APROSYS FINAL EVENT

Integrated Project on Advanced Protection Systems

Intelligent Safety Systems

Advanced side impact system for crash mitigation

Side Pre-Crash Sensing System

FUNCTIONALITY

- Detect & track objects impacting the side of the car
- Determine size and shape of impacting objects (Classification)
- Determine collision risk and decide about a collision latest 200 ms before impact
- Survey an area of 20 m range and the side/ front of the car (Figure 1)

This is achieved by a fusion system consisting of

- a radar sensor network (two sensors)
- a stereo video rig

EXPLOITATION

The side pre-crash sensing system consists of several exploitables, which can also be taken individually or in other configurations:

- The radar sensor network
- The stereo video rig
- The fusion system
- The decision module

SOCIO-ECONOMIC IMPACT

Using pre-crash sensing information, the conventional passive safety devices can be significantly enhanced. Knowing what is impacting when and where offers a potential to protect the car occupant much more effectively. After frontal pre-crash sensing systems have an increasing market share, side pre-crash sensing systems will be offered in the near future.

TECHNICAL DESCRIPTION

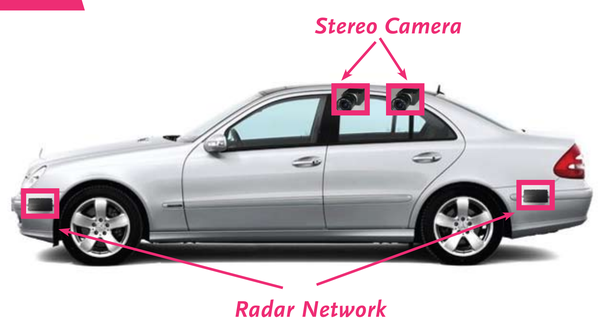

Figure 1: Mounting positions of sensors in the experimental sensor vehicle

The radar sensor network

The Continental short range radar was adapted for the specific needs of the side looking application. Features:

- Centre frequency ~24 GHz
- Signal bandwidth 1000 MHz
- Measues simultaneously:
  - Distance (accuracy 0.1 m)
  - Angle (accuracy ~2°)
  - Relative speed (accuracy 1 m/s)
- For smooth integration

under front and rear bumper, antenna adapted to look into front/side direction (cf. Figure 2)

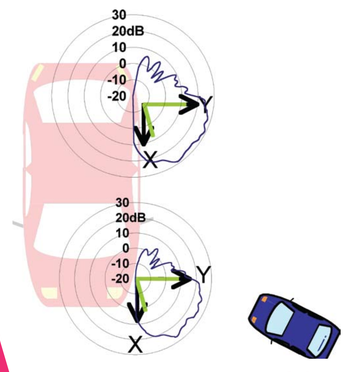

Figure 2: Beam patterns of the adapted radar sensor prototype

The stereo video rig

The Fraunhofer stereo rig was built to cope with the specific needs of the side pre-crash application. The individual cameras have a non-standard orientation with respect to the rig base. The frame rate is 15 frames per second or better. Figure 3 shows a video input image. From stereo depth measures, 3d-points are computed and clustered to form object hypotheses. For these, object position, relative speed and time to collisions are determined.

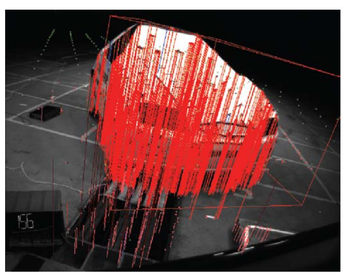

Figure 3: One of the two stereo video input images with depth measures and their projection to the ground plane.

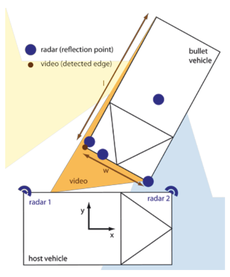

Figure 4: Schematic view of radar and video information to be fused

The fusion system

The fusion system enables spatial alignment and synchronised data acquisition of the radar and the video subsystem. This is crucial for the demanding side pre-crash application. The fusion system can associate matching video and radar objects and provide them to the decision module in a consistent format (cf. Figure 4).

The decision module

The decision module performs a risk assessment: it extrapolates all detected objects in time and calculates eventually the time to collision (TTC). It determines if it is physically possible to escape the collision by braking or steering and calculates accordingly a collision probability. If TTC and collision probability cross certain thresholds, the decision that a collision will happen is taken and communicated to an actuator system.

Conclusions

- Environmental sensors combined with fast actuators offer new protection strategies (adaptivity).
- Although side impact detection with vehicle mounted sensors is inherently more difficult than e.g. frontal impact detection, side pre-crash is feasible.
- Pre-crash systems taking action latest 200 ms before a crash are feasible. Already at this time it is possible to determine that a collision cannot be avoided.
- Fusion of stereo video and radar provides good results (detection efficiency for true alarms combined false alarm discrimination).

Future work

Continental offers the developed near distance pre-crash radar sensors to car manufacturers and uses the gained knowledge in other pre-crash applications. Fraunhofer-IITB institute offers the stereo video system and uses the knowledge in engineering consulting activities.

SIXTH FRAMEWORK PROGRAMME

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