An experiment to improve the safety and the flow of traffic in a cross-roads by V2V communications

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Abstract. Decision algorithms used to do driverless car control are used in a cross-road simulated experiment. Also two real tests are shown.

Keywords: ITS, driverless car**,** safe intersection, communications

1 Introduction

A cross-roads is a place where the car driving has to be extremely careful, as well as if the cars are manually driven or they are automatically driven. Several experiments have been done in different projects [1]. Our research group have been involved in two of them [2][3]. Here a basic experiment which has permitted us to tune up all the necessary techniques is described. These experiments allow us to study the findings and performance by simulations and to verify the results with several cars in the IAI-CSIC facilities.

2 Geometric route description.

In order to guide a car automatically, the reference trajectory to be followed has to be known a priori. To simulate the control of the car before to experiment with real cars, it is convenient to use analytical curves like reference trajectories, which allows obtaining their tangents and normals in any point and using them to carry out the control. Two examples of interesting curves to study a cross-road are the following:

- Bernouilli's lemniscata $y =$ (**1**)
- Rose of three petals $y = +$ (**2**)

3 Funcional route and car description

In a convenient abstraction, a cross-road can be reduced to an intersection of two straights segments. In our simulations we have considered one way roads. In spite of simplicity this model has all the necessary elements to study the control functionality; the shape of the loop has not relevance.

A state vector containing the car position, speed and the segment along it is moving is assigned to each car. The car controller sends its state to the other cars if it is going to move toward the cross. Also it verifies if there is another car in the cross area and it receives the sate vectors from other cars in the area. The fastest car communicates to the other cars into the cross area that it takes the pass priority and goes on by its route with the current speed [4], the slowest car brakes until stopping if it is necessary (in fact the longitudinal car controllers are STOP & GO ones) to allow the pass of the fastest car and recovers the previous speed when the cross becomes free. The apparition of a pedestrian during the maneuver can change the pass priority.

With this strategy it has been designed a fuzzy controller to guide cars in a cross-road and has been simulated a route along a trajectory in the Verdun Square of La Rochelle, France. (Figure 2)

4 Places and test tracks

The following figures show the places where the experiments have been made. The experiments have been made using different cars with different equipment belonging to our partners of TNO (NL), INRIA (FR) and IAI-CSIC (ES)

Fig. 1. The cross-road and the followed loop in ZOCO, Arganda del Rey, Spain
Fig. 2. The Verdun Square and the followed loop in La Rochelle, Francia.

5 Conclusions

The simulation results show that the speed based strategy improves the traffic flow. The experiments carried out in ZOCO and in La Rochelle with real vehicles moving along a loop with a cross road show that a real implementation of a cross road controller is possible. These experiments show that the flow capacity of the cross road using a conventional priority strategy (the car on the right has priority) is lower than the one obtained by simulation.

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References

1. Journal of Field Robotics, August and September 2008, special DARPA Urban Challenge
2. CyberCars 2 Final Rapport (in preparation)
3. EUROCAST 20007, LINC 4739
4 ETSC: Vehicles get frequency to talk to each other. Safety Monitor 74, October 2008.