interactIVe IP: Perception platform and modules

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Agenda

1. Introduction
   1.1. interactIVe project
   1.2. Environment perception in interactIVe

2. Perception Platform
   2.1. System architecture
   2.2. Perception Horizon
   2.3. Perception Modules (+ short duration demos)

3. Conclusions & future work
interactlVe project

- Development & evaluation of next generation safety systems providing continuous support and utilizing active intervention

Current systems:
- independent functions
- multiple expensive sensors
- unnecessary redundancy

interactlVe:
- vehicle components shared among various safety systems
- integrating applications upon a common perception framework
- discrete architectural layers common to all applications

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Environment perception in interactlVe

• Fusion of information from heterogeneous sources to provide a holistic environment perception
  • Perception sensors: radars, cameras, laserscanners etc.
  • Digital maps
  • Wireless communication (V2X)

• Design of a common perception framework for multiple safety applications

• Advanced research on enhancing the electronic safety zone surrounding vehicles:
  - Sensor refinement
  - Object refinement
  - Situation refinement

➢ Active intervention poses “hard” real-time requirements for data processing & fusion modules
Perception Platform - the concept

- Reference implementation

- Common *interface structure* for every sensor type or information source

- Different sensor types and products attached based on the *plug-in concept*

- Development of a variety of *perception modules*, e.g.
  - object perception & classification
  - lane detection & road geometry extraction

- Unified Output: *Perception Horizon*
Perception Platform - architecture overview

Input Manager

- ADASIS v2 Horizon Provider
- Enhanced Vehicle Positioning

Road Data Fusion
- Vehicle State Filter
- Frontal Object Perception
- Side/Rear Object Perception
- Lane Recognition
- Frontal Near Range Perception
- Recognition Unavoidable Crash
- VRUs Detection
- Free Space Detection
- Moving Object Classification
- Vehicle Trajectory Calculation
- Assignment of Objects-Lanes
- Road Edge Detection
- EVRP-ToRoad

EVRP: Ego Vehicle Relative Position
VRU: Vulnerable Road User
V2X: Vehicle to Vehicle or Vehicle to Infrastructure

Perception Horizon

CAN line (to application PC)

Digital Map
GPS
Odometer Gyroscope
Vehicle sensors
Camera
Lidar
Radar
Ultrasonic
V2X Nodes
Temperature/Rain sensor
Functional architecture
Perception Horizon

- Output interface of the perception platform
- Union of the following three elements:
  - **Synchronized subset** of the perception modules outputs
  - **Configuration files** for each demonstrator vehicle (available sensors, mounting position etc.)
  - **Output manager functionality** (software module translating Perception Horizon data to the communication line between perception platform and applications + diagnostics + logging)

✔ Modular handling - avoiding duplicate structures
✔ Minimization of low - level passing through information
Perception Modules (1 - the road around)
Perception Modules (2 - the objects around)

- Lidar
- V2X Nodes
- Radar
- Camera

Vehicle State Filter (VSF)

Assignment of Objects-Lanes (AOL)
Moving Object Classification (MOC)

Frontal Object Perception (FOP)

Side/Rear Object Perception (SRP)

Assignment of Objects-Lanes (AOL)

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Perception Modules (2 - the objects around)

- 1st video: LRR radar/camera object fusion approach

(highway scenario)
Perception Modules (2 - the objects around)

- 2nd video: Radar/Lidar/Vision fusion approach inc. object classification

(highway scenario)
Perception Modules (3 - the ego + the objects in the road)
Process/Fusion algorithms (maps, radar, lidar, camera):

- Multi-sensor tracking in sensor networks
- Maintenance of Track ID at rear-side-frontal
- Instantaneous fusion using Evidential occupancy grids (Degrees of belief for detection, tracking and classification)
- Efficient object classifier for pedestrian, cars and trucks
- Robust Road Boundary Detection + Adv. Lane Tracking
- Frontal Near Range Perception for collision avoidance
Lessons learned and future work

- Need for hard real-time & multitasking environment for the implementation of the platform
- Reduce complexity, increase scalability and interoperability, allow multiple implementations
- Need for common agreed (standardized?) input/output structures
- Need for massive ground truth data covering all scenarios
- Dynamic maps with advanced attributes & enhanced accurate positioning

- Towards implementation in (distributed) embedded systems
- Plug & play concepts
- Early fusion or object level fusion?
- Global trackers & advanced world (environment & traffic) models
- New low cost high performance sensors & actuators
- Fault-tolerant perception architectures
- Need for verification-certification methods for perception
Thank you.

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