Safety trends in automotive electronics

Safety awareness for vehicles has been increasing strongly since the 1980s. It started with simple seat-belt systems, continued with airbags, and has now led to the first really intelligent safety systems. Besides safety improvements for drivers and passengers, there is increasing awareness of unprotected road users, especially pedestrians and cyclists.

With today's advances in sensor and processor technology, the possibilities are growing rapidly. Governments are also viewing these as ways to decrease traffic casualties, and legislation is starting to demand that car manufacturers make use of the technology.

Simply not seeing other road users is unfortunately a common cause of road accidents. Reasons include driving in the dark, blockages in the driver's view, or lapses in alertness, and a range of new electronic systems address these problems.

Night vision camera

Most car headlights can light the road up to around 60 meters away. Lamps like High-Intensity Discharge (HID) types have gradually increased the range, but it is still limited. Infrared imaging systems (Figure 1) will allow drivers to gain information about traffic up to around 150 meters away - more than twice the distance of ordinary low beam headlights.

Figure 1: Night Vision camera

These new systems will be able to recognize people or animals, with "insignificant" image details being cancelled so they do not distract the driver's attention. Further enhancements are expected, and far-infrared systems are expected to "look" even further ahead - expected to be up to 300 meters. At a driving speed of 100 kph, that gives as much as five extra seconds to react.

Blind spot detection

Most blind spot detection systems (Figure 2) use radar sensors located behind the rear bumper that can monitor both sides of a vehicle. The driver is alerted to any potential hazard when another vehicle enters the blind spot. Very often, this is done by a visible icon displayed in the side view mirror, although some vendors are now also using cameras for blind spot detection. Radar has the advantage of operating in all weather conditions, and accurately measures the distance to moving objects. Cameras can identify moving and stationary objects, though, and can therefore improve the accuracy of radar obstacle detection systems.

The individual images from multiple 180º aperture angle cameras can be combined to give a composite image that shows the entire vehicle from above, eliminating blind spots. The driver can also use a zoom feature to focus an individual camera on a particular part of the car, such as the trailer hitch, that would otherwise be invisible.

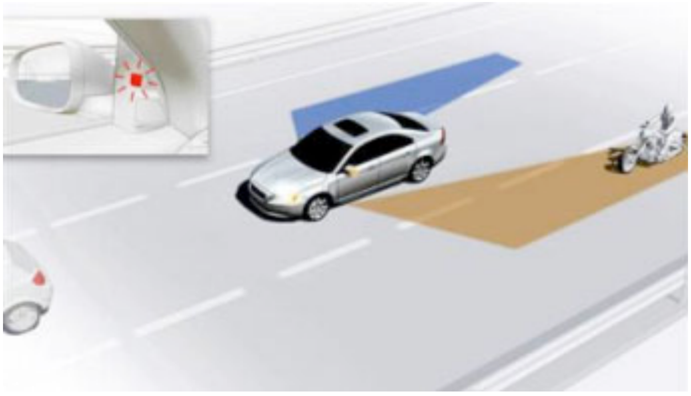

Figure 2: Blind spot detection

Intelligent (LED) lighting

LED lighting is becoming a regular feature of tail lighting, and the first cars with LED headlights have reached the market (Figure 3). We have also seen the first cars to combine LED headlights with new camera technology in an Adaptive Headlight Control system. This system, based on an "image grabber," turns high beams off automatically when tail lights are recognized within 400 meters ahead, an oncoming vehicle is within 800 meters, or the vehicle enters a well-lit area.

Other systems can adjust the light intensity when the car is driving in different weather conditions. Sensors can measure ambient light conditions inside and outside a vehicle, and the system can optimize the brightness of internal and external lighting systems to these conditions. In well-illuminated urban zones, the beams can be lowered and lateral lights made brighter to improve the view of pedestrians and cyclists. Headlights, tail lights, brake lights and indicators can similarly be brightened or dimmed.


Figure 3: Intelligent lighting systems Figure 4: Rear light

Curve adaptive lighting systems can also direct part of the headlight beam in the direction in which the vehicle is being steered. These typically turn the lighting beam up to 15° in either direction, in response to steering input and speed. More advanced systems include control using cameras or even (if carefully implemented) using GPS data and detailed roadmaps.

For both headlights and rear lights (Figure 4), the use of LEDs helps to improve safety. LEDs are helping because the reaction time to LED rear lights is only 200 milliseconds, which is the equivalent of 5 meters additional braking time at 100 kph. Also, some new systems can indicate how hard a driver is braking by increasing the intensity of brake lights. Some can even illuminate the brake lights when a driver's foot is moving towards the pedal. This reduces reaction time and gains valuable meters of braking distance in order to avoid an accident or reduce its impact.

Driver alertness

Drivers not being alert, whether from fatigue or distraction, is one of the main causes of vehicle crashes. For some high-end cars, buses and trucks offer an option that monitors the driver's face using a camera located in the vehicle instrument panel.

The camera monitors a driver's head and eye position (Figure 5), and the frequency at which the driver blinks his or her eyes. When needed, it sounds an alert to keep the driver awake, and can apply additional braking force when other sensors predict an imminent collision.

Figure 5: Driver alertness systems

Lane departure warning

In the USA alone, around 4,500 deaths occur each year from head-on collisions or sideswipes when vehicles cross the centerline and collide with oncoming traffic. Lane departure warning systems (Figure 6) can indicate when it's possible to cross the centerline using a green symbol on the dashboard display. They can provide an auditory alert if a driver crosses a lane marking without first having indicated. Most recent systems use CMOS cameras to "follow" the centerlines. Besides lane departure warning systems, these cameras will in the near future also be used for traffic sign recognition. They are the first steps to fully automatic driving systems.

These are just a few examples of possibilities that have been or soon will be introduced. One thing they all have in common is that they will improve safety - another is that drivers will soon start relying on the technology.

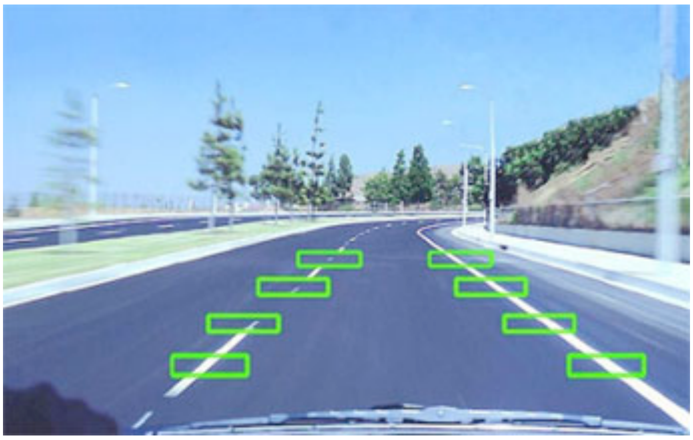

Figure 6: Lane departure warning system

Manufacturing challenges

Safety related products must of course be very reliable, and failures can have serious consequences. If your car stereo fails once in a while, you can simply replace it - but you might not have a second chance with a failing airbag. Safety features that fail cannot be tolerated, and this will put pressure on suppliers to provide fail-safe products. The design of the product needs to be good, but suppliers of these safety systems are also facing a real challenge for manufacturing products with zero defects.

As the complexity of automotive electronics systems rises, the probability of failure rises with it. Estimates are already blaming around half of all breakdowns on electronic failures, with dangerous consequences for car safety and reliability.

Manufacturers must deliver products that work the moment they are needed. Here, particularly, end users can't be used to finish product validation and testing. From the first car leaving the factory, the quality needs to be good. Teething problems are not acceptable for safety related products. The best way to deliver perfect quality products is by using production equipment that is designed for zero defect manufacturing.

With components becoming vanishingly small, rework is becoming impossible, and scrapping populated boards is prohibitively expensive. Estimates suggest that the cost of finding and curing a manufacturing fault increases tenfold at each subsequent stage of production (sub-assembly, board-level, final assembly, distributor and customer). If anything, this underestimates the cost of allowing defects through to customers. Even aside from protecting customer safety, there are huge hidden costs from insurance claims, field recalls, and loss of reputation that reduces future sales.

These issues and costs must be reduced at source - by avoiding placement defects in the first place. That means increasing First Pass Yield, which in turn means improving the accuracy and repeatability of the assembly processes. And that primarily depends on the process capability of the Pick & Place machine.

Conventional assembly uses sequential placement with overhead gantries. These have one or two robots, each with 20 or so heads. Although this approach has lowest initial costs, it has severe limitations. The robots have to work at very high speeds, giving very little time for the individual Pick & Place placement actions. The 40 or more pipettes or nozzles per machine make the risk of nozzle contamination high, which only adds to placement variation. And worse, the revolver heads or multiple nozzle heads that are commonly used make continuous individual component monitoring either impossible or very expensive.