The service concept of direction of "Future Link" realized by Vehicle-ICT

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Abstract

In the near future, people, vehicles and the society will be closely connected to one another by ICT. In preparation for the future, FUJITSU TEN strives to realize the services of leading user behavior by making influence using Human Centric HMI on the service of "**FUTURE Link**,"," enabled by Vehicle-ICT². Human Centric HMI that understands what human means is realized by Vehicle-ICT system. The system sense users, external environment, vehicle and driving situations, and also accumulate these data from the past to the present day as well as information of the world and other vehicles, and analyze and predict "differences from usual state" or "events that will happen" by making full use of accumulating information.

This paper elaborates the direction of the " **FUTURE Link**, " and the development concept of its three platforms.

2) Technology that contributes to materialization of safe and reassurance vehicles and traffic society by use of the ICT, including the base technology for connecting cloud data as collective wisdom, amassed in various fields by the FUJITSU group

¹⁾ General term for connecting services of FUJITSU TEN. Services that provide and add new values to vehicles by connecting data of people, vehicles and the society.

Introduction

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The world of Internet of Things (IoT), the so-called connected world will further advance in the future. Accordingly vehicles will be a part of the world and be connected to people, mainly drivers, and the society. Being increasingly connected to people and the society, the vehicles are expected to enhance their original values, such as security, safety, and fun.

However, it is also expected that unprecedented values and new use of the vehicles may arise from many unused hours and data acquired through traveling of the vehicles.

Moreover, automated driving is estimated to spread from 2020 although the targets for the achievement vary, depending on country, region and manufacturer. Therefore, efforts are required to prepare for the future automated driving society.

This paper elaborates on the concept of our service using the Vehicle-ICT and on our technological development to provide the service that will solve future issues from the viewpoints of "considerable shifts (people, things and society) that affect the automotive environment" and "evolution of vehicles."

Considerable Shifts that Affect Future of Automotive Environment

First, in the oncoming connected world, we suppose that the 4G environment will be in place worldwide by around 2020 or 2025 and that 5G service will be available in some developed countries around 2020. Under these circumstances, besides interactive communication of a large amount of contents, not surprisingly, different types of huge volumes of data will be accumulated, analyzed and thus used to provide highly optimized services.

Wearable devices, one of recent popular topics, will be more frequently used as an input/output device for the services and will be spread in various manners suitable for purposes of use. For example, the user will receive information of exercises and diet tailored to his/her condition of the day based on data in the device, and the user will be able to see contents matched to his/her hobbies and preferences immediately without selecting them. The environment to receive more personally-customized services will be in place.

On the other hand, when taking a look at possible changes in motions, behaviors and actions of people, elements, such as "slow" and "easy to understand" will be new values in the super-aged society in Japan where the elderly people account for the majority. As a result, slow and uncomplicated services will be emphasized to match their slow pace.

Further, in 2025, the number of senior drivers will reach 25 million in Japan so that the entire transportation system will need an approach for monitoring elderly pedestrians and drivers and thus for preventing accidents, from the viewpoints of the society and vehicles. As for the behaviors of people, close attention is required for changes in values of vehicles. The idea, "car sharing or use of cars when needed rather than keeping them even without use" is not unfamiliar any longer. Our society will change into a society where awareness of the environmental-friendliness, safety-oriented mindset and risk avoidance will have permeated and rooted more than ever in the lifestyle and tastes of consumers.

In such a society, people will have fewer occasions to drive vehicles and thus will be relatively uneasy with driving vehicles. Therefore, less experienced drivers who have less knowledge about vehicles will increase. (See Fig. 1) Moreover, the times will expect vehicles to include functions serving as a part of the eco-system in the society, in addition to their conventional values, such as transportation and traveling space.



Fig.1 Considerable Shifts that Affect Future of Automotive Environment

Evolution of Vehicles

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With respect to changes in vehicles, auto manufacturers are expected to introduce an automated driving function by around 2020. According to a survey, about 25% of new vehicles in 2025 and about 40% of new vehicles in 2030 will be equipped with the automated driving function. (See Fig. 2).

However, around 2025, only limitedly automated driving function will be available, possibly in the level 3 in which drivers need to drive vehicle themselves in some cases, for example, to avoid danger and hazard. The fully automated driving will be realized in 2030 or after.



Fig.2 Penetration of Automated Driving

Until realization of the fully automated driving, along with sophistication of external environment sensing technology as the further advanced technology of advanced driver assistance systems (ADAS), various sensing devices and systems will be widely installed to monitor drivers and passengers in the cabin. Those devices will detect line of sight, the faces, etc. of the users, using cameras, and will be used for safe driving assistance in fusion with other sub-sensors. It is likely that the future connected vehicles will be connected to the outside of the vehicles and thus will instantly recognize the external information and the environment outside the host vehicles (external environment) to predict dangers and changes outside. Moreover, the vehicles will be also connected to the drivers and the passengers to provide support and information appropriate for their states.

With regard to changes in the cockpit of the vehicles, information devices tend to require more space than before, due to a larger center display and installation of a multi-display and/or a head-up display.

A larger amount of information may lead to less concentration of drivers (driver distraction). Therefore, we estimate that the amount and the balance of the information in the cockpit will be changed as shown in **Fig. 3**: Information (support) related to security and safety will increase until realization of the fully automated driving, and after the realization, the percentage of multimedia information will increase again while the information related to security and safety will decrease.





Fig.3 Transition of Volume and Balance of Information in Cockpit



The listed below are the summary of the predictions of the changes in the world that affects the vehicles and the evolution of the vehicles by 2020 or 2025.

<Changes in the world>

- Expansion of the connected world and wide spread of more personally-customized services in every aspect of life
- (2) More emphasis on slow and uncomplicated services for senior citizens, the majority of the super-aged society
- (3) Demand for user-friendly (comfortable to each person) services due to a heightened awareness of

safety/security, environment and danger avoidance

(4) In the environment above, an increasing number of drivers with less experience and less knowledge about vehicles due to less occasions of driving vehicles

<Evolution of vehicles>

- Despite progress of autonomous driving technology as advanced ADAS technology, limited use of the technology and growing importance of safe driving support provided to drivers
- (2) Expansion of the area where more personally-customized and sophisticated driving support services will be provided, due to the vehicles connected to the outside of the vehicles and to drivers
- (3) Use of HMI, considering an appropriate balance between safety support and multimedia in the cockpit

We believe that one of our challenges to be taken in these circumstances is how to increase the value of vehicles by use of Vehicle-ICT for the society where people have less experience and less knowledge about vehicles and have fewer occasions to drive them. Increasing the value of vehicles substantially means further strengthening the advantages of vehicles or eliminating their disadvantages. To that end, we are taking a comprehensive approach from the viewpoints below:

- Meaningful traveling hours
- No confusion
- Avoidance of danger
 No concerns/mess
- Public use
- i ublic use

Thus, we aim to develop the current service that provides only present information into a service that can provide predicted information and further that can motivate the user to move into action (Fig. 4).

| Viewpoint of provided value Meaningful traveling hours | Generation 1 Generation 2 Generation 3 Present info. Predicted info. Motivating info. Even in vehicle Seamlessly Special in vehicle | Enhanced fun in vehicle | hicle |
|---|--|----------------------------------|----------|
| More f | Easy to understand Easy to use Duconsciously | Cafer Imara | f ve |
| Avoidance of danger | Obvious danger Danger Steering to prediction avoidance of danger | secured | lue o |
| No concerns/mess | Present info. Prediction of Avoidance of added | Venicle | se va |
| Public use | Business operator Individual Society | New added value of vehicle | Increase |

Fig.4 Service Road Map of Future Link

Based on the information feedback loop as shown in Fig. 5, our service will provide each driver with information that encourages him/her to move into next action spontaneously. Sensing the driver, the passengers, the external environment, the host vehicle and the driving situations, the system employing the service can accumulate those information as data from the past to the present day as well as information of the world and other vehicles. The system can analyze and predict "differences from usual state" or "events that will happen" by making full use of the accumulated information and then motivate and encourage, via a human-centric HMI, the users to move into action. Further, the service also will detect their action as a result of that and feed it to the system to form the feedback loop.



Fig.5 Concept of Future Link

"Motivating drivers to make the cabin into enjoyable space," "guiding drivers to make operation smoothly without confusion," "leading drivers to avoid dangers," and "encouraging drivers to relieve anxiety." The motivating of drivers will change the society and thus will "contribute to the society and the environment."

As described above, the concept of **Future Link** we is the service that "fully uses information and lead driver behavior by making influence."

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Technological Approach

The next described is a technological approach to the Vehicle-ICT system we are striving to realize **Future Link**, to provide the service that will lead driver behavior by making influence.

<Three platforms (PFs)>

In order to lead driver behavior by making influence, the service needs to 1) identify ideal driving behavior based on the external environment and the present state of the host vehicle, 2) understand and predict the state and action of the driver and 3) guide the driver to be in the ideal driving behavior in consideration of his/her acceptance characteristics of the predicted state.

We believe that the configuration based on the three platforms (PFs) in **Fig. 6** is useful as an integrated PF for Vehicle-ICT to realize the service.

The sensing PF is for detecting states and changes of the driver and the external environment, using external sensors, such as cameras and a millimeter-wave radar system, driver monitoring systems, such as a driver monitoring camera, vital sensors and others.

The information PF is for processing not only information acquired from the conventional limited source of the in-vehicle network but also information stored, analyzed and predicted by cloud computing. In addition to the state of the driver, the external environment and their changes



Fig.6 Concept of PF of the Vehicle-ICT and Technology for realizing Future Link

acquired by the sensing PF, the information PF will use traffic information, personal information of the driver, etc. in the cloud database. With an understanding of the traffic situation and the state and the driving characteristics of the driver, the PF will predict possible future changes and will formulate a plan to lead the driver to be in the ideal driving behavior.

The HMI-PF consists of in-vehicle user interface (UI) systems and a HMI controller. For example, the in-vehicle user interface systems are: display systems, such as the center display, the meters and the head-up display; audio systems, such as speakers; input systems, such as buttons and dials; and operation systems, such as the steering wheel and the accelerator, and the HMI controller comprehensively controls them.

Based on the plan formulated by the information PF, the HMI is controlled on a real time basis to lead the driver to be in the ideal driving behavior by the full use of the UI systems on the vehicle.

<Technologies to be developed>

It is essential to develop the following technologies illustrated in **Fig. 6**, to materialize the service that will "make full use of information and lead driver behavior by making influence to be in the ideal behavior," which we are striving to realize through **Future Link**.

- ①Human sensing technology that will understand the state of human being, especially the driver
- ②External environment sensing technology that will accurately understand the external traffic situations
- ③Advanced information processing technology that will predict near future based on present information related to the states of vehicle and the driver and the traffic situations
- ④IoT platform technology that will allow for the advanced information process and a secure information network environment
- (5)Human-centric HMI technology that will lead the driver to be in safer and more comfortable state

We think that the Vehicle-ICT system, the integration of the sensing PF, the information PF and the HMI PF created by those technologies, will allow for the realization of the service that will "fully use information and lead driver behavior by making influence."

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Conclusion

From now on, we will make our efforts to realize the concept of that will optimize the volume of provided information, depending on driver, and also that will lead the driver to be in safer and more comfortable driving behavior in each scene, by linking data on "people," such as driving characteristics of the driver, data on "vehicles" acquired from the in-vehicle devices and sensors and data on "society" from the infrastructure, the Internet, etc.

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