Current Status of Incident Data Study by Drive Recorders

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To investigate the primary factors that induce traffic accidents, it is effective to detect and analyze not only accidents but also incidents by using drive recorders. This paper introduces the research activities on drive recorders carried out by the Society of Automotive Engineers of Japan (JSAE).

***Key Words**: drive recorder, incident, traffic accident, database*

1. Introduction

Regarding recent railway accidents in Japan, the subway train derailing and collision at Nakameguro station of Tokyo's Hibiya Line on March 8, 2000, and the derailing and crash of a Japan Railways Fukuchiyama Line train on April 25, 2005, are still fresh in our memories. Such accidents involving trains or other means of public transportation can easily lead to tragedy and rightly receive considerable attention in newspapers and on television.

However, the loss caused by railway accidents cannot compare with that caused by auto accidents. In 2004, for example, auto accidents killed 7 358 people and injured another 1.2 million. Based on the overall population of Japan, we can calculate that about one of every 100 Japanese suffers from an auto accident each year. Nonetheless, because the chance of being involved in an auto accident is very high compared with train accidents and others, people tend to think it will never happen to them. But involvement in an auto accident brings tragedy, both to the person involved and to that person's family. In addition to such personal suffering, it is estimated that Japan suffers economic loss of more than 4 trillion yen each year as a result of auto accidents. To curb this personal and economic loss, Prime Minister Koizumi at the beginning of 2003 announced a goal of halving traffic fatalities over the next 10 years, and measures are being introduced to improve safety.

In order to prevent accidents, it is essential that their causes be clarified. In the case of airplanes, a "black box" records all flight data and is useful in clarifying cause in the case of an accident. In the case of the above JR Fukuchiyama Line train accident, investigators were able to identify train speed at the time of the accident because of a recording device installed on the train, and there is a movement to make installation of such devices mandatory on all trains. Regarding automobiles, image recording "drive recorders" have been introduced, and reportedly about 35 000 are currently being used, mainly in taxis.

2. History of Drive Recorder Development

As part of the Advanced Safety Vehicle (ASV) Project being carried out by the Ministry of Land, Infrastructure and Transport, an investigation was performed on drive recorders to analyze the safety benefits of their technology and usefulness in accident investigations. The results of that investigation are shown in reference paper 3). Another type of drive recorder was developed by specialist traffic accident investigators in response to persons who had lost family in traffic accidents and were not satisfied with investigation results based largely on the vague statements of witnesses. This drive recorder, an image recording device that fulfills the role of a witness, is quickly gaining popularity in taxis because it greatly speeds up the accident investigation process and is useful in teaching driving safety.

In some overseas countries, automobiles are being mandated to carry a device called EDR (Event Data Recorder) without video recorder, which keeps record of acceleration, etc. before and after a collision. The use of such data as those for checking actions of safety devices like air-bags, and for automatic emergency call, is also under study.

3. Activities of the Society of Automotive Engineers in Japan (JSAE)

As mentioned above, 7 538 persons died in traffic accidents in Japan in 2004, and because fatalities have been declining in recent years, it would appear the government's traffic accident countermeasures are working. However, the total number of accidents in 2004 was about 950 000, and the total number of persons killed or injured in traffic accidents was about 1.2 million, both increases from 2003. As seen in **Fig. 1**, figures for these two categories have been steadily increasing over the years, although the number of traffic fatalities has been decreasing. Many reasons for these opposing trends can be offered, but the conclusion is that less people involved in accidents are being killed. Certainly improvements in vehicle technology related to collision safety and lifesaving techniques have contributed greatly to this favorable trend, but there are many cases in which a person is saved but is left severely handicapped, so our joy over this statistic cannot be unrestrained.

What we should aim for next is a major reduction of the overall number of traffic accidents. Concerning vehicle technology, tremendous strides have been made until now in the area of passive safety, i.e. occupant protection in the event of a collision, but from now efforts should be directed mainly at improving active safety, i.e. accident prevention.

In 2002 the JSAE established a Future Traffic and Safety Committee (chaired by Professor Chikamori of Shibaura Institute of Technology) in its Collaborative Research Center to discuss and determine a vision for "21st century safe mobility" and a roadmap for achieving that vision. This committee completed first-phase activities in the first three years and has already begun second-phase activities. Details regarding these activities have been published in reference publication[2]. In the second phase, the committee is asserting that we aim to reduce not only traffic fatalities but also the number of accidents, and that to achieve that aim, a multifaceted approach including not only improvement of automobile technology but also improvement of driving environments

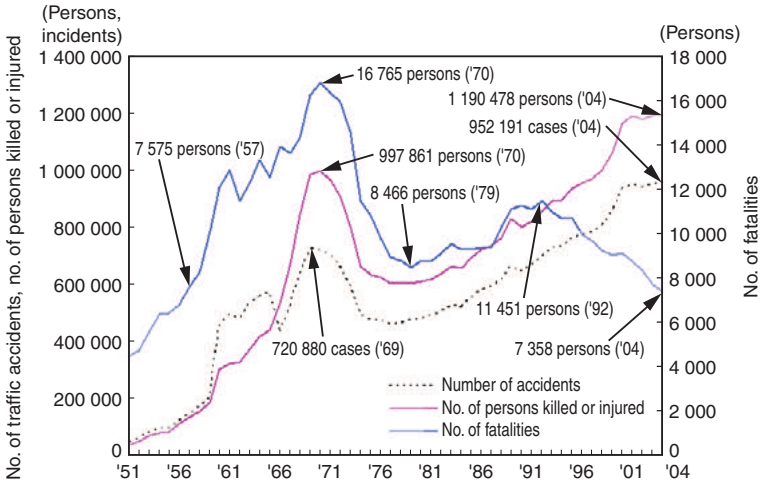

Fig. 1 Traffic accident trends[1]

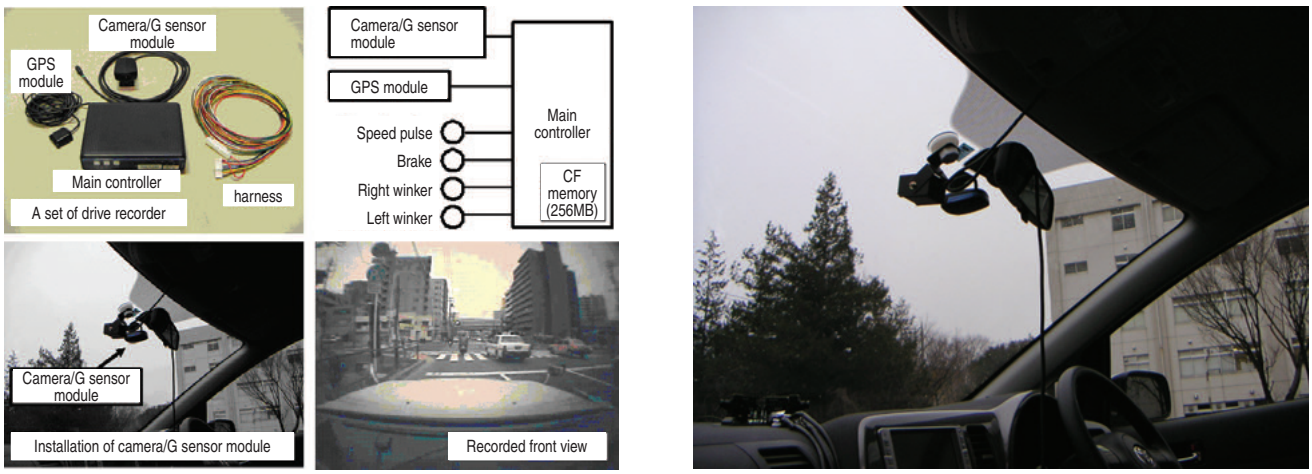

Fig. 2 Drive recorder (simplified type)

and driver education is necessary. In particular, this committee believes that in order to reduce accidents, it is necessary to study near-miss incidents in detail to arrive at countermeasures that eliminate root causes.

In August 2004, a Near-miss Incident Analysis Committee (chaired by Professor Nagai of Tokyo University of Agriculture and Technology and vice-chaired by Professor Kamata of Tokyo University) and a Near-miss Incident Working Group were established. An outline of research activities carried out in 2004 is provided below. This research was carried out on consignment from the Road Transport Bureau of the Ministry of Land, Infrastructure and Transport for the purpose of investigating the effectiveness of ASV, etc. through near-miss incident analysis. Research activities continued in 2005.

4. Near-miss Research

4. 1 Preparation of Drive Recorder

A drive recorder receives images of the vehicle front end, the driver, etc. by means of a camera and measures such vehicle data as accelerometer data, vehicle speed pulse data, and brake operation signals as well as GPS-based vehicle position and direction information. When preset trigger conditions are met, the images and data measurements from 10 seconds before the trigger through 5 seconds after the trigger (times can be varied) are recorded.

Using existing drive recorders and the investigation report[3] for reference, we prepared 60 drive recorders of the two types shown below.

■ Data collection type ("simplified type"): 55 units
■ Detailed analysis type ("high-function type"): 5 units

Information the simplified type records and measures, as shown in **Fig. 2**, is the vehicle's front view as taken by the camera, longitudinal and lateral acceleration as measured by the accelerometer, position and direction as measured by GPS, speed pulse measuring vehicle movement, brake operation signal, and turn signal operation (left/right).

The high-function type, in addition to the above-mentioned functions of the simplified type, records a view of the driver in the vehicle, measures yaw rate, and has a spare channel that can be used if necessary. Furthermore, this type not only can record data on the recording medium but also has a transmission function by which collected data can be transmitted by use of a cellular phone.

In the case of both types, the trigger specification is such that images and measurement data are recorded whenever emergency braking is applied or a collision occurs. There also is a manual switch that allows the driver to activate the trigger at any time.

We prepared the drive recorders described above, installed them on vehicles, collected near-miss incident data, analyzed the collected data, and clarified drive recorder specifications (image and measurement items, trigger specifications, data collection methods, etc.) and other matters requiring improvement.

Figure 3 shows an example of composite acceleration and composite jerks during emergency braking. As shown, the jerk value at the start of acceleration is high. Qualitatively, it is thought that when the speed of pressing the brake pedal is high or when the vehicle has a light collision, the jerk value becomes high.

Before installing the drive recorders on taxis, we installed them on passenger vehicles and performed a simple emergency braking test. Based on the results, we determined the acceleration value and jerk value required to ensure trigger activation during full braking to be L_a = 0.8 G, and L_j = 8.0 G/s, respectively. We then installed the devices on the taxis using these trigger settings. Also, the sampling frequency was set at 10 msec.

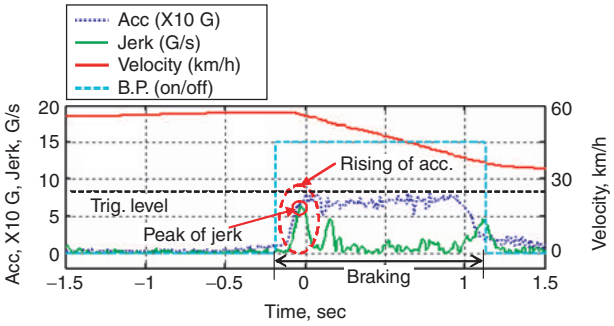

Fig. 3 Time history of acceleration and jerks

5. Collection of Near-miss Incident Data

We installed 58 of the drive recorders on vehicles and collected near-miss incident data during driving in the Tokyo area and outlying areas such as Tsukuba. We also constructed a database and entered the collected data.

1) Near-miss Incident Data Collection

Of the 55 simplified type drive recorders, 35 were installed on Tokyo area taxis and the other 20 on passenger cars owned by Japan Automobile Research Institute (JARI) employees, and near-miss incident data was collected. Three high-function types were installed on two taxis and one JARI vehicle for the same purpose.

2) Database Construction

We constructed a new database system comprising the two functions below to enable unified control and efficient analysis of a very large amount of near-miss incident data.

[Data collection and entering function]

· Data collection and entering by recording medium (CF)

· Data entering through data transmission system utilizing a cellular phone (for the high-function type only)

[Data reading and analysis function]

· Data reading and analysis by means of user interface module

6. Microanalysis of Near-miss Incident Data

We analyzed representative cases of near-miss incidents based on data collected by the simplified and high-function recorders to investigate the effectiveness of the drive recorders. Shown below is an example of a near-miss incident recorded by a high-function drive recorder.

Near-miss incident: sudden lane change by vehicle to the left-front of test vehicle

· Place of occurrence: Straight area of general four-lane highway

· Driver: Driver C (experiment vehicle No. 2)

· Description of near-miss incident (**Figs. 4** and **5**): A vehicle to the left-front of the test vehicle simultaneously turned on its turn signal and began to cut in front of the test vehicle (vehicle A). To avoid a collision, the test vehicle had to apply emergency braking.

· Driver's driving behavior: Driver C habitually used only his right hand to steer the vehicle. He applied the brakes 0.44 seconds after the car to the left-front turned on its turn signal, and 0.42 seconds thereafter he placed his left hand on the steering wheel (in addition to his right hand) to avoid a collision.

· Triggering: The recording circuit was triggered by the acceleration.

· Vehicle behavior: Maximum acceleration was 0.82 G, and the maximum jerk was 6.6 G/s. During estimated full braking time of 1.28 seconds, rapid deceleration of 20.2 km/h was experienced.

· Causes of near-miss incident: The driver of the left-front car changed lanes without checking traffic in

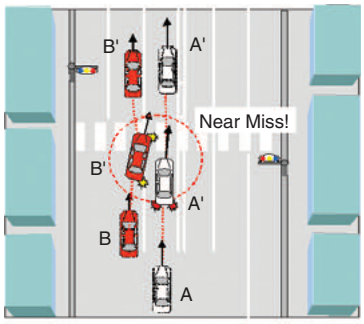

Fig. 4 Near-miss incident (cut-in lane change)

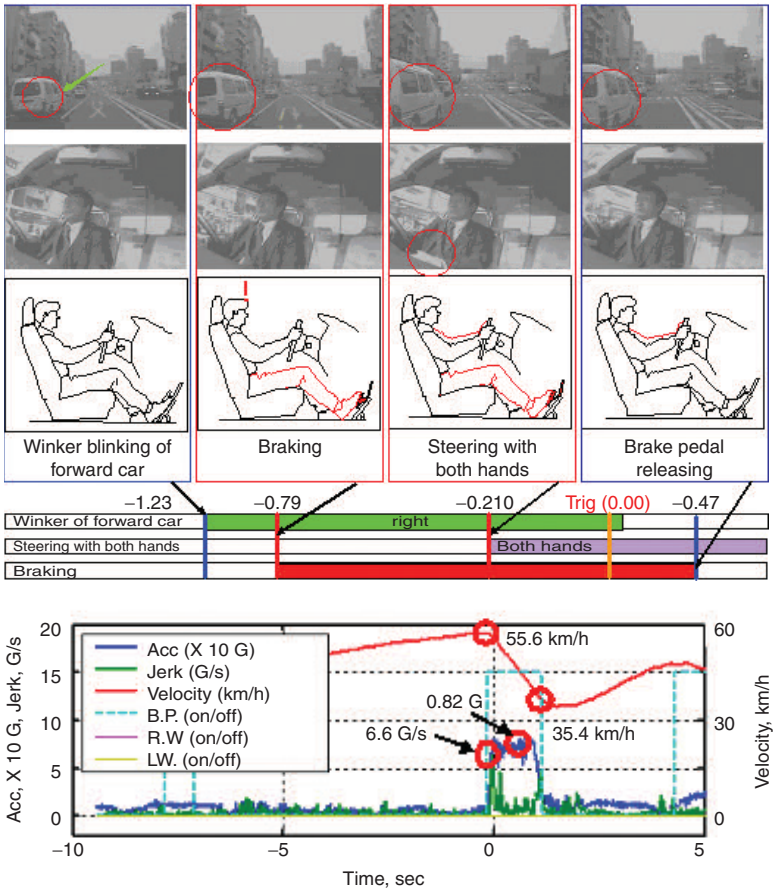

Fig. 5 Analysis of near-miss incident (cut-in lane change)

the adjacent lane, and Driver C was slow to carry out avoidance maneuvering because of holding the steering wheel with one hand.

Analysis of near-miss incidents: Near-miss tendencies by driver

Sixteen near-miss incidents in addition to the above were analyzed, and results by driver are shown in **Fig. 6**. These incidents also are broken down into the following four categories depending on incident cause: automobile, bicycle, pedestrian, and light-collision accident. The number of incidents experienced by Driver C is conspicuously high, apparently the result of his tendency to apply emergency braking often. The possibility is high that such differences in individual driving behavior significantly influence the number and type of incidents experienced.

7. Summary of Near-miss Incident Investigation

The near-miss incident investigation started in 2004 resulted in the following findings:

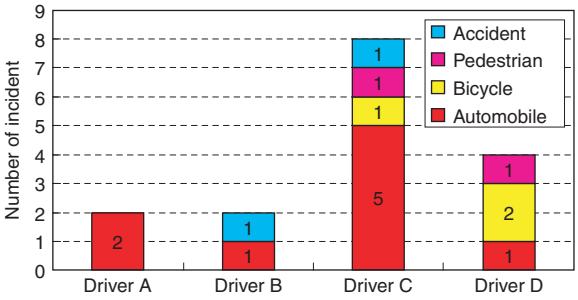

Fig. 6 Breakdown of near-miss incidents by driver (16 incidents)

1) Specifications of the drive recorders and items to be improved have been clarified.
2) The occurrence of near-miss incidents on the test vehicles was 1.5 incidents per 1 000 kilometers.
3) The near-miss incident recording device was shown to be effective in microanalysis of driver avoidance maneuvering and vehicle behavior during near-miss incidents.

This research carried out on consignment from the Road Transport Bureau of the Ministry of Land, Infrastructure and Transport was continued in 2005, focusing mainly on the following three issues (refer to **Fig. 7**).

1) While continuing to accumulate near-miss incident data through the field use of drive recorders, the committee will carry out macro-analysis of the collected data. Also, it will select representative near-miss incidents. The plan is to collect some 5 000 pieces of near-miss incident data in 2005.
2) Based on the idea that near-miss incidents can also be detected by activation of preventive safety devices, the committee will prepare drive recorders that can detect preventive safety device activation and investigate preventive safety device (including ASV technology) activation frequency and occurrence situations.
3) The committee will develop methods of simulating representative near-miss incidents on a driving simulator in order to clarify mechanisms inducing near-miss incidents and understand such matters as the influences of man, road situations, and automobiles.

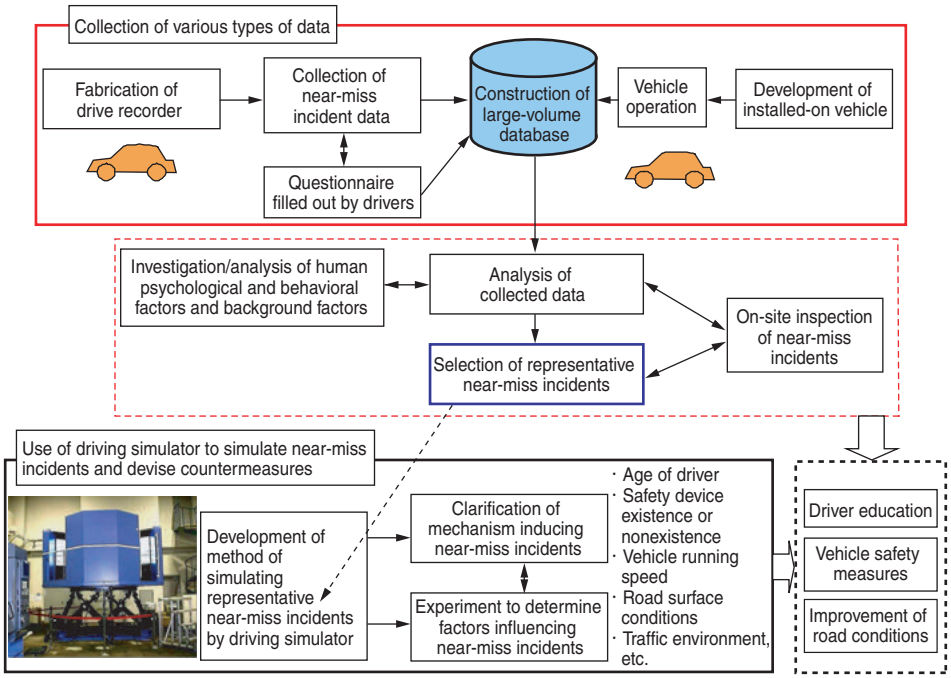

Fig. 7 Flow chart of near-miss incident research by JSAE

8. Conclusion

In this paper, the research activities of the Near-miss Incident Analysis Committee aimed at eliminating fatalities and injuries resulting from traffic accidents have been introduced. This committee hopes in the future to expand its activities and formulate effective countermeasures against such fatalities and injuries.

Recently various drive recorders have become commercially available, and many activities involving the use of these recorders to collect and analyze data are being carried out. The standardization of drive recorders and databases is necessary, and this will require the cooperation of all concerned parties.

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