

REPOSIT simulator: Vehicle-to-Vehicle communications for road safety applications

(Demonstration)

Miguel Eduardo Gil Biraud
GMV
Valladolid, Spain
Email: miguel.gil.biraud@ieee.org

José Ignacio Herrero Zarzosa
GMV
Valladolid, Spain
Email: jherrero@gmv.com

Abstract—The abstract goes here.

I. INTRODUCTION

REPOSIT (RElative POSitioning for collision avoidance sysTems) is a EU funded project under the 6th Framework Programme which has produced a simulator that enables us to perform safety studies of road scenarios in which the vehicles are equipped with relative positioning units (RGNSS), vehicle-to-vehicle wireless communications and collision avoidance systems (CAS).

The GPS based relative positioning combined with the V2V communications, enable the vehicles in an area to be aware of the positions of its neighbours and their dynamic characteristics. If this information is fed into a CAS module, warnings can be issued to the driver in order to make her aware of potential collisions and let her decide the best way to deal with them.

In the demonstration a couple of specially relevant scenarios will be shown, along with the results that illustrate the benefits of such a system.

II. DESCRIPTION OF THE SIMULATOR

The simulator has been built in a modular way enabling a very flexible environment in which most of the real-life scenarios can be modeled. A short overview of each of the modules will be provided to illustrate this point:

- Road constructor: A broad range of 3D road structures can be created. Support is included for multi-lane roads, roundabouts, curves. Direction of each lane is independent so complex scenarios can be easily achieved.
- V2V communications: An statistical set of models have been implemented for the V2V communications module. The parameters that can be fine-tuned are the frequency of operation, the bandwidth of the channel, message length, transmission rate, degradation of the transmitter and receiver and obstacles between the vehicles (free space, trees and buildings).
- RGNSS: RINEX¹ files are generated in real-time and relative processing algorithms are applied when there is a

successful reception of data through the V2V communication channel. This enables any third-party software to be used for the analysis of the data.

- CAS: Predicts the dynamics of the vehicles based of the relative positioning information provided by the RGNSS module and produces warnings when potential collisions are foreseen if all vehicles maintain their dynamics.
- Presentation module: Charts are produced in simulation time to understand what is happening in the simulated world, and a 3D immersive experience is created to put the user inside one of the vehicles and have a feeling of how the system will work in the real world.

A GUI is provided with the simulator in order to ease the creation of new simulation scenarios in a guided step-by-step process. The first step is to define the vehicles that will be available in the simulated world. Several types of vehicles can be defined as a parallelogram in which all the dimensions can be configured, along with the position of the RGNSS antenna.

After defining the vehicles, it is needed to create the roads available for the cars to move in the simulated world. The creation of the road infrastructure is achieved through an intuitive graphical interface in which the user draws the roads and sets the number of lanes along with the direction associated to each lane.

Once the vehicles and the roads are available in the system, we can bind a vehicle to a lane in a road and define the initial parameters of the motion (initial position in the lane, speed and acceleration).

After this moment, the simulation can be run and the results can be monitored in the simulator. Log files are created in order to allow a further post-processing.

A screencast of the use of the simulator is available in the website of the project (<http://www.ist-reposit.org/results.php>)

III. SCENARIOS TO BE DEMONSTRATED

Two scenarios have been selected to be demonstrated due to the broad range of possibilities available in the simulator.

The first scenario to be demonstrated would be a crossroad in which two vehicles collide in the intersection as depicted in the figure 1.

Such an scenario is of special interest as many accidents happen in crossroads with reduced visibility. The main limiting

¹Receiver Independent Exchange format. A set of standard format ASCII files that enable the use of GPS/GNSS data with any software package.

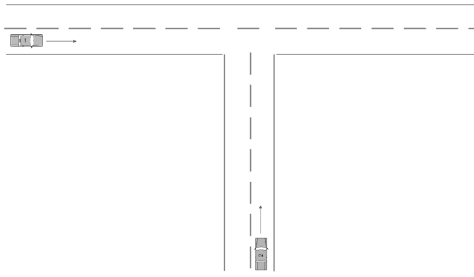


Fig. 1. Crossroad scenario

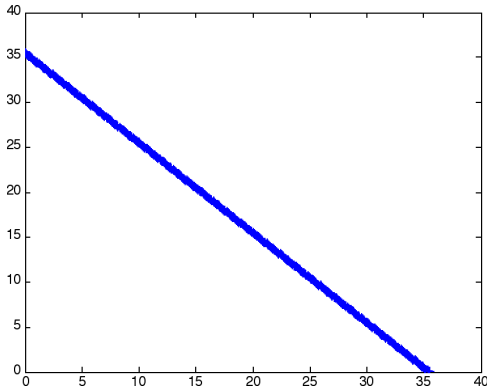


Fig. 2. Simulated time-to-collision in the crossroad and free-space scenario

factor of such an scenario are the V2V communications due to the fact that depending the nature of the obstacles laying in the line-of-sight between the vehicles. The differences between having free-space, a forest or a building will be shown, representing the behaviour in a country road, in a wooded area or in a city.

As an example of the available outputs for the collision warning, figure 2 represents the predicted time-to-collision in seconds versus the simulation time (in seconds) grows. With different obstacles this predicted time-to-collision can change is no V2V communication is possible, opening the door to scenarios in which if no V2V communication is possible until the very last moment, the system cannot warn the driver with enough time to react.

Another of the outputs that shows the good performance of the RGNSS solution for road safety applications is the difference between the calculated relative positions and the real relative positions. This error is represented in figure 3 for the crossroad scenario, showing that sub-meter accuracy can be achieved.

The second scenario that will be shown during the demonstration, represents an overtaking in a two-lane road as depicted in figure 4.

The description of the scenario goes as follows: "A car is driving in a two-lane road faster than a truck. When it gets very near of the back of the truck (3 m) it starts the overtaking and finds another car coming in front of him. When it has

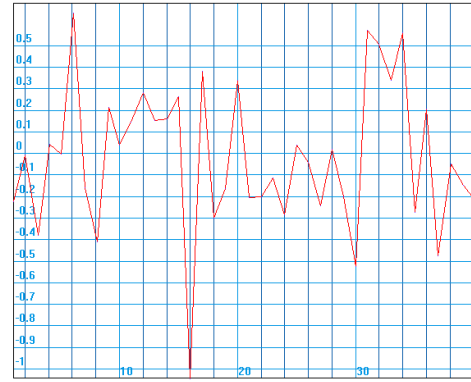


Fig. 3. Evolution of the relative error in the crossroad and free-space scenario



Fig. 4. Overtaking scenario

surpassed the truck, the car finishes the overtaking by returning to the right lane". It is specially interesting to analyse this scenario in order to verify if the V2V communications will work when the fast vehicle gets very close to the back of the truck and is able to receive information of the vehicle coming in the other lane.

Anyway, as this demonstration is an interactive event, if any attendant to the demonstration has an special interest in an scenario it can be run on the spot.

IV. CONTRIBUTION OF THE DEMONSTRATION TO WIVeC'07

By making the demonstration of this simulator, interested actors in the field of the vehicular technology will get to know a tool that can help them understand the behaviour of V2V communications in a simulated world, providing numerical data that can enable further research.

This simulator can be seen as a whole, or as a set of atomic modules that can be easily used in other projects to provide information on the behaviour of V2V communications, relative GPS positioning of vehicles and collisions prediction, which can be useful for any project dealing with road safety or studying processes happening in the roads.

V. REQUIREMENTS FOR THE DEMONSTRATION

In order to run the simulation a laptop will be used so a power outlet to power the computer is required. Additionally, an external display (eg. TFT screen) is advisable in order to be able to show the operation of the simulator and the results to a larger audience in a more comfortable screen as several people standing in front of a laptop screen is far from ideal.

A poster would be used to describe the architecture of the simulator and make clear the interdependencies of the modules, as well as the parameters that can be configured in each simulation.