Development of Drive Recorder (OBVIOUS Recorder)

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Abstract

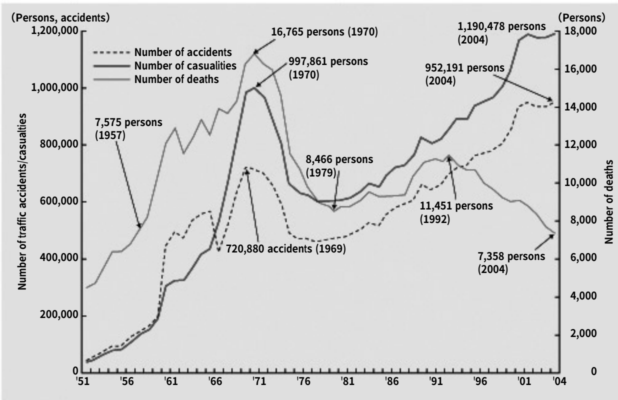
Since 1991 fatal road accidents have been decreasing, however the overall accident and injury counts keep increasing. It is necessary to analyze factors leading to the traffic accident and find the solution to reduce them. In 2005 the Ministry of Land, Infrastructure and Transport conducted a validation test on drive recorders which can detect accidents or near accidents and record driving data and front/rear imagery before/after accidents. The result concludes that drive recorders have three key advantages: ① faster accident processing, ② reduction of the number of accidents, ③ reduction in fuel expenses.

It is expected that drive recorders may grow in popularity in the commercial vehicles market, then in the passenger car market to combine with car navigation/car security system.

This paper gives an overview on in-car and base equipment of the developed drive recorder and the market trends.

1 Introduction

Over recent years since 1991, fatal road accidents have been decreasing due to a "passive safety" systems to guard vehicle occupants in accidents, improvements in vehicle design, compulsory use of seatbelts and provision of airbags as standard equipment. However, the number of road accidents and the number of people injured, continue to increase (Fig. 1).



* 1 According to National Police Agency documents.
2 Number of accidents from 1966 onward do not include damage-only accidents.
3 Figures up to 1971 do not include Okinawa Prefecture.

Fig.1 Trends of the number of traffic accidents and casualties

(Source: 2005 White Paper on Traffic Safety in Japan)

1.1 Background to appearance of drive recorder

An active safety system is needed to reduce future accidents. ". In order to reduce the number of accidents it is crucial to clearly understand the cause of accidents and take measures to prevent them. To this end, for the past 5 years, the Ministry of Land, Infrastructure and Transport (MLIT) has been researching the effects of a "drive recorder", which is an automobile version of a flight recorder.

The "drive recorder" has a small-size CCD camera to record the area surrounding a vehicle. When the vehicle receives a shock such as that due to a collision or slamming on the brakes, the "drive recorder" records the images on the in-vehicle unit. Subsequently such recorded images are transferred via compact flash card (hereafter "CF card") together with data such as date, time, place and speed, to a base office where they are analyzed on personal computers.

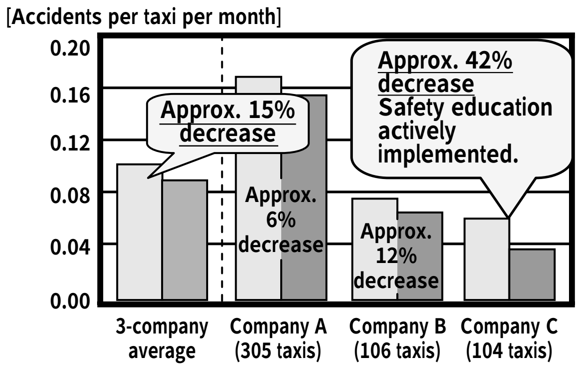


Fig.2 Number of accidents (per taxi per month)

(Excerpt from Survey Report of March 2005 published by MLIT Road Transport Bureau)

A validation test conducted by MLIT using taxis reported that the benefits of being equipped with a drive recorder include not only faster accident processing (by utilizing the recorded images to make objective judgments about the circumstances of accidents), images but also a reduction in the number of accidents, and economic benefits such as decreasing fuel expenses by reducing sudden acceleration or deceleration.

As shown in Fig. 2, the accident rates of taxi companies A and B were lowered simply by installing the drive recorder in their taxis, while the accident rate of company C, who were additionally actively directed in safety, fell by a large amount

2 Development of the drive recorder

Although equipping vehicles with a drive recorder is expected to decrease the accident rate and provide faster accident processing the desire exists to use it more proactively to prevent accidents. Accordingly we identified its issues and carried out development to turn it into a commercial product.

2.1 Pertinent issues

The following issues are pertinent to the drive recorder whose use became widespread in 2005 : ① These record are only in relative time, making it difficult to determine when the images were taken. ② The recording duration of around 20 seconds before and after the recording trigger is too short. ③ It often records irrelevant data, unrelated to the accident, so a great deal of time and effort is required to sort out the relevant images.

2.2 Development goals

Fujitsu Ten has developed two kinds of commercial models of the drive recorder: a single-function model that simply records images, speed and time, and a sophisticated model that additionally records audio and vehicle position data that is useful for active safety guidance. There is also a version of the sophisticated model that does not utilize GPS but rather obtains position information from the in-vehicle unit linked to the Fujitsu Ten vehicle dispatch system, thereby providing a low-cost drive recorder. (Two models, with a total three types were developed as a product.)

In order to overcome the issues, the development paid special attention to the following items:

①Ability to rapidly search for required images.

- Add date and time to the images data recorded by the in-vehicle unit.
- Employ an acceleration (below, "G") sensing algorithm that will allow the unit to distinguish between hazardous driving such as abrupt braking and swerving and normal driving conditions that do not need to be recorded.
- Simplify the data extraction screens at the base station facilities.

②More compact and light-weighted recorder to install in a small size base.
③Employ a structure whereby the camera is separate from the main body, with a view to enhance design and improve driver visibility.
④Provide supplementary means for cases where useful images cannot be recorded.
・Add audio recording functions.
・Provide a record switch that allows the driver to initiate recording of images.

3 Overview of the system

The in-vehicle unit uses the camera to continually record images of the area around the car into an internal memory. When a shock such as a collision or abrupt braking occurs, images of such event are recorded together with the date, time, position and speed, etc., onto a CF card. Via the CF card, hazardous driving analysis is conducted for each time zone and driver by personal computers at the base office. Fig. 3 shows the composition of the in-vehicle unit and the configuration of the base office facilities.

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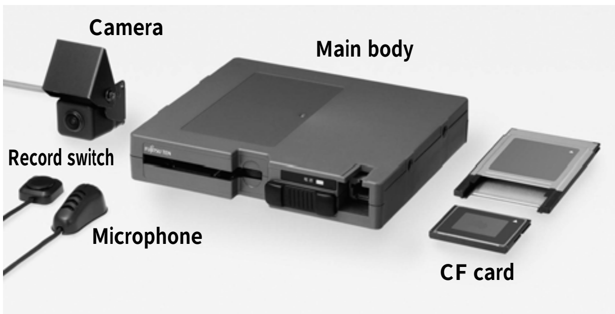

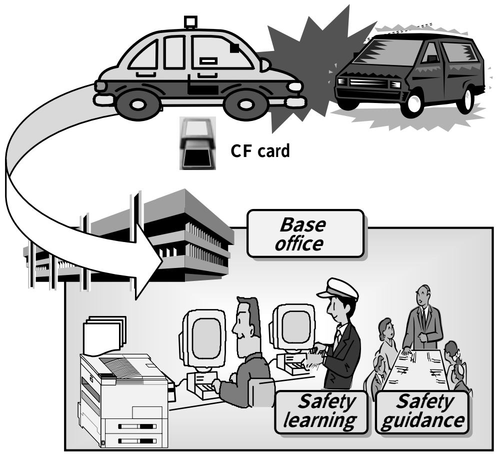

Fig.3 System configuration

4 Main specifications

The main specifications of the in-vehicle unit and base office equipment are given below. Table 1 lists the main specifications of the in-vehicle unit and compares the two models (three types).

4.1 In-vehicle unit

①Two models are available: A single-function model whose main purpose is simply to record images when accidents occur, and a sophisticated model that includes functions to enhance safe driving guidance and education. There is a choice of two types of the sophisticated model, one with and one without a GPS receiver. (Two models, with a total three types are available.)
②The structure is such that the camera and the main body are separate. This is out of consideration for installability, protection of the unit when accidents occur, and ease of card insertion/removal.
③The unit includes a real-time clock that adds the date and time to the image data.
④Recording angles are 131° horizontal and 167° diagonal, making for fewer blind spots in the horizontal direction and permitting recording over a broad range.
⑤Up to three cameras can be connected to the unit, to enable recording of the car interior and in the rearward direction in addition to the forward one. (But no more than two cameras can record simultaneously.)
⑥Audio can be recorded together with the images so that, for example, a voice reading out the license plate number of a vehicle in a side-impact collision can be recorded. Additionally, in the case of taxis, linkage with external triggers (opening/closing of doors, fare meter readings, etc.) will enable utilization of the recorder in surveys of drivers' politeness toward customers
⑦Data saving takes into account the degree of importance of the recorded data. (Should the recording capacity be exceeded, the data is overwritten in descending order, starting from the least important data. Erasure of important data is prevented.)

Table 1 In-vehicle equipment specifications

Main specifications
Common items

Power supply		12 V, exclusive
Composition		CCD camera separate from unit body
Outer dimensions	Body	150 (W) × 27 (H) × 130 (D) mm
	Camera	27 (W) × 24.5 (H) × 35 (D) mm (including mounting bracket)
Weight	Body	300 g
	Camera	60 g (including mounting bracket)
Recording medium		CF card
Event recording capacity		15 events (recording duration 20 seconds/event when 128 MB card is used)
Maximum recording duration		30 seconds/event
Camera		1/4 inch color CCD, filming angles 131 ° horizontal and 96 °vertical
Data recorded		Images, date & time, vehicle No., vehicle speed, G sensor reading

Items differing by type

	Single function model	Sophisticated model type I	Sophisticated model type II
Cameras connectable	1	Up to 3	Up to 3
Audio recording	×	○	○
Operation recording	×	○	○
AVM linkage	×	○	○
GPS receiver	×	×	○

4.2 Base office equipment

①The base office equipment can be composed of commercially available database engines and map data with the present system application software to personal computers.

②When analyzing the images for hazardous driving, the equipment can also be made to show the location of hazardous driving and the traced path of the vehicle on a map displayed by dedicated software.

③The equipment can assist with safe driving guidance by providing safe driving assessments regarding abrupt acceleration/deceleration and excessive speed situations, etc., and by compiling and displaying hazardous driving areas.

The recording capacities for ordinary operation are as follows:

・Images: 1.2 MB/event (30 sec)
3 GB/50 vehicles (calculated assuming 5 events/vehicles)

・Audio: 0.6 MB/minute
0.75 GB/50 vehicles (calculated assuming 25 minutes/vehicles)

5 Main features

So that the personal computer can identify a necessary piece of image data from large total image database, the in-vehicle unit is designed to include in the recordings those hazardous driving images that will be needed for safety learning and instruction but to exclude those images that will not be so needed. For the base office side of the system, care has been taken to improve the data identification process and viewability/readability of screen displays and form printouts, so that safe driving guidance and learning can be implemented with high efficiency for each driver and area. There are also functions that permit easy alteration of the in-vehicle unit's parameters, which must be varied to match operation. These functions are described below.

5.1 G sensing algorithm

The in-vehicle unit must function so that it will reliably record images of almost-accidents involving abrupt deceleration or swerving, etc., but will leave out images that are recorded when going over bumps, during lane changes, and similar situations. Occurrences of G due to abrupt start, abrupt deceleration or collisions during driving can be categorized in the manner shown in Fig. 4. With abrupt start and abrupt deceleration, a relatively low G value occurs for a long duration (①), while with a collision a high G value occurs for a short duration (②). Accordingly, the sensing conditions were set as follows.

Detecting condition 1: Sensed G value must be ① or higher, and time duration ① must be exceeded

Detecting condition 2: Sensed G value must be ② or higher, and time duration ② must be exceeded

The G sensors can detect G values in both the lateral and longitudinal directions. To accommodate braking while swerving, and collisions in diagonal directions, etc., the lateral and longitudinal direction G values are synthesized prior to processing. The images are recorded according to an assessment of this synthesized G value, the set G threshold value, and the occurrence duration. As discussed later, both the G threshold value and the time duration can be changed as desired at the base office.

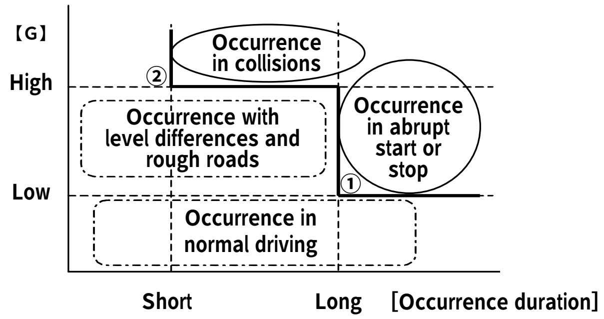

Fig.4 Conditions to detect acceleration G

Fig. 5 shows a result from driving along a stone-paved road. Although there was persistent vibration of the road surface such that the driver could not properly grip the steering wheel, the situation was not sensed as constituting hazardous driving because value threshold ① was not exceeded.

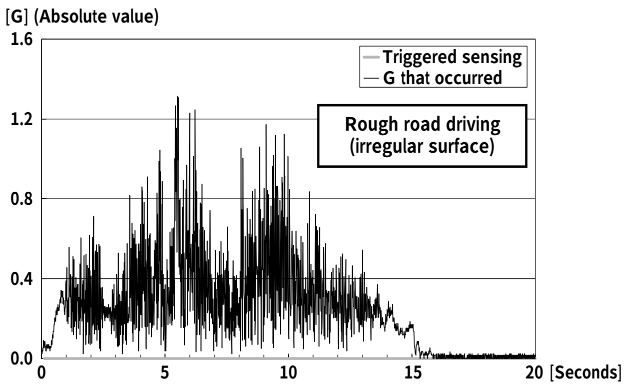

Fig.5 Case where the acceleration G is not detected on the rough road

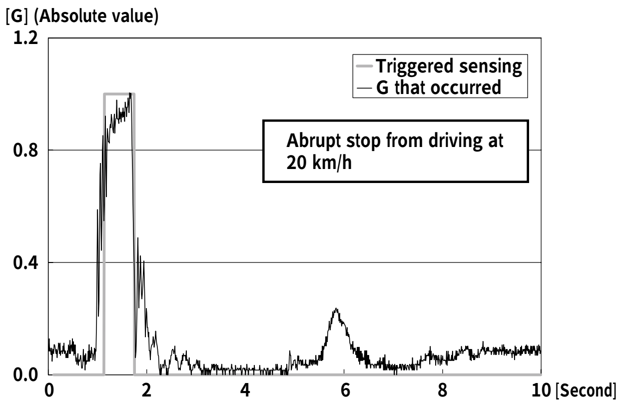

Fig.6 Case where the acceleration G is detected in the sudden deceleration

When the system was monitored in use in actual vehicles, it was able to sense G and record the images in the case of abrupt swerving and abrupt acceleration, in the same way as with abrupt stop.

Fig. 7 shows results of G sensing (under condition 2) in collision tests, where occurrence of high G value lasted approximately 100 ms.

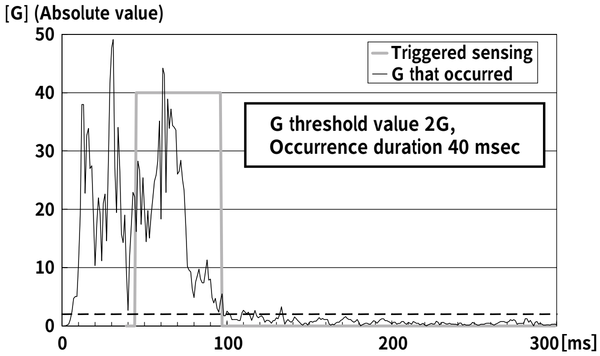

Fig.7 Case where the acceleration G is detected in the collision

Normally, when the CF card's memory capacity is exceeded, the older images are overwritten (erased). However, the system is configured so that images recorded under Condition 2 are assigned high importance since they are highly likely to be images of an accident, and are therefore not overwritten.

5.2 Base office application

The task of the application installed at the base office is to retrieve the image, audio and operation data recorded on the in-vehicle unit's CF card, save such data in the database, and then play back the image and audio data.

Besides analyzing the images, the application assigns scores to the recorded data according to the degree of abrupt accelerations, abrupt decelerations, excessive speed, and similar driving situations for each driver, and arranges such records in a database. This enables it to provide displays of ordered hazardous driving lists (ranked according to degree of hazard) and area/position displays on maps, which can be of use in safe driving guidance.

This software has the following features:

- Save and playback of images recorded by the in-vehicle unit, and printing of instruction sheets
- Save and playback of audio recorded by the in-vehicle unit
- Save driving data recorded by the in-vehicle unit
- Assign drivers a hazard ranking according to the driving data, and printing of instruction sheets
- Analysis of driving data to identify areas where driving violations frequently occur, plotting of those areas on maps, and printing of those maps/results
- Analysis of driving data to identify areas that are good for passenger pickup , plotting of those areas on maps, and printing of those maps/results
- Formatting of CF cards used by the in-vehicle unit

Fig. 8 shows sample application screens and form printouts.

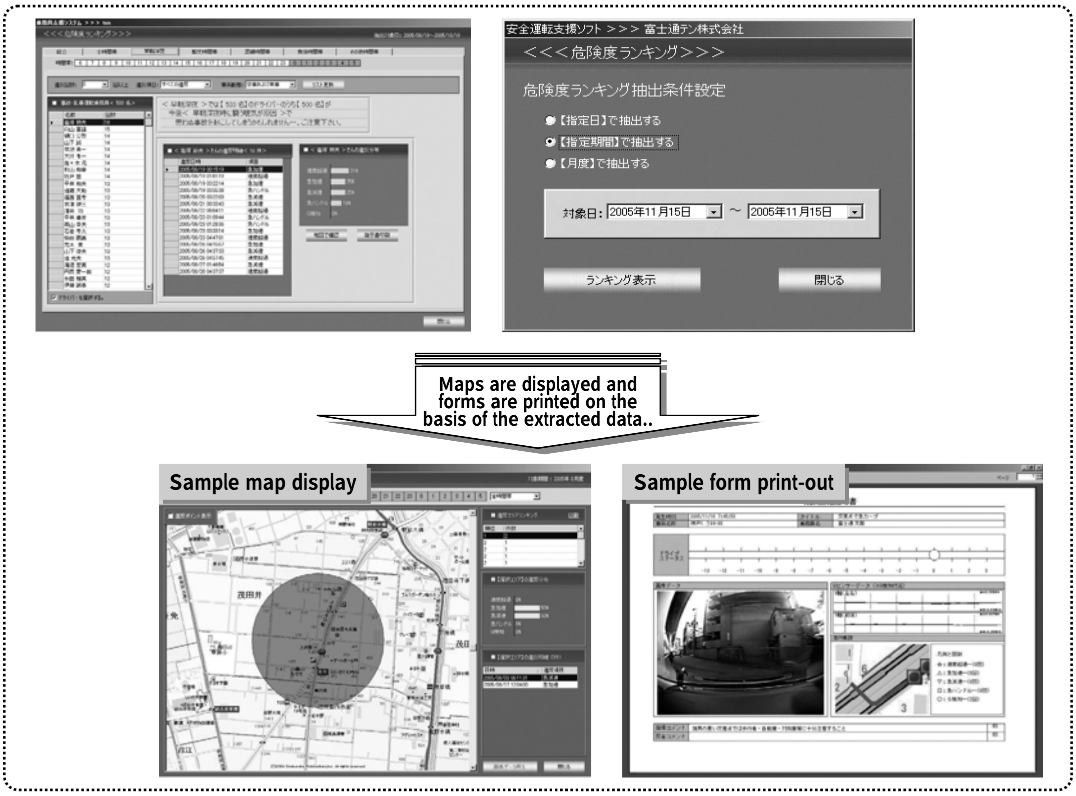

Fig.8 Sample screen images and print-out form at the base office

5.3 Methods of searching and saving the image data

Fig. 9 illustrates an example of how the necessary data is speedily identified from the large image data and utilized for safety guidance.

By specifying conditions for the image data to be identified, a list of applicable image data is displayed. When an applicable data item in the image data list is specified, the images will be displayed. Image data that is deemed particularly necessary can be saved using a "MyNote" function. Utilizing the MyNote function will facilitate image searches during operation guidance.

5.4 Changing the in-vehicle parameters

There will be many occasions when the parameters that trigger image recording will need to be changed, and parameters will vary according to each company or driver.

So as to enable changing of differing parameters for each in-vehicle unit, we decided to store the "operation parameters" and the "in-vehicle unit programs" on the CF card.

By establishing such system, operation parameters and in-vehicle unit programs can be changed directly on the CF cards at the base office and these changes will be reflected in the individual in-vehicle units.

The driver is alerted when abrupt acceleration/deceleration or excessive speed is sensed from the vehicle speed pulse signals.

Parameters can be set at the base office PC for each driver.

The following is an example of parameter setting for abrupt acceleration.

<Example> Abrupt acceleration will be judged to have occurred if a speed increase of 10 km/h or greater occurs within one second. (The acceleration rate and duration settings can be changed.) When abrupt acceleration is judged to have occurred, the driver is alerted via a buzzer or synthesized voice (when the system is linked to an AVM). Further, the data is recorded as driving data, for use in assigning hazard rankings and analysis of frequent violation areas.

Fig. 10 shows screens for parameter setting in-vehicle unit and updating programs.

Fig.10 Sample screen images to set parameters and to update the program

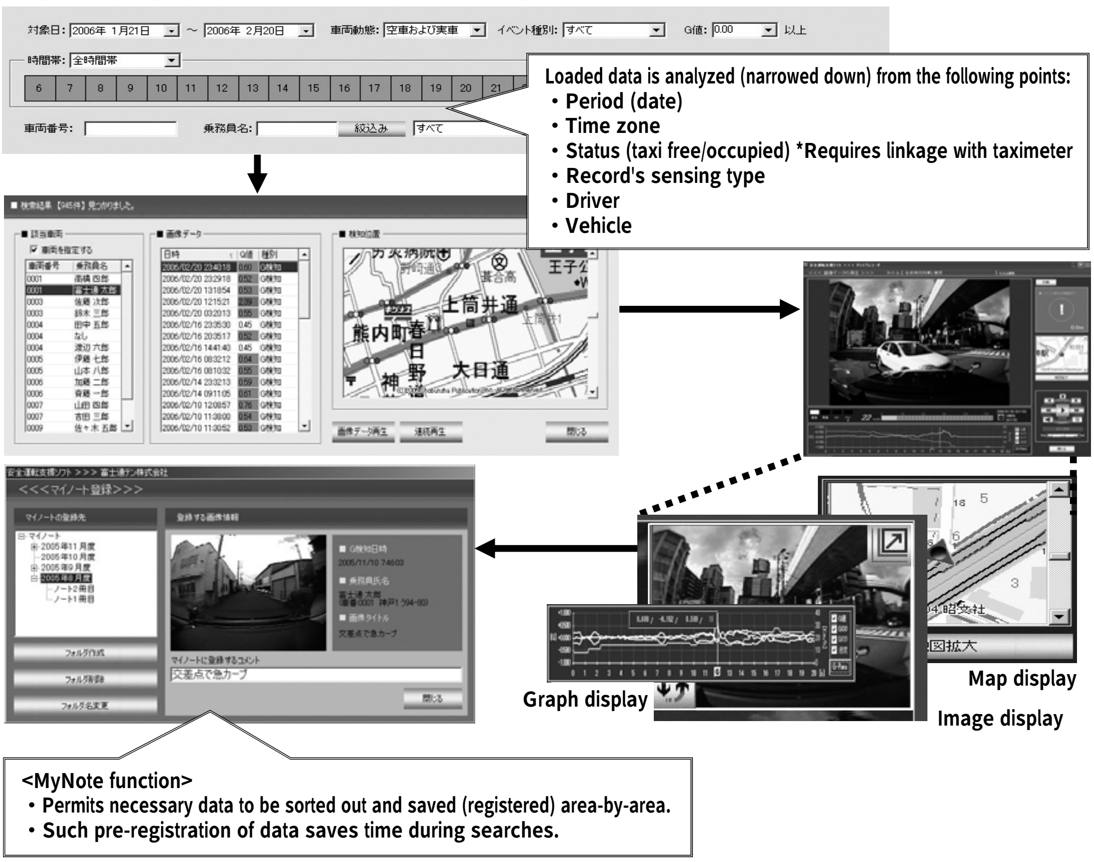

Fig.9 Sample screen images to search/to display/to save the driving data

6 Conclusion

In FY2005 some 30,000 taxis, 10% of the total taxi market, were equipped with the drive recorder due to its effectiveness in reducing the number of accidents and improving fuel economy.

It is anticipated that subsequently the drive recorder will spread into the commercial vehicle market, comprising 19 million vehicles, and from FY2008 onward it will enter the passenger vehicle market, which comprises 56 million vehicles.

The form that the drive recorder takes when it spreads into the passenger vehicle market is likely to be different from that taken for commercial vehicles with a G sensor and camera being added to a car navigation system possessing a hard disk drive.

Besides fusion with car navigation systems, the drive recorder also promises to spread via fusion with "car security functions" using car-interior cameras, with image recognition technology for sensing "dozing-at-the-wheel", and with nighttime "pedestrian recognition systems" using infrared cameras, thereby forming devices that will contribute to reassurance and safety with their particular functions.

In the times ahead we will develop distinctive products, with easy to use functions taking the lead in pioneering a drive recorder market with major potential for the future.

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