Navigation System Conforming to Naviken S-Standard and VICS

● Atsushi Ichimura ● Masatsugu Kamimura ● Kanji Kataoka

● Kojiro Chikazawa

VICS car navigation service started in April 1996. In June, later this same year, the Navigation System Researchers' Association was established and a new format of car navigation data, the S-Standard, was introduced. The S-Standard format is capable of linkage with Vehicle Information and Communication System (VICS) and of drawing various maps that contain such characteristics as fine details and landmarks. In addition, various attributes for guidance and data structures for quick routing were added to the new format. We developed a navigation system conforming to the VICS and S-Standard format. This was released in April 1997. The following is an outline of the characteristics of the VICS and S-Standard car navigation formats. In addition, the main functions of our car navigation system are described.

1. Introduction

Recently, the usefulness of car navigation equipment has become recognized and its market demand is stably increasing.

VICS service was first released in the Tokyo, Yokohama, Saitama, Chiba, Osaka, and Nagoya areas, and has been increasingly attracting attention.

Fujitsu TEN has been developing and manufacturing car navigation products supporting map data in the format specified by the Navigation System Researchers' Association (hereinafter referred to as Naviken) ①.

Recently, Naviken reviewed format standards and established a new format of VICS-accessable, landmark, and other road data called the S-Standard.

Accordingly, Fujitsu TEN is developing and manufacturing navigation products that conform to the new S-Standard format.

2. What is VICS?

VICS (Vehicle Information and Communication System) is an information system to provide drivers with the latest news about traffic conditions. By supplying this information and other useful en-route services to drivers, added benefits are realized. These benefits include the cutting of costs by shorting travel time, the increase in safety by obtaining accurate information about traffic and other road conditions, and the preservation of the environment by assuring the smooth flow of traffic. It transmits traffic jam, traffic control, and other real-time road information, which is edited and processed by VICS center. The data is edited and processed by VICS center to be displayed as text and graphics on a navigation monitor and other equipment in a car ②, ③. Currently, VICS service is available in the major metropolitan areas surrounding the greater Tokyo region and the Osaka and Nagoya areas. Service is scheduled to expand to the Kyoto area in November 1997.

VICS configuration is as follows (Figure 1):

Road traffic and parking information collected by the Japan Road Traffic Information Center and parking lot administrators is edited and processed at the VICS Center. Then, this processed information is forwarded to three types of media centers. Each type of media center transmits information to car equipment via the medium assigned to each media center. This means that users can obtain the latest traffic information in three display formats.

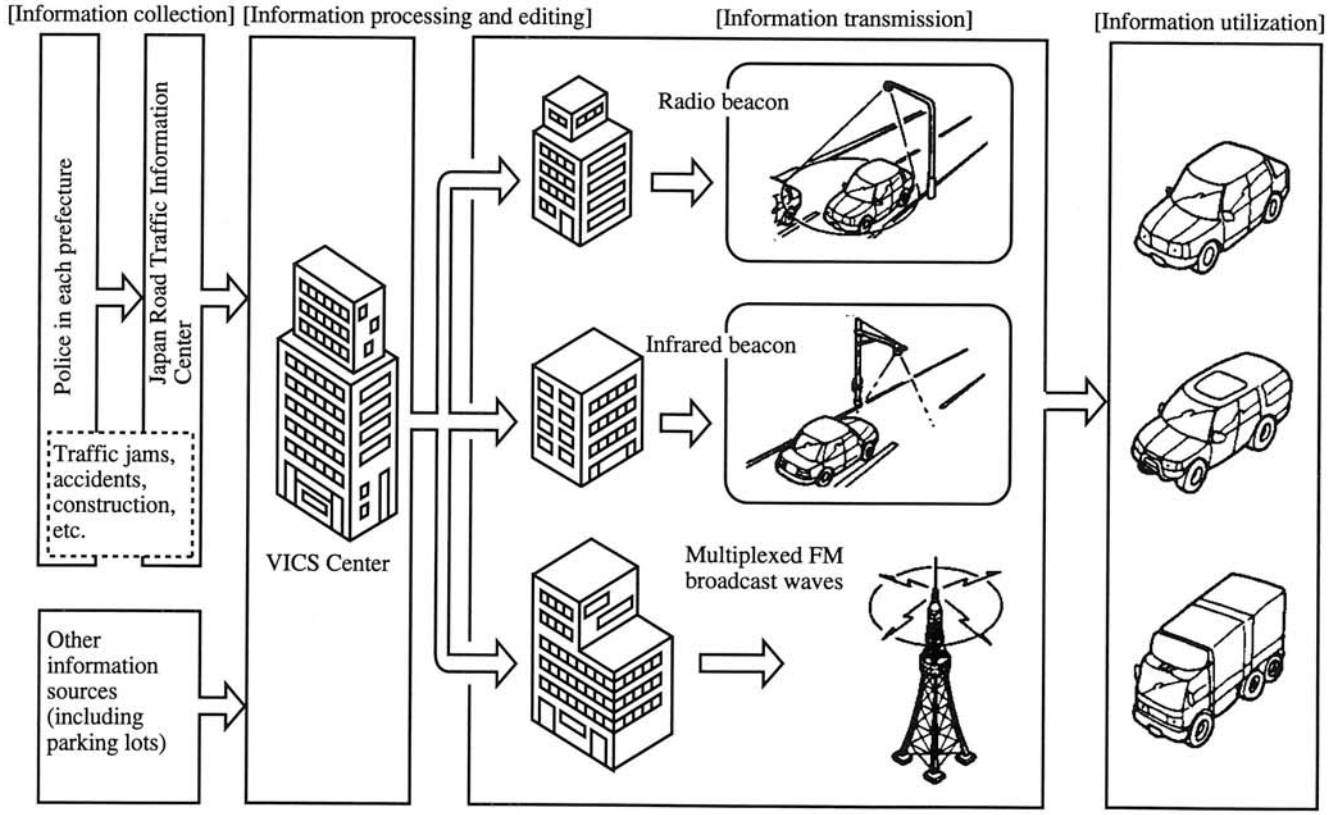

Figure 1. Vehicle information and communication system

Road traffic information edited and processed at the VICS Center is transmitted via beacons and multiplexed FM broadcast waves. Two types of beacons are used: Infrared and radio. Infrared beacons are placed along main roads and use light (infrared rays) as the transmitting medium. Radio beacons are placed along highways and use radio waves (sub-microwaves) as the transmitting medium. These beacons are used to provide information to limited areas. Multiplexed FM broadcast waves are used to transmit road traffic information to broad areas.

3. Naviken S-standard

3.1 Difference from previous version

The new data format based on the S-Standard is considerably different from the previous format (Version 2.1). Version 2.1 was, in effect, designed only for handling simple data. The S-Standard focuses on database features. This means developing navigation functions that take advantage of the benefits provided by the new format becomes important.

3.2 Characteristics of S-standard

The S-Standard format is outlined below:

(1) Displays maps in multicolor because of increased flexibility in color representation achieved by layer superposition.

(2) Systematically links route finding nets, road nets for map matching and map drawing, and VICS and other infranets.

(3) Displays detailed maps of all regions of Japan, including street maps, and road maps of a 50 meter or a 100 meter scale.

The principal characteristics of the S-Standard are represented by the following items:

① Supports detailed maps (scale of approximately 1:5000)
② Supports quick map scrolling
③ One CD-ROM covers the entire country
④ Additional attributes for reliable route guidance (useful cross information)
⑤ Supports quick route finding
⑥ Supports linkage with existing infrastructures
⑦ Supports affluent landmarks and has proven techniques of landmark detection
⑧ Enhanced capabilities of information processing
⑨ Overseas versions to be prepared
⑩ Provided hardware has distinct features (pseudo-stereoscopic views, rich colors)

4. Navigation system

4.1 Purpose of development

Emphasis was placed in the design of the following features to take advantage of VICS services, as described in the earlier chapters:

① Improved map display
② Quicker and better route finding
③ Easy-to-follow voice route guidence
④ Readable guidance display
⑤ Full VICS support (three types of media and three levels)

When the existing model was upgraded, consideration was given to methods of implementing desired functions with a limited quantity of memory.

4.2 Map displays

(1) Ordinary map display

For ordinary map display, the S-standard allows the scale to be varied in 2:1 steps. Our navigation system is designed so that the scales are equally spaced, and more scales are selectable than the previous version.

(2) Street map display

Regarding street map display, the S-Standard specifies two types of data: vector and CLUT maps. Vector maps are similar to ordinary maps. CLUT maps are in bitmap format. Our navigation system supports both types of street maps. Figure 2 gives an example of street maps.

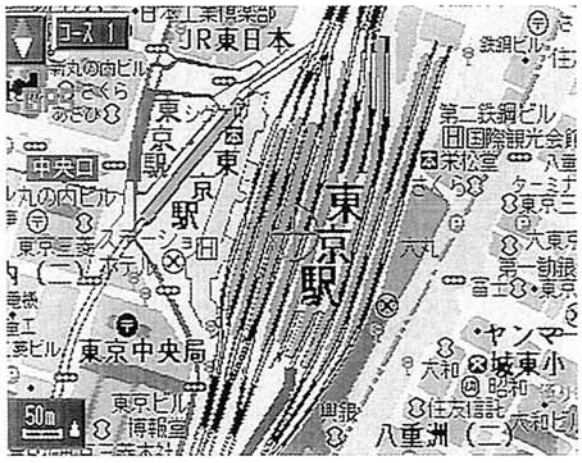

Figure 2. City map (CLUT)
(Vicinity of Tokyo Station)

(3) Heading-up display

The S-Standard includes a feature for map attributes; Displayed characters are prioritized to prevent character overlapping. Our navigation system makes use of this attribute to prevent character overlapping on maps.

(4) Route display

According to the previous standard, data for map and route display were recorded separately. There was a difference in the accuracy of these two kinds of data. This sometimes raised a serious problem. The S-Standard employs a new concept of geometrically deploying route data onto map data. As a result, discovered routes can be displayed in maps on a real-time basis. This means that routes are displayed along roads without an error.

4.3 Landmarks

Figure 3 gives an example of a map that contains landmarks. If a driver gets lost on an unfamiliar road, a driver can easily find his or her way by locating a bank, convenience store, gas station, or other establishment in the landmarks that represent each place.

Our navigation system generates a list of up to 200 landmarks, which belong to designated types of landmarks in and around the displayed area and are the closest to the car (Figure 4). When the user selects a landmark from this list, the system displays the map around the selected landmark.

Figure 3. Land marks on the map display (Vicinity of Kobe Motomachi)

4.4 Route finding

Our navigation system provides the following three functions to find routes:

① Ordinary routing
② Rerouting
③ Dynamic routing

Each of these routing functions is described below.

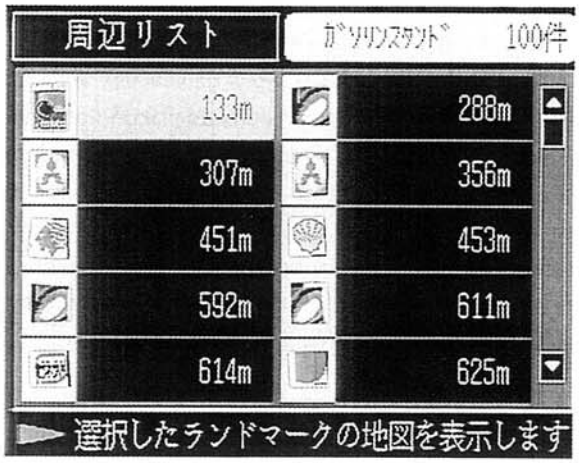

Figure 4 Picked up land mark list

(1) Ordinary routing

Ordinary routing is search for all routes between points designated by the user.

The features of this routing are quick search and multiple priority modes.

Our navigation system has the fastest route finding speed of all Naviken-compatible systems.

As indicated in Table 1, priority mode 1, which was also available in conventional equipment, can be combined with priority mode 2. A total of nine options are available for a user's selection.

Table 1 Priority modes to find routes

Priority mode 1			Priority mode 2		
Highway	Toll road	General road	Recommended route	Distance	Straight

(2) Rerouting

Rerouting is used when a driver deviates from a predetermined route. The driver searches for appropriate paths from a lost location back to the original route quickly.

With the conventional method, the technique for ordinary routing was used to calculate the path from the current position to the target position. The Fujitsu TEN system uses a separate route finding technique to return to the original route. This scheme has greatly shortened the calculation time. In general, no more than several seconds are required to find a new route back to the original.

(3) Dynamic routing

Dynamic routing is a method of finding the freest flowing route that avoids traffic jams and other traffic obstructions that may occur ahead. The information of level-3 traffic jams and traffic obstructions from infrared beacons is used.

For ordinary routing, static route information contained in the CD map is used. For dynamic routing, this static route information is replaced with dynamic route information that varies depending on jams and other related traffic obstacles. Route calculation relying on such dynamic information allows users to avoid jams and other driving anxieties.

4.5 Route guidance

Our navigation system provides the following four functions for route guidance:

① 3D enlarged guidance pictograms
② Traffic signal guidance
③ Warning that the car lights are on
④ Path guidance

Each function is described below.

(1) 3D enlarged guidance pictogram

Three-dimensional guidance offered by our navigation system features quasi-3D enlarged images of junctions and intersections as shown in Figure 5. This guide is very easy to read for users. Users can select one of three view angles; 15, 30, and 90°.

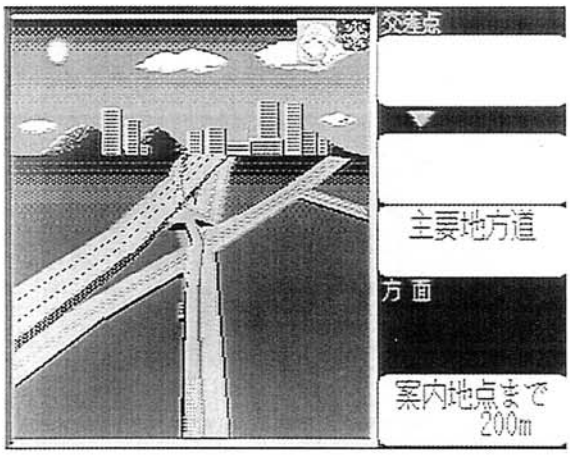

Figure 5. Guidance pictogram (quasi 3D)

In addition, the guidance is supplemented with the following: cross street names; the destination names (and distances) of where roads lead; road names (and signs); landmarks; and voice information, available depending on the subject of the guide. Thus, detailed guidance is available.

Furthermore, the display background changes color and design with the seasons and time zone. Seasonal images and calendar events may be included, making the guidance monitor more than just a simple display. The display is both a convenient and entertaining driving aid.

(2) Traffic signal guidance

The S-Standard format shows the presence (or absence) of traffic signals. The signal guidance function of our navigation system relies on this feature of the S-Standard.

This function counts the signals that are present between the current position and a junction or intersection, the count is displayed and the driver is shown the distance between the current position and the junction or intersection, in meters. In addition, the number of traffic signals between the distance is announced by verbal guidance. Thus, the user can obtain exact information about how long it will require to reach a target destination.

(3) Warning that car lights are on

This function provides a voice recorded warning that the lights are on after the car has exited a tunnel, according to tunnel attributes of a route, and the status of the lights before and after entering and exiting a tunnel.

(4) Path guidance

In Figure 6, the path guidance screen is shown. In the display, places chosen from a list of possible destinations of the current route, the distances between two chosen places, and additional road information about reaching each place are displayed.

This function allows users to easily obtain an outline of an entire route, the current position on a route, and other information that could not be easily accessed with conventional route guidance facilities.

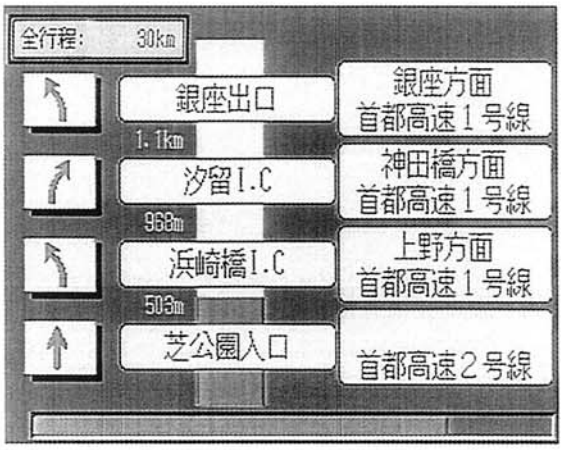

Figure 6. Path guidance

4.6 Text and graphic VICS information

Broad-area text and graphic information carried over FM multiplexed waves are reorganized as a database within the system. This allows drivers to view selected information from menus.

A joystick is provided for easy selection of information and page feed. Users can check information in a short period of time, such as, while the car is parked. If information to be displayed consists of more than one page, the "automatic feed" function can be used to display the pages in 10-second intervals.

Detailed text and graphic information from infrared and radio beacons are displayed as received, interrupting the current display.

Figures 7 and 8 give examples of text and graphic information displays.

Figure 7. VICS Information from FM Tokyo (character type)

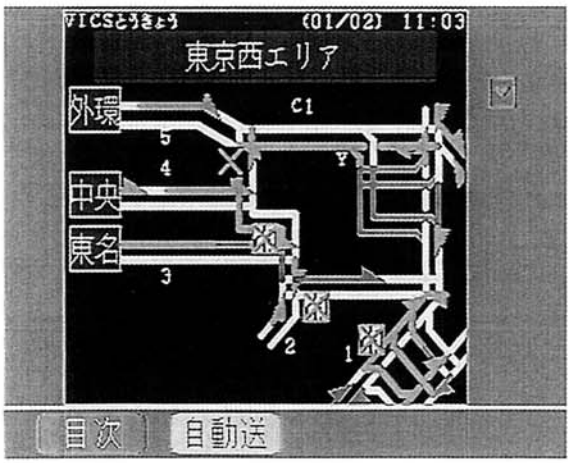

Figure 8. VICS information (graphics type)

4.7 VICS Information displayed on maps

VICS information that is displayed in maps includes information about traffic jams, traffic obstructions, and the vacancy of parking lots. Figure 9 gives an example of VICS information displayed in a map.

Figure 9. VICS information (map display type) (Vicinity of Tokyo Meiji Street)

An arrow that appears left of a road indicates a traffic jam. Traffic jams, traffic obstructions, and other information, which has detailed information, is displayed as an icon. These icons represent a type of information.

Users can display detailed information by pressing ENTER and selecting VICS. The meat information can be switched by moving the joystick in the indicated directions. The joystick is easy to operate. (Figure 10)

Figure 10. Detail information of regulation icon (Vicinity of Tokyo Aoyama)

Memory capacity of VICS information displayed is fairly limited. The range of VICS is a circular area with a radius of 15 kilometers around an equipped car. Traffic obstructions are displayed in a map at the scale of 800 meter or less because of database limitations.

5. Conclusion

In the above, the purpose of developing supporting the Naviken S-standard and VICS-accessable navigation system, and the principal technology leading to this development were discussed.

Navigation equipment requires more advanced and diversified functions as market demand increases. The major problem is how to design a navigation system that provides the necessary and accurate information and presents this information to drivers and passengers in an entertaining manner. The aim is to reduce a driver's anxiety and burden of navigation while driving.

Our plan is to develop and propose navigation systems that reflect the highest level of available multimedia technology.

Bibliography

(1) Takeuchi et al.: "Car-navigation" Fujitsu TEN Technical Report Vol. 14 No. 1, pp.46-52, 1996

(2) Vehicle Information and Communication System Center: "Endeavor for VICS," 1996

(3) Kamai et al.: "VICS- Receiver for 3 Media" Fujitsu TEN Technical Report Vol. 14 No. 2, pp32-38, 1997

Authors

Atsushi Ichimura

Employed by Fujitsu TEN since 1989; engaged in developing car navigation systems; currently a member of the Multimedia System R&D Department, the Multimedia Division, A.V.C. Products Group

Kanji Kataoka

Employed by Fujitsu TEN since 1987; engaged in developing AV equipment and car navigation systems; currently a member of the Multimedia System R&D Department, the Multimedia Division, A.V.C. Products Group

Masatsugu Kamimura

Employed by Fujitsu TEN since 1986; engaged in developing signal processing algorithms and car navigation systems; currently a member of the Multimedia System R&D Department, the Multimedia Division, A.V.C. Products Group

Kojiro Chikazawa

Employed by Fujitsu TEN since 1986; engaged in developing AV equipment; currently Assistant Department General a Manager of the Multimedia System R&D Department, the Multimedia Division, A.V.C. Products Group