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Using Information Technologies In Dredging

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Abstract
The article deals with various aspects of using information technologies in dredging. The possibilities of modern information technology in the framework of improving the efficiency of dredging are shown.
Key words: DREDGING, POSITIONING, INFORMATION TECHNOLOGIES, GEOGRAPHIC INFORMATION SYSTEMS

Introduction

Dredging is a complex process consisting of multiple steps and is characterized by a large number of parameters. The purpose of dredging on inland waterways is to provide guaranteed navigable depths. For prompt and effective management of dredging at all stages of production it is necessary to take into account a variety of parameters and be able to compare different data.

When the pre-preparation and design stages, and production work, the use of dredging projects in geographic information systems (GIS), Global Navigation Satellite Systems (GNSS), and monitoring systems and automated control of hydraulic digging process, to simplify the task of monitoring and control site to be developed.

Use of geographic information systems in dredging

Using the data of engineering surveys in different years in the software environment of GIS provide analysis of the sediment accumulation of water area and the current mode of channel rearrangement. With this approach to the organization of pre-training is possible to combine and analyze a variety of information (data surveys, satellite imagery, design documentation, etc.) and to evaluate the technical and engineering risks, receiving a full and objective picture of the task site. At the design stage the use of GIS technology solves complex hydraulic problem of choosing the shipping route slots in the implementation of this choice guided by parameters such as: safety and comfort conditions for the passage of vessels through it and minimizing the volume seized of the soil. Also an important aspect of project preparation is not ignored - evaluation of soil characteristics and selection of dredging equipment in accordance with them [1,2]. Thus, such measures of introduction geographic information systems enable organizations to operate more efficiently, increasing the quality of their work and minimizing costs. Visualization of the project structure using GIS is shown in Fig. 1.

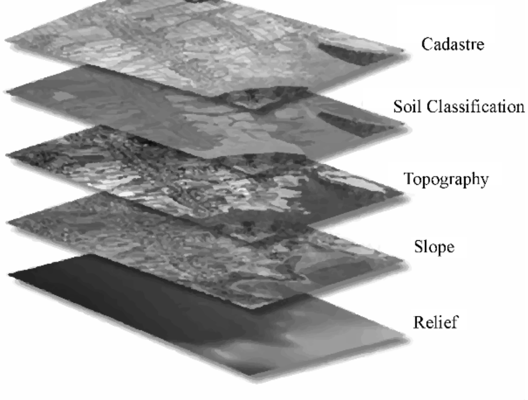

Figure 1. Visualization of the project structure using GIS

Modern software systems of positioning allow collecting and storing information from a variety of external devices: navigation receivers, depth sounder, magnetometers, heading sensors. It can be directly integrated with GIS (in this case the data exchange is realized in real time) or transfer the data obtained by exporting [3]. Using GIS technology directly in the manufacturing process works, makes it possible to visualize the process of dredging in a timely manner to analyze and evaluate the results of operations and respond quickly to the need to finalize the design decisions.

Positioning of dredger

In the production of dredging, dredgers constantly change their location, moving forward along the trench or moving across the slot «swinging» from edge to edge. To make these movements correct and remove dredged soil from the bottom of the reservoir, should be placed where it is needed, avoiding crossing undeveloped plots slots it is necessary to have special orientation and positioning system, allowing to determine where the dredge at this time [4,5].

To date, technical fleet is using positioning system based on global navigation satellite system (GNSS) such as GLONASS / GPS and differential additions DGLONASS / DGPS. These systems are constantly being improved with the development and optimization of the structure of the satellite segment, segment of management and control.

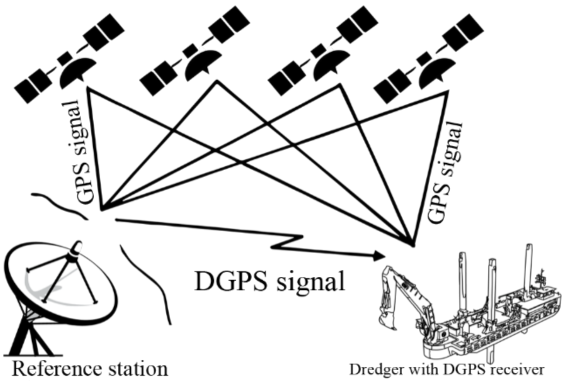

Figure 2. Schematic diagram of the DGPS system

In positioning systems of dredgers based on GNSS, location of dredger is determined according to the pseudorange measurements between navigation spacecraft and the satellite receiver, established on the dredger. Using differential mode DGLONASS / DGPS positioning systems dredgers identified the need for more accurate positioning than the normal mode, the accuracy of which is tens of meters. Currently, with the operation of the orientation of the dredgers in differential mode DGLONASS / DGPS positioning accuracy is possible to get up to 1 m [3].

The method of differential correction is based on relative constancy of the errors of satellite radio navigation systems in time and space. Differential mode of satellite radio navigation systems presupposes at least two receivers or receiver-navigation spacecrafts. One is located on the receiver-control and correction stations (reference stations), the second is designed to determine the coordinates of the user. Coordinates of correction stations are known, they are defined precisely and geodetically tied to the adopted coordinate system (usually a coordinate system PZ-90 for DGLONASS and the WGS-84 for DGPS) [6]. The scheme of the system is shown in Fig. 1.

There is also an alternative DGLONASS / DGPS positioning technology that allows you to receive a higher positioning accuracy - Real Time Kinematic (RTK). The method uses a differential GPS RTK carrier phase measurements, providing an accuracy of about 1 centimeter in real time.

Measuring carrier phase is the most accurate method of measuring pseudoranges. Carrier phase fluctuations are constant frequency, in contrast to the recorded on the GPS receiver due to the Doppler effect (some "shift" is formed by the transmission signal of the distance from the satellite to the receiver). Thus, the phase of the carrier measured between the satellite and the receiver antenna phase center will consist of an integer number of phase cycles and fractional part. Unfortunately the GPS receiver is unable to distinguish between a carrier cycles. It can measure the fractional part of the phase, and then to monitor its change: the initial phase is uncertain. In order to use the current phase for the pseudorange measurement the unknown number of cycles or ambiguity must be calculated along with the coordinates of the receiver [7]. Positioning technology is shown in Fig. 3.

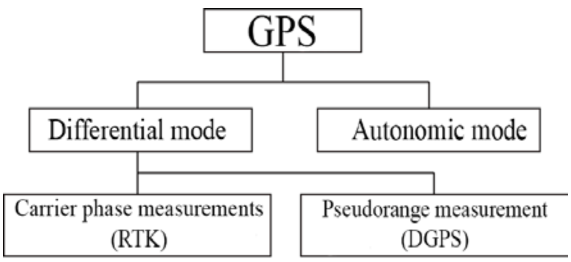

Figure 3. Positioning Technology

Monitoring and automation of hydraulic digging process

Task of automation process hydraulic digging is to achieve and maintain such relations digging parameters under which the process will be optimal. In this case, there is the task of achieving the best possible performance, consistent with the change in the rate of the working movement of the dredger and the terms of digging and transportation of soil.

Unlike automated positioning systems dredger, which are universal for all types of dredgers, process of automation of hydraulic digging requires a special approach, for example, dredgers have more opportunities to automate the process of control than multi-bucket dredgers.

Automation of the process includes automatic selection of the optimal mode of ladle drive or pump installation and the choice of automatically moving projectile, providing the regime [7].

The first step towards the creation of automated process control system of digging is to build a monitoring system. The objective of the system is the automatic collection of information about the processes in the dredger.

This information includes performance characteristics such as structure and rate of slurry, the level of penetration of device, and others.
The purpose of monitoring these data is to provide accurate data to the operator of the dredger, which will allow him to adjust the process quickly and to achieve maximum performance.

Sensors monitor the operating parameters. Sensors convert physical parameters into electrical signals and low-level transmitter converts electrical signals into the standard low-level electrical signals. These signals may be connected directly to the digital display, which will render information about a particular process [3,8].

In the next step, PLC (Programmable Logic Controller) implements the amount of information from various sensors, their comparison and building relationships. PLC is the heart of the monitoring system or control. This device is composed of input and output modules under the control of the microprocessor control program and, if necessary, communication modules to enable it to send and receive data from other devices such as computers and graphic displays. For example, the controller may display the instantaneous density flow in real time [9-12].

The program to manage the process of dredging will use the PLC, which will monitor all incoming data and automatically control the on-board devices; it is a transition from a simple display of information about the process to direct control of the process.

Conclusions

The use of modern geo-information technologies and the creation of complex hardware and software systems will maximize the effectiveness of the design and manufacture of dredging and optimize processes. Thus, the task of overall coordination of the project and its control will be simplified, and at the same time is reached improving the overall efficiency of dredging. In the foreseeable future, we should expect the evolution of automated systems into intelligent ones. Intelligent systems [13, 14] will be able to educate themselves directly in the production process works in parallel with an analysis and processing of statistical data.

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