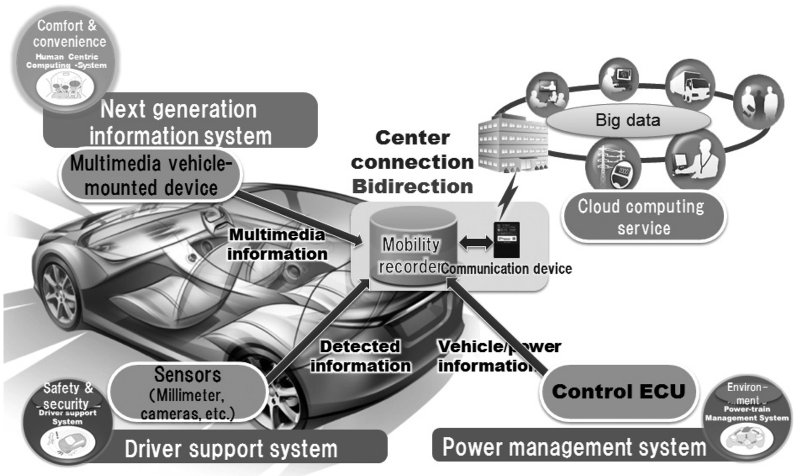
Driver Support Service of Future Link™ Realized by "Mobility Recorder"

Yutaka YABUUCHI
Masato MARUOKA



Abstract

The link service "Future Link™," released in 2014 by FUJITSU TEN, realizes the Vehicle-ICT business that is set forth in our ten-year vision. The service is developed based on the concept, "service that utilizes information and encourages people to move into action." Being designed to encourage drivers to move into action via HMI, the Future Link™ is a driver support system linked to a data center where a variety of information acquired from vehicles as data is processed by cloud computing as well as by a vehicle-mounted device. Therefore, the connection between the center and the vehicle is inevitable. In the vehicle, there are various types of information and data related to the outside situation, vehicle, driver's state, etc., that are acquired by sensors. Simple supply of various service requires a system for converting the data collected by the vehicles into values expressed in the same unit and calculated using the same weight that are different for each vehicle model and also a system for structuring data to easily accumulate the data in a database. If the function "Mobility Recorder" is installed in vehicle-mounted devices, we believe, the driver support service using the Future Link™ can be realized because a huge amount of data from many and various vehicles can be compiled as a database by the function and thus the analyzed data can be given to drivers as feedback.

1 Introduction

In these days, vehicles are equipped with sensors and radar units that monitor situations and states changing inside and outside the host vehicles (a term "host vehicle" refers to a vehicle on which those devices are installed). If one of those devices determines that the situation is dangerous, it activates a safety system to support the driver of the host vehicle. One example of those devices is a radar system (**Fig. 1**) that includes a millimeter wave radar unit for measuring an inter-vehicular distance to a preceding vehicle and that controls the brake of the host vehicle if it detects a sign of a collision with the preceding vehicle. It also measures acceleration of the host vehicle, using a g-sensor, and activates an air bag system in the case where it detects a possible collision.

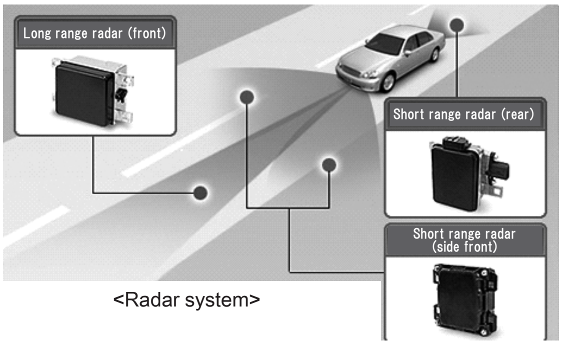


Fig.1 Example of Current Driver Support System

Those devices are characterized in real-time sensing by sensors and/or a radar unit installed for control of the host vehicle and in automatic activation of the safety unit based on determination made by a control unit. On the other hand, the driver support service of Future Link™ (hereinafter "Future Link™ driver support service") is characterized by predicting future changes and encouraging drivers to move into action based on the real-time information sensed by the devices as well as other input, such as traffic information, weather information and data accumulated, analyzed and predicted by cloud computing that cannot be acquired only by the control sensors and the radar unit (**Fig. 2**).

Fig.2 Image of Future Link Driver Support System

The air bag system and the radar system can acquire data directly from the sensors and the radar unit installed on the host vehicle. However, the Future Link™ driver support service utilizes data accumulated and analyzed in a data server that receives information not only from the host vehicle but also a huge number of vehicles. In order to analyze a large amount of received data in the data server, certain rules are required for the data sent from the vehicles. FUJITSU TEN developed "mobility recorder," which is a function of accumulating data in vehicle-mounted devices before the data is sent to the server.

This paper elaborates on what role the mobility recorder plays and how it works to realize the Future Link™ driver support service.

2 Role of Mobility Recorder

Making full use of information inside and outside the host vehicle, the Future Link™ driver support service encourages driver to move into action. The service gives information not only about things happening in the host vehicle but also about difference from the usual and possible near future predicted based on various types of information, such as traveling data of other vehicles and traffic situations. In order to realize that, information of a brief moment is not enough. It is necessary to analyze data accumulated from the past. Moreover, various data collected by many vehicles must be accumulated as big data to analyze and predict the future.

The mobility recorder has functions: collecting data from various sensors connected to the host vehicle and in-vehicle LAN (CAN, etc.); storing the collected data on a memory; and using the stored data. While the recorder is not a separate unit, it can send a variety of data collected by the host vehicle, to a data center, when it is installed in the vehicle-mounted device with a communication function, and thus the data server compiles the data as a huge database.

3 Recording process of mobility recorder

The mobility recorder collects the various types of data acquired from the vehicle and records them on the memory. The recorder arrays each of the collected data and records the arrayed data as one record.

Important points for the mobility recorder recording the data are described below.

3.1 Normalization

If there is no rule for data to be accumulated in the server from the sensors selected to optimally control their host vehicles, as described in the foregoing chapter, a large volume of data is recorded but the accumulated data cannot be analyzed because those data are not expressed in the same unit and are not calculated using the same weight. Therefore, unified profile for data, such as unit and weight, is required to accumulate the data in the server for easy analysis. The data collected by the mobility recorder from the vehicles are converted and recorded in the form of the unified profile. This process is called normalization.

One example of the normalization is explained below with reference to **Fig. 3**. A vehicle A and a vehicle B are traveling at the same speed (100km/h). The speed calculated in the vehicle A is expressed in fixed point and 1 bit is equivalent to 1km/h. However, as for the vehicle B, its speed is expressed in floating point in mile/h. In this case, although the traveling speeds of those vehicles are the same, the calculated values (values handled in a computer) are different. Since data in different profiles cannot be processed as the same data in the data server, the mobility recorder normalizes all vehicle speed data to fixed point values weighted 0.1km/h for 1 bit. As shown in **Fig. 4**, after the normalization, the value 0x03E8 is sent to the server as the vehicle speeds of both vehicles A and B.

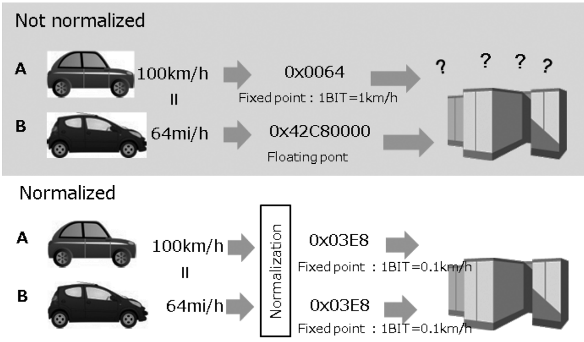


Fig.3 Image of Normalization Example of Vehicle Speed

3.2 Association with Time and Location Information

The data collected by the mobility record is used to identify "difference from usual" and to predict "what will happen." Analysis of huge data helps find a trend of traffic congestion or a traffic accident that often occurs at a location on the road under certain conditions. It is important that the mobility recorder here associates the data with time and location information when storing it. Even If measured and analyzed accurately, data with no information of time and location does not tell when and where a predicted event will happen so that it is not useful for driver support.

Fig. 4 illustrates data acquired by the mobility recorder from an experiment. The data includes the location and time where and when the events occurred. Tendency can be found by accumulating and analyzing such data in terms of what happened and of when and where under what condition it happened.

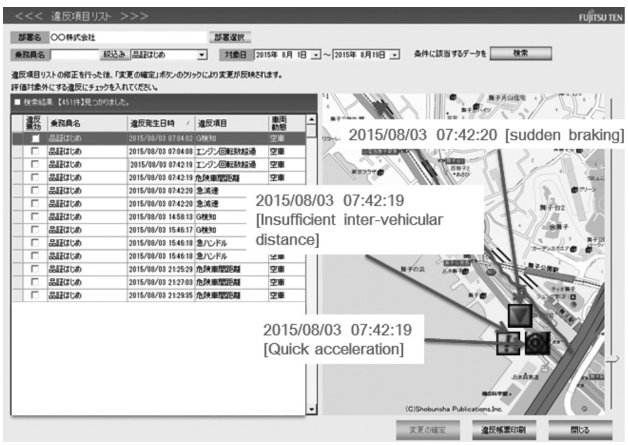


Fig.4 Running Test Data Recorded by Mobility Recorder

3.3 Chronological Sorting of Data

The data collected by the mobility recorder is associated with the time information. However, the data needs to be chronologically sorted for easy analysis. For example, it is necessary to identify rapid changes from vehicle speed data and G-data that have sampled several times in order to detect an event of a rapid acceleration. However, if the data is accumulated in a random order, it is impossible to analyze how it changed. Therefore, the sampled data is chronologically sorted when it is stored.

Fig. 5 illustrates a traveling route generated by extracting the location information from the data recorded by the mobility recorder. Since the data is chronologically recorded, the traveling route can be generated based on the location information.

Time	LAT	LONG	Speed	Rotation	Acceleration X	Acceleration Y	Acceleration Z
16:05:44	34.660	135.164	55.0	2019.4	0.0	0.1	0.0
16:05:47	34.661	135.163	55.4	2032.1	0.0	0.1	0.0
16:05:50	34.661	135.163	55.4	2010.4	0.0	0.2	0.0
16:05:53	34.662	135.163	56.0	1990.9	0.1	0.3	0.0
16:05:56	34.662	135.162	56.4	1993.4	0.3	0.4	0.0
16:05:59	34.662	135.162	54.1	1889.1	0.1	0.2	0.0
16:06:02	34.663	135.162	55.0	2000.4	0.0	0.1	0.0

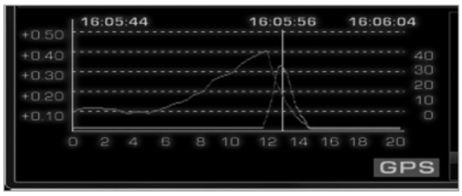


Fig.5 Image of Traveling Information Recorded by Mobility Recorder

4 Actual Example of Mobility Recorder

The mobility recorder is not a standalone device but only a function that plays role in supplying recorded data to applications. "OBVIOUS Recorder G500" (hereinafter "G500") released in September 2015 is actually equipped with the mobility recorder. Referring to G500 in **Fig. 6**, the actual example of the mobility recorder installed in a device is described below.

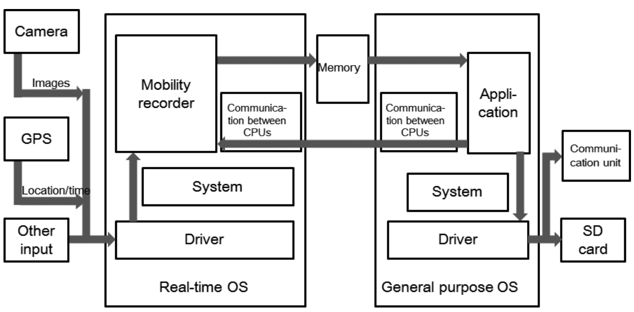


Fig.6 Example of OVBIOUS Recorder G500

The G500 is connected to cameras and a g-sensor so as to function as a drive recorder, and associates images captured by the cameras with the location and time information acquired from the GPS. The mobility recorder must rapidly response because it needs to associate the data input from, for example, the cameras, with the time information about when the data is input, normalize the data, sort the normalized data and then write the normalized data on the memory before the next data is acquired. Therefore, the mobility recorder is executed on a real-time OS. The record on the memory is retrieved and used by the application executed on the general purpose OS. The application of the G500 writes image data acquired from the memory and the values from the g-sensor onto a SD card. Besides that, the G500 sends the data to the data server via a communication unit. The data accumulated in the data server is used for analysis to find dangerous areas and then warning of the audio guidance is provided to a driver who is traveling in the dangerous area, such as traffic intersections where an accident often occurs (**Fig. 7**).

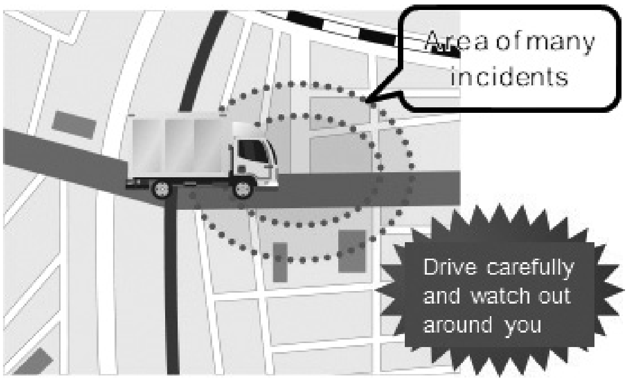


Fig.7 Waning about Dangerous Area by G500 Analyzing Data

This series of service from acquiring data to giving drivers feedback via normalization and cloud computing analysis of the acquired data is the Future Link™ driver support service materialized by the mobility recorder.

5 Conclusion

We believe that we took one step forward for future growth of the Future Link™ driver support service by developing this mobility recorder, one element of the service. The G500 gives a trigger for action to drivers by identifying the dangerous areas based on the information accumulated from the past. However, our future challenge is to develop a technology for predicting risks and changes that may happen. As an increasing number of products including the mobility recorder in the future, information from more vehicles can be accumulated in the database. We will make an effort in development of an analysis technology that enables us to give drivers more accurate feedback. Thus, we would like to expand the Future Link™ driver support service by using the developed technology for the service, and to enhance the value of vehicles.

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Profiles of Writers

Yutaka YABUUCHI
ITS Engineering Group
Software Engineering Dept 1

Masato MARUOKA
ITS Engineering Group
Software Engineering Dept 1