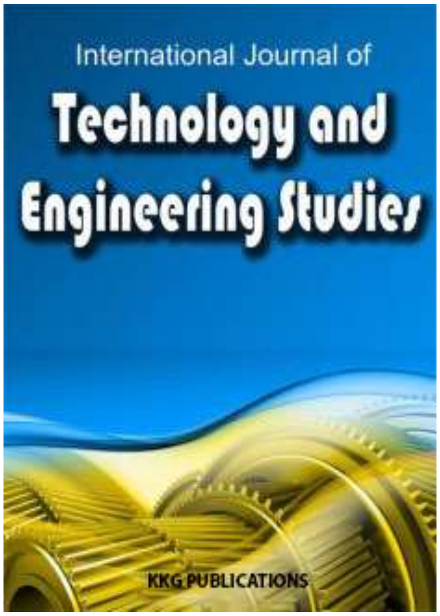

MODELING THE CONTROL SYSTEM OF SENSOR MOVEMENT MECHANISM OF LOGGING UNIT

OZHIKENOV KASSYMBEK [1*], TULESHOV ERKEBULAN [2], ISMAGULOVA RAUZIYA [3], AITZHANOVA GULNARA [4], OZHIKEN AIBEK [5]

[1,2,3,4] Kazakh National Technical University after K.I. Satpayev, Almaty, Kazakhstan,
[5] Kazakh National University after Al-Farabi, Almaty, Kazakhstan

Published online: 17 October 2015

To cite this article: K. Ozhikenov, E. Tuleshov, R. Ismagulova, G. Aitzhanova and A. Ozhiken "Modeling the control system of sensor movement mechanism of logging unit," *International Journal of Technology and Engineering Studies*, Vol. 1, no. 3, pp. 68-73, 2015.
DOI: https://dx.doi.org/10.20469/ijtes.40001-3

To link to this article: http://kkgpublications.com/wp-content/uploads/2015/12/IJTES-40001-3.pdf

KKG PUBLICATIONS

International Journal of Technology and Engineering Studies

IJTES

Vol, 1, no. 2, pp, 68-73, 2015

MODELING THE CONTROL SYSTEM OF SENSOR MOVEMENT MECHANISM OF LOGGING UNIT

OZHIKENOV KASSYMBEK [1*], TULESHOV ERKEBULAN [2], ISMAGULOVA RAUZIYA [3], AITZHANOVA GULNARA [4], OZHIKEN AIBEK [5]

[1,2,3,4] Kazakh National Technical University after K.I. Satpayev, Almaty, Kazakhstan
[5] Kazakh National University after Al-Farabi, Almaty, Kazakhstan

Keywords:
Well Logging Measurements
Logging
Logging Unit
Processing and Conversion of Information
Software and Hardware

Received: 16 April 2015
Accepted: 18 June 2015
Published: 15 August 2015

Abstract. This work addresses the issue of geological exploration and search of rich ore deposits. One of the effective methods is the use of the logging principle, which consists of: a well is drilled in 25-35 cm diameter, then the good side face is studied, i.e. the ore percentage is determined on the good height. The logging unit specified in this work consists of a main stepper motor, reducer, winch, and a shell with a telescopic sensor. The sensor consists of ionizing radiation sources, the proportional counter used for the detector, a preamplifier, and a sensor movement stepper motor. A motor implements an important function, consisting of lowering and lifting the logging instrument into the well. Therefore, a motor control function composition, the movement of which will reconcile with the movement of sensor movement motor. The work process covered research on developing a new method and technology of computer control, and information processing of logging unit, an X-ray radiometric logging unit mathematical model and control function was developed. The study results can later be used in creating automated mobile logging units that can be used in the mining metallurgical industry.

INTRODUCTION

To enhance geological works, it is necessary to make a sharp breakthrough in the sphere of exploration, engineering and development of innovative prognostic and search technologies for identification of new promising deposits of various metals with mandatory certification by field studies. The number of these developments include modern logging units that allow to precisely assess the ore grade and presence of mineral deposits, to predict the further technology of extraction and processing [1].

The purpose is to implement the methods of optimal design and logging unit operation control using new information and geo information technologies.

Wide development and spread of information technologies, as well as their availability has led to integration of many branches of science and technology with computer technologies [2]. The use of information technology in geophysical researches of wells will let [3], [4]: optimize the logging process by creating a mobile logging unit with automated control and information processing system, based on the advanced method of well logging; reduce the cost of well exploration, data transmission by wireless networks will not require a foundering of additional expensive cables; recording and monitoring of the logging process in a well in real time; remote control of a shell with telescopic sensor.

Logging unit designing goals

The initial goal in logging unit design is need to identify a set of functional and system requirements. On the part of a user the developed device is put the following requirements: indication of the current position of the probe (immersion depth); alert on completion of measurements (beep noise); an alert in detection of obstacles, closure of the flaps and lifting or stopping of the probe (a beep noise, engine stop).

A developed logging system should have the following functions [7]: controlling the depth of device dismount into a well (lifting/lowering the probe); control of the speed of cable movement, cable tension (measured parameters are displayed on digital light indicators); sound light alarm, emergency stop (power off) when reaching the zero mark and/or programmable values in depth, as well as when reaching efforts on tension transducer of a predetermined value; a record on flash memory; positioning of its location via

* Corresponding author: Ozhikenov Kassymbek
E-mail: kas_ozhiken@mail.ru

Global Positioning System; connection of personal computer (PC) with a measuring probe on a radio channel; processing the flap position of the probe (open/close); indication, charts; rotation around the axis of the well, moving to required distance to the wall of the well.

In accordance with the above functional and system requirements, x-ray radiometric logging station (XRLS) with computer control and data processing system was developed, which consists of three main parts [5]: power, electronic and software. The power part includes a main motor, reducer, winch and a shell with telescopic sensor. A motor implements an important function, consisting in lowering and lifting of the logging instrument into the well. The sensor consists of ionizing radiation sources, proportional counter used for detector, preamplifier and a sensor movement stepper motor. Fig. 1 shows a process functional diagram of XRLS.

Fig. 1. Process functional diagram of XRLS

Division of a logging unit into hardware (power, electronic) and software parts

This stage of work requires a determination of the functions of hardware and software parts, so we allocate the functions.

Functions of the hardware part: display of the parameters on liquid crystal display; control of the sound signal switching in overcharge; control the opening/closing of the probe flap; controlling the main engine; positioning the sensor in the mine.

Functions of the software part: receiving signals from the sensors; beep; determination of the depth; detection of an obstacle; determination of door position (open/closed).

At this stage of work it's necessary to make a general functional structure and algorithms of the software and hardware part operation. The end user must receive diagrame charts, displaying information on the content of minerals in drilling site, with subsequent comparison of the obtained results with the available spectrograms. This information is easy to process and present through a PC, and it can be received descending a sensor (S) into a well with the help of a winch (W), to transmit information from the sensor to the PC data processing unit (DPU) is required. For automated reading of information, at different depths and in different directions a control unit (CU) is required, which controls the positioning of the sensor in the well with a winch, and an angle of the sensor movement in a well using a stepper motor. Thus, the logging station can be divided into several functional blocks, shown in fig. 2.

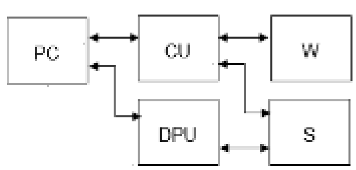

Fig. 2. Functional diagram

Let's consider each functional unit separately (fig. 3). The whole station will consist of a stationary part and a movable module. Structurally terrestrial part consists of a PC, motor, microcontroller (MC) ensuring a winch engine control; motor driver (MD), ensuring a connection of a motor with microcontroller; a feedback (FB), ensuring a control of depth of immersion of the movable module, and a speed of lifting/lowering; radio transmitter for connection with a movable module. The movable module consists of a microcontroller of the sensor (MCS), flash memory (FM), radioactive sensor (RS), stepper motor driver (SMD), stepper motor (SM), a radio transceiver (RTC). The microcontroller reads the information from the sensor, records it into flash memory, and transmits from RTC and MC to PC, controls the angle of sensor rotation by means of a stepping motor.

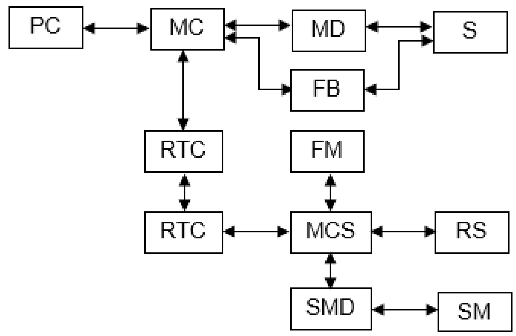

Fig. 3. A structure diagram of a logging unit

X-ray radiometric field instrument RPP-12 is used as a sensor, which is designed for ore assaying in natural deposit (mine walls, open-cut mining benches, natural outcrops, etc.), in a loosened mined rock and coarsed-crushed sampling materials (hand specimen, core samples, etc.).

For development of complex software it's necessary to develop an algorithm of its operation. The user will use the program on PC, which will represent an interface between the whole system and man. We divide this program into three large blocks: a setup of the whole system; taking data from the well; concluding results.

A technology of computer modeling of microcontroller control system of a logging unit sensor actuator

This stage of work provides the main points that should be paid attention when designing stepper motor (SM) control system based on PIC microcontrollers. Let's consider a circuit diagram of microcontroller control system of logging unit telescopic sensor actuator. The scheme is collected in intellectual environment of ISIS modeling of Proteus package. The scheme consists of the microcontroller U1, the driver SM U2, SM D1, LCD1 display and the variable resistor RV1 as a feedback or control signal. The applied microcontroller PIC16F873 provides analog-to-digital conversion (ADC) analog input signal received at the port AN0. The input signal can vary from 0 to +5 B. After the ADC, the microcontroller generates a control command in a sequence of connection of the windings SM D1 to the supply circuit and rotates the motor shaft at a given angle. Liquid crystal display (LCD) LCD1 displaying the processed control signal in decimal form indicates the position of the sensor. The drive control can be arranged in the form of a given program when upon receipt of actuator startup signal SM moves the sensor at a certain distance and after a specified time pushes it. In particular cases this may lead to failure of the mechanism, since without feedback the well wall roughness is not taken into account. To solve this problem it's necessary to use distance measuring devices from a shell to a well wall at a given depth.

An electric drive of logging unit telescopic sensor control unit is developed in Proton IDE. It is conditioned by the fact that Proton IDE is the simplest in solving such problems. It is a product of Mecanique company and designed to work in conjunction with microcontrollers of MicroChip company.

Unlike computer models, the real scheme includes additional components, which are overdrawn in virtual environment in view of insistence of their presence in the schemes. Thus, the real scheme uses a crystal resonator to 20MHz, a voltage regulator for 5V and terminals for node connections. External crystal resonator ensures a more precise operation of the microcontroller. As there is one power source for stepper motor, display and microcontroller, a voltage regulator provides a control scheme for stable 5V power supply. Laboratory prototype uses miniature SM from computer floppy drive for flexible diskettes. It lets debug the control system on a real device, and at the same time not to spend a lot of financial resources for the experiment. The difference between the laboratory prototype and future trolley line is only in SM power, and respectively, in the amplifier. For miniature SM microcircuit L293D driver is used, which provides bi-directional control of motors up to 4 watts.

In general, modeling results of modeling electromechanical processes in SM allow to evaluate the accuracy of the set movement, dynamic quality of the system, calculate the mechanical force in system elements and their impact on the main variables of the SM electromechanical processes. The conducted researches identified the possibility of creating a microcontroller control system of electrical drive of logging unit telescopic sensor with the accuracy of a set movement.

The principle of building a connection between a shell with telescopic sensor and a host computer

In XRLS for data transfer between the shell and host computer TCP/IP setup is used [9]. In intranet, operating on the basis of TCP/IP, the information is transmitted in the form of discrete units called IP packets or IP datagrams. Due to TCP/IP software, host computer and logging shell, connected through a wireless Wi-Fi network are in the same intranet. Connections to intranet are identified by 32-bit IP addresses, which are expressed in the form of decimal numbers separated by dots [5].

Fig. 4 shows the scheme of connection to XRLS intranet blocks. Subscriber station 1 (Wi-Fi access point) is connected to hose computer via a twisted pair, then a signal through antenna is transmitted to a logging shell over the wireless network.

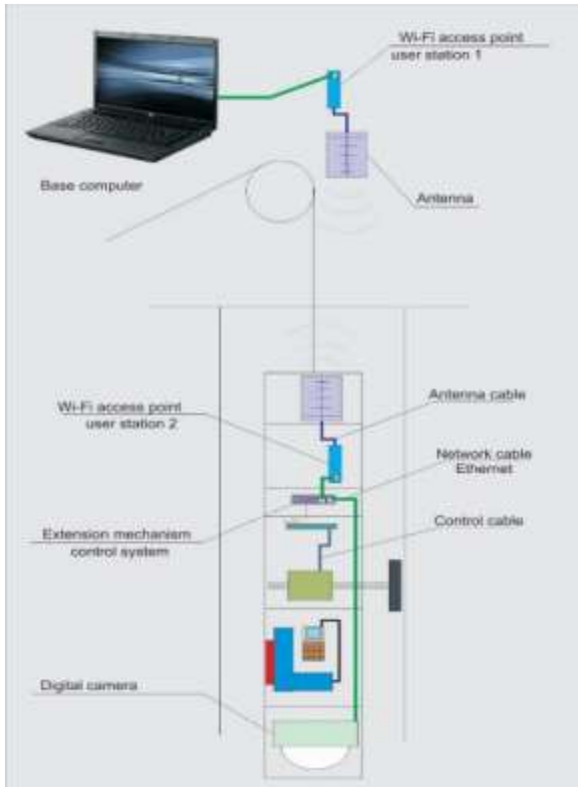

Fig. 4. A scheme of transferring data of hose computer and logging shell

In logging shell the signal is received by Subscriber station 2 (Wi-Fi access point) and passes over twisted pair up to a digital camera and moveable mechanism control system.

Testing the microcontroller control unit of shell with telescopic sensor in CAD

In addition to analysis of ore material in well, the development of information technology let use advanced visual observation transmitting the image in real time to the hose computer via a wireless Wi-Fi network. In this case, Liquid Image LIC727 EGO camera, a pocket camera for extreme shootings, is used. A distinctive feature of this camera is the built-in Wi-Fi module, which allows to pre-set the angle and to select the most advantageous location. The camera allows to broadcast an image real-time to the host computer. Fig. 5 shows the image transmitted by the camera to host computer.

The camera also allow as to video record the well, it will help to clearly examine the entire column to determine the presence or absence of faults and fractures, as well as to know the water level, well depth and a clearance of drilled cement rock of the main water shut-off [6]. The water level in the examined well is found at 24.75m mark. At the level of 76.65m the ettles are seen on a well wall (fig. 5).

Fig. 5. An image from the camera at 0.27m, 24.75m and 76.65 m level, accordingly

CONCLUSION AND RECOMMENDATION

Mobile x-ray radiometric logging station that meets the functional system requirement of the end user is developed. A new method and technology of computer control and information processing of logging station are developed. A technology of computer modeling of microcontroller control system of stepper electric drive of logging unit sensor is developed. The principle of construction of a wireless connection between a shell with with telescopic sensor and hose computer is developed. An algorithm and a control program of entire operation of logging unit electro mechanic system is developed. Results of the study revealed the possibility of creating a mobile logging station with microcontroller control system of electrical drive of telescopic sensor of logging unit with the possibility of working out of a given displacement.

Declaration of Conflicting Interests

This research study is an original work of authors and all the authors made equal contributions; there are no conflicts of interest present.

Acknowledgement

The article is prepared within the frames of the project «A development and design of a driving actuator and a controlled parallel manipulator of x-ray radiometric logging station on the principle of feedback», in accordance with the Order of the Chairman of the Committee of science of MES RoK №17 dated 08.04.2013.

REFERENCES

[1] Y.M. Drakunov, A.N. Lezin and N.P. Pukha, "Modern logging unit," *Computational Technologies*, no. 2, pp. 47-55, 2007.

[2] A.A. Tuleshova, "Panels and control functions of the logging device of station," *Vestnik KazNU: Series: mathematics, mechanics, Informatics*, Special issue no. 4 (67), pp. 248-250, 2010.

[3] O. Kassymbek, T. Erkebulan, U. Ruslan and T. Azhar, "Improvement of manipulating robot servo drives' control system," *In Robotics in Alpe-Adria-Danube Region (RAAD), 23rd Int. Conference on*, pp. 1-5, Sep. 2014.

[4] A.K. Tuleshov, K.A. Ozhikenov, A.K. Ozhiken, "The dynamical processes adaptive stabilization in the robot electric drives control system," *International Journal of Experimental Education*, no. 2, pp. 63-65, 2013

[5] K.A. Ozhikenov, R.M. Utebayev, D.A. Nurpeisova, N.A. Koltun and A.K. Ozhiken, "The use of modern information technology in the development and design of a logging station shell," *Proceedings of the Int. forum, Engineering education and science in XXI century: Problems and prospects*, dedicated to the 80th anniversary of KazNTU after K. I. Satpaev, vol. 2, pp. 304-308, Oct. 22-24, 2014.

[6] Anonymous, "Development and design of the drive and controlled parallel manipulator of x-ray radiometric logging station on the principle of feedback," The research report, state./reg. no. 0112PK01482, Inv. no. 0214PK01664, 2014.

[7] M. Gandr, R. Seabra, and F. P. Lima, "A low-cost, versatile data logging system for ecological applications." *Limnology and Oceanography: Methods*, vol. 13, no. 3, pp.115-126, 2015.

[8] A. Patrascu, and V. V. Patriciu, "Logging system for cloud computing forensic environments," *Journal of Control Engineering and Applied Informatics*, vol. 16, no. 1, pp.80-88, 2014.

[9] D. Medhi, B. Ramamurthy, C. Scoglio, J. P. Rohrer, E. K. Çetinkaya, R. Cherukuri, X. Liu, P. Angu, A. Bavier, C. Buffington, and J. P. Sterbenz, "The GpENI testbed: Network infrastructure, implementation experience, and experimentation," *Computer Networks*, vol. 61, pp.51-74, 2014.

— This article does not have any appendix. —