Visualizing "underground risks" at excavation sites with GNSS high-precision positioning
Reducing workloads, while improving precision of risk management

Kajima Corporation ("Kajima") is a leading general construction company operating in Japan. It has managed many pioneering projects since the foundation of the company, greatly contributing to the development of Japanese industry and the economy. Since 2017, Kajima has been involved in the largest wind power generation plant in Japan, the Tsugaru wind farm. Promoting IT implementation at construction sites, it developed a subsurface object detection system in conjunction with WinX Co., Ltd. This navigational system reduces the risk of damage caused when a construction machine makes contact with objects buried underground during the course of demanding excavation work at such sites. As a key positioning device for the said system, Kajima employs the rugged 7-inch tablet, TOUGHPAD FZ-M1, which is installed with a high-precision positioning solution that enables positioning accurate to 10 cm, as provided by Panasonic.

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(Above photograph) Duct excavation work at night. Even under conditions where a sufficient field of vision cannot be secured, it is possible to check the positioning of subsurface objects on screen, thereby obtaining more security than ever.
(Photograph on the left) Thanks to the extensibility and compact design of TOUGHPAD FZ-M1, it realizes more than an adequate equipment configuration even in a driver's cabin of a construction machine, where installation space is limited.

Background to introduction

TOUGHPAD FZ-M1 is equipped with a positioning performance that corrects to about 10 cm with a single-frequency RTK system. It is the only solution that enables high-precision positioning at realistic introductory costs.

Promoting the implementation of IT at construction sites, Kajima has long considered the introduction of a GNSS-based positioning system to prevent human error, while also promoting work efficiency at excavation sites. A main challenge was the fact that safety management used in order to prevent subsurface objects from making contact with construction machines depended on "human checks." For conventional work procedures, the positions of subsurface objects were marked on the surface prior to excavation, as a guide reminded machine operators. However, this was accompanied by the possibility of human error, while depending on the efficiency of actual site conditions.

In addition, as the Tsugaru wind farm is located in "agricultural land with few guides around," and in a harsh area with a lot of snow, site staff very much called for the introduction of a positioning system. Based on opinions, in selecting positioning equipment accurate to 30 cm to 1 meter, as required for excavation work, they initially studied two-frequency RTK positioning equipment, a commonly used high-precision positioning device. However, there were problems, as such devices are very expensive and too large in terms of size to be accommodated in construction machinery.

Why TOUGHPAD FZ-M1 was chosen

Point 1	**Point 2**	**Point 3**
High-precision positioning accurate to about 10 cm realized at a cost less than one-tenth of professional equipment	Windows-run high-specification device that can utilize existing systems and has high extensibility	Compact-size and rugged design makes it easy to install in a driver's seat of construction machinery

Mr. Honda then came across Panasonic's high-precision positioning solution when conducting a survey. He discusses why they chose this solution:

"It was mostly attractive because while with a single frequency, it has a precision positioning performance accurate to 10 cm and realizes such top performance at a realistic cost. Another attractive point was that as TOUGHPAD FZ-M1 has a Windows 10 OS with a high-performance CPU, we can easily utilize our existing systems and know-how accumulated thus far. As Panasonic is a Japanese manufacturer, they promptly delivered demonstration units, and we feel a sense of safety in terms of support, too."

The main advantages of this 7-inch device include its compact size, which is easy to install in a driver's seat of construction machinery, a ruggedness that can withstand vibrations during operations, plus water-resistant design and being temperature resistant against snow and rain. Therefore, they finally decided on TOUGHPAD FZ-M1.

Introduction benefits

Reduces risk even under adverse conditions. Improves quality of human operations, thanks to double-check with the equipment.

Kajima has developed a subsurface object detection system that maps the positions of subsurface objects on the screen of TOUGHPAD FZ-M1 by utilizing high-precision positioning solutions. During introduction studies, introductory costs were given priority to be reduced to one-tenth of the cost assumed with two-frequency RTK models. Furthermore, according to Mr. Honda, during a test run using a demonstration unit, they really appreciated positioning precision accurate to 10 cm at an excavation site and confirmed that the necessary precision could be secured. Within a short period of just two months after starting the selection of devices, a demonstration test of the subsurface object detection system was realized.

In an actual mechanism of the system, positions and outlines of subsurface objects on construction drawings are displayed on the device screen. The current position of construction machine equipped with the device is navigated with the high-precision positioning solution, like a car navigation system. When the machine comes close to a subsurface object, a reminder is given by issuing an alarm on the screen and an LED warning light connected to the device turns from normal green to yellow and begins flashing. If the positioning precision of GNSS cannot be secured, the LED warning light turns red. In such a case, an operator will use the machine while only following the orders of the guide.

In relation to the benefits since introducing this subsurface object detection system, Mr. Honda pointed out the following: "Risk reduction with the realization of double-checks utilizing the system," "prevents the slowing down of work speed," and "improves operators' productivity."

As for further details, Mr. Akemoto, Director of the Construction Work Office, said as follows: "Conventionally, owing to the structure of construction machines, operators had difficulties seeing places to be excavated, so decisions on locations that required attention depended entirely on staff and guides. However, since introduction, with the device being in the driver's seat, it enables operators to better comprehend conditions below. Operators can now use construction machines while paying additional attention to other potential risks."

Mr. Sato, Deputy Director of the Office, also mentioned that the attitudes of guides and operators toward work have changed: "As they can now work, while checking the positional information of subsurface objects, they can act more independently." As important information such as subsurface objects can be double-checked by an actual person and the system, they can pay more attention to surrounding environments, including general pedestrians, which has led to making the overall working environment an even healthier place. Mr. Sato goes on to say that there have been changes in the content of managers' operations: "As we can now register all subsurface object information in advance in the system, information transmission operations that used to take place on a daily basis are now unnecessary, thereby making administrative duties that much more efficient."

TOUGHPAD FZ-M1 created an environment where operators, guides and managers can concentrate more upon their own operations, which results in improving the quality of work that can only be done by humans.

Also, this site with its strong winds and heavy snow is not suitable for IT implementation, as conventional 3D mapping by drones or the installation of sensors on the ground cannot be applied. Regarding the effectiveness of the subsurface object detection system that functions in such an environment, Mr. Honda says: "It is great that under such conditions, we have been able to enhance safety and productivity without any problems. Through this demonstration test, I feel that it will turn out to be an effective system under harsher conditions."

Future outlook of using TOUGHPAD

Studying the possibility of introducing high-precision positioning system in urban environments.
Utilizing IoT to improve total quality in the construction industry.

With a favorable response on-site, Kajima is now studying the possibility of introducing the positioning system utilizing TOUGHPAD FZ-M1 at not only agricultural land, but also in cities going forward.

"In urban areas where construction demand is anticipated to increase for redevelopment in the near future, we think we can utilize the system to reduce the risk of damage of making contact with subsurface objects. In cities, information pertaining to water pipes, wiring and other subsurface objects is available as data in most cases, but by using this subsurface object detection system, we can enjoy double or better layers of safety measures."

Mr. Honda has also sought quality improvements for the entire construction industry through IoT. He thinks that TOUGHPAD FZ-M1 can play an active role.

"We have received some ideas about the utilization of this Windows-based device from operators who have used it. One of the main benefits is a sign of invigorated IT implementation."

TOUGHPAD FZ-M1 is expected to further contribute to issues that the construction industry will face going forward, such as increasing loads on workers and a decreasing working population.

Product: TOUGHPAD FZ-M1

Benefit 1
Drastically decreases risk by double-checking with high-precision positioning accurate to about 10 cm and human sight

Benefit 2
Prevents operational delays with highly reliable marking

Benefit 3
Improves quality of entire on-site work with a "visualization" of site