Positioning Engine for Smartphones

1. Outline

Sumitomo Electric System Solutions Co., Ltd. develops and sells AgentNavi, a navigation software development kit for smartphones. AgentNavi offers route guidance to the destination together with information about traffic congestion and regulations.

To offer appropriate guidance, the navigation software needs to identify the road on which the vehicle is running. Usually, the road is identified based on the latitude and longitude obtained from the global positioning system (GPS) sensor.

In an environment where it is difficult to receive GPS signals (e.g. urban areas), information errors tend to increase. For example, in Fig. 1, the driving route is indicated by a dashed line, and coordinates derived from the GPS information are indicated by diamonds that show opposite lanes and buildings. The road on which the vehicle is driving cannot be identified based solely on the GPS information.

AgentNavi has a positioning function to estimate the road on which the vehicle is driving based on various sensor information (including the GPS signals received by a smartphone) and to compensate the position information ("map matching").

This paper explains the map-matching function of AgentNavi based on a comparison with general in-vehicle systems ("car navigation systems").

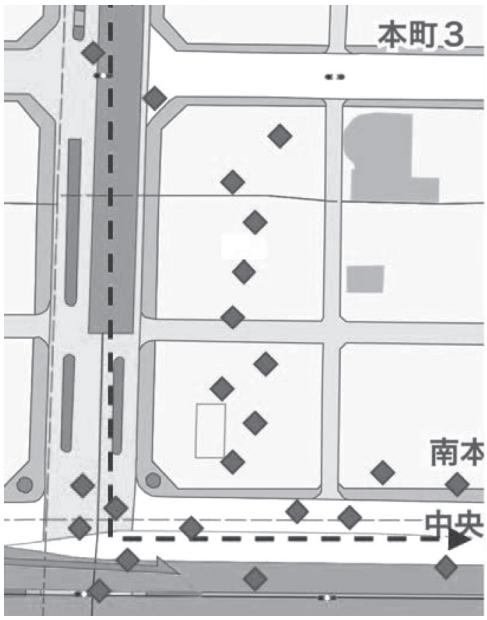

Fig. 1. GPS information in an urban area obtained by a smartphone

2. Features

2-1 Flow of the map-matching process

Figure 2 shows the basic matching process of AgentNavi. While car navigation systems are designed to be used by drivers, smartphones may be used during walking. The user of smartphone applications is not necessarily in a vehicle. If the position information is always compensated on a smartphone, when the user is walking within a land lot, an adjacent road is likely to be misidentified as the current position.

To avoid this problem, AgentNavi uses the speed and other conditions to determine the user's means of transport. If the application determines that the user is walking, it does not compensate the position information. Even if the application determines that the user is in a vehicle, when a candidate road does not exist around the vehicle (e.g. when the vehicle is parked in a parking lot), the application does not compensate the position information.

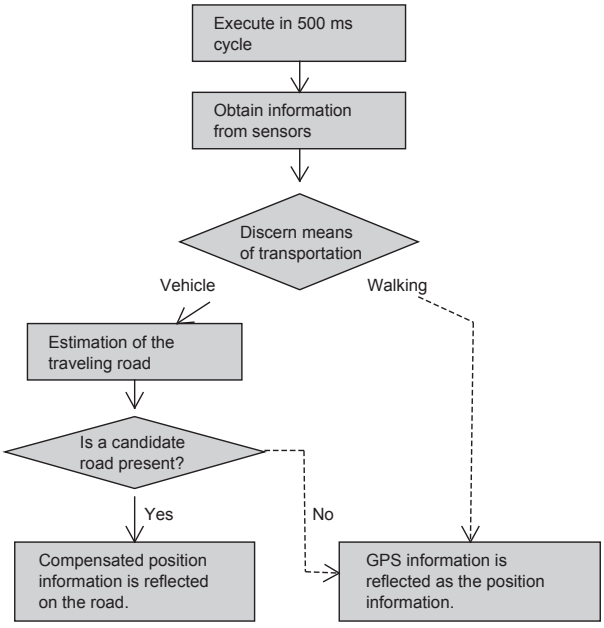

Fig. 2. Basic process of map matching

2-2 How to ensure accuracy of vehicle information and sensor signals

Today's car navigation systems can identify the position of a vehicle even in a tunnel by receiving the vehicle speed pulse and other information via the vehicle's controller area network (CAN).

However, smartphones cannot receive the vehicle speed information. The position of one's own vehicle cannot be estimated if the GPS signals cannot be received.

To cope with this problem, AgentNavi uses the vehicle's speed and bearing that are estimated based on signals from motion sensors built into the smartphone (e.g. acceleration, gyroscope) to update the vehicle's position. Thus, the road on which the vehicle is driving can be identified even in tunnels.

In general, even when GPS signals are available, the degree of error in the GPS information obtained from sensors built into a smartphone is higher than that of a car navigation system. For this reason, in areas where multiple roads are running in parallel, one's own vehicle is likely to be indicated on a different road based on the GPS signals.

Thus, if the position of the vehicle is estimated based solely on the GPS signals, the vehicle may be indicated on an incorrect road. Notably, if such error occurs in an area where a general road is running in parallel with an expressway, the guidance to turn right or left cannot be offered accurately.

AgentNavi has multiple conditions to make correct judgments. The inclination is one of these conditions. An urban expressway (which is elevated in most cases) has a slope near a ramp. If the inclination of the vehicle changes significantly near a ramp, the application can judge that the vehicle has entered or exited an expressway. AgentNavi estimates the inclination angle from the acceleration sensor.

The estimated average vehicle speed and signals from various sensors are also used to achieve accurate determination of the road on which the vehicle is driving under various conditions (e.g. a flat ramp, an area where multiple general roads are running in parallel).

2-3 Evaluations and commercial applications

Smartphones cannot obtain the vehicle information, and the accuracy of their sensor information is low. To achieve accurate map matching using smartphones, various techniques must be used to reduce errors.

Sumitomo Electric System Solutions has a track record in developments in this field (from car navigation systems to telematics services), and has accumulated information about areas that are likely to cause problems.

The company evaluates AgentNavi on various road environments (such as the areas mentioned above) to increase the overall accuracy of the guidance functions including the map-matching function.

These efforts have been highly evaluated, and the product has been used in navigation applications for smartphones such as Yahoo Japan's CarNavi.