Development of Offshore Construction Management System Using GIS

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ABSTRACT

Because many kinds of construction work including foundation improvements and reclamation converge in large scale offshore constructions, it is important to convey construction management information in a timely manner in order to give work instructions to the work vessels based on the work status, to ensure the construction quality, and to control the safe and efficient traffic of the work vessels. Means of communicating these information include marine vessel telephones, radios, and work completion reports in person, and these conventional methods address the following issues:

Construction management is performed separately for foundation improvements, land reclamation and other construction works, causing redundancy and requiring extra time for information exchange and adjustments.
Information cannot be conveyed simultaneously to numerous work vessels and management office, requiring more time to give instructions and notices.
The finished form and progress of construction works cannot be checked visually.
Survey results are brought back to the office for post-processing, thus are not available when needed.

To resolve these issues, we have developed and implemented an ID System that integrates the information related to construction management ("Important Data") and information on marine weather forecasts and emergency information provided over the Internet ("Internet Data"), in order to increase productivity, secure construction quality, and improve safety.
In October, we have conducted actual offshore experiments in the Tokyo Bay area on the operation control and construction management of the especially important sediment vessels important to verify the validity of the System.
This report summarizes the System features and the experiments conducted.

1. SYSTEM OVERVIEW

Figure 1 shows the concept diagram of the System. The System transmits GPS vessel location information, work progress information from sounding and other construction management information, and emergency information on a real-time basis (using radio on sea and Internet on ground), and integrates the information using the Geographic Information System (GIS).

1.1 Equipment Configuration

Figure 2 shows the configuration diagram of the System. Each work vessel is equipped with a GPS for positioning, Multi Channel Access (MCA) for data transmit/receive, an echo sounder and other measuring instruments and apparatus, and a computer for control/display. MCA and a computer is also installed at the office for bi-directional communications between the work vessels and for Internet connections between the project owner, main

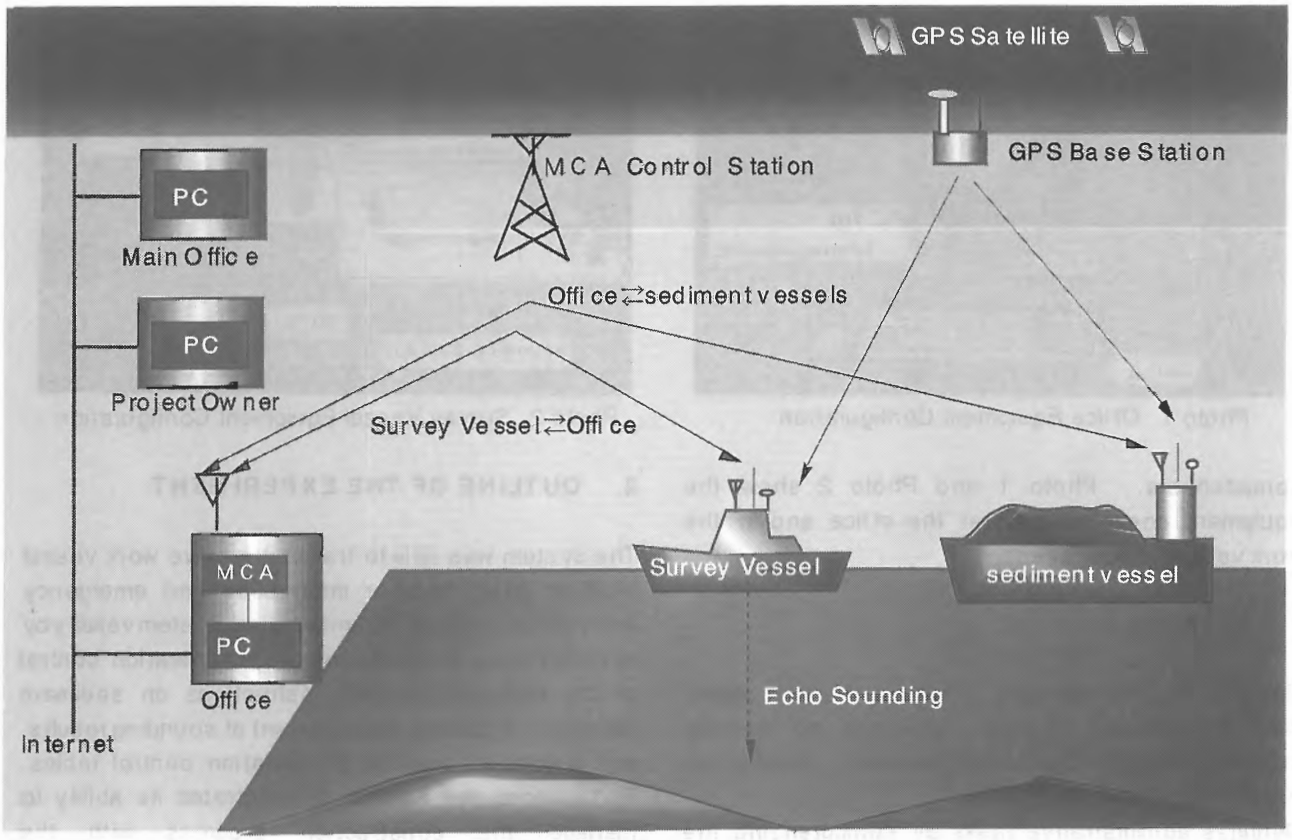

Figure 1 Concept Diagram of the System

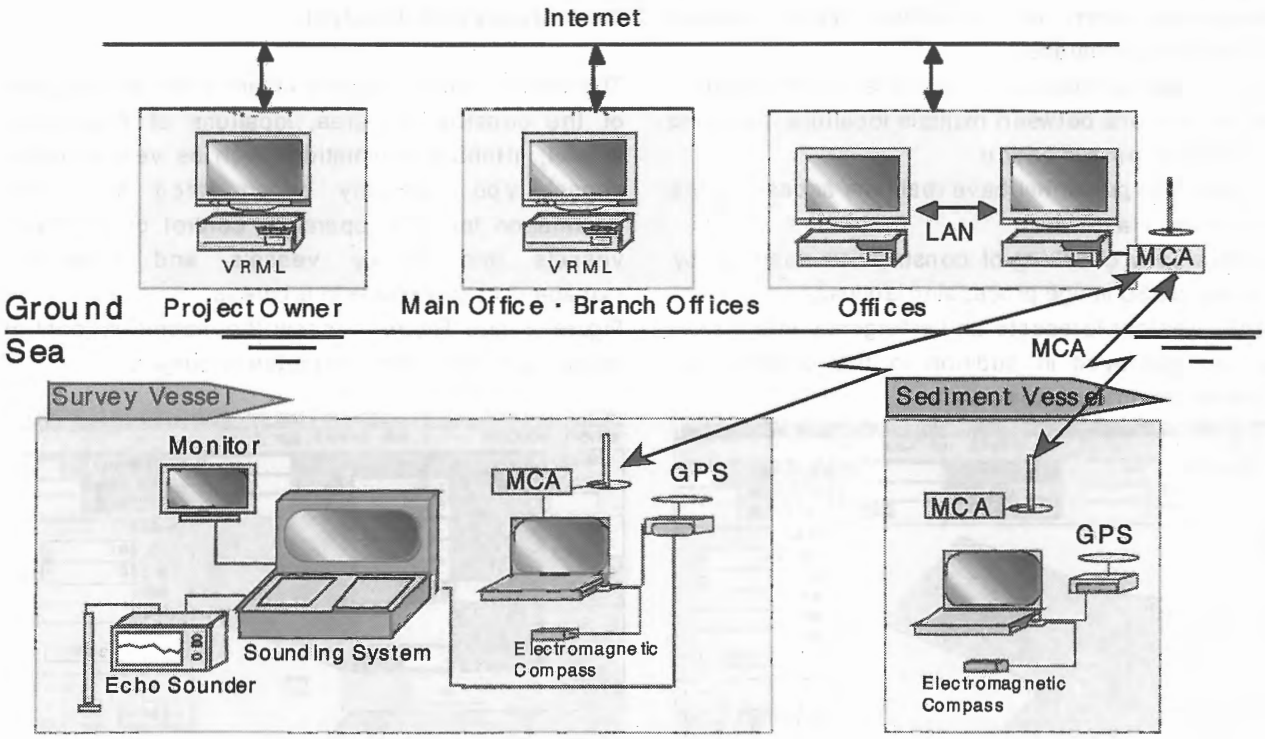

Figure 2 Configuration Diagram of the System

office and branch offices. The processing software is based on GIS that stores geographic data and layers of construction management information for each work to be shared and integrally managed. A language would allow 3D image processing on the Internet (VRML) is used to produce drawings and

Photo 1 Office Equipment Configuration

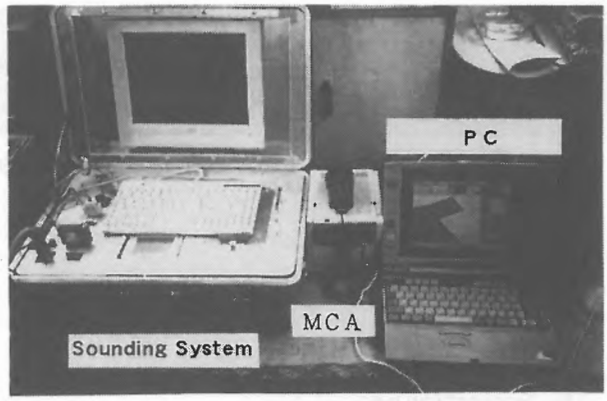

Photo 2 Survey Vessel Equipment Configuration

spreadsheets. Photo 1 and Photo 2 show the equipment configurations, at the office and in the work vessel, respectively.

1.2 Features

Enables easy processing (analyze, collect, save, search, convert, display, process) of various information and selection of screens (layers) as necessary by the use of GIS.
Reduces administrative tasks by computerizing the production of drawings and spreadsheets.
Displays the information on the monitor, preventing miscommunication and providing highly reliable information conveyance.
Allows wider communication areas and simultaneous communications between multiple locations by using digital MCA communication.
Construction personnel have real-time access to the information via Internet.
Enables easy checking of construction qualities by utilizing the 3D image processing language.
Marine weather forecasts and emergency information can be conveyed in addition to the construction management information.

2. OUTLINE OF THE EXPERIMENT

The System was able to transmit/receive work vessel location data, weather information and emergency information using MCA, and verified System validity by demonstrating its ability to perform operation control of the sediment vessels, instructions on sediment discharge locations, management of sounding results, and automatic creation of operation control tables. Furthermore, the System demonstrated its ability to manage the construction progress with the construction data using the Internet.

2.1 Operation Control

The monitor screen displays layers of geographic data of the construction area, locations of each work vessel, attribute information (such as vessel name, vessel type, company owned, etc.) and other information for safe operation control of sediment vessels and survey vessels and integrated management of the work in progress.
Figure 3 and Figure 4 show the operation control screen and the vessel's attribute information,

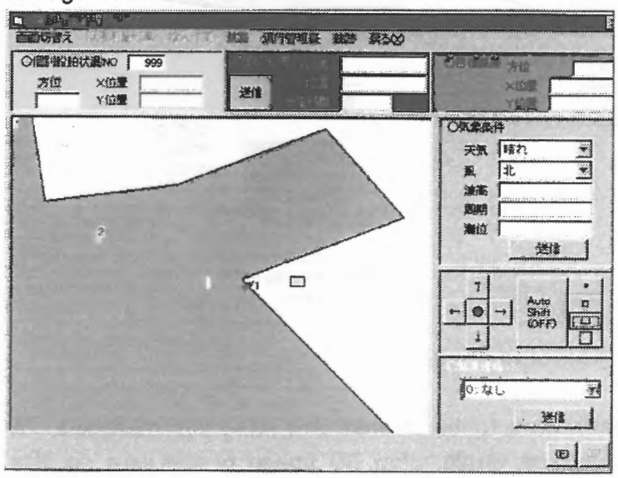

Figure 3 Operation Control Screen

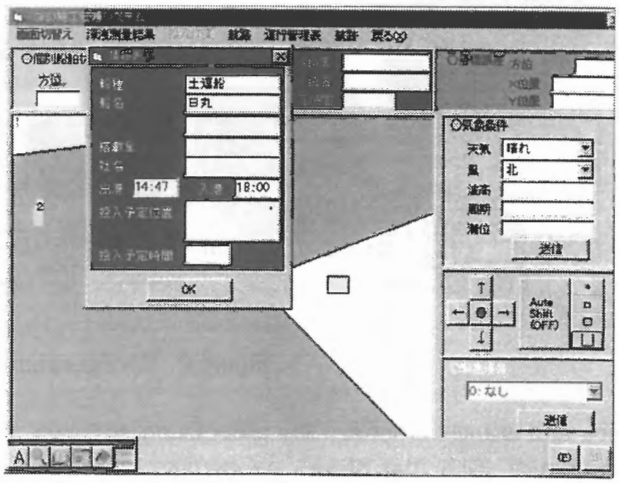

Figure 4 Vessel's Attribute Information

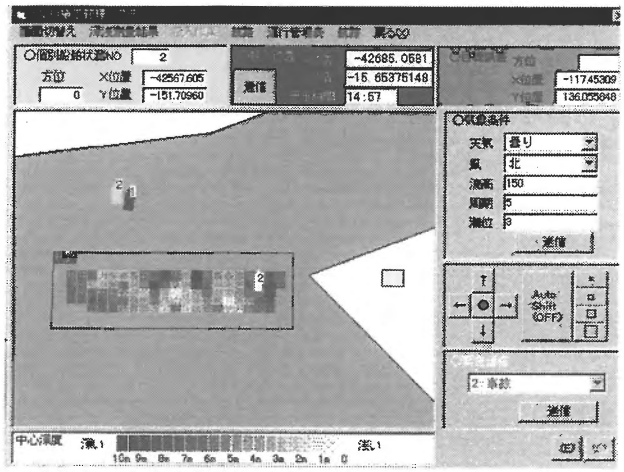

Figure 5 Discharge Control of Sediment Vessels and Gut Vessels/Sounding Control

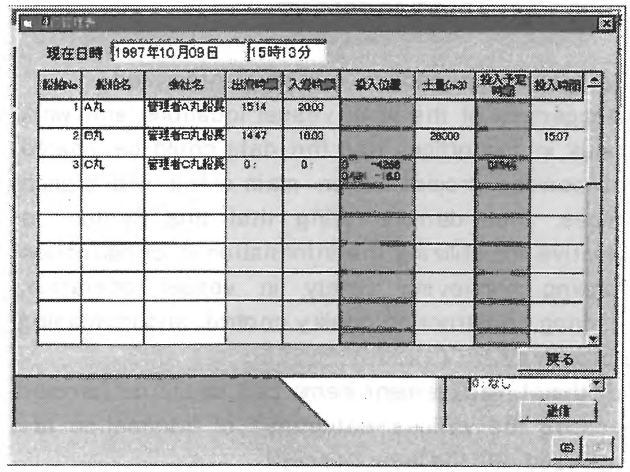

Figure 6 Operation Control Table

respectively. Some of the major check items were:
Transmit/receive of work vessel location data, survey results, weather information, emergency information;
Update status of the monitor screen.

2.2 Construction Management

Similar to the above, the monitor screen displays layers of the sounding results. The System shared and utilized the construction management information by giving instructions to the sediment vessels on sediment discharge locations, analyzing the sounding results, and creating operation control tables for these tasks. Figure 5 and Figure 6 show the discharge control screen and the operation control screen, respectively. Some of the major check items for the experiments were:
Transmission time of the sea bottom topographic sounding results, and reliability of the transmitted data;
Processing of the survey results received at the office, and the validity of image displays (contour displays);
Instructions on sediment discharge locations given to the sediment vessels based on the screen displays in item above;
Manipulation of vessel navigation in relation to the targeted discharge locations on the monitor display;
Automatic collection/updating of vessel arrival/departure times, work log information, etc., and production of control tables;
layer selection and display of sounding results, locations of buried measuring instruments such as gravitation meters, etc.

2.3 Management of Construction Status Using Internet

The in-progress construction information was stored in the on-site LAN server as Internet-compatible 3D images to check the finished form and progress at randomly selected hours. Figure 7 shows the finished form screen processed as 3D images. Some of the major check items were:
Validity of the 3D images of construction status;
Processing status of construction management information via Internet.

Figure 7 Finished Form Diagram of 3D Display of Sand Compacting Construction Status

3. CLOSING STATEMENT

The System is capable of real-time, integrated management of the work vessel locations and work status in the office, and the data could be shared between the project owner, main office and branch offices, thus demonstrating that this System is effective for utilizing the information in construction planning, improving safety in vessel operation, ensuring construction quality control, and increasing productivity.

Additional management items can easily be handled because the various categories of information are organized with the layer concept.

We hope that this report will be useful for those intending to develop similar systems.

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