Vehicles as Sensors for Cooperative Systems

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Cooperative SAFESPOT Networks

Decentralised Approach:
• The nodes distribute information which enable them to *individually* recognize and warn about safety critical events
• The nodes are multiple actors in parallel use cases

- environmental perception
- wireless short range communication
- vehicle dynamics control
- wired or wireless infrastructure network
- vehicle equipped with SAFESPOT platform
- non-equipped vehicle

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Centralised Node Architecture

- Client-server architecture in each node
- Single interface for platform users / clients: Local Dynamic Map (LDM) database server
- All node input flows through data fusion to LDM
- LDM content includes platform state and environment model
- A node’s involvement in parallel use cases with unknown current actor roles necessitates common message generation rules for all nodes (vehicle and infrastructure)
Moving Platform’s State

- **In-vehicle data sources** for platform state
  - Vehicle dynamics systems
  - Body management
  - Occupant safety systems
  - Navigation systems
- **External sensors**: camera, laser scanner, radar etc.
- **Communication**: Safespot messages (+ external applications)
- Vehicle positioning will be improved wrt GPS alone by new technologies (SP3)
- LDM database will store and provide (filtered and fused) state data to clients
Multi-layered Environment Representations

- Raising of level in general by finding relations (wrt space, time, attributes)
- Scope usually increases with level, whereas resolution decreases
- Sensor systems, sources often provide data on different levels
- Data fusion levels grouped in
  - Object Refinement
  - Situation Refinement

Elementary situations: object groups and relations wrt time, space, attribute

Object tracks: groups in state space and wrt time, i.e. across frames

Geom. primitives: groups wrt space in single frame

3D reflection pts pixels

Sensor preprocessing, screening, data synchronisation, classification,…

radar, laserscanner, vision, ego state, navigation, map, VANET (other vehicles and infrastructure)
Data Fusion

- Reconstruct the traffic scenario around the vehicle thanks to the data collected from several sources of information (on-board sensors and communication)

- **Object Refinement:**
  - spatial properties: position, orientation, velocity
  - attributes: identification, classification.

- **Situation Refinement:** relationships between objects, e.g. lane association

- Affects and is affected by LDM object modelling and application interface

- Results are stored in LDM
Local Dynamic Map

- LDM is more than just a storage device
- Unique representation of environment – not a copy of other LDMs
- Moving “horizon” of static information, e.g. road network, landmarks
- Dynamic contents governed by Data Fusion process
- Does not only provide data, but access functions for data projection, selection, filtering, join, grouping, sorting, etc.
- Event-triggered notification can provide extra functionality
Hardware Architecture

- **Positioning PC**: For real-time positioning systems.
- **Applications PC**: For application-specific tasks.
- **VANET PC**: For vehicle ad hoc network communications.
- **GPS & NAV**: For navigation and positioning.
- **Main PC (DF, LDM)**: Central processing unit.
- **Ethernet Switch**: For network connectivity.
- **OEM Gateway**: For vehicle powertrain and body networks (e.g., CAN).
- **Powertrain/body networks (e.g., CAN)**: For vehicle powertrain data.
- **ENP network (e.g., private CAN)**: For extended network protocol (private CAN).
- **Ethernet 10/100BASE-T**: Network interface.

* may be incorporated into Main PC based on algorithmic complexity or in PTW.
Summary

- **SAFESPOT’s cooperative ad-hoc networks will be decentralized**
  - nodes *individually* recognise and warn
  - nodes are multiple actors in parallel use cases

- **Platform architecture will be centralized**
  - database server: local dynamic map (LDM)
  - clients: node’s individual applications & common message generation

- **Applications’ situation recognition emerges by finding relations between objects in the LDM**
  - platforms support this by serving queries and subscriptions to notifications

- **Platform will not just be a mobile sensor but a mobile server of multi-level environmental information**