Tips and Technology

For Bosch Partners

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Electrics / Elektronics

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Driver Assistance Systems

In this issue, we are continuing our series on automated driving (see Tips & Technology issue 2/2015) and taking a closer look at driver assistance systems.

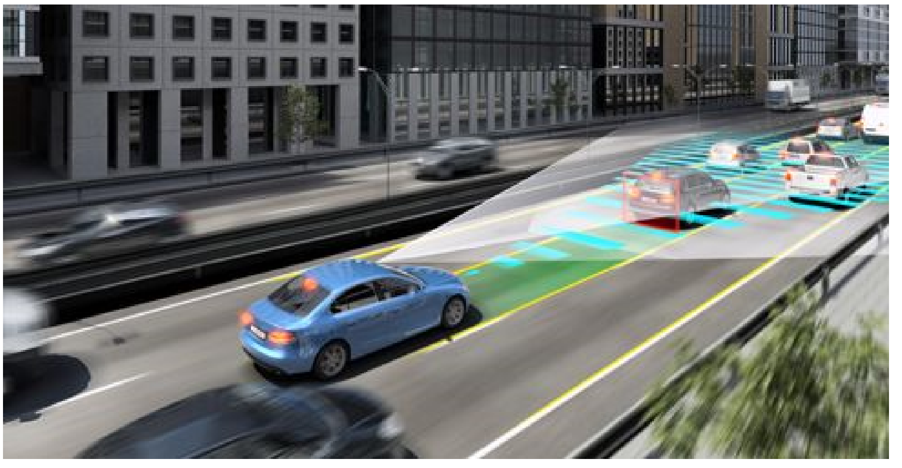
With the assistance of intelligent sensors, driver assistance systems continuously monitor and analyze the surroundings of the vehicle as well as driving behavior to identify hazardous situations early on. In critical situations, these systems warn the driver, provide targeted assistance or independently intervene if necessary to prevent an accident or reduce its consequences.

1. Predictive emergency braking system

Accident research reveals that most drivers brake too slowly lower or frequently not at all in hazardous situations. Bosch therefore developed the predictive emergency braking system. This system helps avoid collisions and reduce their consequences. The predictive emergency braking system is enabled once the vehicle is started and helps the driver at every speed, both day and night. However, it does not relieve the driver of the responsibility of always driving attentively, cautiously and considerably.

Components of the emergency braking system

a) Radar/video



In the fusion of sensor data, the advantages of physically different sensors or ways of measurement are optimally combined to yield information that individual, isolated sensors are incapable of providing. The fusion of several sensors increases the measuring range, and enhances measurement reliability as well as precision. The difference measuring principles are also used to confirm individual objects.

Multi-functional cameras and radar sensors (long range or midrange radar) mutually enhance each other. With the assistance of powerful software algorithms, a detailed picture is generated by the fusion of sensor data which enables the vehicle surroundings to be interpreted in a highly informative manner.

This allows other assistance and safety functions to be realized such as the protection of pedestrians ("AEB Pedestrian"). The predictive pedestrian function continuously monitors the area in front of the vehicle to identify potential accidents with pedestrians who are in the car's lane or are approaching the lane and posing a hazard. If the function identifies a situation which is hazardous to pedestrians, it can actively trigger braking to significantly minimize the risks and consequences of a collision, or even prevent the accident altogether.
For automated emergency braking – independent braking when the driver does not react in response to a potential collision – Bosch also uses the combined data from a radar sensor and the multifunctional camera. Automated full deceleration at high speeds is only triggered when both sensor systems detect the critical object.

The fusion of sensor data can also significantly enhance the functioning of comfort-related systems. Given the high lateral measuring precision of the video camera, the ACC function can identify automobiles pulling in and out of the lane much earlier and react in a more dynamic fashion. The correct lane assignment of preceding vehicles improves the functioning of the ACC, especially in curves.

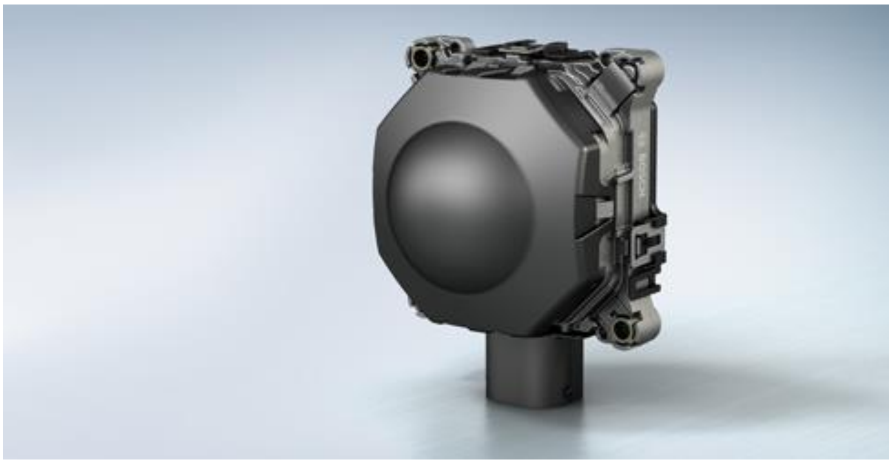
b) Mid-range radar sensor

Bosch has expanded its portfolio of radar sensors with the mid-range radar sensor (MRR). This sensor was produced drawing on the development and production experience of three generations of radars and is especially distinguished by an economical and scalable design.

Bosch developed the MRR as a front and rear version. It serves as the basis for numerous safety and comfort functions which can increasingly be offered in the mid-size and compact class at attractive prices.

The MRR uses of the frequency band of 76–77 GHz which has been permanently approved internationally for automotive applications. The radar sensor is therefore particularly appropriate for global vehicle platforms. The antenna design enables a range up to 160 m (MRR) and 80 m (MRR rear) as well as an opening angle up to 42° (MRR) and 150° (MRR rear).

c) Long-range radar sensor



The fourth generation long-range radar sensor (LRR4) is based on the development and production experience of three radar generations.

With the LRR4, vehicle manufacturers can realize a range of safety and driver assistance functions and thereby satisfy the increasingly higher safety standards demanded by lawmakers and consumer protection organizations. To received the highest rating of five stars starting in 2014 in the Euro NCAP (European new car assessment program), new vehicle models must be equipped with at least one driver assistance system. Great value is placed on automated emergency braking systems.

The LRR4 is a monostatic multimode radar with six fixed radar beams. The central four antenna beams are optimally configured for detecting the vehicle surroundings at high speeds. In the remote range, the approach of preceding vehicles is effectively monitored, and the influence of vehicles in neighboring lanes has been reduced. Within the close range, the outermost two antenna beams extend the horizontal field of vision. Vehicles entering and leaving the lane can be detected much earlier.

A dual design of the LRR4 can be installed in the vehicle. Optional lens or radom heating ensures complete sensor availability even in bad weather such a snow and ice.

d) Multifunctional camera

With the second generation of the multi-functional camera (MPC2), vehicle manufacturers can realize a range of safety and driver assistance functions with a single sensor and thereby satisfy the increasingly higher safety standards demanded by lawmakers and consumer protection organizations.

With the MPC2, Bosch offers a scalable, monocular camera platform for video-based driver assistance systems. The versions of the MPC2 are based on a correspondingly scalable processor design and can hence be optimally adapted to the desired range of functions. Bosch offers a uniform system architecture for all versions of the product with uniform interfaces and functions.

The imager module of the MPC2 consists of the lens system and a highly dynamic CMOS color imager (complementary metal oxide semiconductor) with a resolution of 1,280 x 960 pixels.

The versions of the multifunctional camera enable a wide range of functions which make driving safer and more comfortable.

The multifunctional camera is an integral component of an environmental sensor network. It can be used in conjunction with other environmental sensors such as radar and ultrasonic sensors.

e) Stereo video camera

With the stereo video camera, vehicle manufacturers can realize a range of driver assistance functions to improve safety and comfort with a single sensor and thereby satisfy the increasingly higher safety standards demanded by lawmakers and consumer protection organizations.

With the stereo camera, Bosch offers a scalable platform which combines the proven functions of a monocamera with the advantages of the three-dimensional environmental protection offered by sensors. The functions of the stereo camera can be largely adapted to the customer's wishes.

The two CMOS color imagers (complementary metal oxide semiconductor) of the stereo camera have a resolution of 1,280 x 960 pixels. With a powerful lens system, the camera detects a horizontal field of vision of 50° and offers a 3-D measuring range of more than 50 m. The highly-sensitive image sensors can process strong contrasts and cover the wavelength range visible to humans.

The stereo camera enables a wide range of functions which make driving safer and more comfortable. The three-dimensional detection of the vehicle's surrounding will also be used as the basis for future automated driving functions.

2. Construction site assistant

The construction site assistant is an expansion of the lane assist program, including for narrow highway construction sites. It is based on a stereo video camera and is active at speeds up to 100 km/h. In narrow lanes, the function helps the driver maintain a safe distance between vehicles in the adjacent lane and safety curbs and guard rails.

As the stereo video camera measures object heights and identifies free areas, the construction site assistant can recognize other vehicles and the lane markings as well as lane borders such as cement walls, safety curbs and guard rails. If a vehicle approaches a border or another vehicle, the system can warn the driver or correct the vehicle's movement with a steering movement or braking.

The function can also prevent the vehicle from entering a driving corridor that is too narrow by warning the driver or independently braking the vehicle in a later expansion stage. The stereo video camera is provided with additional ultrasonic sensors to monitor the lateral area close to the vehicle.

Components of the construction site assistant

a) Ultrasonic sensors

For all ultrasound-based functions, we use structurally-identical, economical sensors which are always installed in the same way. Our modular electronic control unit concept enables a wide range of scaling with nearly the same hardware - an ultrasound ECU for all functions. The system versions and functions are very easy to combine with each other and be integrated in the vehicle. For the automobile manufacturer, this represents a significant savings in cost, particularly in comparison to radar-based or optical systems.

Ultrasonic sensors are based on sonar which bats, for example, use to orient themselves. The sensors transmit brief pulses of ultrasound which is reflected by hindrances. The echo signals are recorded by sensors and evaluated by a central control unit.

b) Radar/video (see page 2)
c) Stereo video camera (see page 5)

3. Driver drowsiness detection

Monotonous driving such as on the freeway makes drivers tired, and their concentration quickly wanes. Driver drowsiness detection is based on steering angle information and continuously analyzes the driver's driving behavior. Phases are identified in which the driver does not steer for a brief time and then corrects abruptly - frequently a sign of waning concentration and creeping drowsiness. The frequency and strength of this reaction pattern is combined with additional data such as the driving speed, time of day or blinking behavior from which a drowsiness index is calculated. If this index exceeds a predefined value, the driver is warned by a visual and/or acoustic signal that he is becoming drowsy and is in danger of momentarily nodding off.

In addition to warning the driver, the information on the driver's drowsiness can also be put to use by other systems within the vehicle. In conjunction with a navigation system, it is also possible, for example, to notify the driver of the next possibility for stopping or taking a break.

Components of driver drowsiness detection

a) Steering angle sensor

The steering angle sensor detects the position of the steering wheel by determining the steering angle. From the steering angle, speed and desired braking pressure or position of the accelerator, the driving maneuver desired by the driver can be calculated.

An increasing number of vehicles are equipped with systems that require a steering angle signal. In addition to the electronic stability program (ESP®), systems such as electrical power steering, active steering, electrohydraulic power steering, curve lighting systems or adaptive cruise control (ACC) use information from the steering angle.

4. Predictive pedestrian protection

The predictive pedestrian system can continuously identify potential accidents with pedestrians who are in the car's lane or are approaching the lane and posing a hazard. If the system detects a situation hazardous to a pedestrian, it can warn the driver or automatically initiate emergency braking. This can prevent a collision with a pedestrian, or at least minimize the speed of the vehicle before the collision. This significantly reduces the risk of severe injury.

<u>Components of predictive pedestrian protection</u>

a) Radar/video (see page 2)
b) Mid-range radar sensor (see page 3)
c) Multifunctional camera (see page 4)
d) Stereo video camera (see page 5)

5. Lane departure warning

With the assistance of a video camera, the lane departure warning system can recognize the lane markings in front of the vehicle and compare them with the position of the vehicle in the lane. If the function senses that the vehicle is about to unintentionally leave the lane, it provides an optical, acoustic and/or haptic warning signal such as steering wheel vibration. In this manner, the driver can be notified early on of a deviation in course and countersteer appropriately. If the driver uses the turn indicator to switch lanes or turn, the warning triggered by the approach of the lane line is suppressed.

Components of lane departure warning

a) Multifunctional camera (see page 4)
b) Stereo video camera (see page 5)

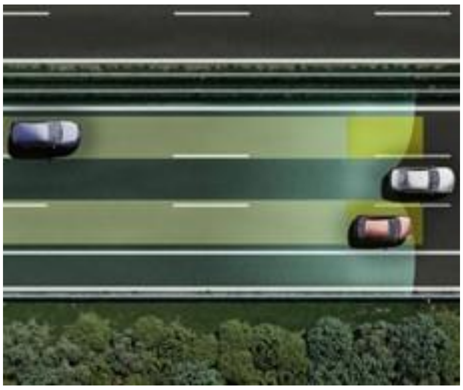
6. Lane assist

This function also uses a video camera to detect the lane markings in front of the vehicle. If the function determines that a specific minimum distance to the lane's edge has not been maintained, it intervenes. With vehicles that have electrical power steering, the lane assist can countersteer gently but noticeably to keep the vehicle within the lane. With vehicles without electrical power steering, countersteering is achieved by the targeted braking of individual wheels. The driver can oversteer this function in any time and thereby assert responsibility for the vehicle. If the driver uses the turn indicator to switch lanes or turn, the intervention triggered by the approach of the lane line is suppressed.

Lane assist components

a) Multifunctional camera (see page 4)
b) Stereo video camera (see page 5)

7. Lane change assistant



The lane change assistant can prevent hazardous situations when changing lanes and thereby reduce the risk of an accident. The system is based on two midrange radar sensors in the rear of the vehicle that monitor the areas next to and at an angle behind the vehicle.

If the system identifies vehicles within the blind spot or vehicles that are approaching quickly from behind, it warns the driver with, for example, an illuminated symbol in the side mirror. If the driver uses the turn indicator because he wishes to change lanes, the system can provide an acoustic and/or haptic warning and thereby additionally notify the driver of the potential hazard.

Components of the lane change assistant

a) Mid-range radar sensor (see page 3)

8. Cross traffic warning

Backing out of a parking space at a right angle to the traffic lane can be especially challenging, particularly when the driver is unable to see cross traffic behind his own vehicle, for example because his vision is blocked. The cross traffic warning makes it easier to back out of right angle parking spaces.

The system uses two midrange radar sensors in the rear of the vehicle. They measure and interpret the distance, speed and probable driving trajectory of identified vehicles in cross traffic. If the function detects approaching vehicles from the left or right, it provides the driver with an acoustic and/or visual warning of the potential collision hazard.

Cross traffic warning components

a) Mid-range radar sensor (see page 3)