3.1.3 True 360° Sensing Using Multiple Systems

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Abstract

Today's automotive passenger restraint systems see a major change from passive safety systems towards active safety systems. The development of passive safety systems is focused on an improved performance of the restraint devices while the need for the protection of all road traffic participants is increasing. This requires new generations of sensors like occupant detection sensors and pre crash sensors, placed on dedicated positions of the vehicle to merge passive safety and active safety.

1 Development of Vehicle Safety Systems

Since the late 80’s automotive safety systems have become standard equipment for most vehicles that we can find on the road today. These systems are well known as airbag systems and are state of the art of passive safety systems. Improved protection devices like foot bags, knee bags, inflatable belts and active headrest are under development. All these systems have in common that the decision to activate the restraint devices such as pretensioners, front airbags, side or head airbag is based on the signals from the acceleration sensors. The accelerometers are installed in the airbag control unit and also in the side and upfront sensors that are used to early sense the impact.

The development of the restraint devices is following the general trend to more individually controlled devices as it can be seen on airbag modules. First systems used single stage inflators, the next generation was equipped with dual stage devices and newer developments are based on multi stage inflator technologies such as variable output inflators (VOI ). In the future we will also see more sensors as well as more sensor networks in automotive vehicles than today.
2 Sensing Requirements

With the introduction of the different types of airbag systems also different type of crash sensors are required. For the first airbag systems with driver only or driver and passenger airbags a central crash sensing was required. The electronic modules where equipped with a single accelerometer or in cases where also an offset performance was required, two accelerometers in a ± 45° orientation relative to the x-axis have been installed. This is the most common arrangement still used in today's airbag systems. With the introduction of thorax side airbags and later on head protection systems like Inflatable Curtain (IC) or Inflatable Tubular Structure (ITS), additional side sensors where required. In the first side sensors an accelerometer and a micro controller was used for signal pre processing. The signal was a PWM signal equivalent to the severity of the impact. Today's side sensor elements have a digital communication, transmitting the actual crash signal to the airbag control unit, where the signal is processed in the crash algorithm.

Upfront sensors represent the latest level of innovation of a passive restraint system. They are installed close to the front of a vehicle and are used to detect a crash signal in the earliest possible phase of the impact. The purpose is a better discrimination of certain crash scenarios as well as to calculate the severeness of the crash to activate a smart airbag system accordingly.

For some vehicle types such as off road vehicles or SUV's, roll over sensors are currently introduced. The necessary components, gyros and low-g z-sensors are integrated directly into the airbag control module.

Future sensor systems will monitor the occupant and enable an adaptive restraint performance, taking in account the physical condition of the occupant and the real demand from the actual crash situation.

3 Sensor Technologies

Early airbag systems used mechanical crash sensors like the Ball and Tube sensor from Breed or the Rollamite from TRW. These sensors where mounted on structural elements in the front of the vehicle. The electrical contacts of this sensor type were closed on an impact and the airbags are inflated. A discrimination of the crash pulse was not possible with this type of sensor. The next big step in the development of airbag control modules was the introduction of so called single point sensing systems. This type of systems became possible with the introduction of electronic crash sensors. The early generations have been piezoelectric sensors, followed by bulk