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THE CONCEPTUAL ISSUES OF IMPLEMENTATION OF THE OIL AND GAS COMPLEX BASED ON INDUSTRY 4.0 SOLUTIONS*

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1. Introduction

The oil and gas complex (OGC) is one of the largest industries in the world that have a significant impact on the global economy. For the foreseeable future, oil and gas will remain important sources of energy in addition to renewable and alternative sources of energy. However, at present, the prospects for the development of the oil and gas industry have raised some doubts due to many factors. The most significant of these are the ever-changing supply and demand cycles and reduced margins, difficulties in oil production from hard and very hard rocks, the growing penetration of renewable energy sources, a growing fleet of electric vehicles and toughening environmental standards. In this environment, OGC Industry 4.0 can play a vital role in enhancing their efficiency and competitiveness. The core technologies of Industry 4.0 are the Internet of Things (IoT), cyber-physical systems, big data, cloud and edge computing, robotics, artificial intelligence (AI). In practice, they present such capabilities as unmanned drilling, digital modelling, preventative maintenance, etc. The purpose of this article is to determine the possibilities of using AI, as Industry 4.0 technology, in achieving greater operational efficiency of OGC. AI is a branch of computer science that uses the methodology of human thinking and the computing power of computers to perform or simulate the work of the human brain [2]. The basic principles of AI include reasoning, knowledge, planning, learning, communication, perception, and the ability to manipulate objects. In addition, he can generalize and study directly from data from various fields. According to the Artificial Intelligence Applications Institute, the field of application of AI technologies is as follows:

- case-based justification: adapting the methodology based on past data and existing corporate resources, such as databases for experimental diagnostics and troubleshooting;
- genetic algorithms: adaptation of the search technique with very wide applicability in the planning, optimization and adaptation of models;
- planning and work: modeling, task setting, planning, execution, monitoring and coordination of various works;
- intelligent systems: the approach of building knowledge-based systems.

2. AI and edge computing as an effective strategy for OGC

It should be noted that AI applications (estimation and forecasting models, big data analytics, etc.) require significant computing power. Computing power in many industries is traditionally achievable on a cloud computing platform, that is, data processing is carried out centrally. However, a geographically distributed environment can cause delays in the collection and processing of production data and the adoption of operational measures in real time. The solution

to the above problems is possible using the paradigm of edge computing. Edge computing is the expansion of computing applications, data, and services from centralized nodes to network boundaries. This allows data processing and analytics as close as possible to data sources - sensors, SCADA and other operating systems. This approach also allows the use of resources even when the cloud connection is broken, avoiding the need to send all raw data for storage and processing on cloud servers. Another common problem that OGC faces is the large amount of legacy equipment that is still running. Edge computing provides the ability to connect this existing legacy equipment, such as analog instrumentation, as well as stand-alone processes so that they can be digitized and integrated into a more reliable network that can provide real-time information, enabling intelligent decisions. Edge computing helps with tasks such as collecting data from locally located facilities, such as an offshore rig, wells, compressor stations, or a refinery, to limit the number of cloud connections. This is especially important for OGC, where there are many remote places like this.

3. The conceptual issues for using AI in OGC

Let's consider some possible applications of AI in the so-called OGC segments: Upstream, Midstream and Downstream [3, 1].

Upstream segment consists of stages of exploratory drilling and production of hydrocarbons (oil and natural gas). One of the key business areas at OGC is the drilling of a production site. Drilling is technically complex and costly. Eliminating the costly risk of drilling, using big data to improve performance and turning a traditional manufacturing system into new predictive technologies are factors driving the growth of the global AI market in OGC. Using AI for precise drilling helps eliminate the human factor, reduce the risks of accidents, oil spills, fires and increases the speed of penetration. Interpretation of data with its help reveals important geological features, for example, abnormally high reservoir pressures, discrepancies and physical boundaries of the raw material reservoirs. The accurate information provided by AI technology is very important for operators because geologists sometimes cannot get all the information due to poor well condition or other external factors. Subsequently, according to the data of drilling in exploration wells, a three-dimensional model of the field is built. The optimal location of production wells in the field is also performed using AI. The maintenance is an integral part of the production processes in the OGS. It directly affects the performance of assets and constitutes a significant part of the costs. Therefore, it is necessary to decide which assets should be prioritized for inspection and maintenance, and which assets may be excluded for subsequent maintenance. The trend is to use a risk-based assessment approach to optimize the plan. But since this assessment is performed manually, it is considered time-consuming, makes high demands on efforts and is vulnerable to human prejudices and mistakes. During inspection and maintenance, technicians seek to detect any anomalies that could threaten the operational integrity of oil and gas assets using various methods, such as ultrasound testing, radiography, magnetic flux leakage, etc. Howeverbased on individual experience, technical personnel develop decision-making skills that have been successfully used in past practices, but in the present time require significant correction. AI-based intelligent service system, in which service is only performed when necessary and before a failure occurs, can significantly reduce costs.

Midstream segment - feedstock is filled into primary tank batteries, where oil is separated from gas and water and then transported to refineries. Oil reservoir management includes several technical aspects, such as interpretation of seismic data, geology, reservoir management, production, etc., for which the degree of optimization and maintenance is very high. AI systems can be trained based on these technical data and help in field surveillance, lowering the cost of maintaining the tank, developing the tank, etc. Monitoring oil and gas transportation will ensure the safety of workers and the environment as a whole. Accidents can be monitored using

intelligent video surveillance, robots, drones, etc., to reduce the degree of potential damage. Frequent equipment inspections and risk assessments will help companies take predictive measures to avoid unforeseen circumstances. For example, the pipeline has a system for detecting any oil leak. Currently, this system is serviced by operator personnel, who must be in standby mode and monitor the status of the piping system. They must take into account the various operating parameters of the pipeline, such as pressure, temperature and flow, to detect any irregularities. A significant drawback of such a system is the increased requirements for staff qualifications and the relatively high probability of false alarms. The same task will be performed better and faster with the help of AI because it includes the type of pattern recognition task. Another application of AI in a pipeline monitoring system is the detection and determination of the type of threats during third-party operations near the pipeline.

Downstream segment - here, oil or natural gas is processed into final products, such as gasoline, kerosene, jet fuel, diesel fuel, fuel oil, lubricants, compressed gas, plastics and other materials for their subsequent sale. In this segment, customer support and customer interaction are crucial, as for any business. AI-based chatbots help OGC companies interact with their customers by providing product information, addressing their issues, recommendations, etc. Chatbots can conduct surveys on their websites to collect customer feedback and further improve customer service.

4. Conclusion

AI has a significant impact on the oil and gas industry, and its applications continue to grow. Its applications include seismic image recognition, formation characterization, permeability and porosity prediction, drill bit diagnostics, pressure drop assessment in pipes and wells, optimization of well production, well productivity, general decision-making operations, etc. The studies conducted in this work show that AI is of great interest and importance for the effective solution of these OGC problems. Together with Industry 4.0 technologies such as big data, IoT, cloud and edge computing and robotics, AI significantly affects the industry, helping it to develop advanced applications for maintenance and infrastructure management, make informed decisions in exploration and identify new oil and gas fields, in compliance with environmental standards and ensuring the safety of workers.

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