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Building a real time augmented map for road risk assessment

BACKGROUND

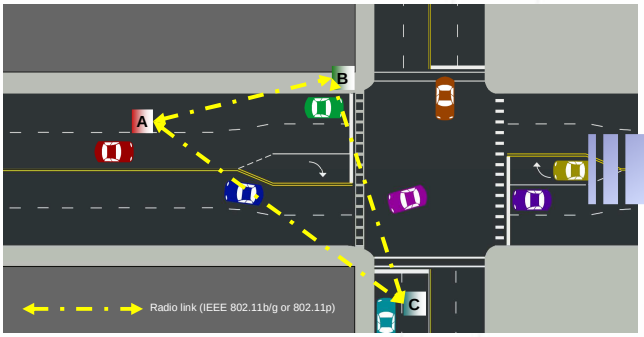
A vehicle equipped with sensors such as radars, cameras, laserscanners, etc. can build a **local map** to represent its surroundings. This map can be used by varied ADAS* and PADAS* to perform convenience or safety tasks. However the local map presents several limitations :

- ***Limited range and field of view.***
- ***Risks of failure or malfunctions leading to erroneous data.***
- ***High cost of quality sensors => limited market penetration.***
- ***Ergonomics and interface issues with the driver.***

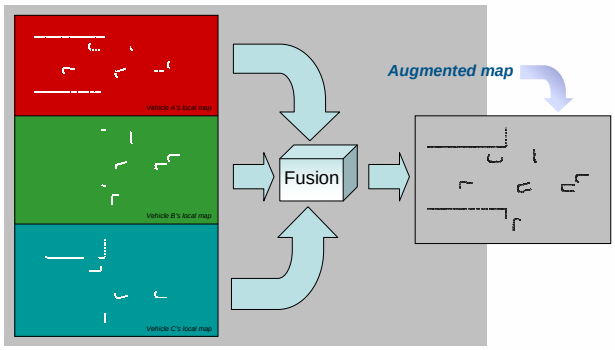
Cooperative Vehicle-Infrastructure Systems (CVIS) can compensate for these limitations by exchanging information to :

- ***Extend the perception range and field of view [WD07].***
- ***Improve accuracy and reliability.***
- ***Allow simple sensors to attain performance similar to expensive ones [ANL06,DNCH08].***

- **Augmented map concept:**
  - An **augmented map** provides information to an *agent* (the vehicle) so it can take the *best possible decision* in order to carry out a manoeuvre or an action that will *minimise the current risk*.
  - The augmented map is built by merging local maps.
  - Locals maps and any additional information can be exchanged between vehicles (**V2V***) and infrastructure (**V2I***). Possible communication media are : *radiofrequencies (WiFi, UMTS, etc.), infrared systems*.
  - Exchanging data allows to extend the perception range and confirm/correct perceived objects.
  - Augmented perception can apply to vehicles having no perceptive capabilities (*blind vehicles*).
  - Augmented perception must work despite a heterogeneous fleet.
  - Previous studies have already shown that a simple V2V system can significantly reduce risk (*20% improvement*) for a limited 5% market penetration [Mou06].



Example of an intersection scenery with V2V* communication and LIDAR* sensors



Fusion of broadcasted local maps

AIM & RESEARCH APPROACH

This research aims at providing more precise, reliable and robust augmented maps for safety applications

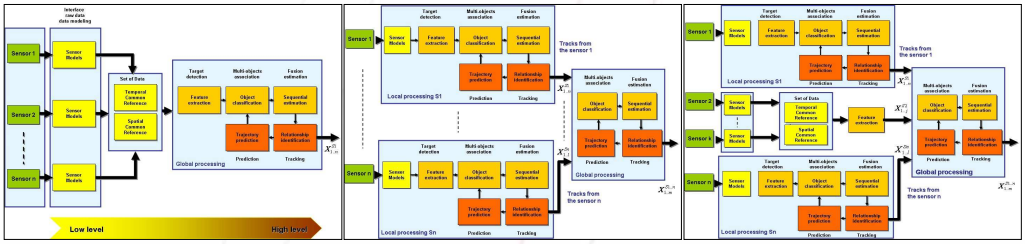
Research approach:

Optimising data fusion

- Numerous methods and architectures for data fusion already exist. Our aim will be to assess which one, or which combination, is the most efficient for the specific problem of augmented maps creation, especially in a *on-vehicle real time context*. LIVIC already has experience on that subject and our research will benefit from it.

Introducing the concept of *auto-diagnostic*

- Auto-diagnostic is a novel concept for data fusion and sensor management. It aims at assessing, through the appropriate physical or software method, the confidence in a sensor's output. Whether a sensor would be found to be deficient, it could be shunt off the fusion framework in order to reduce the "damage" it causes to the reliability of information on the map. Also if the sensor is not deficient but its output has too much incertitude or latencies, the sensor's contribution to the fusion framework could be weighted down, reducing the imprecision introduced into the fusion process and leading to more accurate results.



Three existing **data fusion architectures**, (1) centralised (2) decentralised & (3) hybrid. Our research will assess these types of global architectures but also more detailed processing such as target detection, association or prediction.

SiVIC (***Si**mulateur **V**éhicule **I**nfrastructure **C**onducteur*, Vehicle-Infrastructure-Sensor Simulator) is the sensors simulator that we propose to use for development and testing of fusion frameworks and other software. It is developed by the LIVIC and increasingly used by transports researchers in France (graphical rendering for machine vision & driving simulation depicted).

ACRONYMS

ADAS : Advanced Driver Assistance Systems.
CARRS-Q : Centre for Accident Research and Road Safety, Queensland. Brisbane, Australia.
LIDAR : Light Detection and Ranging, other name for a laserscanner.
LIVIC : *Laboratoire sur les Interactions Véhicule-Infrastructure-Conducteur* (Vehicle-Infrastructure-Driver Interactions Laboratory). Versailles, France.
PADAS : Partially Autonomous Driver Assistance Systems.
UVSQ : University of Versailles Saint-Quentin-en-Yvelines. Versailles, France.
V2I : Vehicle to Infrastructure.
V2V : Vehicle to Vehicle.

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