TRANSMISSION SYSTEM FOR AUTOMATIC CALIBRATION TEST OF DEEP-WATER MAGNETOMETER

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Introduction

"We live in a complex age where many of the problems we face can, whatever their origins, only have solutions that involve a deep understanding of science and technology. Modern society desperately needs the finest minds available to devise solutions to these problems." (Carl Sagan).

Continuous development of technology helps to improve the social sphere of human activity. Each invention that is produced by a human for society must have high technological and technical parameters, among which sensitivity of devices and settings for calibration instruments have an important role.

The magnetometer is a device for measuring intensity of magnetic field and magnetic properties of materials. [1] There are many different types of magnetometers, but for this project it is planned to use a fluxgate magnetometer because of its high sensitivity. This device can be used to measure and evaluate magnetic fields (in general, constant or slowly varying magnetic fields) and their gradients.

It is necessary to create a system of calibration data to use a high-sensitivity sensor without distortion of the field value and have the maximum measurement accuracy. We know that modern systems for automatic calibration of sensors have already been implemented. However, these systems are designed for different purposes. The principles of action of these systems are different, and as a result, they provide different accuracy for the calibrated sensors.

The main idea of our project is to create a system of automatic calibration of a deep-water magnetometer. Calibration is carried out with a stepper motor driver.

These systems can be applied in deep submersibles, such as deep-water robots and submarines. Via accurate calibration of sensors it is possible to achieve location of objects under water to the depth of 10,000 meters with accuracy of not less than 10 nT.

In the future, it is expected to use the system to calibrate not only deep-magnetometers, but also other sensors. For example, it can be inclinometers – these are devices to determine the angle and azimuth of the borehole deformation in order to control its spatial position (used in oil and gas industry).

The main goal of our project is to create a system of step motor control for fine regulation of sensors in the enclosure of a coil.

The main objective of the study is to analyze different structural approaches to solving the problem of calibration. The main objective of our research defined the structure of the future system. After development of the structural scheme it is necessary to make a choice of necessary elements.

The uniqueness of our project is in the fact that the anticipated system has no analogues in the Russian Federation or abroad and, consequently, will be in high demand at the market.

Development of the block diagram of the designed device

Firstly, it is necessary to define the basic functionality of the projected system, its purposes and relationship between its components. Graphically, the structure of the designed system is shown in Fig 1.

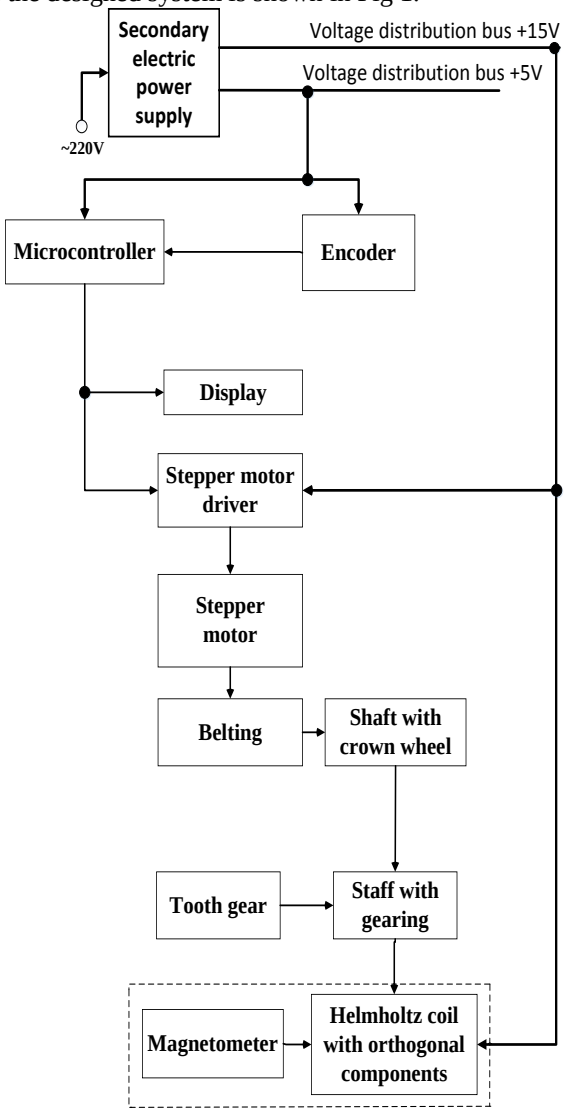

Fig. 1. Functional diagram of the automatic calibration of deep-water magnetometer

To understand the principle of operation of the system it is necessary to explain the mechanism of each block, its purpose and how it impacts further selection of specific devices and definition of their parameters.

Secondary electric power supply

It is a device that is designed to supply other devices with electrical power by converting the energy of different power supply sources of AC voltage of 220V.

Helmholtz coil with orthogonal components

Helmholtz coil with orthogonal components represent a plastic coil that has copper wires on the outside surface of the coil. Using them a magnetic field is created. It is based on the principle of Helmholtz coils. [2]

Magnetometer

It is a block containing a special sensor. Due to the fact that one of the main requirements for the designed system is its high sensitivity, it is necessary to use a flux-gate magnetometer in the research. It is an instrument for measuring and evaluating magnetic fields (constant or slowly varying magnetic fields) and their gradients.

Encoder

This device converts linear or angular movements into a sequence of signals that allow determining the amount of movement. [3] In our system, the encoder is required for external impact: offset of the calibrated magnetometer in the coil is performed by shaft rotation.

Microcontroller

A microcontroller is a special electronic chip for controlling different types of electronic devices. In the created system, a microcontroller will be used to ensure stepper motor control. The control will be carried out due to external impact on the encoder that converts the angle of rotation of its shaft into electrical signals that subsequently are transmitted to the microcontroller.

Display

It is an electronic device for displaying digital, alphanumeric or graphic information electronically. The display that is used for the designed system should display the value of the angle of rotation of the shaft encoder that is calculated by the microcontroller, and up/down arrow indicating the direction of movement of the calibrated sensor.

Stepper motor driver

The stepper motor driver is a powerful power supply scheme of the motor windings. [4] The stepper motor driver is selected based on the model of the stepper motor.

Stepper motor

It is an electromechanical device that converts a control signal into an angular (or linear) movement of the rotor. This movement passes with its fixation in a predetermined position without feedback. [5] The stepper motor of the designed system rotates clockwise or counter-clockwise, depending on the signal incoming from the microcontroller.

Belting

It is a device that enables transmission of mechanical energy using a flexible element due to the frictional forces or forces of engagement (power grip belts). [6]

Shaft with crown wheel

The shaft has two gear hills. When the first gear hill (part of belting) sets in motion the second gear hill starts rotating because it is on the same shaft. They will drive the staff with toothed.

Tooth gear

It is a gear wheel that is necessary for rigid fixation of toothed staff.

Staff with toothed

It is a staff that has daps for gearing. The magnetometer is clipped at the end of the staff that moves in the cavity of the coil.

Conclusion

By the end of 2015, the final version of the product – a system of automatic calibration for deep-water magnetometer – will have been created. By the stated time, the system will be debugged and adjusted through identification of all its defects. Currently we have already made analysis of the working capacity for the automatic calibration, prepared and analyzed engineering documentation; all the necessary resources and facilities have been attracted.

The final product will be used, as it was mentioned earlier, for deep-water robots and submarines. It is assumed that the main customers will be factories that produce submarines or radar systems.

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