Local and global evaluation of risk, impact of C-ITS

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Abstract

Nowadays, an increasing number of assistances is available to help the driver: they are growing toward automated functionalities. Given the sensing capacities, it now becomes possible to have a local view of the surrounding and, with existing communication capacities, this view can be shared. Standardization activities show even that future messages exchanges between vehicles and with the infrastructure will provide an in-depth knowledge of surrounding vehicles dynamic states and position. We propose to provide a broader and more accurate understanding of the traffic situation, at the vehicle level and infrastructure manager level using high level indicator as risk definition. At the vehicle level, it allows a faster evaluation of the surrounding, simplifying decision process. At the infrastructure level it enables a fine description of the road usage.

Background

Even with the introduction of engineering solutions, as driving assistance and dynamic control or better road surface, of better education policies and enforcement procedures as speed camera, the number of fatalities remains high. However, detailed car accident studies show that whatever the use case, the driven is often seen as being responsible. With the increasing development of driving assistances, we can access to an overall description of the vehicle close environment. Communication devices are also common, even using a third party devices, but the trend is going to the standardization. ETSI Group, in Europe, now provides a common references and vehicles can exchange basic information with CAM. A payload part allows more flexibility and, possibly, more information.

Methods

An Autonomous Vehicle must (i) understand the overall environment, (ii) predict the short term future behavior and inform their intention to the other road users and (iii) react to the environment to ensure safety (e.g. minimizing longitudinal and lateral acceleration, maintaining a safe inter distance with the front vehicle, obey to the driving rule…). For this last part, most of the approaches now define a two steps planning, regarding the overall risk and accurate definition of the trajectory. This specific description of risk has a large impact on the remains of the decision process. Moreover, the risk definition could also be used at the infrastructure level to describe the safety of a road segment.

The risk, related with an event includes two parts, namely, the gravity and the probability. In order to define the last one, we use a monte-carlo approach. However, these class of method are time consuming and require a large computation architecture. We describe an implementation on a GPU architecture, which, comparatively, achieved far better results than a traditional CPU based process.

Next, the risk evaluation relies on the description of the environment. We discuss about three different architectures, in term of data exchange that provides the data needed for the monte-carlo process, in term of sensing, from expert knowledge to full communication.

Results

We compare the results of our methodology on the risk evaluation and prediction of the environment evolution with respect to existing criteria that define the risk related with the road traffic description

(as Time to collision and Time Headway), with comparable results and under one evaluation process. The risk evaluation gives significant results (see Figure 1) on three different scenarios in order to define the vehicle speed in a decision process. The GPU based architecture is also compared in term of performance with a CPU based approach in order to assess the feasibility in real time and embedded in existing solution. Based on a NVIDIA Quadro M4000 and depending on the number of particles in the Monte Carlo process, the algorithm performs 30 times faster than the CPU version (Intel® Core™ i7-6700HQ).

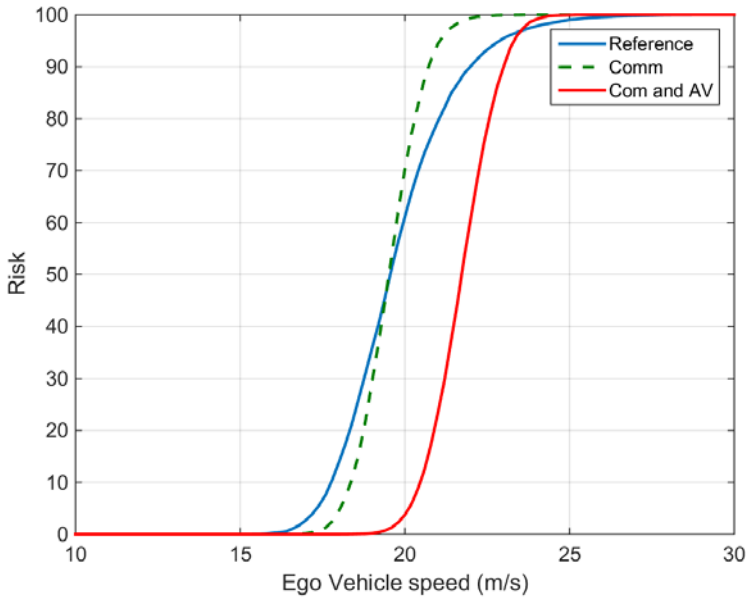

Figure 1 Risk related with a leading vehicle under three scenarios : Human driven vehicle as a reference, CITS enabled vehicle and AV

Conclusion

In this article, we develop a risk evaluation to describe the surrounding of the vehicle, first from a local point of view, it is extended with the use of communication devices to a global risk evaluation. The feasibility of the approach is assessed regarding the performance of existing architecture available in the vehicle. We show the impact on low level and high level description of the traffic safety and the adequation with existing description.