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WORKSPACE DETERMINATION FOR THE RTTRR MODULAR SMALL-SIZED SERIAL ROBOT

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Abstract: *the paper presents a method to determine the shape and the dimensions of the workspace of the RTTRR-type modular small-sized serial robot. This method uses the CAD model of the analyzed robot. At the end of this paper, some conclusions on the implementation of this robot with five degrees of freedom can be drawn.*
Key words: *workspace determination, modular robot, small-sized robot, CAD model.*

1. INTRODUCTION

The workspace or work envelope of a robot is defined by the range of the movement on each joint [1]. The shape and the dimensions of the workspace of a robot are generally given by the number of joints, their type (rotation or translation) and their arrangement within the mechanical structure of the analyzed robot and, of course, by the stroke each joint is designed to have.

2. THE RTTRR MODULAR SMALL-SIZED ROBOT

The RTTRR robot is a small-sized, modular robot having five degrees of freedom, and its kinematic diagram is presented in fig. 1. The CAD model of the robot was determined in [2], according to [3], [4], [5] and the constructive dimensions, related to the notations from fig. 1, are expressed by the equations (1).

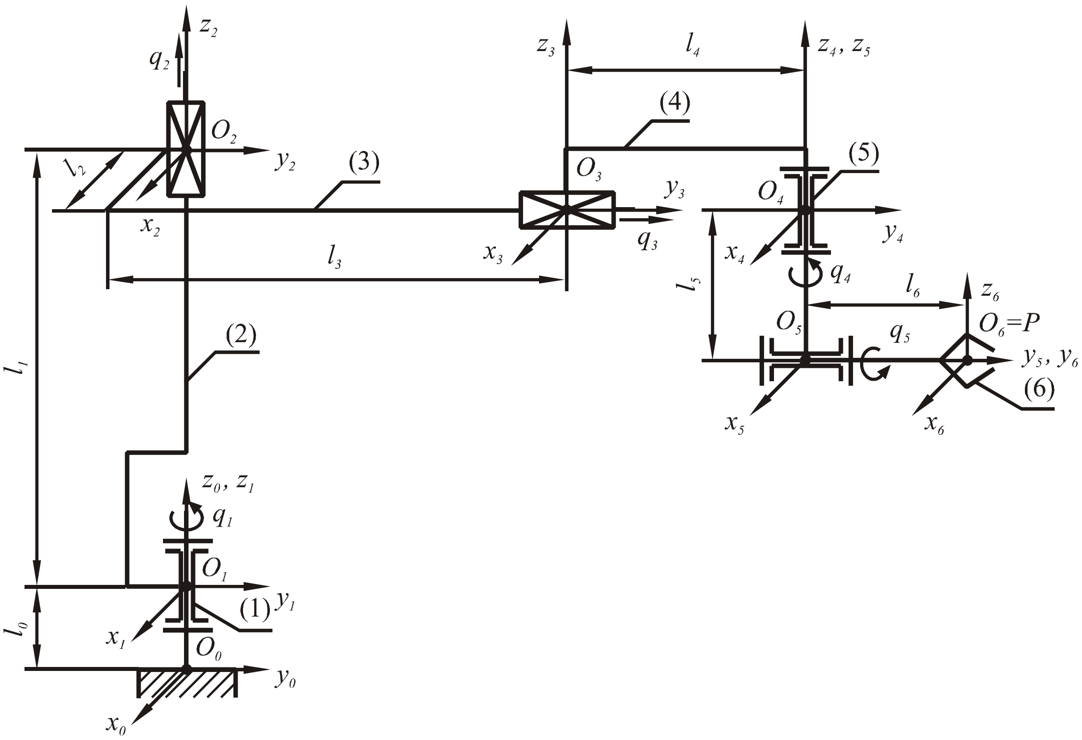

Fig. 1 The kinematic diagram of the RTTRR small-sized robot

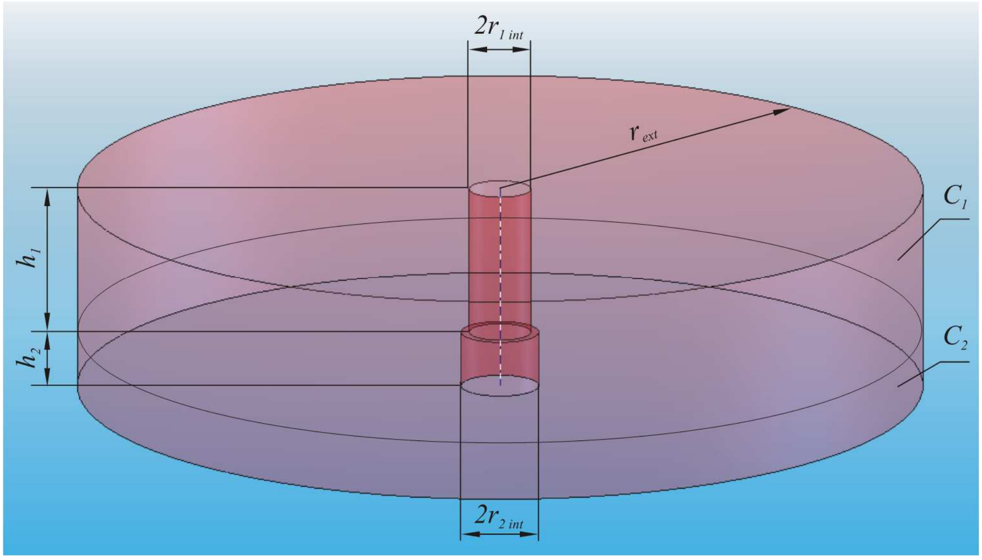

Fig. 2 The workspace of the RTTRR small-sized robot

$$
\begin{aligned}
&l_0 = 135.50 \text{ mm}; && l_1 = 72 \text{ mm};\\
&l_2 = 32 \text{ mm}; && l_3 = 0 \text{ mm};\\
&l_4 = 111.50 \text{ mm}; && l_5 = 130 \text{ mm};\\
&l_6 = 148.60 \text{ mm}.
\end{aligned} \tag{1}
$$

3. WORKSPACE DETERMINATION

In the particular case of RTTRR modular small-sized robot, the workspace has a cylindrical shape (fig. 2), obtained by the union (overlapping) of two coaxial cylinders C_1 and C_2, of a hollow shape, having the same external radius, of the expression:

$$r_{ext} = l_3 + q_{3\max} + l_4 + l_6 = 611 \text{ mm}. \tag{2}$$

The common height of the two cylinders is given by:

$$h = h_1 + h_2 = q_{2\max} - q_{2\min} = 295 \text{ mm}. \tag{3}$$

The height of the C_2 cylinder, measured on the CAD model, is:

$$h_2 = 80.3 \text{ mm}, \tag{4}$$

wherefrom the height of the C_1 cylinder is:

$$h_1 = h - h_2 = 214.7 \text{ mm}. \tag{5}$$

The internal radius of the C_1 cylinder, has the expression:

$$r_{1\text{int}} = l_3 + q_{3\min} + l_4 - l_6 = 44.64 \text{ mm}, \tag{6}$$

and the internal radius of the C_2 cylinder, determined by CAD model measurement, has the value:

$$r_{2\text{int}} = 56.5 \text{ mm}. \tag{7}$$

The figures 3-8 outline different particular configurations of the RTTRR robot, having the gripper's characteristic point in the lower or in the upper plane of the workspace, generating the external radius or the internal radii of the two cylinders, by displacements in joints. For a better visibility of the robot in its workspace, the configurations were represented in both front and trimetric views.

The volume of the workspace is computed by summing up the volumes of the two hollow cylinders, using the relation (8).

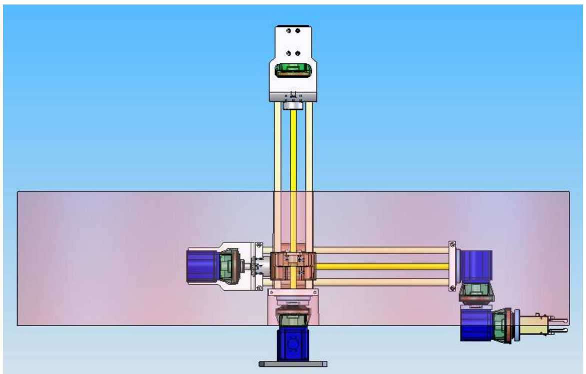

Fig. 3 The lower plane of the workspace, external radius generation, front view

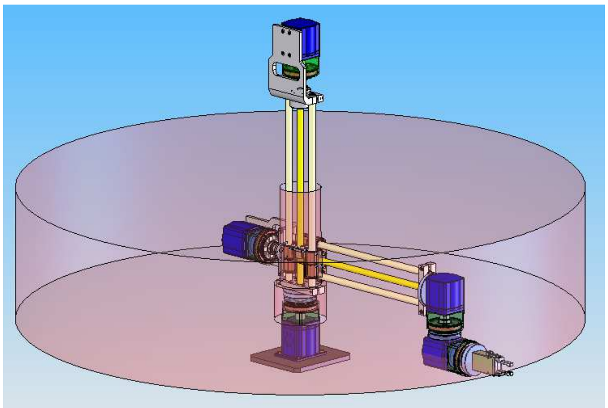

Fig. 4 The lower plane of the workspace, external radius generation, trimetric view

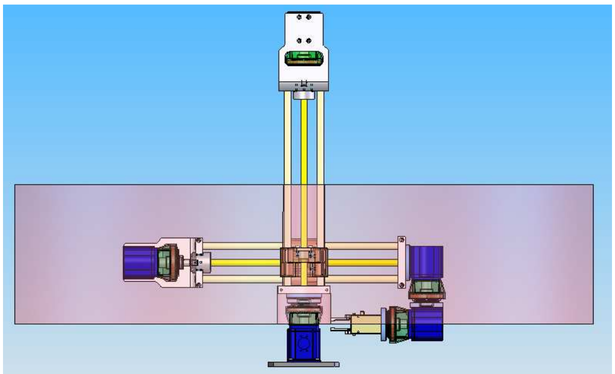

Fig. 5 The lower plane of the workspace, internal radius generation, front view

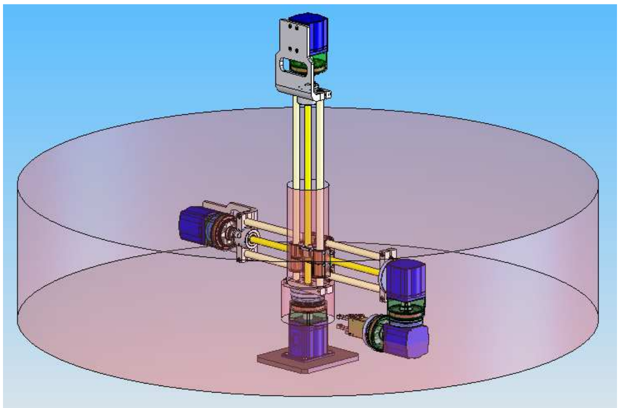

Fig. 6 The lower plane of the workspace, internal radius generation, trimetric view

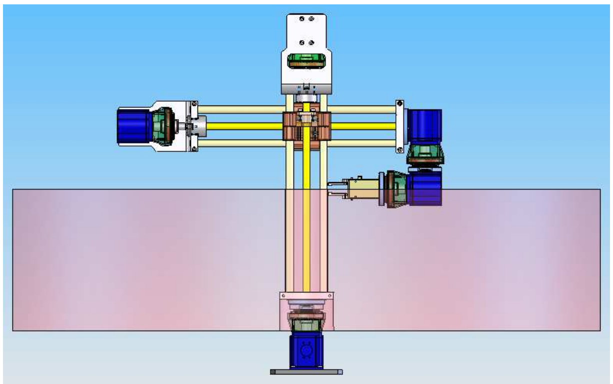

Fig. 7 The upper plane of the workspace, internal radius generation, front view

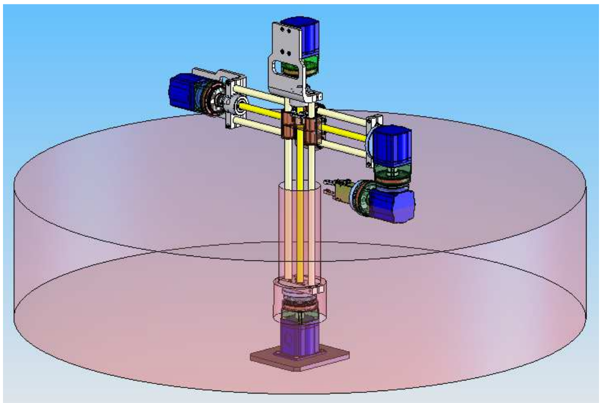

Fig. 8 The upper plane of the workspace, internal radius generation, trimetric view

$$V = \pi r_{ext}^2 h - \pi r_{1\mathrm{int}}^2 h_1 - \pi r_{2\mathrm{int}}^2 h_2 = \\ = 3.4383 \cdot 10^8 \,\mathrm{mm}^3 = 0.3438 \,\mathrm{m}^3. \quad (8)$$

4. IMPLEMENTATION EXAMPLE

An example of implementation is presented in fig. 9, where the robot is a part of a flexible robotic cell, having the aim of packaging microprocessors into a partitioned tray, with five compartments.

The robot (1) is programmed to pick the microprocessors (3) from the carrier (2) and place them into the partitioned tray (4). The numerical and graphical analysis of the implementation of the RTTRR modular serial robot into this work cycle will be presented in a future paper.

5. CONCLUSIONS

By analyzing the shape and the volume of the RTTRR small-sized robot workspace, it can be observed that the robot can be implemented in technological processes of manipulation, assembly, sorting, quality testing, or packaging [6] of pieces or electronic or mechanic components of small size.

6. REFERENCES

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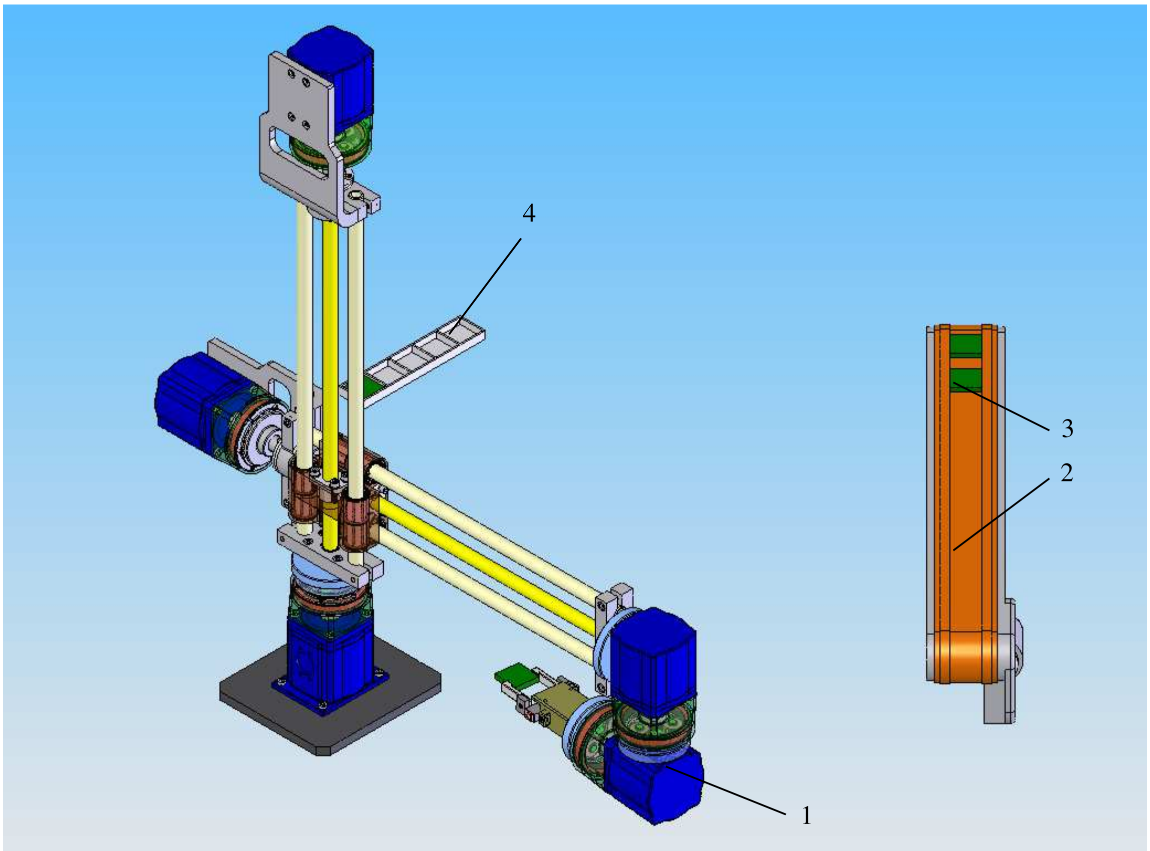

Fig. 9 The RTTRR small-sized robot implemented in a task of microprocessors packaging

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Determinarea spaţiului de lucru al minirobotului serial modular RTTRR

Rezumat: Lucrarea prezintă o metodă de determinare a formei şi dimensiunilor spaţiului de lucru al minirobotului serial modular de tip RTTRR. Această metodă foloseşte modelul CAD al robotului analizat. În finalul lucrării pot fi trase anumite concluzii referitoare la implementarea într-un proces tehnologic, a acestui robot cu cinci grade de libertate.

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