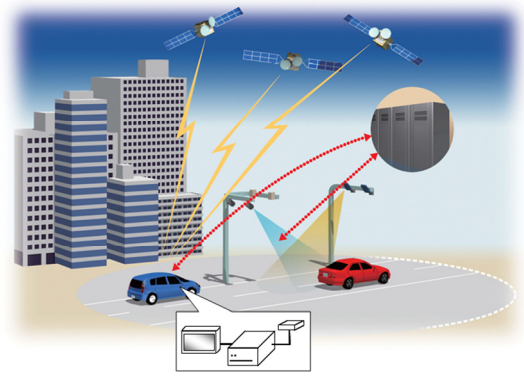
New GPS-Based Electronic Road Pricing System



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The electronic road pricing (ERP) system that incorporates a global positioning system (GPS) has entered the validation stage in Europe. The system will become mainstream in the future. Mitsubishi Heavy Industries (MHI), Ltd. has developed a GPS-based ERP system intended for use in urban areas. The system is introduced below.

1. Configuration of the system

1.1 Outline

In a GPS-based ERP system, on-board units detect the position of the vehicle and its traveling route, automatically charging the fee by judging the need for charging and determining the charged amount based on the record.

The system also identifies violation vehicles (such as the vehicle travels without inserting card) and creates a summons including the charging results and testimonial images, automatically sending the summons to the driver.

1.2 Configuration of the system

The configuration of the GPS-based ERP system, which is being developed by MHI, is shown below (**Figure 1**).

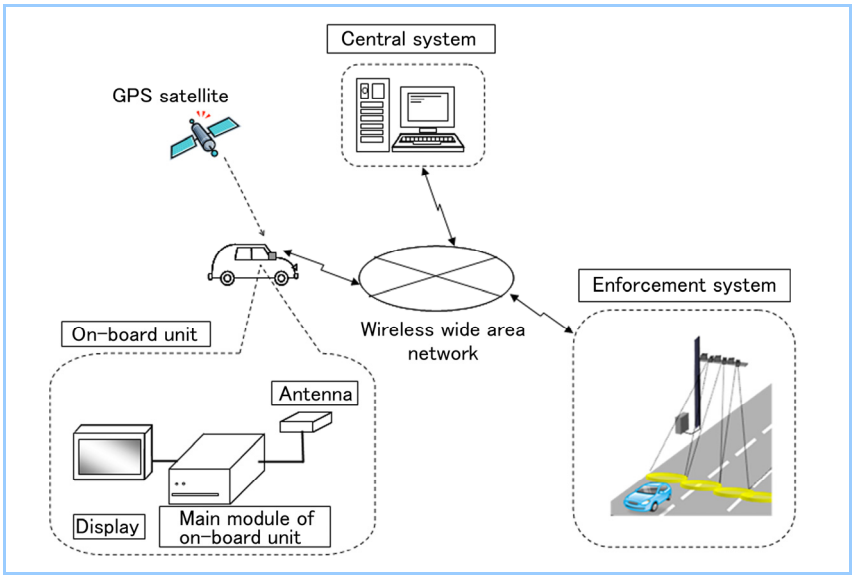

Figure 1 Configuration of MHI's GPS-based ERP system

2. Characteristics

2.1 Characteristics of the GPS-based ERP system

The on-board unit detects the position of the vehicle and its traveling route as well as the entry of the vehicle onto toll roads independently and determines the necessity of charging. Because of these functions:

(1) Charging can be done by the on-board unit alone. Therefore, roadside units except for enforcement cameras are unnecessary.

(2) The system is capable of point-based charging, where a uniform rate is charged by detecting the entry of vehicles onto toll roads, which is done by conventional DSRC-based ERP systems, as well as distance-based charging, where the rate is charged according to the distance travelled, realizing appropriate operation of the charging system depending on the state of traffic congestion (**Figure 2**).

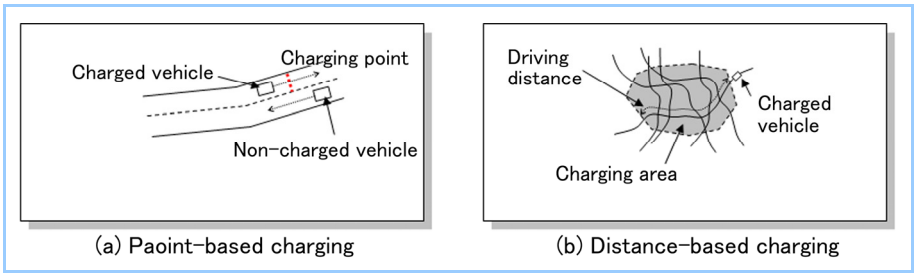

Figure 2 Charging methods

2.2 Characteristics of MHI's system

(1) On-board unit

- The system developed by MHI is characterized by an on-board unit that performs all of the operations, including vehicle-location measurement, charge-fee calculation, and charging based on card information. This system does not need to send the location of every vehicle to a central system. As a result, the load on the wireless wide area network is reduced, while realizing real-time charging.
- The vehicle's location can be corrected by Map Matching and the measurement results are corrected based on road line segments, providing high-accuracy information on vehicle location and driving route (**Figure 3**).
- Information needed for the measurement of locations can be obtained by sensors. This eliminates the need for information from vehicles such as vehicle speed pulse or CAN (Controller Area Network) information. Therefore, the system can be easily installed and can also be mounted for use on motorcycles.

Figure 3 Results of positioning in urban areas

(2) Enforcement system

- Enforcement systems that control violation vehicles continue to take pictures of vehicles from diagonally from behind and OCT (Optical Character Reader) processing is performed on the license plates that have been captured. Because of this feature, the chance of capturing license plates of vehicles behind trucks has been improved, realizing a higher capture ratio.
- There are several enforcement systems available: the fixed system featuring stable performance, the movable system featuring easy installation, and the vehicle-mounted system (**Figure 4**). Performance stability is difficult to attain when using the movable or vehicle-mounted enforcement systems, compared to the fixed type. However, the moveable and vehicle-mounted systems are especially useful when toll roads are introduced or changed unexpectedly.
- The enforcement system features vehicle-data measurement and vehicle-type discrimination using a laser scanner (**Figure 5**). This enables the detection of mismatching between on-board units and vehicle types and enhances the accuracy of identifying violation vehicles.

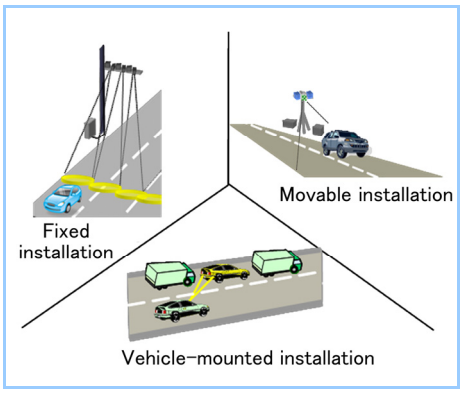

Figure 4 Enforcement system

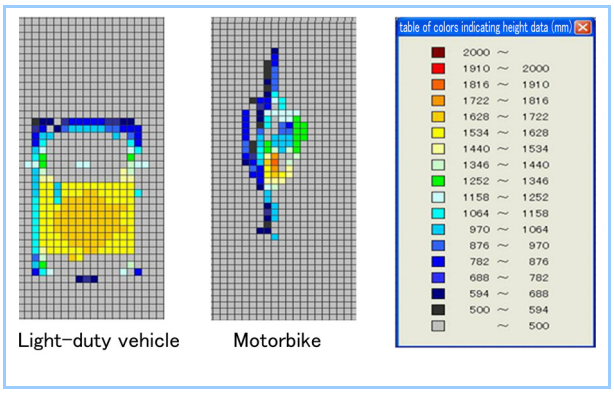

Figure 5 Vehicle element measurement data

3. Efforts for optimization of traffic stream

This system offers the following services utilizing technologies for measuring vehicle location and driving route by GPS:

(1) Traffic stream measurement

In conventional systems, traffic stream and average vehicle speed are measured only at places where roadside units are installed. In this system, traffic stream and average vehicle speed can be measured at any point on the map because the on-board unit continuously measures the driving routes and vehicle speed.

(2) Distribution of ITS (Intelligent Transport System) information

The on-board unit receives traffic-related information, such as traffic congestion and accidents, and displays the information for the driver using three possible media: a wireless wide area network from the central system, DSRC communication from special roadside units, or FM broadcasting.

Based on (1) and (2) above, the application will be expanded to operation control and vehicle navigation. In the future, a system that is capable of managing the entire road network will be established.