

DEVELOPMENT OF ASV IN JAPAN – ASV PROMOTION PROJECT, PHASE 3

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ABSTRACT

Japan has been promoting the development and spread of Advanced Safety Vehicles (ASVs), which feature a high level of intelligence and remarkably improved safety thanks to electronic and other new technologies that have been rapidly developing in recent years. The ASV Promotion Project, Third Phase, has been in place since 2001 for the further development and spread of ASV technologies. As one of activities of spread of ASV technologies, we defined the safety guideline of driver assistant systems as “Concept of Driver Assistance” on the base of the ASV design principles.

ASV technologies help improve safety, yet there is a new risk of accidents. For example, the driver may rely too much on the technology and neglect to pay attention to safety, thus possibly becoming an unsafe driver. Therefore, It is very important to make an effort to define common understandings among Japan, the U.S. and Europe.

1. BACKGROUND

The development of automobile society increases traffic accidents, traffic jams and environmental problems, which have now become a serious issue of public concern. In Japan, traffic accident statistics show that the number of fatalities reduced by about 24% in the past ten years and reached 8,326 in 2002. The number of injuries, however, showed an inverse tendency increasing by more than 33% in the same period, although it decreased slightly from the previous year in 2002 to reach 1.17 millions.

The prevention of traffic accidents requires a comprehensive safety policy. One of the effective solutions is to develop and spread safer vehicles.

For this purpose, Japan has been promoting the development

and spread of Advanced Safety Vehicles (ASVs), which feature a high level of intelligence and remarkably improved safety thanks to electronic and other new technologies that have been rapidly developing in recent years. The ASV Promotion Project, Third Phase, has been in place since 2001 with the cooperation among industry, academia and government for the further development and spread of ASV technologies.

2. OUTLINE OF ASV PROMOTION PROJECT

An Advanced Safety Vehicle (ASV) collects information on the traffic environment and road conditions around it with various onboard sensors and telecommunications systems and, based on the information collected, helps the driver drive safely by giving him advice and warning. [ref. Appendix 1]

To promote the development and practical use of these ASVs, Japan carried out the first five-year phase of the project from 1991 to 1995 and the second five-year phase from 1996 to 2000.

In the first phase, we focused on passenger cars to confirm the feasibility of ASV technologies through the construction of nineteen ASVs. In the second phase, we extended the scope of study to trucks, buses, and two-wheeled vehicles. Through the construction of thirty-five ASVs of automatic-support type, we defined the design principles and design guidelines of the ASV and experimented their coordination with road infrastructure.

As it can be seen in the introduction into the market of vehicles with ASV technologies, the practical use of ASV technologies is making progress. Since the progress is still largely insufficient, however, we are developing the third phase of the project from 2001 to further our researches for the development of advanced technologies, while reviewing major actions to be newly implemented for the spread of ASV technologies.

	ASV Phase 1	ASV Phase 2	ASV Phase 3
Implementation Period	1991-1995 (5-year period)	1996-2000 (5-year period)	2001-2005 (5-year period)
Objectives	Proving technological feasibility	Creation of environment conducive to practical use	Continuation of technological development and efforts to encourage widespread use (40% reduction in traffic fatalities)
Categories Evaluated	Passenger vehicles	All vehicle categories (passenger vehicles, trucks, buses, and motorcycles)	←
Technologies Covered	· The vehicle itself	· The vehicle itself · Links between road and infrastructure	· The vehicle itself · Links with other vehicles · Links between road and infrastructure
Items Evaluated	1. Setting of development objectives 2. Evaluation of accident-reduction effects	1. Preparation of design principles 2. Establishment of design guidelines 3. Evaluation of accident-reduction effects	1. Development of next-generation technologies · More advanced autonomous vehicles · Development of communications-related technologies 2. Encouragement of spread · Examination of incentive policies · Enhanced of acceptance among vehicle users and general public · Analysis of the effect of ASV technologies · Formulation of guidelines for practical use · Internationalization of ASV technologies 3. Development of infrastructure-linked technologies

Fig. 1 Outline of ASV Promotion Project

3. CONCEPT OF DRIVER ASSISTANCE

3.1 Design principles of the ASV

With the development of driver assistance (control) technologies, it has become possible to replace part of the operations so far carried out by the driver with the vehicle's systems. To ensure and improve safety while replacing the driver's operation with such systems, it is necessary to clarify the role division between the driver and the systems.

In the second phase of our ASV Project, the design principles of the ASV technologies were summarized as follows: a) driver assistance, b) driver acceptance, and c) social acceptance. It was along these principles that subsequent development and propagation programs have been conducted.

1. **Driver Assistance**
ASV technologies should understand driver's wills and support their safe driving based on the concept of driver responsibility.
2. **Driver Acceptance**
ASV technologies should be easy to use and be trusted by drivers. This means that a human-machine interface design should be appropriately implemented.
3. **Social Acceptance**
ASV technology-equipped vehicle must operate with unequipped vehicles and pedestrians. Therefore, we must consider how to obtain proper understanding of the public.

Fig. 2 Design Principles of ASV

In the future, as ASV technologies are phased into place, it will be necessary to define this design principles more in detail. For example, if the driver depends too much on the assistance systems as they develop further, it may have the opposite effect to what was intended and worsen safety. We should discuss our position on such problems.

In view of this, in the third phase of the project, we detailed further the design principles and defined the safety guideline of driver assistant systems as "Concept of Driver Assistance" on the base of ASV design principles.

3.2 Relationship between the driver, the system and society

A driver, as such, is required by society to ensure the safety of traffic. We must be well aware that, without his fulfilling this responsibility, traffic safety cannot be ensured.

To let a driver seek assistance to systems at ease, there must be a good relationship between them in such a way that 1) there are good communications between the driver and the systems and that 2) the systems give him assistance in a safe and stable actuation.

However, since a system does not always work perfectly, it is necessary that 3) the driver should keep an eye on the working of the systems and that 4) the systems should not disturb this surveillance and let him place too much confidence or distrust in them.

On the other hand, 5) the driver should be able, if necessary, to intervene in the systems, and 6) when the system recognizes that the situation goes beyond its control, it should smoothly

pass over the control of operation to the driver.

As for the relationship between the system and society, it is needless to say that 7) the systems should not worsen safety by their actuation. Further, 8) to acquire the understanding of society, it would be better to introduce current technologies in phases, because sophisticated systems always require some time to get understood by society.

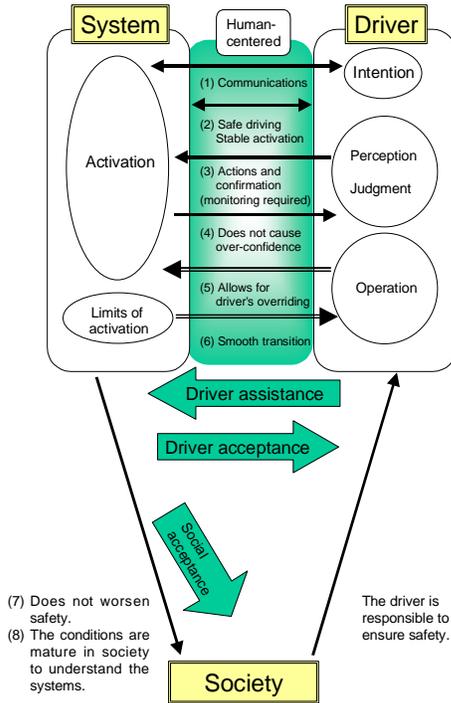


Fig. 3 Relationship between the Driver, the System and Society

3.3 Classification of ASV technologies

Classified according to whether or not they require the intervention of driver, when the system works, and which part of the vehicle is controlled, ASV technologies may be classified as shown in Fig. 4.

ASV technologies may be classified by part of vehicle controlled. Systems that control accelerator (A), brake (B), steering (S) or all of them have already been introduced on the market.

ASV technologies may also be classified according to when the system works: A system works either in an emergency, continuously or during a specific length of time. Systems working in an emergency have been largely introduced. Technologies used in systems working continuously are very close to those for systems working in an emergency. Systems

working for specific length of time are technologies used only on express highways.

		Brake	Accelerators	A+B	Steering	A+B, S	A+B+S
Requires the driver's intervention	Partly		CC	High-speed ACC Low-speed ACC	LKA		
	Continuously			All-speed range ACC			Driver load reduction control
Doesn't require the driver's intervention	In an emergency	ABS Damage mitigating brake		VSC TRC			Accident avoidance control
	Continuously	CBS			4WS EPS		Automatic cruising
(Reference) Reduces force required for operation		Booster brake	AT		Power steering system		

are technologies already on the market.

A: Accelerator
B: Brake
S: Steering

Legend

CC: Traditional cruise control (on the market)
 High-speed ACC: Commercialized ACC (on the market)
 Low-speed ACC: ACC enabled in a low-speed range (following a preceding vehicle in congested traffic)
 All-speed range ACC: All-vehicle-speed range ACC (seamless control ranging from low speed to high speed)
 ABS: Anti-lock brake system (on the market)
 4WS: 4-wheeled steering
 LKA: Lane keeping assistance (on the market)
 VSC: Improves stability around the limits of movement (on the market)
 TRC: Traction control (on the market)
 EPS: Electric power steering (on the market)
 CBS: Dual combined brake system (on the market)

Fig. 4 Classification of ASV Technologies

Further, depending on whether they require or not the intervention of the driver, ASV technologies may be classified into two groups: driver load reduction control technologies and accident avoidance control technologies. Driver load reduction technologies (those aiming at producing indirect effects on safety such as reduced fatigue and maintained attention of the driver by partly substituting for the driver's operation) may be interpreted as those requiring the intervention of the driver.

Automatic cruising technologies are technologies by which the vehicle itself ensures safety by combining accident avoidance technologies, driver load reduction technologies, etc. At the current level of technologies, however, it is difficult to realize them.

Classified from these viewpoints, existing technologies may be roughly classified into three groups: accident avoidance technologies, driver load reduction technologies, and automatic cruising technologies. Since automatic cruising technologies are not likely to be feasible in the immediate future, we summarized the concept of driving assistance by excluding these technologies.

3.4 Concept of driver assistance

We summarized concept of driver assistance into the following eight principles:

It should be noted that the responsibility for driving falls in the driver. This is the basis of the concept and the expectation of society.

- (1) Driver load reduction control technologies
 - 1) The system should act after confirming the will and intention of the driver..
 - 2) The system should assist driver in safety.
 - 3) The system should be checked by the driver at any time.
 - 4) The system should inspire a proper amount of confidence in the driver, not causing him to place too much confidence nor distrust in the system.
 - 5) The system should be overridden by the driver.
 - 6) The system's control should be smoothly passed over to the driver when the situation goes beyond the range of assistance of the system.
 - 7) The system should not make a negative impact to the traffic environment.
 - 8) There should be mature society to accept the system.

- (2) Accident avoidance control technologies
 - 1) The system should act according to the will of the driver or what the driver normally expects in terms of safety.
 - 2) The system should assist driver in safety.
 - 3) The system should be checked by the driver at any time.
 - 4) The system should inspire a proper amount of confidence in the driver, not causing him to place too much confidence nor distrust in the system.
 - 5) The system's control should be overridden by the driver in the case that the driver operates for more safety.
 - 6) The system's control should be smoothly passed over to the driver when the situation goes beyond the range of assistance of the system.
 - 7) The system should not make a negative impact to the traffic environment.

- 8) There should be mature society to accept the system.

4. DISCUSSION

4.1 Spread of ASV technologies

The ASV Promotion Project estimates that, once spread, ASV technologies may have a potential to reduce accidents by 40%. On its part, Europe finds advanced driver assistance systems (ADAS) indispensable to achieve its objective of halving its traffic fatalities by 2010 (eSafety Action Plan).

In some countries, ASV technologies such as ACC (Adaptive Cruise Control) have already been introduced into the market. Japan became the first country worldwide to introduce lane keeping assistance systems and other technologies into the market. In Japan, the U.S., and Europe, surveys and researches are being conducted to experiment on public roads vehicles with stop-and-go systems for following a preceding vehicle in congested traffic, collision preventive systems with forward obstacles, etc. Discussion on international standards on these systems is also under way. All these factors let us expect that ASV technologies will be introduced more and more fastly in the coming years.

No.	ASV technologies	Status
1	ACC	On the market
2	Stop-and-go system for following a preceding vehicle in congested traffic	Driving test on public roads
3	Lane keeping support system	On the market
4	Automatic braking system for reducing injury	On proving ground
5	Doze alert system	On the market
6	Rear lateral / lateral collision avoidance advisory system	On proving ground
7	Curve overshooting prevention support system	On the market
8	Emergency braking advisory system	Driving test on public roads
9	Night-time forward pedestrian advisory system	On the market
10	Two-wheel vehicle presence advisory system	On proving ground
	...	
	...	

Fig. 5 Development status of ASV technologies

4.2 Necessity of common understandings

Because they are completely new and innovative, new technologies such as ASV technologies were not taken into account by safety and environmental regulations currently in force in their development process. This is the reason why we cannot simply apply existing regulations as they are to these vehicles.

The following problems may arise, for example:

- 1) When the current regulations are forced to be applied, the ASV technologies cannot be introduced, for they may conflict the current regulations.
- 2) Since no relevant regulation exists, these technologies may be introduced to the market without thoroughly studying their negative aspects in advance. This may diminish the safety.
- 3) If a certain technology is evaluated in the market as being not safe, a hurdle for introducing the technology again into the market will be very high. Thus, there is the possibility that its introduction into the market will be retarded.
- 4) Some technologies are too innovative that it is difficult to judge their safety. As a result, each government may handle the technologies in a different way.

ASV technologies help improve safety, yet there is a new risk of accidents. For example, the driver may rely too much on the technology and neglect to pay attention to safety, thus possibly becoming an unsafe driver. Therefore, the negative aspects of ASV technologies should be summarized.

A consistent approach toward the safety of ASV technologies should be adopted throughout the world, so the technologies should preferably not be introduced in a country where unique regulations exist. It is hoped that respective countries will cooperate to maintain the consistency of regulations.

Therefore, it is necessary to work for defining common understandings among Japan, the U.S. and Europe.

4.3 Japan's position

As described above, Japan has been working for the spread of ASV technologies based on ASV Promotion Project by defining basic concept of driver assistance, etc. Other countries are also working for advanced technologies as is seen in their efforts for IVI in the U.S. and RESPONSE programs in Europe.

Accordingly, Japan has started to make an effort towards

establishing common understandings among Japan, the U.S. and Europe.

5. CONCLUSION

The third phase of ASV Promotion Project starting from 2001 aimed at further developing and spreading ASV technologies to remarkably improve the safety of vehicles with these technologies. It summarized principles as "Concept of Driver Assistance".

As similar efforts are being made in the U.S. and Europe, Japan plans to make further efforts for the spread of ASV technologies, so that all the countries may deal with these technologies on the basis of a common understandings.

Appendix 1

Schematic of ASV

Image of Advanced Safety Vehicle (ASV)

Computer Recognizes a risk, judges it from sensor information and transmits it to a control device.

Sensor Recognizes driving environment and vehicle conditions.

Control device Provide information and warning based on computer information and assist driver's operation.

Major Systems Developed in the ASV-2

- ① Forward Obstacle Collision Prevention Support System
- ② Curve Overshooting Prevention Support System
- ③ Full Speed Range Adaptive Cruise Control System with Brake Control
- ④ Lane Departure Prevention Support System
- ⑤ Lane Keeping Assistance System
- ⑥ Blind-spot Obstacle Collision Prevention Support System
- ⑦ Advanced Front-lighting System
- ⑧ Neck Injury Mitigation System for Rear-end Collision
- ⑨ Vehicle Body for Mitigating Pedestrian Injury and Airbag System for Pedestrian Protection
- ⑩ Drowsiness Warning System
- ⑪ Seatbelt Warning System for All Passengers
- ⑫ Side Obstacle Advisory System
- ⑬ Emergency Braking Advisory System for the Following Vehicle's Driver
- ⑭ Nighttime Pedestrian Monitoring System

