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PROSPECTS FOR USING ROBOTIC COMPLEX IN THE MINING INDUSTRY (using basalt mining as an example)

Alimova Nodira Batirdjanovna [1], ***Yusupov Bekmurod Bayotovich*** [1], ***Ozodova Dilrabo Oltinbek qizi*** [1]

[1] Department of Mechatronics and robotics,
Tashkent State Technical University, Uzbekistan

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Abstract

The main technological stage in the extraction of minerals is the mining and processing complexes. The article analyzes the current state, prospects and general directions of development of robotic mining equipment. Robots are key tools for increasing productivity because they perform a wide range of manual tasks more efficiently and consistently than humans. Therefore, the development of robotic systems is an important development task for the mining industry.

Keywords: *minerals, basalt, robotic complex, safety, efficiency*

Introduction

Currently, the mining industry is in constant development, which determines the use of innovative technologies and modern equipment. Increased efficiency of a mining enterprise can be achieved by increasing the productivity of the process of transporting rock mass, saving fuel, reducing the vehicle fleet, reducing operating and maintenance costs. In addition, the mining industry has to work in all climate zones in more dangerous and complex mining, geological and natural conditions, in hard-to-reach regions, complicated by the deepening of quarries, dust, gas pollution and difficulty of ventilation. These and other factors have a negative impact on the health of personnel.

Robotization of production is an integral part of complex automation and is the process of implementing a robotic complex, which includes isolated or combined robotic sections and lines.

Robotization of production provides an undeniable advantage in increasing production productivity, increasing the number of manufactured products per unit of time, improving their quality and reducing production costs. Modern industrial robots can

flexibly and quickly switch from one technological operation to another by replacing the control program. Robotic complexes (RC), like robots, are widely used in various industries, from industry to medicine and military affairs. In industry, RTCs are used to automate production, improve quality and reduce production cycles. In other areas, they are used for reconnaissance, monitoring, search and disposal of explosive objects (Dzhigaris, D. D., Makhova, M. F., 2002).

Formulation of the problem

The introduction of robots in the mining industry has revolutionized the sector. Mining companies now use robotics in a variety of operations, from open-pit mining to underground mining and mineral processing. The main benefits of robots in the mining industry include increased safety and efficiency.

In the mining industry, robots are used in a variety of operations, such as transportation, drilling, blasting, and mineral exploration. Some of the most commonly used robots include autonomous trucks, drilling robots, and robotic conveyor systems (Kamolov, B. S., 2023).

In recent decades, comprehensive scientific research work aimed at saving metals has been conducted in the Republic of Uzbekistan. Since not only in our country, but also throughout the world, there is an acute shortage of metals. This is evidenced by information available in technical sources of the press (Kurbanov, A. A., 2009). Scientists argue that there is a need to expand research into unexplored areas of nature and increase the volume of processed natural resources, especially those that are little studied, which can create import-substituting types of products (Kurbanov, A. A., 2018).

The study showed that there are little-studied minerals in nature that consist of metal-containing oxides. Basalt rocks can be classified as such minerals. According to the Ministry of Geology, the raw material reserves of basalt rock today amount to more than million tons with an iron content of, for example, 15÷20% (Shevchenko, V. P., Gulamova, D. D., 2011, Kurbonov, A., Sattorov, L., Kamolov, B., Rakhimov, O., 2023, Kamolov, B. S., Kurbanov, A. A., Sattorov, L. K., 2023).

Basalt is a natural igneous rock formed by the cooling of lava. It is widespread on Earth, making up a significant portion of oceanic crust and volcanic rocks. Due to its properties, basalt has found application in many industries, including construction, industry, and even space technology.

Basalt is distinguished by its color variety: from black to gray and greenish shades. The structure of basalt depends on the composition. So, if it includes minerals, then when cut, inclusions of green, white or gray color are noticeable. Glass wool is also characterized by small impurities, but there are very few of them.

Basalt is characterized by columnar jointing. This means that high columns are visible in the structure. They are formed due to uneven cooling of lava. Moreover, their height fluctuates from several centimeters to meters. Therefore, the rock pattern looks original. If the basalt is marine, then instead of columns, separate pillows are formed.

The rock texture should be massive, porous, with almond-shaped formations – oval areas that are filled with other minerals such as calcite or feldspar.

The main advantage of basalt is its strength and resistance to environmental influences. The material is practically not subject to corrosion, does not lose its properties under the influence of moisture, temperature changes or chemical reagents.

Basalt processing involves various types of processing of this igneous rock, from crushing to the production of various materials and products. Basalt is used as a raw material for crushed stone, basalt fiber, as well as for the production of building blocks, tiles, statues and other products. Innovative technologies have expanded the range of applications of basalt (Drobot, N.F., Noskova, O.A., Steblevskii A. V., 2013).

Solution to the problem:

Basalt can be processed in a variety of ways, depending on the desired end product. The main processing methods include:

– **Mechanical processing:**

Basalt can be processed manually to create small parts, while large slabs are produced using conveyor production.

– **Heat treatment:**

Basalt is heat treated to produce basalt fibers, which can then be used in a variety

of applications, such as insulation, building materials, and other products.

– **Melting:**

To produce basalt fiber, basalt is crushed, washed and melted at high temperature, then extruded through nozzles to produce continuous strands.

– **Flake processing:**

Basalt rock is loaded into a furnace, melted, and then the melt is discharged through a feeder to produce basalt flakes, which are used in various fields.

Figura 1. *Basalt and its crushing*

The use of robots in basalt mining is possible and promising in various operations, including transportation, drilling, blasting and exploration. Robots can be used to improve productivity, safety and reduce costs in mining operations. In particular, autonomous trucks and drilling robots, as well as robotic conveyor systems, can significantly simplify and optimize the basalt mining process.

Advantages of using robots in basalt mining:

– **Increased productivity:** robots can work around the clock and without breaks, which allows for an increase in the volume of basalt mined.

– **Increased safety:** work in hazardous conditions (for example, in tunnels or during blasting operations) can be performed by robots, minimizing the risk to personnel.

– **Reduced Costs:** Robots can reduce labor requirements and lower equipment maintenance costs.

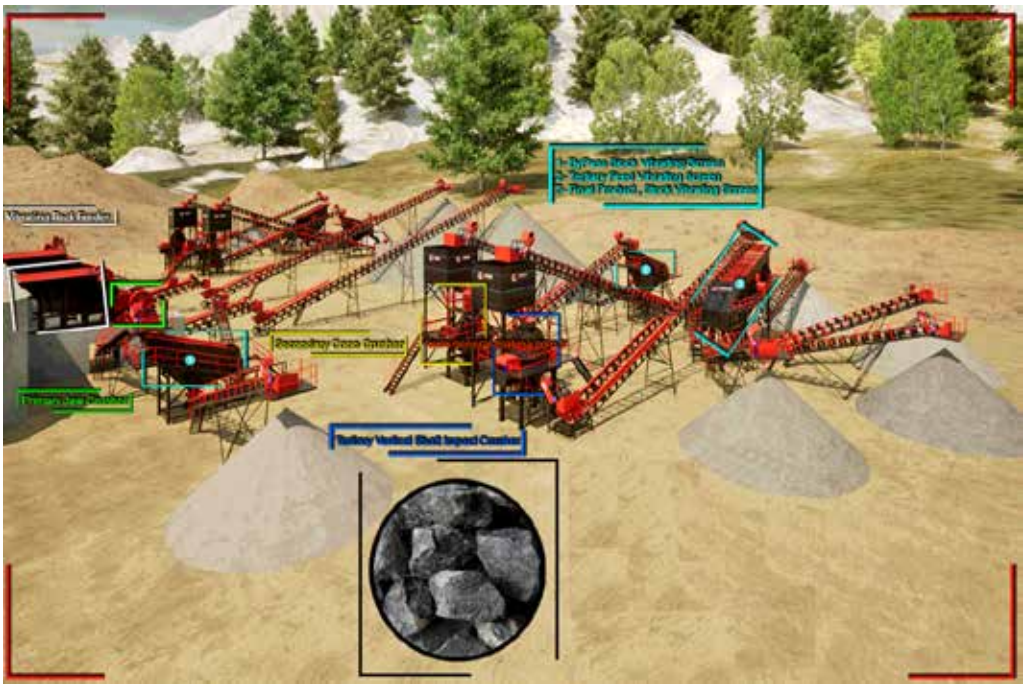
– **Improved Product Quality:** Robots can provide more precise and controlled extraction, which can improve the quality of the final product.

Types of robots used in basalt mining:

– **Autonomous trucks:** These are used to transport basalt from the mine.

– **Drilling robots:** These are used to drill into rocks.

Figura 2. *Basalt crushing scrreningplant*



– **Robotic conveyor systems:** These are used to transport basalt around mines and quarries.

– **Mobile mapping robots:** These are used to create accurate maps of the mines.

Applications of robots in basalt mining:

– **Open-pit mining:** Autonomous trucks and drilling robots are widely used in open-pit mines.

– **Underground mining:** Robots can be used for drilling, transporting and blasting in mines.

– **Exploration and geological survey:** Mobile robots can be used to collect information about deposits.

Examples of robots being used in basalt mining:

– Some companies use autonomous trucks to transport basalt from mines, allowing them to reduce transportation costs and improve safety.

– Other companies are using robots for drilling and blasting operations in mines, helping them increase productivity and reduce risks to personnel.

– In some cases, robotic conveyor systems are used to transport basalt, making the mining process easier and faster (Alimova, N. B., Ozodova, D. O., 2025).

Conclusion

Basalt is thus a versatile and environmentally friendly material that continues to find new applications. Its unique properties make it indispensable in both traditional and high-tech applications.

As the industry is under pressure to reduce costs and improve efficiency and safety, automation is becoming the solution.

Based on the above studies, the need to develop a concept for processing different types of basalt raw materials for maximum satisfaction of the growing demand of the national economy for new, cheap, competitive and currency-saving basalt products, and thus rational and comprehensive use of natural raw materials, has been proven.

In this regard, robotics surpasses human capabilities in performing tasks with precision, resulting in increased efficiency, reduced waste in mining operations, reduced machine damage, increased equipment life, and reduced manual labor. Therefore, the topic of robotics is prominent in the sector, highlighting it as one of the key investment areas that the industry prioritizes.

In addition, safety is increased by performing dangerous tasks without the need for humans.

References

Dzhigaris D. D., Makhova M. F. Basics of production of basalt fibers and products: monograph. – M.: Teploenergetik, 2002. – 411 p.

Kamolov B. S. O rasprostranenii syr'yevykh zapasov bazal'tov po Uzbekistanu // Journal of Innovations in Scientific and Educational Research. 2023. – № 6(10). – P. 126–132.

Kurbanov A. A. Spetsificheskiye osobennosti bazal'tov Kyzylkuma. Monografiya. – Tashkent: Fan. 2009. – 160 p.

Kurbanov A. A. Razrabotka ratsional'noy tekhnologii pererabotki raznotipnykh bazal'tov Uzbekistana. – Navoi, 2018. – 257 p.

Kurbanov A. A., Rakhmatov B. U., Kamolov B. S., Rakhmatov KH. B. Sravnitel'nyy analiz fiziko-khimicheskikh svoystv bazal'tovykh porod dlya vybora kriteriy pri vypuske raznoobraznoy produktsii // KarDU KHAB. 2019. – 78 p.

Shevchenko V. P., Gulamova D. D. Polucheniye i issledovaniye svoystv bazal'tovogo volokna na osnove prirodnogo syr'ya Uzbekistana // Khimiya i khimicheskaya tekhnologiya. – Tashkent, 2011. – № 2. – P. 10–12.

Kurbonov A., Sattorov L., Kamolov B., Rakhimov O. Chemical and mineralogical studies of basalt "Aydarkul" BIO // Web of Conferences. 2023. – № 71. – P. 02040.

Kamolov B. S., Kurbanov A. A., Sattorov L. K. (2023). Features of filtration of industrial gases from dust with a basalt filter // E3S Web of Conferences. – Vol. 411. – P. 01036.

Drobot N. F., Noskova O. A., Steblevskii A. V. et al. // Use of Chemical and Metallurgical Methods for Processing of Gabbro – Basalt Raw Material // Theoretical Foundations of Chemical Engineering. 2013. – V. 47. – No. 4. – P. 484–488.

Alimova N. B., Ozodova D. O. Analysis of existing methods of basalt ore processing in Uzbekistan. Internauka. 2025. – No. 20 (384). Part 5. – P. 10–13.

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Contact: nodira.alimova.71@gmail.com