Advanced Driver Assistance: Modular Image Sensor Concept

Supplying value.
Integrated Passive and Active Safety Systems

**Scope**
- Reduction of accident probability
- Get ready for the accident
- Mitigation of accident impact for passengers

**System**
- Active Safety: ADAS: Blind Spot, LDW, LCA, Night View, ACC...
- Vehicle Dynamics: ABS, ASC, VSC, BA, ...
- Pre-Crash system
- Restraint system
- Post-Crash system: GSM, Telemetrics, Rescue, ...

**Situation**
- Normal Driving
- Critical Condition
- Pre-Crash
- In-Crash
- Post-Crash

**预备事故**
- Accident avoidance
- Accident happens
ADAS Technology Trends

- Sensor Technology
  - CMOS Camera
  - 24/7 GHz Radar
  - 3D Camera

- Computing Hardware

- Algorithms

- Architecture

- Detection and Classification Performance

- Calculation Speed

- HW Platforms

- Client/Server SW Product Communication
ADAS Overview

Sensing Technologies:
Camera, Radar, Lidar, US Navigation Data

Collision
- Collision Warning
- Advanced Parking Aid
- Electronic Mirror
- Night View
- Traffic Sign Assistant
- Pre-Crash
- Lane Keeping
- LDW (Lane Departure Warning)
- Driver Monitoring
- Driver Vigilance
- Occupant Monitoring
- Driver Status
- ACC + Vision/Stop & Go
- Electronic Drawbar
- Blind Spot
- Lane Change Assistant
- Collison Mitigation (Emergency Brake)
- Collision Warning
- Night View
- Pre-Crash
- Advanced Parking Aid
- Electronic Mirror
- Traffic Sign Assistant
- Collision Warning
- Pre-Crash
- Advanced Parking Aid
- Electronic Mirror
- Night View
- Traffic Sign Assistant
ADAS Camera Applications

- Lane Change Assistance
- Driver Monitoring
- Driver Vigilance
- Lane-Assistance
- Night-View
- Object-Detection
- Rear Camera
- Lane Change Assistance
- Occupant Monitoring
- Front Camera
**Key Components for Advanced Driver Assistant Systems**

### Radar
- **77 GHz for far range**
- **24 GHz for near range**

**Advantages**
- Provides accurate range and velocity
- Resistant to dirt and rain, invisible mounting

**Applications**
- ACC, Pre Crash
- Near distance sensing

### Video
- **Monocular Vision**
- **Stereo Vision**

**Advantages**
- High angular resolution
- Emission free

**Applications**
- Occupant Monitoring
- Lane detection
- Object detection and classification

### SIT
- Based on Laser and CMOS technology

**Advantages**
- High range and angular resolution and accuracy

**Applications**
- Occupant Monitoring
- Object detection and classification
CMOS HDRC Camera

- CMOS technology is free of blooming and smearing
- High resolution (300,000 pixel) optimized for outdoor applications
- Synchronous shutter eliminates distortion on moving parts.
- High dynamic range (>120 dB) delivers excellent image quality in bright and dark areas
- High sensitivity allows night time operation
CMOS High Dynamic Range Camera (HDRC)

- Resolution, Pixel Size: 750x400, high fill-factor
- Shutter Type: global, high shutter efficiency
- Signal Response: up to 120dB, programmable Slopes
- Data Interface: 8 or 10 bit parallel
- Configuration Interface: UART
- Temperature Range: -40°C to +105°C (-40 F to 221 F)

Specials:
- low dark current
- fast readout
- High dynamic range,
- synchronous shutter,
- Configurable Region of Interest,
- Subsampling
- Bad/Hot Pixel Replacement
Modular Camera System Architecture for Advanced Driver Assistant Systems

Advantage: Reusability by flexible HW and SW modules:
- Synergies between multiple applications
- Fast development of new applications
- Cost reduction
Multi Function Approach

Algorithms for Detection and Interpretation of Driving Environment

Sensors
- Camera Front Sensor
- Radar Front Sensor

Processing / Algorithms
- Image Processing
- Lane detection
- Object detection
- Object tracking
- Object Classification

Possible Functions
- Night Vision
- ACC, ACC Stop & Go
- Trafic Sign Identification
- Collision Mitigation
- Lane departure warning
- Lane Keeping
- ACC, ACC Stop & Go
- Trafic Sign Identification
- Collision Mitigation
Application Examples:
Lane Departure Warning
Object Detection

Supplying value.
Advanced Driver Assistant Systems
Front Camera

Lane Departure Warning
Lane Keeping
Night Vision
ACC + Camera
What is "Lane Departure Warning" about?

- Lane departure is the single largest cause of automotive highway fatalities in the United States.
- "The main focus of LDW Systems is to help the driver keep the vehicle in the lane on highways and highway-like roads. Accordingly, a warning is issued to alert the driver in case of lane departure caused e.g. by inattention." *
- "LDWS are not intended to issue warnings with respect to collisions with other vehicles or control vehicle motions." *

*ISO Draft Standard ISO/TC204/WG14/N123.32 – Nov 01, 2002
LDWS: definitions
(according to NP17361 © ISO)

- **Time to line crossing (TTLC):** Calculated time to cross the lane boundary.
- **Warning Threshold:** The location on the road in which the warning shall be issued (depending on TTLC).
- **Latest/Earliest Warning Line:** The outermost/innermost limit of the warning threshold.
Sensor Data Fusion

- **Navigation System**
  (Coordinates, Street name, Country, ...)

- **Vehicle Dynamic Sensors**
  (Wheels Speed, Yaw Rate, Steering Angle, ...)

- **Camera**
  (Objects, Obstacles, Lanes, Traffic Signs, ...)

- **Radar**
  (Objects, Obstacles, Velocities, Distances, ...)

- **Object Classification**
  - Pole
  - Vehicle
  - Pedestrian
  - Wall

- **Object Properties**
  - Position
  - Velocity

- **Accident Forecast**
  - Probability
  - „Time to Collision“
  - Overlap Rate
  - Delta-Velocity at Contact

**Applications:**
Pre Crash, Pedestrian Detection, Collision Warning, Collision Mitigation
Summary

Modular Image Sensing System for ADAS:

- Flexible HDR CMOS Camera Modules with Optics
- Image Processing ECU with high Computing Power
- Modular Interfaces & Communication
- Modular Architecture and Layer model for ECU - SW Framework
- Coherent Development Rules, Quality Concept and Guidelines
- Cost Optimization on Core Technologies
- Flexible Response to changing requirements
- Short development times