A New Method for Safe Distance Estimation between Moving vehicles

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Abstract
One of the main dangerous specially in high speeds that threaten the life of drivers, is this fact that human reaction is low and in comparison with high velocity of moving vehicles in some special conditions such as in freeways, it will be lower. So, driver would not have enough time to react and it causes some bad accidents.
What you will see in this paper, is a new method and system that can estimate differential velocity and distance of a vehicle that it is situated, from other car that is moving head of the mentioned car.
Whereas our system is based on image processing, first a summary of done research and works in traffic control that uses image processing, will be presented. Then new method will be explained. And we look at a background method that proposed method is based on it and at last we will see the advantages and limitation of this method and discuss about the result of experiments.

Keywords:
Safe distance, Differential velocity, Human reaction, Decreasing accidents, Response time

1- Introduction

As you know, along with growing of automobile industry, we have seen considerable increasing in velocity of vehicle and this problem has increased number of vehicles accident rates.
Important attempts in this way can be considered as follow:
In some cases, optical sensors are used to control traffic density. In this way, instead of transmitting an enormous volume of images, information of selected objects is sent to local computer networks that reduces amount of useless data transferring and increases speed of evaluations. Therefore, quick decisions are made about traffic events [1].
Also, in order to control and monitoring on traffic, infra red image processing systems can be used that are suitable for places with insufficient light and bad weather conditions [2].
When you want to control velocity of vehicles, you can use mean velocity estimation system without needing to calibration of camera and only by using geometrical relations and isolation of vehicle path in different frames of pictures and its length parameter [3].
Making automatic traffic control is another case that can improve traffic problem in freeways. In this system, all events of freeway can be saved together with their dates and times. So, information of car owners can be registered when it is needed [4].
One of the other methods in traffic control is 3D analysis of traffic in a sequence of captured pictures by helicopter and following moving vehicles path by them [5].
Another way is gathering and calculation traffic information from taken pictures by camera and sending them to traffic control station [6].
Image processing can be used in analysis of road traffic and car numbers and authentication of car owners. Also, navigation system based on image processing should play three main roles: a) Road detection b) Obstacle detection c) Traffic signs detection [7],[8],[9].
When we need to high performance and high accuracy, intelligent cameras are used. Although such cameras have their own features such as special hardware and software and communication method, but are very useful when we need to high quality and performance [10],[11].

In Traffic controlling issue, registering of accidents is very important. In this system, voice and images of occurred accidents are compared with information of special databases in the case of velocity, accident voice and weather condition. Then, it presents an analysis of accident [12].

Image processing can also be used in navigation of vehicle in narrow ways. Such a system uses sided lines of the road for this purpose [13],[14]. Visual guidance of machine by approximation of moving scale and position of vehicle by filtering of images is one of another application method in this area [15].

But, none of the mentioned methods does not consider mistakes and slow reaction that is major factor in many accidents. What is presented in this paper, is a method that by using it, distance between a car and its front car is realized and this will help to control the differential velocity of to vehicles due to their distance. We will use a accurate and rapid distance estimation method for this system [16],[17].

Most of drivers want to arrive to destination as soon as possible and don't consider that in high speed driving, possibility of accident is higher. More of these events are because of this fact that human reaction has a fired time and in high velocity it is not speed enough to answer.

This is an important reason that reminds us the necessity of auxiliary devices which may help drivers to control their environment during driving.

One of reason that causes very bad accidents in highways is this issue that many o derivers don't observe the safe distance that if front vehicle suddenly stops, our vehicle have enough chance to stop safely.

In this paper a new method will be presented that come atomically control thois safe distance and safe human life

2- A brief view of proposed method

In this method we have a system that situated in the front of our vehicle. This system has a comers that take pictures in equal intervals and send it to software that analyzes this picture and estimates the distance between front car and our vehicle. It red back lights of front car as a feature that all cars have it commonly and because of these lights are located in the back of car distance of them from camera is equal to distance of car from camera.

This system uses a subtle method for distance estimation that will be discussed in the next section. Using this method the distance is estimated in two successive pictures and by subtracting them, differential distance is calculated and then we can find out the differential velocity. If we have a dynamic table that determines the relation of distance and velocity in a safe condition our system compares result of its calculation with the columns of this table and if estimated distance was less than distance column related to differential velocity, sends an alarm to drivers and warn him or her from dangerous.

Remember that we need to dynamic table that amount of its columns change depending on base velocity of our car. For example this system uses a table when our car has 30 km/h speed and uses another table for 100 km/h speed. Also, we can have an automatic stop system rather than alarm only.

3-The background method

This background method includes two steps [2]: First, calculating an interpolation function based on the height and the horizontal angle of the camera. Second, using this function to calculate the distance of the object from the camera.

In the first step, named the primitive evaluation phase, the camera is located in a position with a specified height and a horizontal angle. Then from this position, we take a picture from some lines with equal distance from each other. Then, we provide a table in which the first column is the number of pixels counted from each line to the bottom edge of the captured picture (as the origin line), and the second column is the actual distance of that line from the camera position.

Now, by assigning Lagrange method to this table, the related interpolation polynomial is calculated:

In the second step of this method -with the same height and horizontal angle of the camera- the number of the pixels between the bottom edge of the target in the image (the nearest edge of an object in the image to the camera) and the bottom edge of the captured image is counted and considered as **x** values in the interpolation function.

The output of this function will be the real distance between the target in the image and the camera [16],[17].

4- Advantages and limitations

Some important advantages of such a system are:

a) It reduces the role of human reaction time in accidents.

b) It does not need to any calibration for camera.
c) It has acceptable response time.
d) It uses a background method that has a high accuracy and is very quick.
e) It can be used even if back lights of the car were crashed. Because this system use the color of cover of this lights and does not need to any optical instruments.
f) It is flexible to any speed and ain its information only from pictures that are captured from its single camera.

But main limitations that: The only feature that used, is the red color of backlight's cover. So, it can not answer if somebody uses another color for this covers.

5- Result of some Experiments

As you can see in below pictures, this system examined in three possible cases that cause system to reaction:
a) Speed of our car is increased. In this case, system send an alarm because differential velocity is changed and our car will be closer to the front vehicle than which is safe distance in new differential velocity should be.
b) Speed of the front vehicle is increased . It has similar reason to send an alarm. But now, reducing the velocity of the front car causes to cars will be closer than safe distance.
c) Speed of both of our car and front vehicle are increased. In this case, although the differential speed is constant, but whereas the base velocity is increased, so system should use another table for this new case.
Experiments show that in all above cases, mean time of response time in a 600*800 resolution for captured images, is about 2 seconds.
Whereas the background method has a high accuracy about 8% and we do not need to such a accuracy here, we can decrease the resolation of pictures to 640*480. In this case response time will be about 1.5 seconds.
This time is more quickly than human reaction time.
Specially, notice that if the red lights of the front car don't act correctly, driver of the back car could not aware from decreasing of velocity in the front car and it ay cause an accident in high speeds.
Following, you can see three pictures that are taken in three different cases to realize the differential velocity and distance between the front car and our car, and then control the safe distance:

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