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A Car Guy's Expectations for Electronics

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1. Introduction

The automobile industry has reached the greatest turning point of the last one hundred years. The primary challenges are energy restrictions and environmental constraints represented by CO2 emission limitations. In this context the fuels have been diversified and power trains with electric drive have evolved. Another challenge is the growing demand for safer vehicles. Aiming for zero fatalities and injuries in traffic accidents, tougher regulatory measures are being taken into account, along with safety assessments. Besides, due to the growing demand for product safety, vehicles need to be less susceptible to accidental failures and irregular usage. In the meantime, the markets are undergoing radical structural changes. Specifically, the demand for vehicles is rapidly expanding in emerging nations. While on the other hand some urban residents in Japan and Europe do not drive vehicles as often as they used to, and in North America consumers are buying more compact cars than ever. As information and communication technologies evolve, vehicles with electric drive will be involved in the energy infrastructures, and at the same time they will be connected to the information infrastructures.

2. Transformation of vehicles with the evolution of car electronics

This chapter discusses the roles played and the evolution made in car electronics.

In relation to environment, the first generation of electronically controlled fuel injection and ignition goes back to 1980's. Since then, many electronically controlled systems such as gasoline direct injection and variable valve timing mechanisms have been introduced. Thus, higher-speed and higher-precision control is being pursued to meet strict requirements of improved fuel efficiency and reduced emissions. As a result, micro computers for the power train have been customized. Now a single-chip micro computer is equipped with high-capacity flash ROM, highly accurate ADC, specialized I/O, digital signal processing and communication controls.

In the next generation of green vehicles with electric drive such as Hybrid-Vehicles, Electric-Vehicles and Fuel Cell Hybrid-Vehicles, higher voltage drive has become a notable feature, which makes motors more compact and efficient. As inverters need to be compact yet high-power, devices that achieve both high breakdown voltage and low on-resistance have been developed (See Figure 1).

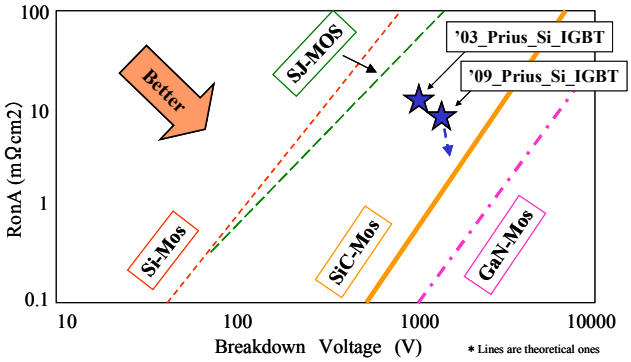

Fig 1 Evolution of Si-IGBT

To reduce injuries as a result of collision, various types of airbags have been invented since 1990's. The development of electronic systems, with high reliability at low cost, promoted the common use of airbags. In a quest for zero accidents, the scope of development has been expanded from passive safety to active safety. ESC, for instance, detects unstable movement of a vehicle, using various sensors including a yaw rate sensor, to prevent skidding by controlling braking or driving torque on each wheel.

More active safety systems have been developed which have been put to practical use. For instance, a Pre-Crash Safety system with cameras and radars activates the brakes to decrease impact speed, when it detects an unavoidable collision. Lane Keeping Assist technology is designed to alert the driver when the system detects an unintended deviation from a traffic lane. There are more safety systems that have been launched, and they are to be integrated so as to support a driver's tasks such as recognition, judgment and maneuver, in a collective manner (See figure 2).

Along with the above-mentioned structural market changes vehicle development itself is undergoing a major transformation. For instance, as the use of recyclable energy such as solar power and wind power increases, vehicles with electric drive are consequentially involved in the energy infrastructure. Likewise, once a vehicle is connected to the information infrastructure, data from various sensors in the vehicle is collected and compiled into a database. This enables services customized to each individual driver's current situation as well as his or her lifestyle. This way the system will achieve optimized transportation that satisfies personal demands as well as optimized energy utilization through "Smart Grid".

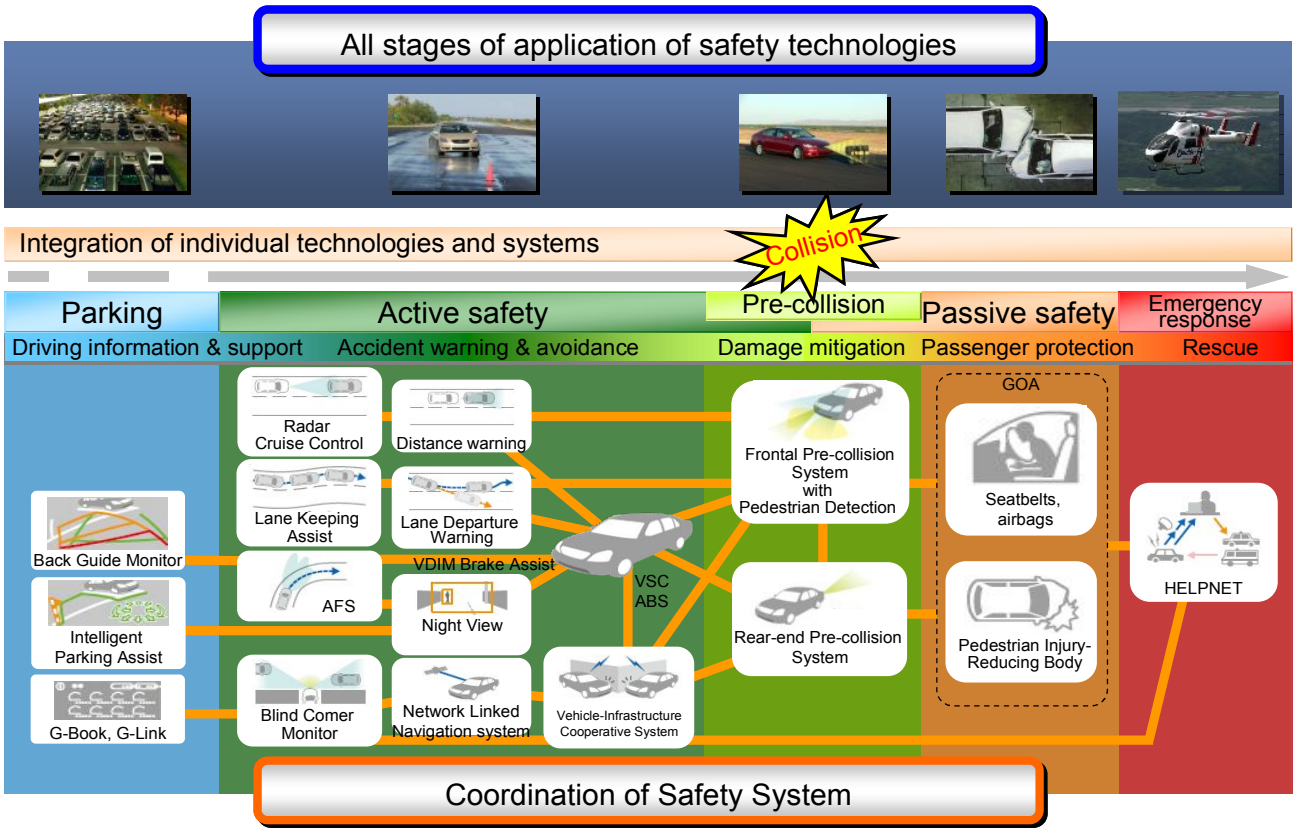

Fig 2. Integrated Safety Management Concept

3. Challenges of Car Electronics

The more vehicle functions are electronically controlled, the better environmental and safety performances of the vehicles will be attained. Traditionally, Japanese automakers have been good at integrating many inter-related systems and components and building them into a product. Exhaustive coordination among systems and thorough optimization, even at the chip level, have been contributing to the differentiation of products and establishing high brand value for them. But now, the development scale has expanded to the extent that the number of actuators to be installed in a car is almost one hundred and thirty, and more than one hundred computers are necessary to control them. This development style, based on integration approach is facing a challenge to its economical rationality, taking the required effort to secure quality into consideration.

It is unquestionable that advancement of electronics technologies and systems will continue to play an important role in the improvement of product appeal and performances of vehicles. To effectively develop car electronics systems it is essential to manage to use modular technology in place of integration technology. The traditional integrated products have to be transformed into those with modular architecture, which makes best use of each player's core competencies. So thus each development partner can perform their duty more efficiently in a well coordinated way.

4. Our expectations to future car electronics

It is certain that the automobile market will keep growing, mainly in the emerging nations, which may raise environmental or safety issues. On the other hand, in industrialized nations, there is movement to seek for new urban traffic infrastructures, where vehicles should be well integrated.

Toward 2020, research and development to meet each different market needs will further increase its roles to minimize environmental impact and create safer and dependable vehicles. Specifically, the technologies and devices to realize systems below are expected to be in use;

-higher energy density batteries,
-smaller inverters with higher efficiency,
-thermal electric generators,
- driving environment recognition to avoid collision,
-fault tolerant devices and software,
-HMI system to enhance safe driving and easy operation, with comfort, including driver monitoring,
-energy harvesting,
-ubiquitous sensor network and cloud computing.