the tracking speed, but also introduces the method of Kalman tracking to

improve the tracking accuracy.

**Conclusion**

In this paper, we proposed a new lane detection preprocessing and ROI selection

methods to design a lane detection system. The main idea is to add white extraction

before the conventional basic preprocessing. Edge extraction has also been added

during the preprocessing stage to improve lane detection accuracy. We also placed

the ROI selection after the proposed preprocessing. Compared with selecting the

ROI in the original image, it reduced the non lane parameters and improved the

accuracy of lane detection. Currently, we only use the Hough transform to detect

straight lane and EKF to track lane and do not develop advanced lane detection

methods. In the future, we will exploit a more advanced lane detection approach to

improve the performance.

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