Design of Autonomous Obstacle Avoidance System for Driverless Vehicle Based on Machine Vision

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ABSTRACT

With the continuous development of artificial intelligence technology, more and more automation technologies are combined with various machines. Automation technology has reached the driving field from the industrial revolution. Driverless technology has gradually become a major direction of the automobile market. The focus of driverless vehicles is the development of autonomous obstacle avoidance system. The perception system of driverless vehicles is responsible for sensing and interacting with the surrounding environment, usually including sensing information, data fusion, positioning and other functions. The reliability of machines is higher than that of people. In theory, automatic driving technology will be safer, and driverless vehicles have also proved this statistically. It can indeed make people's travel safer and reduce the probability of traffic accidents. Moreover, the autonomous obstacle avoidance system of driverless vehicle based on machine vision can greatly improve the overall traffic efficiency and greatly alleviate the traffic congestion. The experimental results show that the design of autonomous obstacle avoidance system for driverless vehicles based on machine vision reduces the road congestion rate by 8%. Machine vision enhances the ability of unmanned vehicles to successfully complete trajectory planning and following tasks when driving on any road, and its algorithm needs good real-time performance and stable reliability. For the limitations of the research on driverless mode, the method of innovative combination is adopted to update and iterate the autonomous obstacle avoidance of driverless vehicles, and the path planning for local navigation of various vehicles is analyzed, discussed and summarized, so as to enrich the research results of vehicle automatic obstacle avoidance system.

CCS CONCEPTS

• **Computing methodologies**; • **Artificial intelligence**;

KEYWORDS

Machine Vision, Driverless Vehicle, Autonomous Obstacle Avoidance, Path Planning

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1 INTRODUCTION

In the complex traffic environment, there are various dynamic obstacles around. Generally speaking, it is difficult to understand and predict the movement intention of other vehicles and users, which makes decision-making and planning very difficult. For example, the behavior of other individuals at intersections is very difficult to predict [1-2]. Driverless vehicles integrate sensors and machine vision algorithms on the basis of traditional vehicles to realize real-time interaction with the surrounding environment [3-4]. As an intelligent system, unmanned vehicle can automatically sense the surrounding environment and make correct driving behavior. The functions of unmanned vehicle can be roughly divided into four modules: environment perception, behavior decision-making, path planning and behavior control [5-6].

In order to solve various hidden dangers caused by traffic problems, developed countries such as Europe, the United States and Japan are vigorously developing intelligent transportation systems, and driverless technology is gradually becoming the mainstream of the market [7-8]. The design of autonomous obstacle avoidance system for driverless vehicle based on machine vision mainly extracts fixed features through local selection and manual design of machine vision, inputs a large number of positive and negative samples into the learning algorithm, and obtains the optimized discrimination function based on the statistical knowledge of machine vision, that is, constructs a classifier of the object to be detected. When the new sample fixed features are input to the classifier, the target object detection can be achieved by judging whether the result is correct or not according to the classifier.

The innovation of this paper is to put forward the research of unmanned driving technology under machine vision, through the analysis of a large number of road pictures and information, enrich the analysis of autonomous obstacle avoidance system for various road obstacles in case of emergencies. This paper aims to analyze the connotation and significance of the development of automatic obstacle avoidance system under the condition of machine vision. The area to be detected in a picture is separated from the original image, where the existing area of lane line pixels is extracted, and then the accurate position of lane line is further determined. The research of unmanned driving is of great significance to human society. In order to realize the autonomous navigation of driverless vehicles, it is meaningful to study its core technical difficulty: fusion positioning and decision planning strategy. The purpose of this study is to find a new road suitable for the design of autonomous obstacle avoidance system of driverless vehicle based on machine vision.

2 UNMANNED DRIVING TECHNOLOGY UNDER MACHINE VISION

2.1 Unmanned Driving at the Present Stage

The vision sensor converts the information of the three-dimensional world into a picture composed of pixels, processes the image information through various algorithms, and obtains the position and motion information of the vehicle. Lodewyk Kr believes that the data flow chart of data communication between obstacle avoidance system and image system is interrelated. The sending service of obstacle avoidance system sends image information through the network, receives it by the receiving service of image system, and transmits it to image processing algorithm for relevant calculation [9]. Lander N J believes that machine vision can be an adaptive automatic obstacle avoidance system for driver behavior. The input of the system includes road curvature at the forward preview distance, vehicle speed, error between ideal spacing and front vehicle spacing, steering wheel angle, lateral deviation from the road centerline and indicator light, while the output of the system is steering wheel angle and vehicle speed [10].

In the process of unmanned driving, there will be many road conditions that need to avoid obstacles, such as objects falling from the front car or mountain, slow driving of the vehicle in front, and merging into the lane in front of the vehicle after overtaking. The visual sensor has rich and direct perception of the environment and obtains more information. Therefore, the accuracy of road and obstacle detection in front of the vehicle is higher, the sampling rate of the visual sensor is fast, and it can provide more environmental information at the same time. Proper application of this function can design an effective algorithm in the design and development of autonomous obstacle avoidance system of driverless vehicle, which has the following forms. $MSE=\frac{1}{n}\sum_{i=1}^{n}(X_t-\hat{X}_t)$(1)

The calculated value of the algorithm is, and the formula is as follows: $MAE=\frac{1}{n}\sum_{i=1}^{n}|X_t-\hat{X}_t|$ (2)

The following formula shall be used for the test: $MAPE=\frac{1}{n}\sum_{i=1}^{n}\frac{|X_t-\hat{X}_t|}{X_t}\times 100\%$ (3)

2.2 Decision Rules in Unmanned Technology

For autonomous navigation of driverless vehicles, it is to perceive and locate the environment through their own equipment, make decision planning and control through the information of perception and positioning, and finally complete the navigation task. Among them, environmental perception and positioning are the basis, and decision-making planning is the difficulty. Finally, the sending service of the image system sends the processing results to the obstacle avoidance system, and the receiving service of the obstacle avoidance system receives the data and then transmits it to the data processing part, which calculates and makes a decision on the driving path. It is directly obtained by machine vision sensor. Without obstacles, the intelligent vehicle tracks the path through the preset path given by GIS.

3 AUTONOMOUS OBSTACLE AVOIDANCE SYSTEM UNDER MACHINE VISION

3.1 Current Situation of Machine Vision

The monocular vision detection method in machine vision mainly realizes the detection and recognition of obstacles in the scene by analyzing the appearance characteristics (color, shape and texture) of obstacles. This method has good results in simple and specific scenes, but it is not suitable for complex scenes. Binocular vision can not only obtain the appearance characteristics of the scene, but also obtain the geometric characteristics of the scene. The parallax of machine vision is the offset between the point in the image of the left camera and the corresponding point in the image of the right camera. The closer the object is, the greater parallax. In the actual imaging process of the camera, due to the structure, manufacturing, installation and technology of the camera itself, radial and tangential distortions occur in the imaging process, so that the imaging model does not conform to the pinhole model. Therefore, the model is called nonlinear model. Ideally, any parallel line such as the lane line and the road railing parallel to the lane line on the image will pass through the vanishing point through the intersection of perspective projection, so the distance from the vanishing point to all lines is zero, so finding the location of the vanishing point is transformed into solving the problem of minimum distance.

3.2 Machine Vision in Autonomous Obstacle Avoidance System

Before controlling the vehicle, it is very necessary to master the kinematic model of the vehicle. Vehicle kinematics model is a kind of model that can describe the law of vehicle motion. Generally speaking, the more complex the model is, the closer it is to the real vehicle motion law. Therefore, an eight degree of freedom vehicle dynamics model will be established in this chapter, including the modeling of tire and vehicle driveline. Two important technologies in machine vision are feature point extraction and matching, which are widely used in object recognition, 3D reconstruction and other fields. The extraction of image feature points is to traverse each pixel of the image and save the pixels that meet certain characteristics. In driverless decision planning, it mainly determines what to do next, and even considers what to do next in complex environment, which is difficult to obtain rule samples. Therefore, machine vision is trained by reinforcement learning in this paper. Visual obstacle detection realizes the segmentation of obstacles and roads by extracting specific texture, color and shape information in the scene. The specific results are shown in Table 1

4 AUTONOMOUS OBSTACLE AVOIDANCE SYSTEM OF DRIVERLESS VEHICLE

4.1 Development Analysis of Machine Vision under Actual Road Conditions

The advantage of monocular vision technology over binocular vision technology is that it can directly obtain the three-dimensional

Table 1: Annual direct costs of medication for hepatitis B related diseases in China

Disease name	Inspection fee	Treatment costs	Hospital costs	total
Chronic hepatitis B	577	8176	5550	13726
Liver cirrhosis	1030	13625	10632	252817
Hepatocellular carcinoma	2615	43826	28771	75212

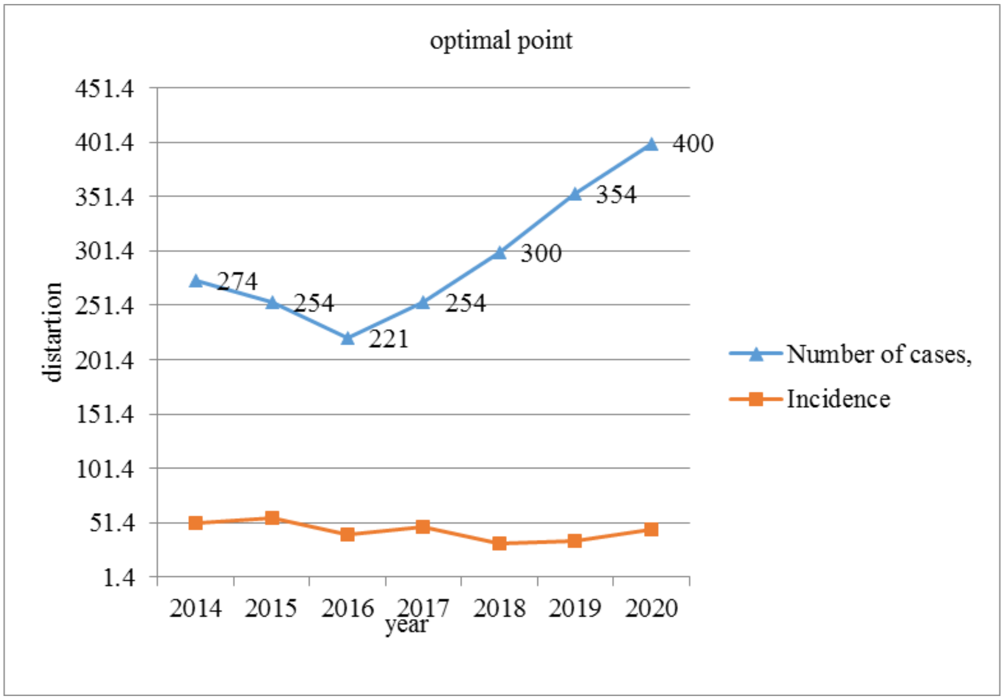

Figure 1: Incidence number, incidence rate and adjusted incidence rate

information of the scene. For the missing fixed features in the unstructured road scene, it can supplement the geometric relationship between obstacles and pavement as the segmentation basis between obstacles and pavement to realize obstacle detection. The collected video image is pre detected for suspected obstacles. The change of the contour size of the suspected obstacle object in the region of interest in the image determines the value of the dynamic obstacle determination coefficient y, that is, y depends on the width W and height h of the object in the image. The camera installed on the vehicle has a fixed viewing angle range, so the change of the outline size of the object also indicates the change of the area ratio of the object in the image. The specific results are shown in Figure 1. The application level of automatic driving technology in China is more comprehensive, and the number of statistical applications is rising steadily year by year.

4.2 Obstacle Avoidance System Analysis of Driverless Vehicle

Obstacle avoidance system of driverless vehicle according to the above requirements, driverless vehicle hardware platform includes vehicle body, various sensors, on-board computer, steering gear, etc.: according to the realization function, driverless vehicle system is usually divided into three parts: perception part, planning decision-making and bottom control. For the trajectory planning and control of unmanned vehicle, the environmental perception and information fusion modules are not discussed. Therefore, we assume that the environmental information and the state information of obstacles can be accurately obtained through the information fusion of sensors such as machine vision. At home and abroad, the detection of lane line is generally realized based on the image processing algorithm of computer vision, and there are also research on the detection algorithm using the reflection of lidar. However, this detection method has high requirements for the quality of lane line marking and is not easy to realize. Therefore, this method is mainly used as an auxiliary means to help the computer vision algorithm detect lane line. Based on this information, the decision-making layer makes the most suitable strategy for unmanned vehicles in the current environment, the planning layer makes detailed trajectory planning based on specific strategies, and the control layer makes the vehicle drive in strict accordance with the planned reference

Table 2: Statistical table of sample library

Predictive model	RSR	prediction	confidence interval
BPNN	0.25	30.00	31.64
WBPNN	0.67	54.74	52.62
GABPNN	0.58	49.80	46.21
GAWBPNN	1.00	75.52	73.12

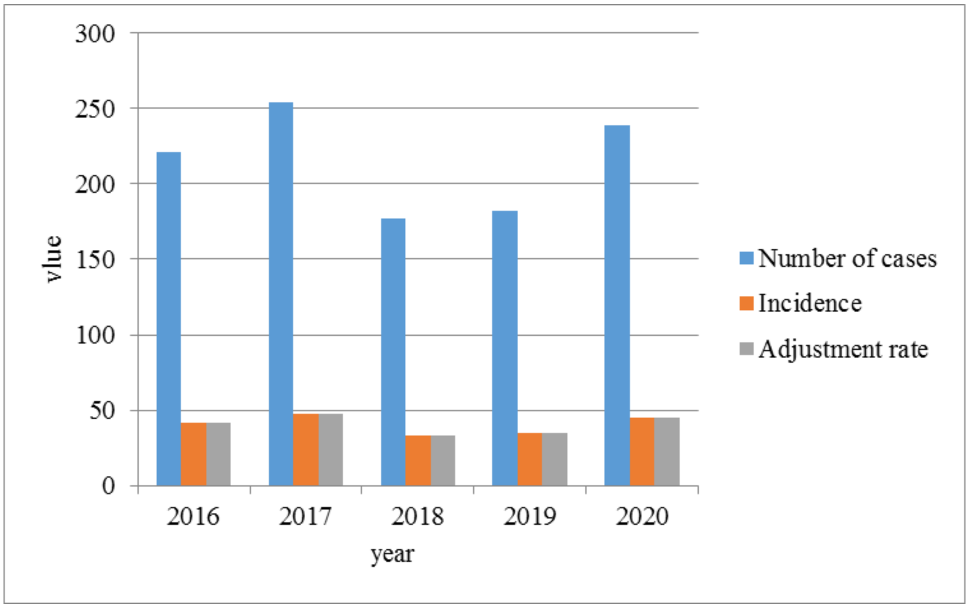

Figure 2: Comparison of running time

trajectory by controlling the vehicle steering wheel, throttle and braking. The specific results are shown in Table 2

Driverless vehicle is a multi-disciplinary experimental verification platform involving system design, pattern recognition, artificial intelligence and mechanical structure, which reflects the level of national industrial intelligence. The design idea of vehicle autonomous obstacle avoidance system is: firstly, some preprocessing is carried out on the image to be detected to improve the quality of the image, and then the edge information of the image is extracted, the region of interest to be detected is found, the feature points are extracted, and the least square method is used to fit the lane line. This paper mainly focuses on the design, implementation and verification of the functional algorithm of the driverless vehicle obstacle avoidance system. The specific image transmission technology between the obstacle avoidance system and the image system is not described in this paper, and the wireless network is used for data transmission in the simulation environment. 200 actual road images are collected in different time periods as test data. The data set has good positioning labels, but it includes other multiple targets, such as pedestrians, traffic lights, bicycles, etc. Moreover, in the position label of the data set, if the area of the vehicle in the collected image is less than 1 / 15 of the original pixel area, we assume that the vehicle does not exist. Because the physical area of vehicles far away collected by the camera is relatively small, it is considered that these vehicles have little impact on the driving safety of this test in actual driving, so they can be approximately ignored. The specific results are shown in Figure 2

5 CONCLUSIONS

Although in the design of autonomous obstacle avoidance system for driverless vehicle based on machine vision, there are great deficiencies in the content of the article due to the one-sided data that may be collected. With the development of artificial intelligence, brain science, automatic control, sensor technology and other fields, people's interest in vehicle automation is also growing. The developed auxiliary driving systems such as adaptive cruise control and lane keeping assistance are popular among consumers. People also hope to develop more autonomous vehicles without manual control and realize automatic driving. Various applications of machine vision can also be used in industrial design, and its functions still have many in-depth contents worthy of research. There are still many steps to study the design of autonomous obstacle avoidance system of driverless vehicle based on machine vision, which are not involved due to space and personal ability. In addition, the practical application effect of the relevant experiments of autonomous obstacle avoidance system of driverless vehicle can only be compared with the traditional model from the level of theory and simulation.

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