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VEHICLE POSITION INFORMATION SYSTEM FOR ACCURATE OPERATIONAL MANAGEMENT AND OPERATIONAL SUPPORT OF SNOW AND ICE OPERATIONS

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Summary

On Expressways during the winter season, Vehicle position Information System (VPIS) was developed and introduced because it is necessary to grasp the position and work of snow and ice vehicles in real time, perform appropriate snow and ice work, and secure a good road surface. VPIS is a system that automatically transmits data on snow and ice vehicles to the control room, which is used to ascertain vehicle location information, etc., and to prepare work diagrams and work inspection data. With the introduction of VPIS, snow and ice operations management personnel are able to provide accurate work instructions and operational control. In addition to facilitating the securing of good road surfaces, the time required to prepare work management documents has been reduced, and the efficiency of operations has been greatly improved.

Introduction

The Central Nippon Expressway Co., Ltd. (NEXCO Central), which is in charge of expressways in central Japan, has been working to ensure

smooth traffic on expressways during heavy snowfall by strengthening the advance deployment of snow removal trucks and increasing the number of rotary snow-plows in response to the record heavy snowfall in the Kanto and Koshin regions in February 2014 [1][2]. However, this has resulted in congestion in the location information of snow removal vehicles and increased the burden of management and operation of snow removal work details, making it difficult to accurately manage snow removal work, and a formula to improve this has been sought.

To achieve this, the snow and ice operation supervisors at the snow and ice base needs to know the location and work status of the snow and ice vehicles in real time. In order to support the accurate operation and efficiency of this snow and ice operations, Central Nippon Highway Engineering Nagoya Co., Ltd. (Eng. Nagoya) has been working since 2014 on the development of Vehicle Position Information System (VPIS) to make this possible.

Development of VPIS

VPIS is a unique Eng. Nagoya system that is installed on snow and ice removal vehicles and traffic control vehicles patrolling expressways during the winter and visually displays on route maps and maps which routes and points the vehicles are traveling and working, enabling accurate work vehicle management. The VPIS system consists of on-board units (smartphones), a vehicle management server at the data center, and PCs installed at each Inter Change (IC) and snow/ice control room (SICM) for monitoring snow/ice operations (Fig.1). The system collects the location information from the GPS function installed in the on-board unit and transmits the location information and the vehicle work details entered by the on-board unit to the data center.

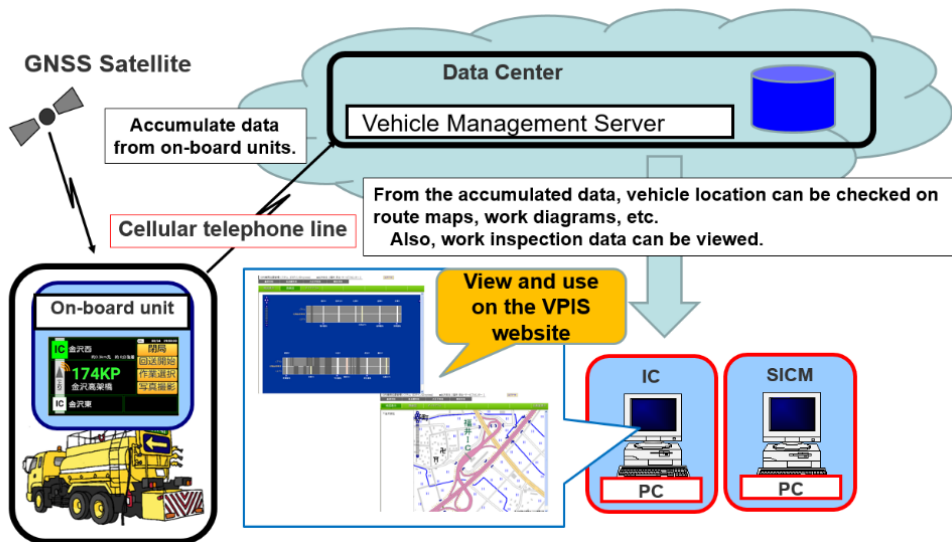


Fig. 1. Image of VPIS

The data is stored in the vehicle management server and can be checked in real time on PCs used to monitor snow and ice operations at each IC and at each SICM in NEXCO Central.

VPIS has the following four features.

The first is the use of a general-purpose Android OS smartphone as the on-board unit, which enables the use of the latest hardware performance, such as CPU, and a wide selection of smartphones from which to choose from and whose applications can be easily upgraded.

Second, because it uses cell phone lines, the communication speed is faster, more reliable, and cheaper to use.

Third, the use of a cloud system for VPIS monitoring site makes maintenance and upkeep more efficient and speeds up the response to problems.

Fourth, location information is obtained from the GPS function of the smartphone and, in tunnels, from vehicle speed pulses.

Introduction of VPIS

Installation Status

NEXCO Central manages expressways with a daily average traffic volume of 1,853,000 vehicles over 2,170 km at 24 offices in four branches [3], and the system has been installed in approximately 1,600 vehicles in the four branches combined. Figure 2 shows the percentage of vehicles with VPIS installed. VPIS has been installed in wet salt spreaders, snow removal trucks, patrol vehicles, sign trucks, etc. VPIS is also used to support operations such as patrols and regulatory work on expressways.

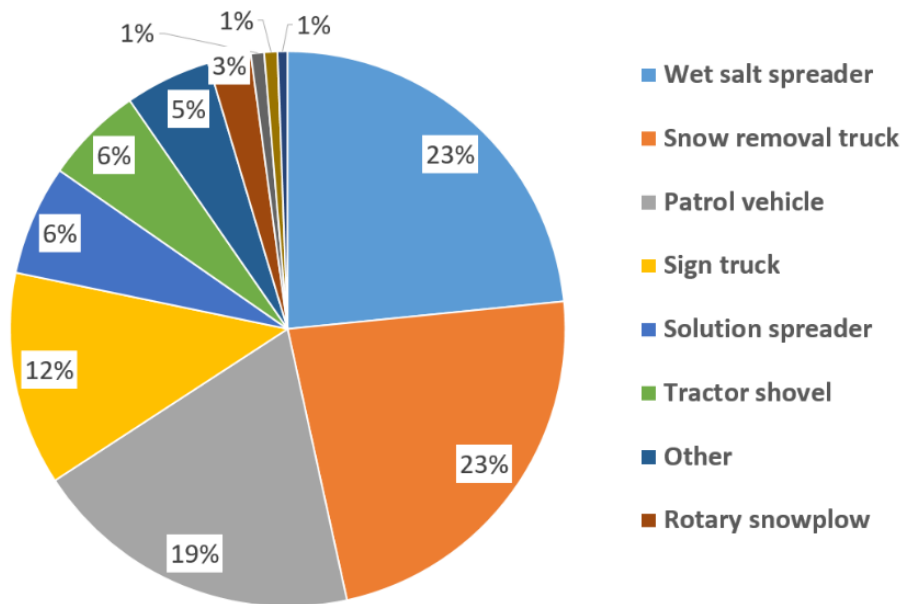


Fig. 2. Percentage of vehicles with VPIS at NEXCO Central

VPIS Operation

With VPIS, the current vehicle location information and the work selected by the operator are automatically transmitted and can be visually confirmed on the monitoring PCs at each IC and at each SICM, enabling systematic operation management. The monitoring PC can display route maps or maps and trajectories on a map.

The system also has a function to share images of road surfaces and weather conditions taken by smartphone cameras with data such as time of day, route, and kilometer post, etc. The continuous shooting function at 5-second intervals can be remotely operated from a monitoring PC in the SICM without any burden on the operator, and can be viewed as a simple video.

In addition, it can draw work diagrams and create and output work inspection documents based on data (location information, work content, etc.) stored on the server. The system can output work diagram drawings by selecting dates, areas, routes, vehicles, etc., and can save them in PDF form. It also has a real-time diagram display function, which allows users to select the route and maintenance/service center, they wish to view and display diagrams from the current time up to 24 hours before.

Improvement

After the full-scale introduction of VPIS in FY2014 and beyond, the interviews were held regularly, and the following new functions have been added so far.

In the first case, a coloring function was added to the map or route map by the section where the wet salt spreading vehicle sprayed and by the elapsed time after spraying (Fig. 3).

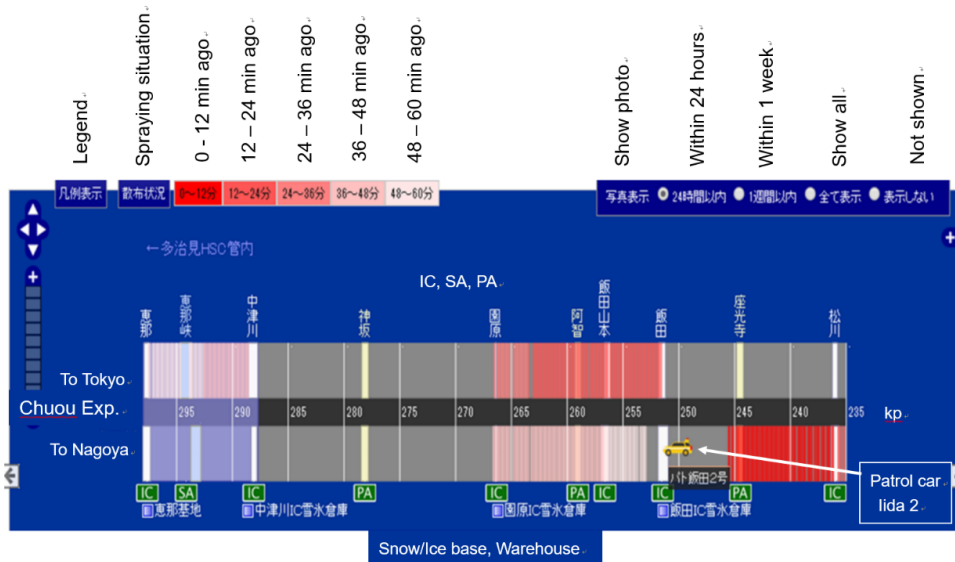


Fig. 3. Support function for monitoring spraying status

The second example is an alert support function for snow and ice operations to prevent human error. When the snowbanks in the no-throwing zone were sometimes unrecognizable due to snow accumulation, inexperienced operators had varying degrees of awareness of the hazardous areas, resulting in erroneous snow throws. This function displays a text message on the terminal screen and voice warnings when a certain kilometer post is reached (Fig. 4). The content of alerts, both text and audio, can be set freely, allowing the driver to inform the driver of caution and danger points, and to set alert items for individual items for each vehicle model.

The third example is a search function for photographs taken. By selecting the date, time, vehicle type and route, and kilo-meter post, a point will appear on the map, and clicking on the point will display a photo detail window. The right part of the screen displays a list of photos taken as before.

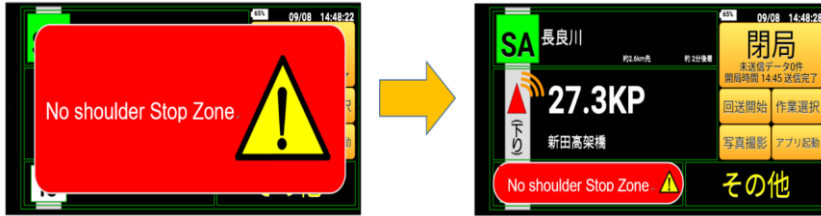


Fig. 4. Alert Screen

Effectiveness

Full-scale introduction of VPIS began in FY2014, and by the end of FY2021, VPIS had been installed in all 1,595 snow and ice vehicles and patrol vehicles in NEXCO Central business area (Fig. 5). According to interview with the person in charge of the snow and ice control room, who is the operator of VPIS, the introduction of VPIS has been evaluated as having reduced human errors, as vehicle information can now be checked visually, whereas before the introduction of VPIS, work was done by radio, which resulted in listening errors. Approximately 60 VPIS units have been installed by other expressway managing companies, and we believe that the usefulness of the functionality of VPIS has been recognized.

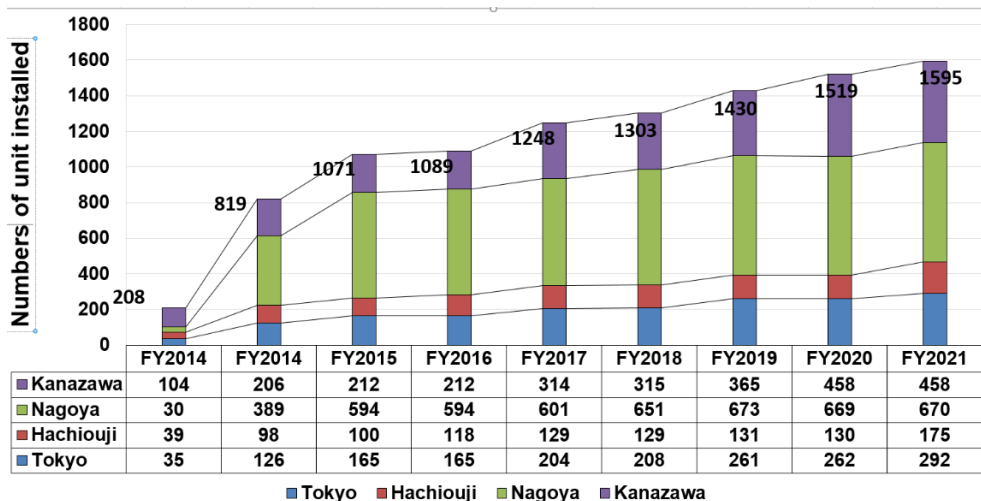


Fig. 5. Number of units installed VPIS

Conclusion

The VPIS system has made it possible to obtain real-time information on vehicle positions and work details during snow and ice operations, enabling accurate work instructions and operational management. This has also led to improved expressway service that satisfies drivers. Based on the operational status and the results of the interviews, we will make prompt improvements and take countermeasures for any defective events, and we also hope to realize requests for the addition of new functions.

In the future, we would like to install sensors to acquire information on road surface conditions, temperature, humidity, etc., to quantitatively check the site conditions, and to consider developing a system that can perform snow and ice operations more efficiently, such as performing snow and ice operations more suited to the conditions and identifying hazardous areas.

References

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