Navigation System for Fire Station's Vehicle Location Management System

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In recent years, vehicle navigation systems have been highly praised for their usefulness, and the navigation device market has consequently expanded rapidly. In the field of emergency services, navigation systems are also being used to speed up and automatize the transmission of vehicle location information and management. Based on our experience in developing commercial navigation devices, we have developed a navigation system for fire vehicle location management which can display a town map on a 10 inch monitor. We delivered the system to Fujitsu in January of 1996.
This paper outlines the configuration and functions of the navigation system and presents its features.

1. Introduction

In emergency activities concerning fires and accidents, the degree of fire damage and the initial treatment of injured persons is largely affected by the response time. Response time is defined as the time from when an emergency call is answered until dispatched vehicles arrive at the scene. Conventionally, radio systems were used to manage the dispatching of vehicles. In fire stations in Nara and Okazaki in Japan, a vehicle location management system was introduced to reduce the response time. The system adopts a navigation system to, for example, centralize the management of vehicle locations and superimposes symbols providing water supply information and other information over a map. The navigation system for the vehicle location management system, which was developed by Fujitsu Ten, was installed in the vehicles. The following will explain this navigation system in detail.

2. Objectives

The navigation system has been developed by considering the necessary functions for fire stations. During development, special emphasis was placed on the following three points:

① Make operations easy and automatic, assuming emergency operation.

② Store programs in flash memory so they can be rewritten in case of navigation software upgrades and product improvements.

③ Use a large display for detailed information needed by fire stations, such as information about water supplies.

3. System outline

3.1 Configuration of the vehicle location management system

Figure 1 shows the configuration of the vehicle location management system. The system consists of a communication center, beacons installed in the fire station garages, and vehicle terminals.

1) Communication center

The communication center accepts an emergency call, determines and conducts dispatches, manages vehicle operations, and so forth.

2) Garage beacon

A beacon installed in the garage of each fire station sends information such as disaster spots to all dispatched vehicles simultaneously.

3) Vehicle terminal

The terminal consists of an AVM terminal section that communicates with the communication center and a navigation system that provides navigation functions.

3.2 Configuration of the navigation system

The navigation system consists of the following units. (See Figure 2.)

1) Navigation device

The navigation device includes a CD-ROM driver, a gyro, a memory, a computer for control. Navigation and image processing are performed based on data sent from sensors and map data in the CD-ROM.

2) 10 inch color liquid-crystal display

The display monitor is a full-color monitor dedicated to navigation which uses a 10.4 inch thin-film transistor (TFT) liquid-crystal display. The monitor also includes a video signal interface, a synchronizing signal separator circuit, a dot clock generator, a switch decoder, and a power supply.

3) Sensor signal processing unit

This unit processes sensor signals sent from the earth magnetism sensor and the GPS antenna and outputs azimuth and position data to the navigation device through serial communication.

4) DC-DC converter

Ambulances of the 24 volt type use a DC-DC converter to convert the power supply voltage from 24 to 12 V.

4. Features
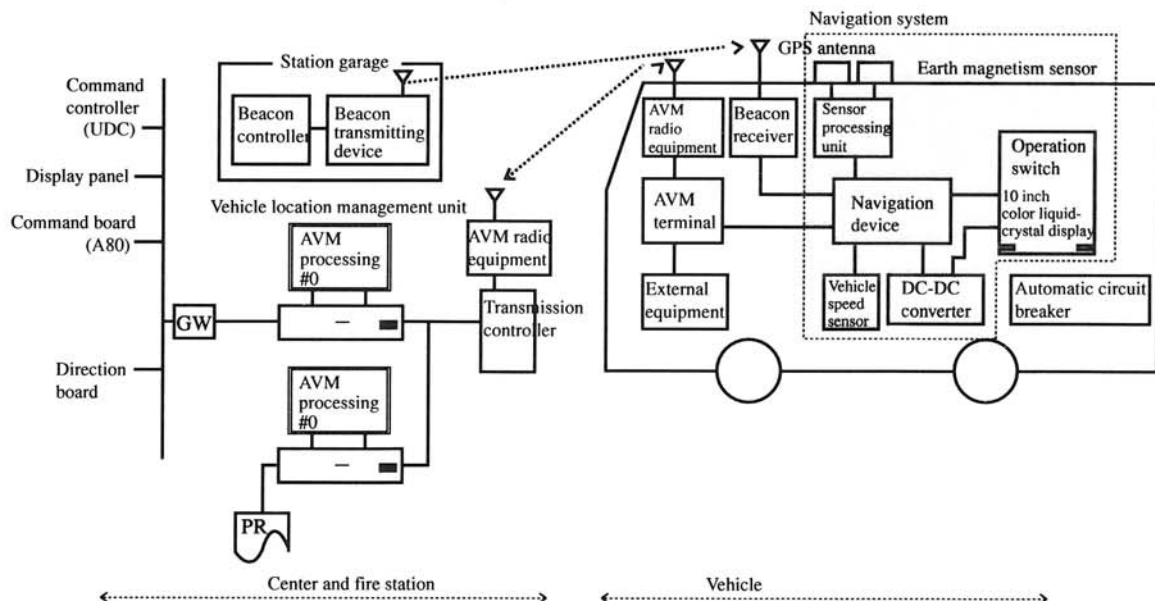
The navigation system has the following features:

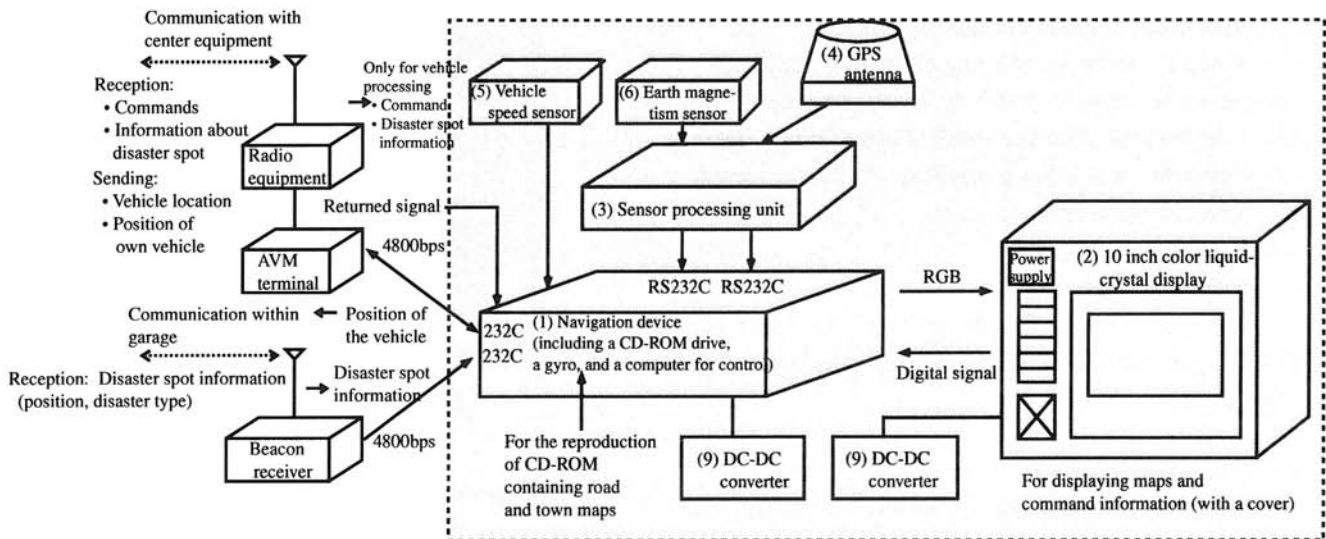Figure 1. Vehicle location management system block diagram

Figure 2. Configuration of vehicle terminal

4.1 TFT liquid-crystal display

As the display monitor of the navigation system, a 26 cm diagonal (10.4 inch), full color TFT liquid-crystal display (active matrix driving method) is used to ensure high-quality images.

In particular, as the display dedicated to navigation, it can reproduce high-precision full color images by analog signal processing. This is implemented by using the vertical stripe arrangement of red (R), green (G), and blue (B) as the TFT pixel arrangement. In addition, the number of dots is set to 921,600 [1920 dots (horizontal) by 480 dots (vertical)] of [640 pixels (horizontal) by 480 pixels (vertical)].

4.2 Automatic setting of a disaster spot

Based on the data sent from the beacon installed in the garage, a disaster spot (a fire, accident, or patient) is superimposed over a map on the screen of the navigation device. Then, that spot is automatically set as the destination.

4.3 Command information

While emergency vehicles are moving toward the destination, units may be reorganized or the destination may be changed. In such cases, the emergency number, type, and address directed from the center via the radio system are displayed with characters. The latest three items are recorded.

4.4 Displaying water supply information

To support fire extinguishing activities on the fire scene, the display projects symbols of fire hydrants, tall buildings, and cultural properties over a town map.

4.5 Searching for medical facilities and addresses

Hospital data is recorded on the CD-ROM map. The location of hospitals can be searched for by name. The data covers not only the district concerned but also nearby cities. This is helpful when a seriously injured patient must be transported to a large, nearby hospital. An address search function is also provided, allowing destinations to be set easily.

4.6 Displaying town maps

Town maps with scales of 1/6000, 1/3000, and 1/1500 can be displayed, allowing the crew to check the geography around the destination and the water supply information easily.

4.7 Reduced start time

Geographical drawing data present immediately before ACC is turned off is stored in memory. This can minimize the data to be read from the CD-ROM during dispatching, which reduces the start time. As a result, a drawing using data about four times as much as conventional data can be started in the same time required for commercially available products.

4.8 Automatic position correcting function

When a vehicle is returning to its fire station after completing an emergency activity, garage position data is sent from the beacon device installed in the garage. Even when the position data has a cumulative error, the current position is automatically corrected.

5. Operation and display

The operational and display specifications of the navigation system have been determined considering the following points:

5.1 Ease of operation

On the assumption that an emergency dispatch is made, large buttons are provided so that the following operations can be performed by the press of a button:

① NAVI (switches maps between the current position and the destination)

② Map switching (switches maps between a road map and a town map) (Figure 3)
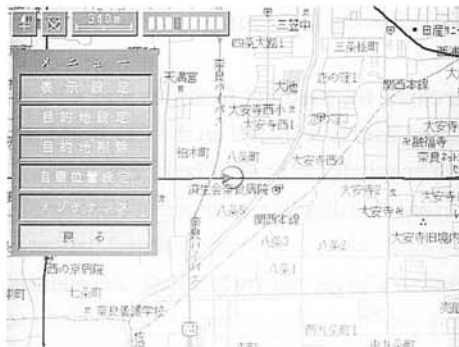

Figure 3. Road map of present location (with menu screen)

5.2 Automatic operation

While a vehicle is on its way to extinguish a fire or to transport paramedics to an accident scene, the crew may be busy communicating with the center. Therefore, the navigation system is designed to provide necessary information without the need of manual operation.

As soon as a fire is reported, data on the scene of fire is sent from the beacon device in the garage to all vehicles simultaneously. As the engine of a fire vehicle or ambulance is started, information about the disaster spot is taken processed by the navigation system. The system then sets the destination automatically. The crew can check the address and type of disaster on the display. (Figure 4)
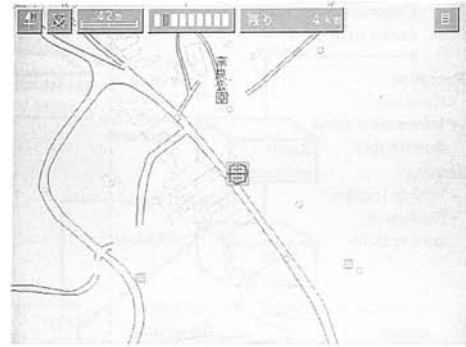

Figure 4. Town map of a destination

As the vehicle approaches to within 250 meters of the destination, the displayed road map automatically changes to a town map to show detailed information about the nearby area of the scene.

6. Map data

Maps for the onboard terminal must satisfy the following requirements:

- Road maps and town maps must be able to be displayed.
- Water supply information, public safety information, and hospital information must be able to be overlaid on maps as required.
- Address and hospital information must be able to be searched for.

To create maps for the onboard terminal that satisfy these requirements, Fujitsu, Zenrin, and Fujitsu Ten have developed a Fujitsu original format. In addition, Zenrin produced the CD-ROM map.

6.1 Map types

Map data is largely classified into road maps and town maps. Appropriate maps can be selected according to the situation at hand. For example, before the vehicle arrives the scene, a road map can be displayed to show the current vehicle's location in relation to the disaster spot. As the vehicle gets closer to the spot, a town map can be displayed to obtain detailed information.

6.2 Road map data

Road maps contain road data. They also contain background data for displaying geographical features such as rivers, railroads, and other facilities, and character and symbol data for indicating names. In addition, hospital information is provided as map overlay information to

display symbols indicating hospital locations. Furthermore, most detailed road maps contain road net data for map matching. A vehicle's position can be accurately detected by correcting its position with the road net data.

6.3 Town map

Town maps contain more detailed data than road maps. Maps at the most detailed display level can show the names of residents of individual houses. Overlay information includes hospital information, water supply information, and public safety information. Since water supply and public safety consists of large amounts of data, the specification defines that such data is overlaid only on town maps. In the data structure used here, information is classified so that necessary information can be selected according to the circumstances. For example, only water supply information may be displayed for a fire vehicle, or only hospital information for an ambulance.

6.4 Solutions to problems with map data

In the earlier development stage of the engineering model, the following accuracy problems arose because of conflicts between the two types of databases, the road map and the town map types:

- Narrow streets existing in the town map were not found in the road map.
- Discrepancies in roads between town and road maps caused by differences in precision.

These problems were solved by obtaining the data on narrow roads from town maps to make the road maps consistent with the town maps.

6.5 Information search data

The CD-ROM map contains information search data as well as map data.

Information search data is divided into two types: data for address searches and data for hospital searches. Each type of data can be searched for by address or name after a particular area is specified. A map holding the specified data can then be displayed. Not only hospital names and addresses but also telephone numbers and medical facility information are recorded as hospital information so that an appropriate search operation is enabled.

7. Conclusion

The outline of the navigation system for fire station's vehicle location management system and its features have been explained.

A similar vehicle location management system is under study for use by police and other services. In the future, such vehicle location management system field will be expanded in the navigation market. The key to future navigation systems is how remarkable features will be incorporated in a product. This is essential to the design of navigation systems. As technology improves, we will continuously put forth effort on the design and development of products. We will also strive to respond to users' requirements for, for example, new functions and price reductions in a timely manner.

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