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**INVESTIGATION OF THE FEATURES OF THE STEPPER ROBOT
MOVEMENT****ИССЛЕДОВАНИЕ ХАРАКТЕРИСТИК ДВИЖЕНИЯ ШАГОВОГО РОБОТА****Lvovich I.Ya. / Львович И.Я.***d.t.s., prof. / д.т.н., проф.*

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Abstract. The paper describes the main characteristics that relate to the movement of a stepping robot. Applications for walking machines are given based on appropriate scheme. Management system requirements are shown. Development of the shortest path search algorithm is carried out. Two variants are shown - the movement using the Deijkstra method, the movement bypassing obstacles.

Key words: step robot, movement, modeling.

Introduction.

Simulation, simulation and analysis of robot motion for production purposes is an integral part of robotics because experimenting with realistic models is a time-consuming process. The ability to perform real-time simulations becomes particularly important later in the design process. The final scheme can be tested before proceeding with expensive laboratory tests [1-3]. Simulation is an important sequence for observational robotics that evaluates, predicts robot behavior, in addition to



verification and optimization. The possibility of simulation opens up a wide range of options for solving many problems creatively [4, 5]. You can explore, design, and test an object even if it doesn't already exist. Robotic mechanisms are mainly used in situations where the process requires high precision, and has a short cycle time, so robots are popular as part of Assembly lines.

Over the years, the use of robots in various areas of human activity, whether in industry [6, 7] or everyday use, has become increasingly prominent. One of the fastest growing field of robotics is mobile robotics. Mobile robotics can be divided into two classes. The first class are remotely operated robots by the operator, and the second class are robots capable of performing certain actions offline. In most cases, the robot is controlled by a human operator at the level of movements, while the person is required to continuously monitor the robot and operational control of its actions [8-10].

To date, stepper motors are widely used in numerical control machines, printers, in everyday life. The stepper motor can also be used for conveyor line applications such as food processing.

This problem is also handled by the servo and drive with asynchronous motor, with the appropriate setting.

It would be tempting to use stepper motors as the power drive of transport systems, because the system with stepper motors is positioned without the use of feedback sensors. The popularity of the use of stepper drives is gradually increasing, from year to year.

However, at the moment they have not yet found a specific and well-established application in any sphere of human life.

The aim of the work is to study a stepper drive for a robot using a stepper motor.

Features of stepper robots.

Stepper robots are designed for automated transportation of objects, research of hard-to-reach territories, escort of people. Research and development on the creation of walking robots are intensively conducted around the world. At the same time, there are four fundamentally different types of movement of automated mechanisms and systems - terrestrial, aeronautical, waterfowl and underground. The theory and practice of the last three types have not yet reached the level, in General, to speak of them today as a reality. Practical development has now received ground walking robots.

Also, according to functionality, they are divided into: performing only one operation and performing several operations.

According to the control method-with a manual system, Autonomous, working on external signals, and with a combined system. In the first case, the parameters of the trajectory are chosen by the operators, the robot system implements and maintains their values. In the second case, the indication of the parameters of the walking movement is carried out completely by its Autonomous automatic control system. In the third - all motion parameters are formed under the influence of external signals transmitted by contactless method.

The control system of walking robots, built on the combined methods of setting the program, provides the decoding of these signals and the development of



commands to the actuators.

Walking robots on adaptability to external conditions are divided into robots with a rigid program and adaptive.

Adaptive robots have sensor software that allows you to adjust the control program in accordance with the information received in the process. The system of these robots allows you to bypass the obstacle encountered in the way of movement, which is very important both from the point of view of safety, and the safety of the robot, and can also be used in mapping the terrain, etc.

The difference in the technical characteristics of walking robots causes a difference in their economic performance and, therefore, in the economic efficiency of their application.

The possibilities of using stepper robots are very large. Transportation of goods, delivery of various goods, support, analysis of debris, the study of difficult areas, cartography, use in space programs, work as a minesweeper, etc. (Fig. 1).

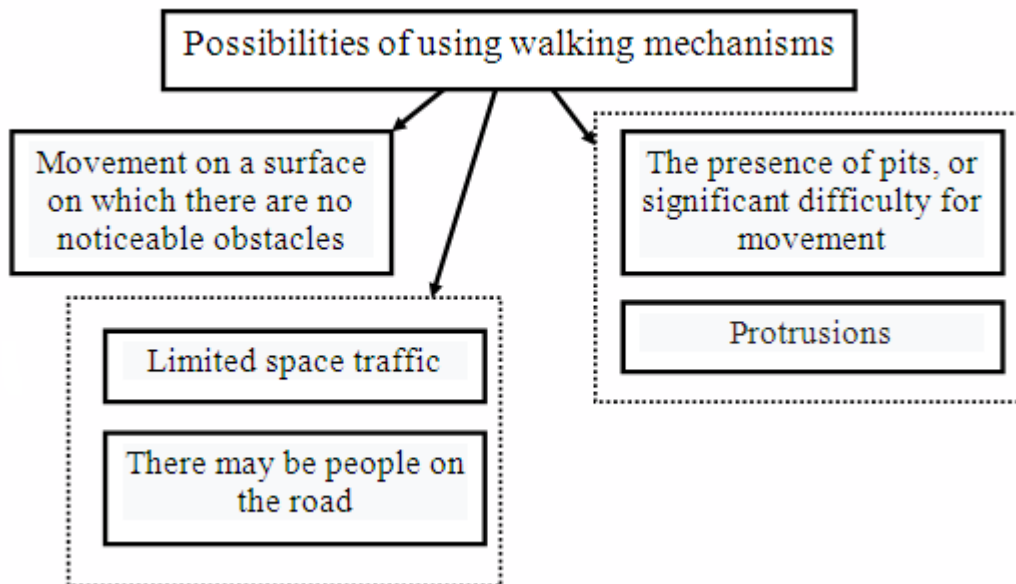


Fig. 1. Applications for walking machines

Management system requirements.

The control device consists of a microcontroller and a stepper motor driver chip. The system works as follows: from the computer to the microcontroller comes user data, such as, the direction of rotation of the motor, the value of the crushing step, that is, it is a full step, 1/2, 1/4, 1/8, 1/16 or 1/32 step, the time interval between steps in microseconds.

After receiving the data from the computer, the microcontroller on their basis generates control pulses and a miander on one of the outputs (for the implementation of the " steps " of the engine), which are fed into the stepper motor driver chip to select the operating mode. The stepper motor driver chip then generates a PWM signal at the output, which is fed to the stepper motor windings [11].

Development of the shortest path search algorithm.

In the framework of solving the problem of finding the shortest path, we use the



algorithm D^* . The algorithm is an optimal and efficient trajectory planning algorithm for a mobile robot. This algorithm can process a full range of a priori information about obstacles, including accurate measurements and their complete absence. D^* is a generalized algorithm and can be used in other applications. It can solve any weight-aware route optimization problem where the weight parameter changes while searching for a solution. D^* is most effective when these changes are detected near the starting point of the search space, which is typical when searching for the shortest route for a robot equipped with a rangefinder. To implement this algorithm, we introduce the following notations and definitions [12]. The space problem can be formulated as a set of directions directed from the robot and having its own value. The movement of the robot begins at the specified starting position and continues in the selected directions (having the lowest cost) until the target state g is reached. Every state X except G has a back pointer to the next state Y , denoted as $b(X)=Y$. D^* uses back pointers to map the path to the target. The cost of passing through the arc from state Y to state X is a positive number, and is determined by the function $c(X, Y)$. If the state Y has no intrinsic arc to X , then the function $c(X, Y)$ is undefined. Two States X and Y are adjacent if the function $c(X, Y)$ is defined.

The experimental conditions were two necessary situations: the movement using the Dejkstra method, the movement bypassing obstacles. Both conditions were simulated in the program, all the necessary conditions of the experiment were met [13, 14].

Conclusion. The paper reviewed mathematical models of the stepper motor. The considered models contain a description of the subject area and the internal device. The methods of stepper motor control were considered: step crushing and vector stepper motor control. Their advantages and disadvantages are also considered. The mathematical component of the simulation of a stepper robotic mechatronic device is analyzed on the basis of the currently presented mathematical bases. An approximate spatial virtual abstract model of the investigated robotic device is formed. Some laws of motion of these automated devices are given, in particular, the algorithm for finding the shortest path, the algorithm for avoiding obstacles and the algorithm for localization on the ground. Experimental conditions for simulation in the predicted environment are formulated. Simulations were carried out in Matlab Simulink. The simulation results are similar in values in each case. The mathematical model was used to understand the dynamics of the motion of the stepper robot and its limbs. This understanding of the dynamics in the future will help in the formation of a utilitarian platform of robotic mechatronic devices to optimize the production of these automated systems.

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Аннотация. В работе дается описание основных характеристик, которые относятся к движению шагового робота. Приведены основные сферы применения для шагающих машин на основе соответствующей схемы. Показаны параметры системы, которая применялась для эксперимента на практике. Обсуждаются возможности алгоритма для определения кратчайшего пути робота. Показаны два варианта - движение по методу Дейкстры, движение в обход препятствий.

Ключевые слова: шаговый робот, движение, моделирование.

Рецензент: д.т.н., проф., Кострова В.В.

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