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The Evolution of Onboard Vehicle Safety Communications and Driver Assistance Systems

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Introduction

As we move further into the 21st century, we look expectantly ahead to a new generation of vehicles in which advanced sensors and communications abilities will drastically improve vehicle safety and reliability

Evolution of Driver Assistance Systems

- Development of advanced sensor technologies have driven the evolution of driver assistance systems

➔ More sensors with greater capabilities paint a better picture of the driving environment to enable

- Anti-lock braking systems (ABS), adaptive cruise control (ACC), electronic stability programs (ESP), lane following, night vision, collision warning, etc.

➔ Continuing development of advanced sensors will play a crucial role for future generations of driver assistance systems

Evolution of Driver Assistance Systems (2/2)

- Wireless vehicle communications will be a significant part of future efforts to improve vehicle safety and driver assistance systems

  ➔ Enables the collection of data from a large number of vehicles’ sensors

  ➔ Can provide a near-real-time picture of the driving environment to help driver assistance systems perform better

Industry-Government Cooperation

- Government and industry are working to advance wireless-enabled safety communications

- U.S. Department of Transportation's (U.S. DOT) Vehicle Infrastructure Integration (VII) program

  ➔ Aims to establish 2-way data conversation between land-based systems and vehicles

  ➔ Public-private cooperation to develop and deploy a cost-effective national intelligent transportation system

Industry-Government Cooperation (2/3)

- European Commission's Cooperative Vehicle Infrastructure Systems (CVIS) and SafeSpot projects
  - ➔ Automotive industry plans to use this technology to increase safety and efficiency of road travel
  - ➔ Will also lead to development of new commercial vehicle-oriented information services
- Car-2-Car Consortium
  - ➔ Initiative of European vehicle manufacturers
  - ➔ Working to establish a European standard for vehicle-to-vehicle communications

Industry-Government Cooperation (3/3)

- Japanese Advanced Cruise-Assist Highway System Research Association (AHSRA) project
  - ➔ Has pioneered the exploration of vehicle-infrastructure communications
  - ➔ Japanese government now pursuing initial rollout of DSRC communications for vehicle safety warnings

Driver Assistance Systems

- Current driver assistance systems are contained in the vehicle
  - → Wireless data from outside the vehicle is not yet available
- Driver assistance systems continue to evolve
  - → E.g., adaptive cruise control to collision warning to collision mitigation
- Path of evolution
  - → Detecting potentially hazardous conditions
  - → Warning the vehicle operator of adverse conditions
  - → Taking partial control of vehicle functions when necessary

Driver Assistance Systems – Vehicle Sensors

- As vehicle sensor technology evolves, so will vehicle-contained driver assistance systems
  - ➔ New sensor technology allows vehicles to better interpret their immediate surroundings
    - E.g., blind spot detection, video detection and image processing systems, closing velocity sensors, etc.

- In the future, wireless communications will gather sensor readings from multiple sources, validate and aggregate them, and deliver them to vehicle safety systems
  - ➔ Within 10 years in developed countries
  - ➔ Will be more difficult and will happen later in less developed countries

Vehicle Communications

- Vehicle communications has historically been a one-way conversation

  ➔ “What can we say TO the vehicle?”
  ➔ E.g., European Radio Data System

Vehicle Communications

- Opportunities for a two-way conversation are beginning to expand

  ➔ Dedicated short-range communications (DSRC) is being used for electronic toll collection worldwide

  ➔ U.S. Federal Communications Commission (FCC) allocated 75 MHz of bandwidth in the 5.9 GHz band for DSRC to advance safety
  - This type of DSRC is called WAVE (Wireless Access for the Vehicular Environment)
  - WAVE is the focus of the U.S. DOT's VII program

Vehicle Communications Technologies

- No single communications technology is suitable for all vehicle communications at all times and all places

- WAVE
  - ➔ Very low latency and high data rate available in footprints of about 300 meters around roadside or overhead beacons
  - ➔ Works for road pricing
  - ➔ Rural coverage likely only on motorways

- Cellular technology
  - ➔ High level of coverage for urban areas and highways
  - ➔ High cost to transmit data
  - ➔ Coverage of some rural areas is spotty

Vehicle Communications Technologies (2/3)

- Mobile wireless broadband

→ Technologies like mobile WiMAX (standardized as IEEE 802.16e) are in the early stages of widespread testing
→ Economics favor deployment in urban areas
→ Multi-antenna signal processing (MAS) technology can help economics

Vehicle Communications Technologies (2/3)

- Vehicle connectivity in rural areas
  - ➔The U.S. FCC has set aside spectrum in the 700 MHz band for use for public safety
  - ➔May be possible to use this band for vehicle safety communications in rural areas
    - Public safety demands will be relatively low in rural areas
  - ➔Japan has allocated 10 MHz in 700 for ITS

Vehicle Communications Technologies (3/3)

- To ensure connectivity for safety, vehicles will need to be able to use multiple communications technologies
- Development of standards to facilitate vehicle use of multiple communications technologies is being done by the international standards committee on ITS (ISO/TC204) Wide Area Communications Working Group (WG16)
  - ➔ Currently developing CALM (Communications Access for Land Mobiles)
    - Transparent in-vehicle use of a variety of communications technologies
    - Includes 2.5G and 3G cellular, satellite, infrared, millimetre wave (63 GHz), DSRC/WAVE at 5.x GHz, and wireless mobile broadband

Probe Processing (Floating Car Data)

- The process of gathering and merging the sensor readings from many vehicles in combination with information from other sources to produce a clear understanding of the overall driving environment
- Probe data enhances the operation of advanced driver assistance systems by advising vehicles in an area of adverse conditions such as obstacles, crashes, or hazardous pavement conditions
- Probe processing is the most promising mechanism for building the super-accurate road map databases needed to support some in-vehicle intervention applications

The Centralized Data Utility

- Communications systems for vehicle safety will continuously appear
  - ➔ Vehicles on the road will have widely differing levels of communications sophistication
- It is going to be difficult for the land-based systems to keep up with the safety communications variations and innovations that will arise every year in new vehicles
  - ➔ Could constrain all future vehicle communications to the relatively low level of sophistication that will be originally present
- A promising approach is to create a centralized data utility, potentially on behalf of the vehicle manufacturers collectively

The Centralized Data Utility (2/2)

- Such a utility would be able to
  - ➔ Accept any data message that any vehicle is capable of sending
  - ➔ Send data to its intended recipient in the form that it wants and is capable of receiving and understanding
  - ➔ This would be true both for land-based operations like crash messages and for messages directed to vehicles

- This approach allows vehicle manufacturers to continue to expand the sophistication of their vehicles' communications capabilities and relieves land-based systems from individually having to keep up with all of the changes

Conclusions

- Safety must figure prominently in decisions about the direction that intelligent transport will take

- To achieve universal connectivity, industry and government must continue to work closely together for the benefit of all involved