MVA '98 IAPR Workshop on Machine Vision Applications, Nov. 17-19, 1998, Makuhari, Chiba, Japan

13—10 A Driver Behaviour Evaluation System

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Abstract

This paper presents a system to evaluate the driver behaviour by analysing the decisions taken by them while seeing different lane change scenes of a video library which are projected onto a screen using a CRT projector.

The paper also deals with the explanation of the system setting needed to acquire real images coming from different video sources that have different fields of view of the lane change experiment and have to be synchronised.

Keywords: driver behaviour, lane change, GPS, video synchronisation.

1 Introduction

One of the difficulties that arises in the field of the intelligent vehicles is to get accurate data for evaluation purposes about the vehicles involved in a traffic situation. This necessity is also present in modelling and evaluating the driver behaviour [1].

Driving simulators are being used in human factors investigations[5][6][12][9]. Normally the images are generated by computer. This simulators basically respond with visual, sound and other signals to the vehicle's controls activated by the driver[2][3]. This paper deals with real scenes rather than simulated scenes. This method has the advantage that the drivers will see real scenes and there is no necessity of scene interpretation. Nowadays evaluation and data acquisition through real scenes are being assessed by different laboratories[4][1]

The first step of our work has consisted in choosing a set of typical lane change situations of possible interest for evaluation purposes. This situations are reproduced through controlled experiments in real scenarios. There are three vehicles involved in most of the prepared lane change situations, each one of them having a GPS receiver, and one of the vehicles has three cameras that record the entire sequence. Then, a post processing is done in order to synchronise the videos and the information provided by the GPS receivers. The synchronised videos are showed simultaneously to a driver who decides what to do. The controls used by the drivers, wich will be registered by a PC, are a steering wheel, an accelerator pedal a break and a directional light. And last, the driver behaviour is evaluated depending on the actions he/she take.

2 System Overview

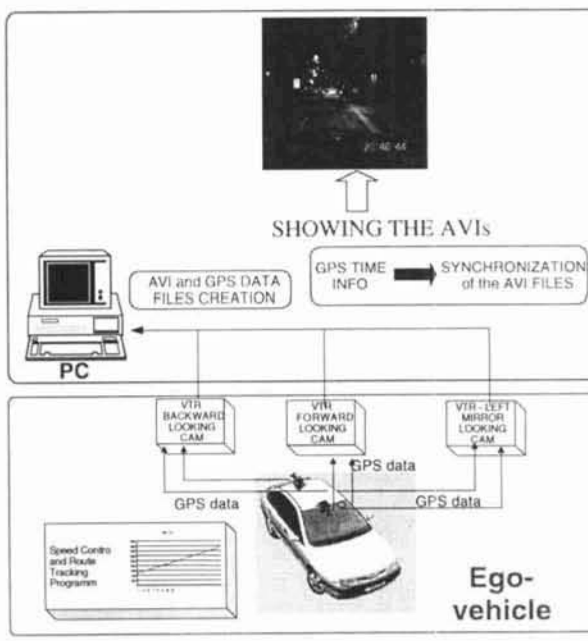

Figure 1. Ego-vehicle and post-processing system

The work we have been developing can be separated in two stages: a) Image and GPS database creation: we have created an image database with real traffic lane change situations. These image sequences contemplate typical possible situations that can take place in a lane change scenario. There are three vehicles involved in most of the prepared scenarios: the ego vehicle, as shown in figure 1, is equipped with three colour video cameras, a GPS and three VTRs. A camera is forward looking, a second one is looking the rear-view mirror and the third one grabs the outside left mirror. The three cameras are connected to VTRs. The VTR's audio input channel is used to record the speed, position and time information from a GPS receiver using a modem. In this way we can collect the informa-

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tion coming from the three cameras and the GPS receiver. Other two cars, one approaching from behind and the other in front of the ego-vehicle, are equipped with a GPS receiver and also a lap top running a speed control and a route tracking program (figure 2). The speed and the position of the vehicle related to the time are saved in a file. All this structure has allowed us to create an image database, perfectly synchronised, obtained in the prepared scenario in a highway when a driver wants to execute a lane change.

b) A drivers' behaviour evaluation: the drivers' behaviour is evaluated starting from the decisions adopted by them when seeing in a screen (CRT projector) the set of traffic lane change situations previously created by us.

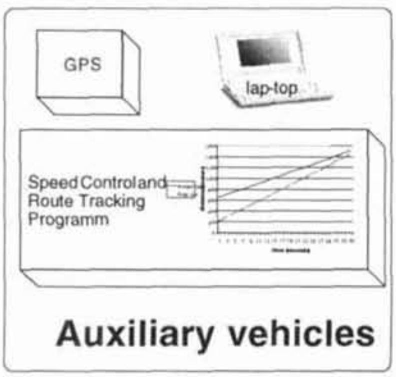

Figure 2. Auxiliary vehicles system

3 Image and Data Collection

In order to build our image database a previous work has to be made. The driver of the three vehicles involved in the data collection stage have to follow the orders given by a speed control and route tracking program that runs in a lap top computer. This program use the GPS time that will allow us to synchronise the position and the speed of the three vehicles and later on the synchronisation of the video filmed with the three cameras. This procedure makes possible a previous arrangement of risky situations which will allow us to evaluate the driver's behaviour in manoeuvres that involve risk: "border decisions". Figure 3 shows an example of the plan that has to follow each vehicle, so that at a determined instant the ego-vehicle may execute a lane change.

In Figure 3, the speed of the ego-vehicle is 110 km/h and approaches a heading car going at 90 km/h. Another vehicle is approaching from behind at a speed of 130 km/h. At a given instant (around second 11) the relative distances between the ego-vehicle and the car that goes ahead and between the ego-vehicle and the rear car are around 50 and 100 meters, respectively.

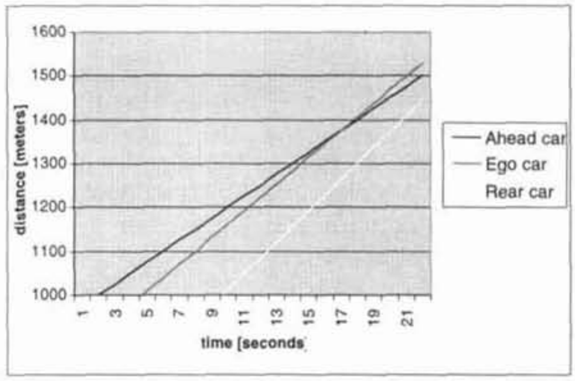

Fig. 3 Example of a sequence's schedule

We have designed a set of different cases having as variables the relative distances between the vehicles and the vehicles' speeds. In all this circumstances the ego-vehicle rams a car ahead of it while at the same time a car is approaching from behind and the driver may want to make a lane change.

In other type of sequences, the route is programmed in such form that there become traffic signals involved in the maneuvers.

During these experiments three VTRs in the ego-vehicle are recording the three video signals (front view, rear-view mirror and backward looking external mirror) and the GPS receiver's data are recorded in the audio channel of the VTR's tape (FSK coded). Parallel, the GPS data of the other two vehicles are recorded in a file on the lap top computer.

4 The GPS as the Master Clock in the Movie Creation

In the studio masters the date and time information given by the GPS receivers are used to set and frame lock multiple time code generators[7][8]. In this way, different video images can be recorded simultaneously across the city or globe, obtaining an accuracy of film production down to the frame. We follow the same philosophy, but instead of setting the time code generators, the GPS information is recorded directly in the video tape. This method allows us to record other GPS information additional to the time and date, such as the position and velocity of the GPS receiver, and consequently, of the vehicle where the cameras and the GPS receiver are mounted.

Previous to show the images onto a screen using a projector to a person whose behavior is going to be evaluated, a movie's creation is needed in order to be able to show in a screen synchronized images as they happened in the real scenario.

The GPS data information was recorded in the VTR's audio channel, so it's possible to recover the images and its corresponding position, time and speed. Making this procedure with the three videos recorded in the ego-vehicle will allow us to merge in an "avi" movie the three video sources synchronously.

There are many tools that support multimedia applications. We have chosen the "avi" format between the multimedia file formats available in the market. The "avi" is a file format for digital video and audio. In this file format, blocks of audio data are woven into a stream of video frames. We are using the Active Movie architecture. The Active Movie control handles all the video and audio rendering, simplifying our programming tasks. Different filters can be constructed and configured in accordance with the necessities of the application.

5 Evaluation of the Drivers Behaviour

There arise some difficulties in the process of the driver behaviour evaluation. The preparation of real traffic scenarios to repeat real traffic situations involves risk. Another problem is how to qualify the behaviour of the driver. A good alternative is to show the driver the real images recorded during one prearranged traffic situation and let the driver decide what he/she would done. This approach brings the advantage that the real traffic situation is produced just one time. Up till now we have chosen six driver categories: the driver can be qualified as attentive (or watchful), inattentive, daring (or bold), careful, undecided and normal. One key question is the previous design of the lane change situations to be done. They should involve actions or some characteristics that permit qualify the driver behaviour as described above. Examples of this are lane change situations with changes in the lane markings, scenes with traffic signals, distances between the vehicles that could introduce some doubt in the action to take, etc.

The driver introduces input data to the system from an accelerator pedal, a brake pedal, a steering wheel and indicator lights simulating the frontal part of a vehicle. A PC system captures this data ,which are used to evaluate the driver behaviour.

The system has to be experimented with a numerous set of drivers.

As we know beforehand the dynamics of each experiment we are able to establish the border times and zones for the different kinds of driver reactions.

Although the drivers are seeing real scenes, they are not driving in the real world. Therefore we think that the driver evaluation should be mode in a comparative way, that is, comparing the responses given by each driver with the modes of reaction of the group of drivers.

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