Fachhochschule Köln
Cologne University of Applied Sciences

Environmental Sensing

Modul 5 Chapter 8

Lecture II

Prof. Dr.-Ing. U. Langer

D. Heß, Dipl.-Ing., M. Sc. Automotive Engineering

Cologne University of Applied Sciences, Germany

Content

Lecture II

1. Short summary
2. Visual sense
3. CCD sensor
4. CMOS sensor
5. Examples – Visual systems
6. Multi-purpose-camera (Daimler, E-Class)
7. RADAR systems – DISTRONIC PLUS and PRE-SAFE-brake

Short summary

- You might now be able to answer the following questions:
  (examples)

ü What is a Driver Assistance System?

ü What are the drivers tasks and which problems are occuring?

ü What are the main factors for accidents and how could an assistance system help?

ü General components of a DAS.

ü Which groups of DAS are existing?

ü What is the Doppler-effect?

ü For what stands the short term RADAR? Which advatages does RADAR have?

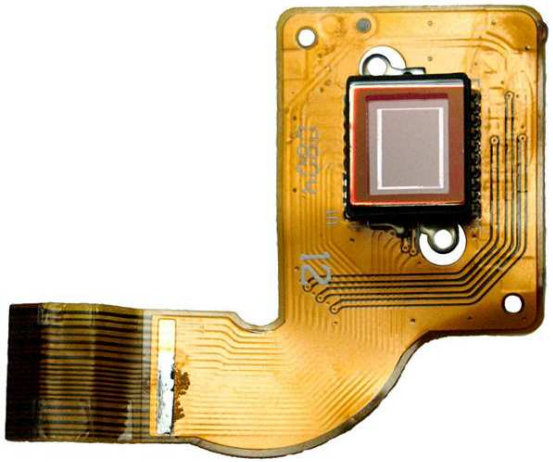
ü Is there a difference between RADAR and LIDAR reffering to the measures of objects?

ü Where could a ultrasonic system be used and which alternative(s) are posssible?

ü What‘s the main problem with FIR-systems?

Visual sense

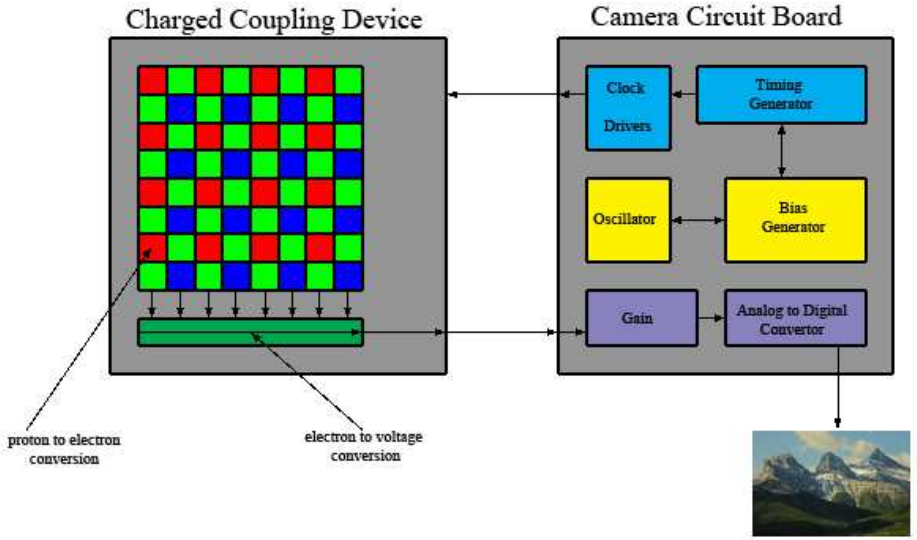
- A visual sense is so important that nearly all creatures have eyes
- But … „why can‘t cars see?“



- The visual detection of the environment can be compared to characteristics of the human eye
- Cameras have advantages where other sensors have disadvantages
- Two major sensors:
  - CCD (**Charged Coupled Devices**)
  - CMOS (**Complementary Metal Oxid Semiconducter**)

CCD sensor

- Analog system
- Aim: Convert light into electrons
- The electrons are colleced in charge pools
- Charge pool can not store endless electrons. Result: Overflow
- Number of created electrons equals the light on every pixel
- Major problem with CCD-sensors:
  „Blooming“



- Blooming: Overflowing of electrons to the pixels‘ neighbours

CMOS sensor

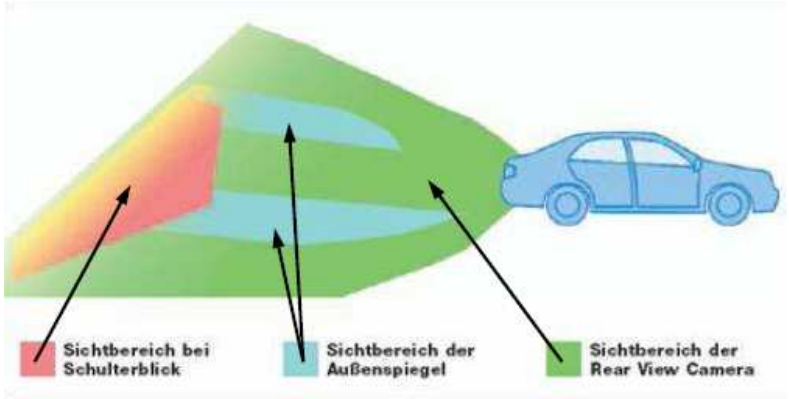
- Mostly based on APS
- Possible to integrate other components like analog-digital-converter
- APS stands for „active pixel sensor“:
  - Image sensor consisting of an integrated circuit containing an array of pixel sensors
  - Each pixel contains a photodetector and an active amplifier
- Problem: Transistors needed. Result: More space needed
- No “Blooming”
- “Windowing” possible: Every pixel has its own address. Some areas can be monitored more often (higher rate)
- CMOS sensors are interesting for automotive applications

CCD vs. CMOS

CCD vs. CMOS Sensors		
	CCD	**CMOS**
cost	expensive to produce because of special manufacturing methods employed	inexpensive because CMOS wafers are used for many different types of semiconductors
power	consumes upto 100x more power than CMOS	low power consumption
noise	high quality, low noise images	susceptible to noise
maturity	produced for longer period; higher quality images, more pixels	less mature but equal in low and middle range resolutions to CCD
extended functionality	technically feasible; other chips are used	other circuitry easily incorporated on same chip
fill factor	high	low

Examples – Visual systems

- **Parking assistance (Toyota)**
- Problem: The driver can not see everything that is/happens behind the car
- Idea: Ultrasonic sensing or a **camera**
- Necessary: Lines for the orientation
- Use a wide-angle objective



- Problem: picture needs to be deskewed
- Example of an image:

Examples – Visual systems

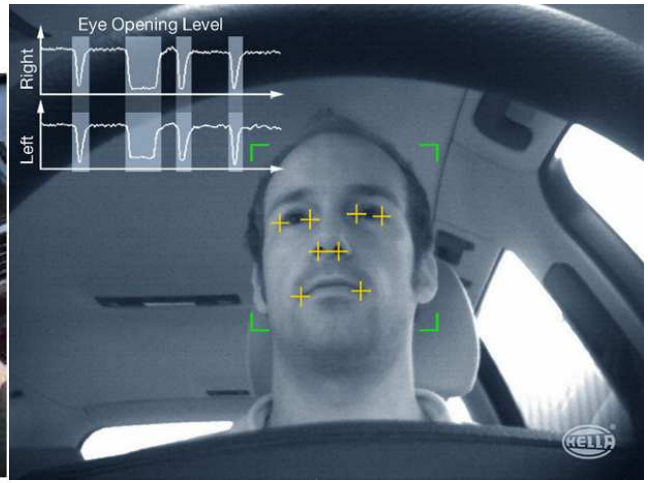
- **Passenger recognition**

- Today cars can contain more than 10 Airbags
- Problem: Airbags can hurt passengers instead of protecting them
- Reason: Passengers are not in correct position
- Solution: A camera-system at the roof observes the passengers
- Quality of data: A distance matrix

Examples – Visual systems

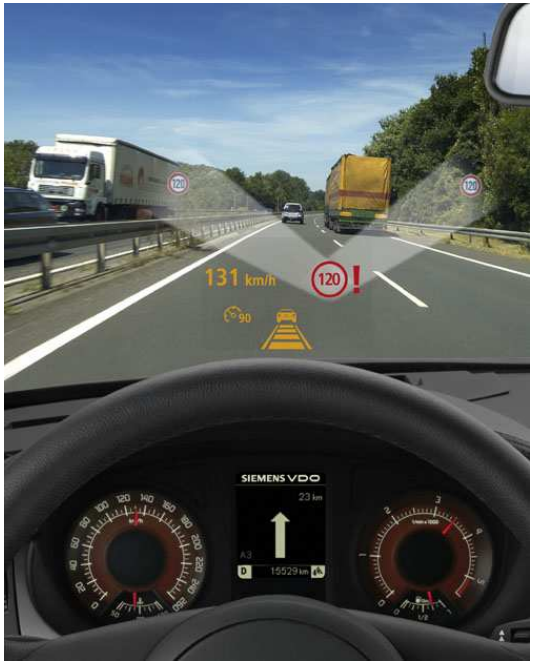
- **Driver attention system (BMW/Daimler)**

- Problem: Drivers are going on a ride without knowing that they are too sleepy -> a mircosleep occurs
- Solution: A camera observes the drivers‘ eyes
- Function: Sleepy drivers are blinking more often with their lid; The velocity of the lid is decreasing



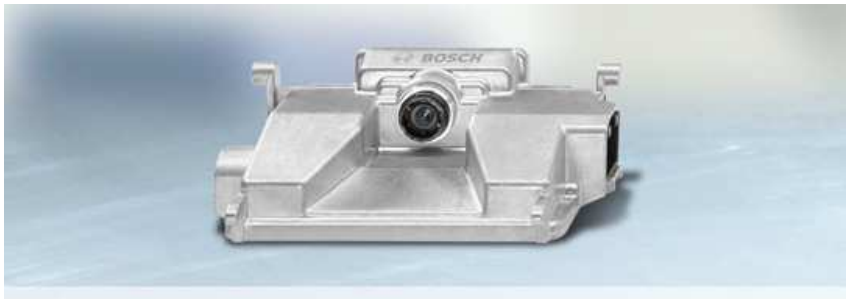
Examples – Visual systems

- **Traffic sign assistance (Opel)**
- Today drivers get sometimes an overflow of information under heavy conditions (weather, stress)
- In some situations the driver is not able so watch all traffic signs
- A camera system supports the driver while concentrating on the most important tasks



Examples – Visual systems

- **Multi-purpose-camera (Daimler/Bosch)**
- More assistance systems with just one sensor (camera)
- Perspective like the driver: Behind the windshield, near the inside mirror
- Brillant view: Always clean (wiper)
- 3 Fuctions:
  - Adaptive high beam assistance
  - Lane keeping assistance
  - Speed limit assistance (traffic signs)



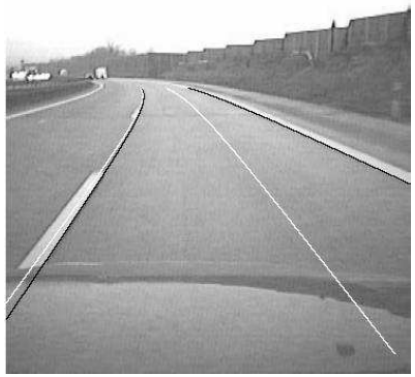
- One-Box-Design: Integrated processing unit in the camera, no video cord, direct generation of CAN-signals
- Steering of the shield heater to have a good view under humid conditions

Multi-purpose-camera (2)

- **Adaptive high beam assistance**
- „Better view and better be seen“
- Advancement of the „Intelligent-light-system“ (Daimler, 2005)

1. Optimizing the illumination
   - For every situation a single position of head lights
   - Idea: Picture processing of the appoaching and the next car (distance)
   - Range of the passing light: Up to 300m
   - In case of no other objects (cars, lorrys, …): Automatic high beam activation
2. Reduction of dazzle
   - Special light characteristics
   - Case right curve: Assymetic light allocation makes a dazzleing of approaching cars possible!
   - Solution: The system generates a symmetric light allocation in the right headlamp
   - Curve: High beam causes a self dazzle
   - Solution: Automatic switch off of high beam in curves

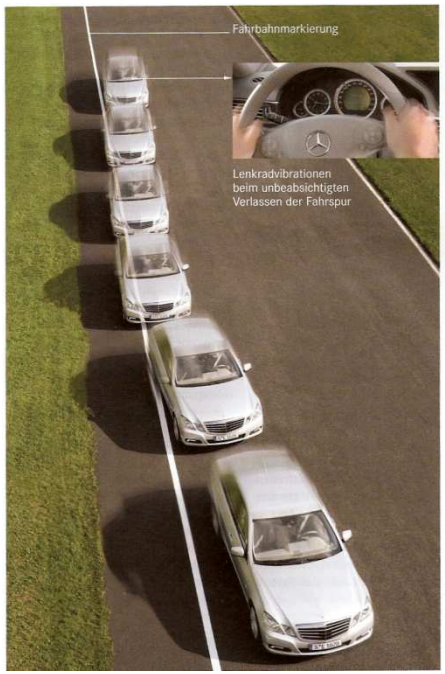
Multi-purpose-camera (3)



- **Lane keeping assistance**
- 60 – 250km/h
- Helps to stay in lane (outside of towns, on highways or autobahn)
- Evolution of other Lane-Departure-Warning systems:
  - Old: Turn light stops warnings
  - New: Warnings are always disabled in case of dynamic driving or avoiding situations (pedestrian, other cars, …)

Multi-purpose-camera (4)

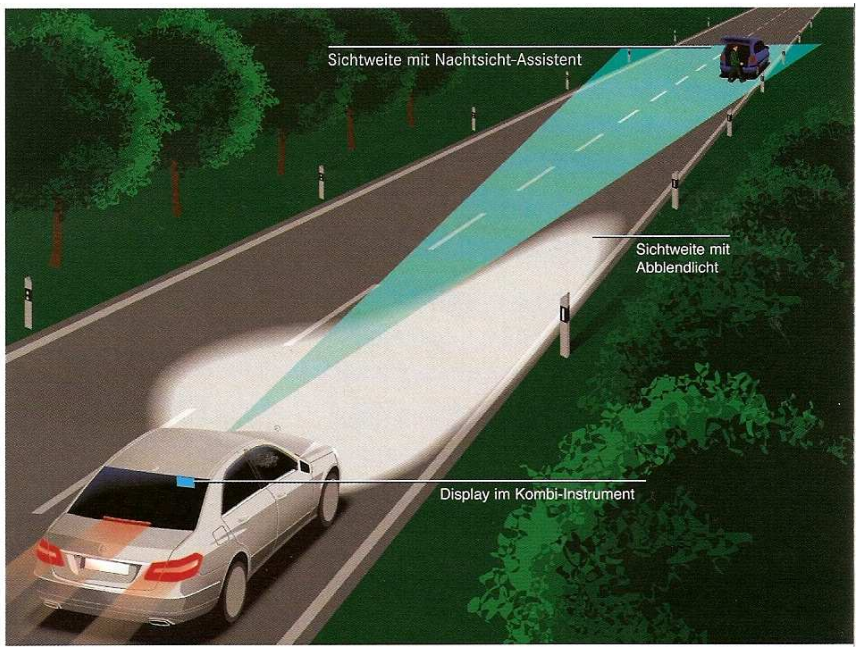
Camera: Picture of the road → **Algorithm:** Where is the lane (light/dark areas) → **Decision making unit:** Activity of driving, attention of the driver → **Processing unit:** Time to cross the marking of the lane → **Warning signals**



- **Speed limit assistance**
- Similar to Opel

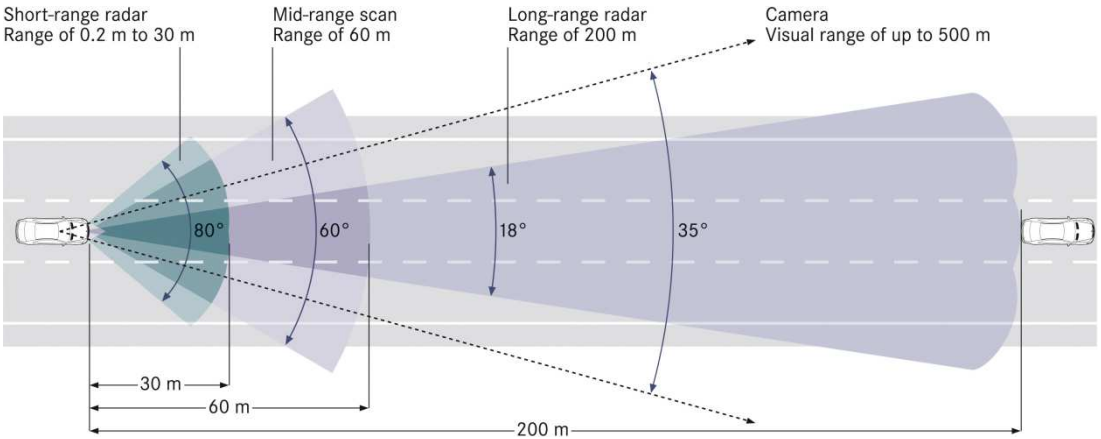
Night view assistance

- View like using the high beam without dazzleing other drivers
- Integrated infrared lamps in the regular lights
- A infrared camera detects the reflected infrared light (FIR-system!)
- Display of the COMMAND system shows the picture
- Automatic recognition of persons

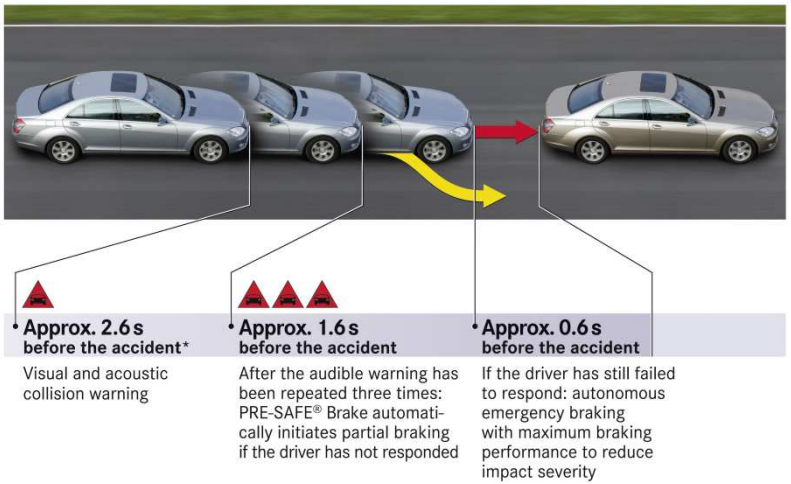


Radar systems

- **DISTRONIC PLUS and PRE-SAFE-brake**
- 24GHz short-range RADAR
- New long-range RADAR:
  Two areas possible,
  Puls-Doppler-system and
  Frequency-Modulated-Continous-Wave priciple (FMCW), two microprocessors, Field-Programmable-Gate-Array

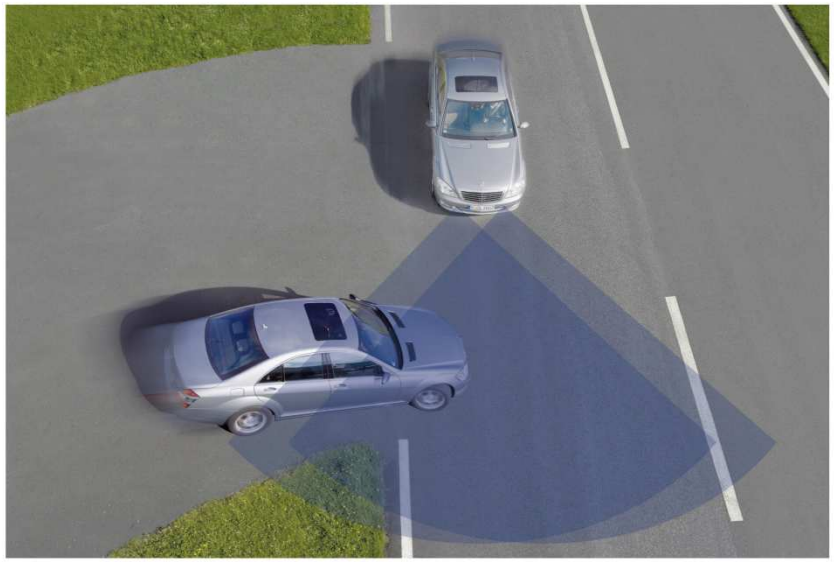


- Support with a camera

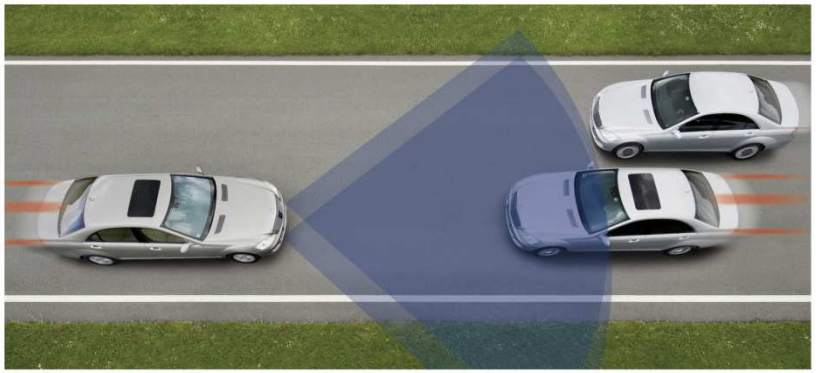


PRE-SAFE

PRE-SAFE®: Activation of the front belt tensioners in response to radar signals



Unavoidable collision at a junction
Activation of the PRE-SAFE® belt tensioners
based on information from the close-range radar



Unavoidable collision with oncoming traffic
Activation of the PRE-SAFE® belt tensioners
based on information from the close-range radar

Literature

And

Publication

All information are given in the paper of chapter 8 by the author