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DEVELOPMENT OF A DESIGN AND CONTROL ALGORITHM FOR A MECHATRONIC MODULE FOR DISPLAYING 3D GRAPHICS ON A SURFACE

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Annotation: This article discusses the main points in the design of a five-axis device capable of layer-by-layer three-dimensional printing by melting plastic at different angles of inclination. The main task in this article is to develop a kinematic scheme of the device and its main mechanical components and elements. Description of the principles of operation of the device and the principles of planning the trajectories of the upper moving part without taking into account the vertical axis.

Keywords: three-dimensional printer, five degrees of mobility, device mechanics, printhead positioning.

Introduction

Working 5-axis milling machines already exist. 5-axis systems come in three basic configurations: table/desk, head/head, and table/head. In this project, it was decided to use a table/head configuration, the main reasons for which are two additional axes that will have additional weight. This must be taken into account when choosing engines and designing the power structure of the machine [4].

For the head/head or head/table system to work properly, the system components must be compact. This creates difficulties during assembly and design. While the table system/The table can be easily built to a larger size, as the weight is offset by stronger motors. One of the advantages of the head/table system over the table system The advantage of the table is that it can work with heavier parts. This system will work with plastic, so the weight of the parts can be ignored when designing.

One of the problems of the system is the attachment of the workpiece to the desktop. This can be a problem when printing, as the adhesion to the desktop may not be sufficient. After testing several prints on the printer, it was found that there was no such problem. Since the plastic adheres well enough to the desktop,and after printing, it is necessary to use force to remove the part from the desktop [3].

Another problem that may arise with the configuration of the head/head and head/table systems is that the plastic may not fully connect or begin to flow down the structure when printing at various angles other than 90° relative to the table on which the printing is performed. Although there are no studies that can support this claim, the table system/the table is more suitable for use in 5-axis printing. In the proposed device, the printhead does not change its

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inclination relative to the surface,on which the device is located, this avoids plastic draining past the part.

Selecting the origin of the machine coordinate system.

In the Head configuration/The two rotating axes will often intersect on the table, so the most convenient location for the origin of the machine tool system (MCS) will be at the point where the rotating axes intersect. An illustration of the intersection point in the Head system/The table can be seen in Figure 1, where the origin of the coordinate system is located at the intersection of the red lines. The rationale for the fact that the zero point of the coordinates of the proposed device is located at the intersection of the axes of rotation, i.e. in the center of the desktop, is that this will facilitate both the process printing and creating a management program due to the fact that.

Modeling of a machine prototype.

The mechanism of the device consists of two parts. The X, Y, and Z axes are located in the upper part. In the lower part of the rack there are additional rotary axes A and C. Since the origin of the machine is located in the center of the intersection of the axes, we need to be able to move either a desktop or an upper movable part for calibrating the printer. For calibration, the method of moving the upper movable part was chosen, this is done using four. The movable plates shown in Figure 4. A belt drive is used to transfer torque from the engine to the upper part. Over time, the belts tend to stretch, therefore, the use of a tensioning roller is envisaged.

A belt drive was selected to move the upper movable part around its axis. The belt drive reduces the backlash in the rotary mechanism and is more wear-resistant than a conventional gear transmission. To control this device, it is proposed to consider the upper rotary mechanism as a separate two-link manipulator, since all movements in this mechanism are nonlinear, and we separate the Z axis since its movements are determined by a single line and there will be no difficulties in calculating its trajectory.

The kinematic scheme of a two-link mechanism consists of two leading links of equal length forming an open kinematic chain. In the calculation scheme shown in Figure 6, the beginning of the system. The HOU coordinate is aligned with the axis of rotation of the first link. The second link is mounted on the first with the possibility of rotation around the attachment point H located at the end of the first link. A working tool is installed at the point P(t) located on the outer diameter of the second link. The working area is limited to a circle of radius R for design reasons.

A review of the market for three-dimensional printing devices and research in this area has shown that the use of three-dimensional printing devices operating in such a coordinate system is currently not represented on the market [9]. Therefore, the use of ready-made software products for managing devices of this kind does not exist. For this reason, to solve this problem, you can use either control systems for CNC milling machines, after appropriate refinement and optimization, or develop a specialized software product using the mathematics proposed in the

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article [5].

Conclusion

The article discusses the principle of three-dimensional printing, based on an original mechanical design, characterized by the use of five degrees of freedom in printing. Using this design avoids the use of support elements that are necessary for standard three-dimensional printing devices and improves productivity by eliminating the need to print substrates. The article also discusses the main differences in control from existing systems, the principles of printhead calibration, which They are necessary in information systems that differ from existing ones.

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