New In-vehicle Information Systems from Hitachi Group

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OVERVIEW: Growing consumer awareness of environmental and safety issues is driving demand for new features in car navigation systems. Such functions developed by Clarion Co., Ltd. include ecological route search functions that reduce fuel consumption, a new around-view monitor with added functions such as detection of objects crossing from the side and parking space recognition, and a wrong-way warning function whereby the car navigation system on its own is able to detect when the vehicle is traveling in the wrong direction on a road, something that has become an increasing problem on expressways and elsewhere in recent years. Plans are already in progress to commercialize these technologies and the company is now setting its sights on technologies that utilize communication capabilities to help realize a safer and more environmentally friendly automotive society.

INTRODUCTION

AGAINST a background of increased consumer awareness of environmental protection and the need to ensure driving safety in an aging society, the functions of car navigation systems are growing in sophistication, providing route guidance that takes account of considerations such as safety and the environment rather than just providing a route that gets you to where you want to go.

This article describes examples of these technologies that Clarion Co., Ltd. plans to commercialize. These are an ecological route search function that minimizes fuel consumption, an around-view monitor with new functions such as the ability to detect objects crossing from the side, and safety technologies such as a wrong-way warning function.

TECHNOLOGY BEHIND ECOLOGICAL ROUTE SEARCH FUNCTION

CO_2 emitted from vehicles is one of the causes of global warming and, to reduce CO_2 emissions, Clarion has developed technology for car navigation systems that can search and determine the route that reaches the destination with the minimum fuel consumption ($\fallingdotseq CO_2$).

Fuel Consumption Estimation

The following equation[1] estimates fuel consumption based on elevation data, driving pattern, and vehicle data.

$$Q=f_{(idle)}T+E\sum_{j=1}^{J}\left[\mu Mg\int_{t_{js}}^{t_{je}}vdt+\sin\theta\, Mg\int_{t_{js}}^{t_{je}}vdt+k\int_{t_{js}}^{t_{je}}v^3dt+(M+m)\left(\frac{1}{2}v^2_{je}-\frac{1}{2}v^2_{js}\right)\right]$$

The first term on the right-hand side of the equation represents the fuel consumption during idling, the second and subsequent terms represent the fuel consumption due to rolling resistance, difference in elevation, air resistance, and acceleration and deceleration. Also, to take account of the fuel cutoff

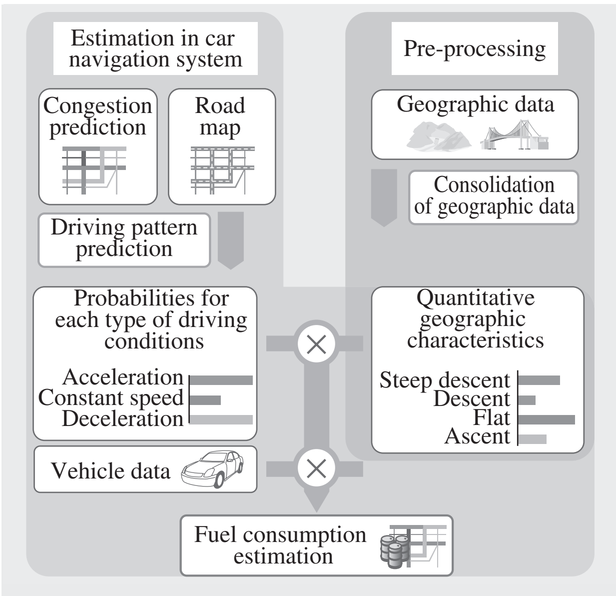

Fig. 1—Sequence of Fuel Consumption Estimation Processing.
Fuel consumption is estimated from realtime processing executed in the in-vehicle unit (left) and pre-processed data (right).

mechanism that operates when the vehicle descends steep downhill sections of road, the proportion of the route made up of steep downhill sections is determined and used to adjust the result. The elevation data is obtained from the map data and the driving pattern of acceleration and deceleration is estimated from the realtime traffic information and travel times contained in the road data. The vehicle data is obtained from catalog specifications and user input.

Fig. 1 shows a diagram of these estimation processes.

Fig. 2 shows two routes from Yokohama City Office to Kunitachi City Office prioritized by time and fuel consumption respectively.

The numbers in the figure show the actual fuel consumptions of two vehicles of the same model that drove the two routes at the same time, both using toll roads where possible.

The results show that the ecological route used 260 mL less fuel, a reduction of approximately 7.4% in fuel usage (≒CO_2).

The time-prioritized route takes the long way round using expressways whereas the route prioritized for fuel consumption mainly travels via ordinary roads and covers a shorter distance with little change in elevation.

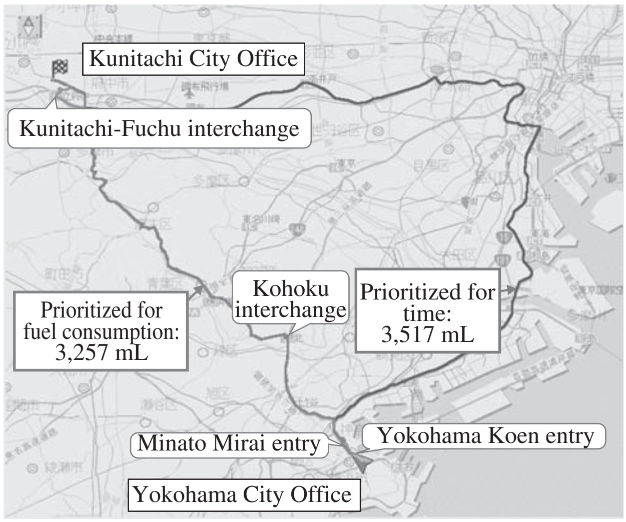

Fig. 2—Comparison of Fuel Consumption for Routes Prioritized for Time and Fuel Consumption Respectively.
The time-prioritized route takes the long way round using expressways whereas the route prioritized for fuel consumption mainly travels via ordinary roads and covers a shorter distance with little change in elevation.

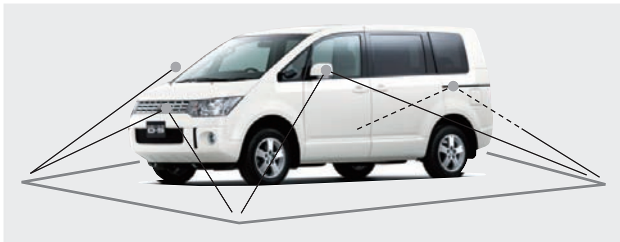

Fig. 3—Operation of Around-view Monitor.
Four cameras capture images of the area around the vehicle. These are translated into ground level projections by the processing unit to generate an image from a virtual camera located above the vehicle which is then displayed on the external display screen. The processing is executed by an image processing ASIC (application specific integrated circuit).

Other Initiatives

The approach described above provides a method whereby a car navigation system on its own can reduce vehicle CO_2 emissions simply by adding the route search software and elevation data to an existing navigation unit. Another current technical trend is the commercial application of techniques that assist ecological driving by using telematics to analyze acceleration and deceleration data.

This works by using a mobile phone to relay acceleration and deceleration data to a center where it is analyzed. The driving practices that will assist each individual driver to achieve ecological motoring are then presented back via the Web. Drivers can improve their fuel consumption by changing their driving behavior in response to these instructions.

DEVELOPMENT OF AROUND-VIEW MONITOR SYSTEM

Although minivans and station wagons are enjoying growing demand, one disadvantage inherent in their design is that they tend to have comparatively large blind spots at ground level and elsewhere where it is difficult to see the region around the vehicle. Because it is expected that this type of vehicle will be used by larger numbers of people in the future, including the elderly, resolving this problem is an urgent issue.

Overview

The around-view monitor is a system that synthesizes an image of the region around the vehicle as seen from above. Images of the surrounding area are captured by four cameras on the front, rear, and sides of the vehicle and then processed to synthesize an image of how the scene would appear from above if these images were projected onto the ground (see Fig. 3).

Fig. 4—Example Display from Around-view Monitor.
The monitor simultaneously displays the composite bird's eye view next to the conventional front or rear display.

As performing the image synthesis processing on the current CPU (central processing unit) is inefficient, a dedicated high-speed image processing ASIC (application specific integrated circuit) was developed for this task. Delivery of the system to Nissan Motor Co., Ltd. commenced in October 2008.

The system is invoked automatically by selecting reverse gear or pressing the camera button. The screen display is split into left and right halves to display the bird's eye view or an enlarged image of the area around the front wheels next to the conventional rear-view or front-view display. As lines indicating the width of the vehicle and its projected path can be superimposed together with proximity information from the corner sonar, the driver can park or pull over the vehicle with confidence while keeping a check on the surrounding area using simple and intuitive operation (see Fig. 4).

Detection of Objects Crossing from Side

This system detects approaching objects (people or other vehicles) when stopped or driving at low speed. Clarion has developed logic to identify objects approaching the vehicle based on movement detection that can generate warnings in a way that avoids misdetection of objects for which the predicted movement of the vehicle indicates a warning is not required (see Fig. 5).

Parking Space Recognition

Clarion has developed logic that can handle various different situations by combining the results of a number of different high-speed and high-precision recognition techniques for detecting lines. A feature of the system is that it is less affected by adverse factors such as shadows, blurring, low contrast, or fallen leaves (see Fig. 6).

Future plans include improving the image recognition and processing techniques and using the system for applications such as monitoring the surroundings using multiple cameras, driving support, and recording the vehicle and surrounding area.

Presentation of PACE Award

An award for the around-view monitor was presented to Sony Corporation, Nissan Motor Co., Ltd., and Xanavi Informatics Corporation (now part of Clarion) at the 2008 PACE (Premier Automotive Suppliers' Contribution to Excellence) Awards run by Automotive News magazine in the USA in

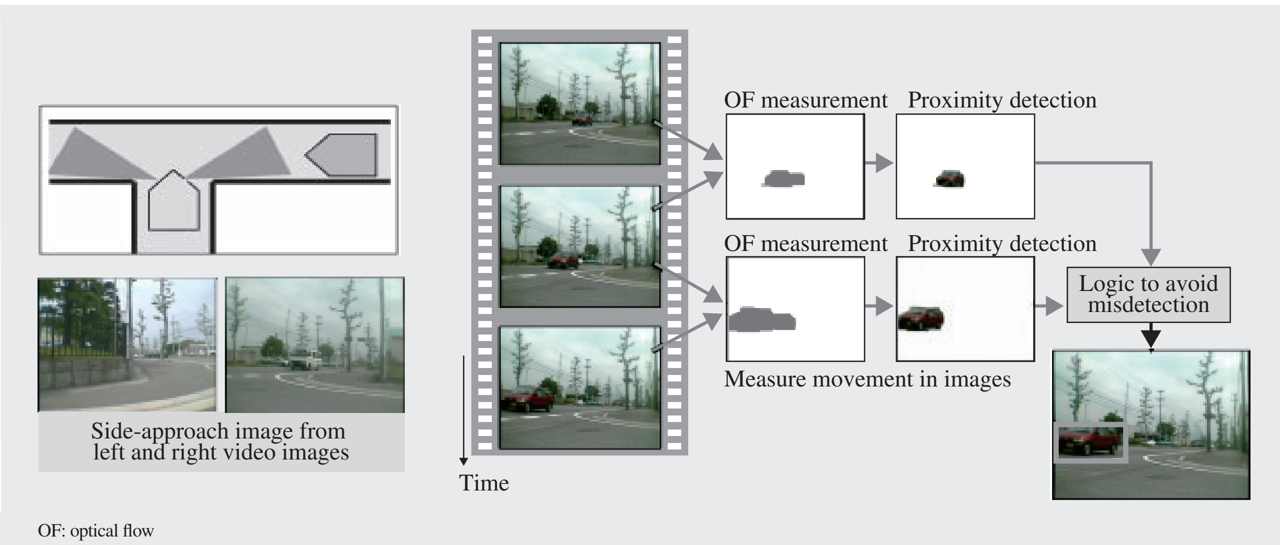

Fig. 5—Detection of Objects Crossing from Side.
The system uses movement detection to detect objects approaching the vehicle.

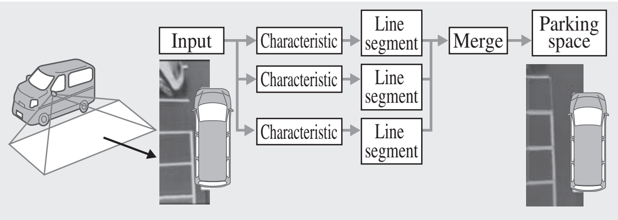

Fig. 6—Parking Space Recognition.
Parking space lines are detected from multiple characteristic quantities including color transformation and edge detection.

recognition of the high level of its technology.

DEVELOPMENT OF WRONG-WAY DETECTION SYSTEM

Incidents of vehicles driving the wrong way on expressways show no signs of diminishing despite measures such as improving road markings and signage or installing sensors that detect and warn vehicles driving in the wrong direction.

As many of these are the result of driver misunderstandings such as mistaking the exits or entries to service areas, Clarion came up with the idea of adding countermeasures in the vehicle itself and developed a mechanism that uses the car navigation system to issue a warning to the driver.

Specifically, the system uses the GPS (global positioning system) positioning information in the car navigation unit to detect when the vehicle is traveling in the wrong direction on a road and then generates both audible and on-screen warnings (see Fig. 7).

The following describes the principle of operation with reference to the figure.

(1) The car navigation system uses its map data to look ahead and detect points where processing is to be invoked. On detecting such a point, the system determines, for the associated site, the area in which to check whether the vehicle is traveling in the correct direction (by executing the check processing) (see Fig. 8).

(2) The vehicle direction (GPS direction) that constitutes “going the wrong way” in the check area is defined in advance. When the vehicle reaches the check area, the system outputs a warning if the output from the GPS indicates it is traveling in this “wrong way” direction (see Fig. 9).

(3) Consequently, a warning is only output if the vehicle exits the wrong way from the site (see Fig. 10).

The data defining the points at which processing is to be invoked and the wrong-way check area are

Audio prompt: “You appear to be going the wrong way. Please take care!”

Fig. 7—Example Screen from Wrong-way Warning System.
Both audible and on-screen warnings are issued.

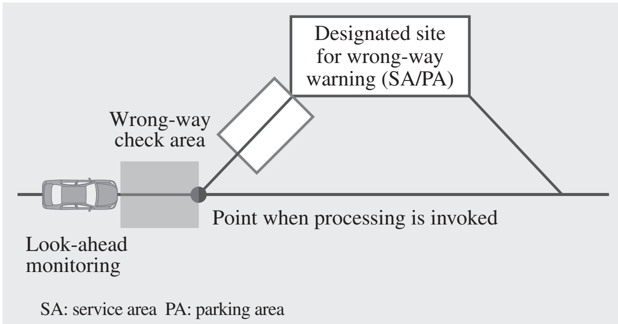

Fig. 8—Identification of Wrong-way Check Area.
The system identifies the wrong-way check areas for designated sites.

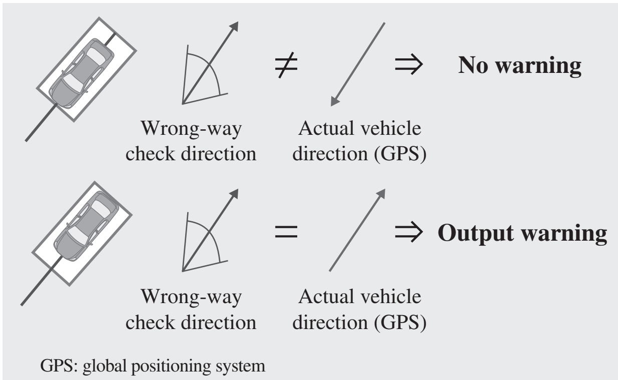

Fig. 9—Wrong-way Check Processing.
The actual vehicle direction is compared to the wrong-way check direction to determine if a warning is required.

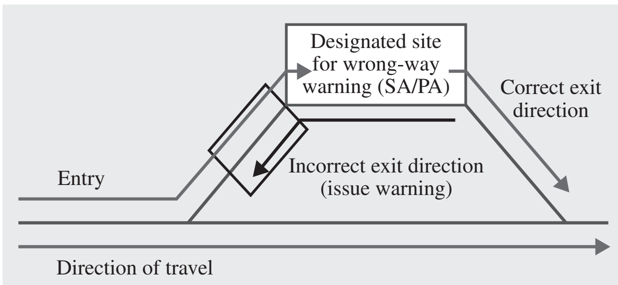

Fig. 10—Designated Site for Performing Wrong-way Check.
A warning is issued if the vehicle exits from the site through the check area.

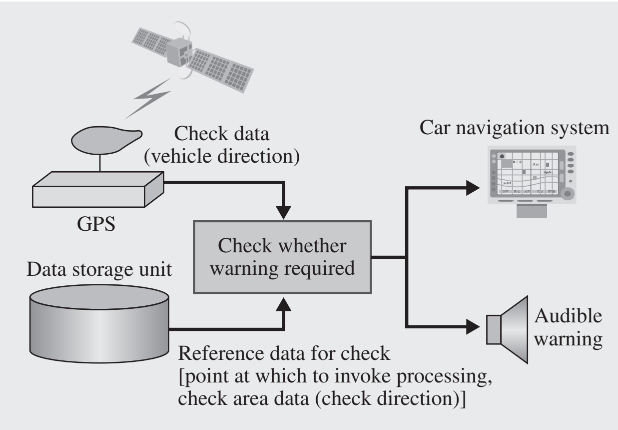

Fig. 11—Method Used to Notify When Vehicle Detected Moving in the Wrong Direction.
The point at which to invoke processing and the data for the check area are recorded on the data storage unit and generated automatically from the road attributes in the map data.

recorded in the car navigation system's data storage unit in the same way as map data and are generated automatically from the road attributes in the map data (see Fig. 11).

When compared to road-side methods, this approach of using the car navigation system to generate wrong-way warnings has the following features.

(1) Advantages

The driver cannot fail to notice the warning because it is output repeatedly until the driver acknowledges it (it is possible that the driver may drive past road-side warnings without noticing them).

(2) Disadvantages

No warning will be generated in locations where GPS reception is unavailable.

Clarion believes that actual deployment needs to be done in the way that obtains the maximum benefit based on an understanding of the features of the various different methods.

CONCLUSIONS

This article has described examples of technologies that Clarion plans to commercialize. These are an ecological route search function that minimizes fuel consumption, an around-view monitor with new functions such as the ability to detect objects crossing from the side, and safety technologies such as a wrong-way warning function.

Functions that take account of environmental, safety, and other such considerations have been developed and applied in car navigation systems. Although this article has focused on functions that can be implemented using in-vehicle units on their own, research and development is already underway on environmental and safety functions that use new forms of communication such as WiMAX* (Worldwide Interoperability for Microwave Access) and mobile phones that are already available to take advantage of the huge data resources and overwhelming processing capabilities of central servers, and the future is likely to see these functions entering practical use.

We hope to make a major contribution to society through its in-vehicle information systems business based on these environmental, safety, and other technologies.

* WiMAX and WiMAX Forum are registered trademarks of the WiMAX Forum.

REFERENCE

(1) Oguchi et al., "Model for Estimating CO_2 Emissions from Vehicle on Urban Roads," Journal of the Japan Society of Civil Engineers, No.695/IV-54 (Feb. 2002) in Japanese.

ABOUT THE AUTHORS

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