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**SCIENCE IN THE ENVIRONMENT
OF RAPID CHANGES**

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INFORMATION AND WEB TECHNOLOGIES

Development of a program for modeling the control of a mobile manipulation robot in the unity environment

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The development of the modern world dictates new technical and scientific challenges for robotic platforms. One of the difficult tasks is the development of control algorithms for mobile manipulation robots within the framework of the Industry 5.0 concept, when the robot is an integral part of the surrounding workspace. [1,2] As a result, the problem arises of developing programs for simulating the control of mobile robots, for developing algorithms and methods for interacting with the environment. [3-9]

As a result, the following set of basic commands for controlling a mobile manipulation robot was proposed:

command `Move _coords(x, y)` - sets the coordinates of the movement of the mobile gripper robot, where `coords(x,y)` are the coordinates of the end point of the movement;

command `Rotate _angle` - sets the rotation angle of the grip of the mobile robot;

command `RotateX _armLink _angle` - sets the angle of rotation of the arm link of the robot along the X axis, where `armLink` is the link number, `_angle` is the angle of rotation;

command `RotateY _armLink _angle` - sets the angle of rotation of the arm link of the robot along the Y axis, where `armLink` is the link number, `_angle` is the angle of rotation;

command `CloseTheGrip` - closes the grip;

command `OpenTheGrip` - opens the grip.

Let's define the concept of a language model (LM) - it is a declarative (non-procedural) language, the purpose of which

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is the definition and description of terminology. As part of these studies, the following specification of the modeling language is proposed:

- allowed alphanumeric characters: -, : ; gap;
- reserved function names: Move, Rotate, RotateX, RotateY, OpenTheGrip, CloseTheGrip

When writing the code, the name of functions and parameters should be delimited with the symbol :, for example, function_name: function_parameters, and the term should end with the symbol;. An example of writing a control program for a mobile manipulation robot is shown in Figure 1.

```
Move: -12, -12;  
Rotate: 60;  
RotateX: 1, 20;  
RotateY: 1, 20;  
OpenTheGrip: 0;  
CloseTheGrip: 0;
```

Figure 1

A fragment of the control program for a mobile manipulation robot

3D visualization of a mobile manipulation robot, developed in the Unity environment, using simple primitives, which will reduce the load on the hardware component and run the application on a mobile device. An example of 3D visualization of a mobile manipulation robot is shown in Figure 2.



Figure 2

3D visualization of a mobile manipulation robot in the Unity environment

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The general view of the program for modeling the control of a mobile manipulation robot is shown in Figure 3.

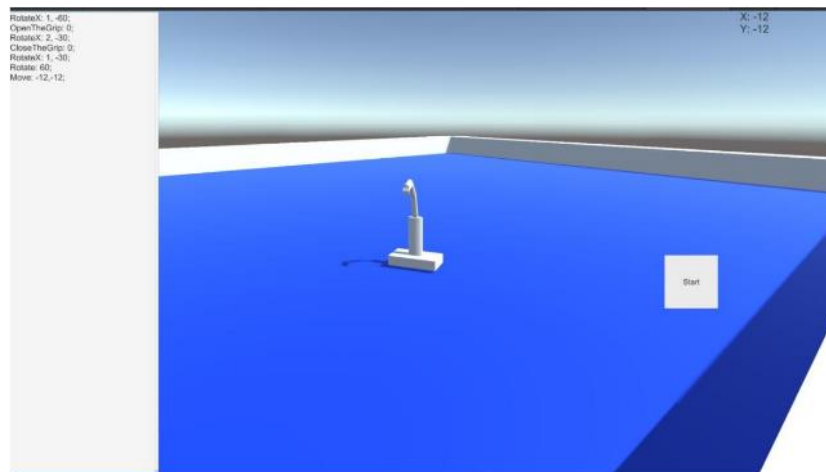


Figure 3

General view of the program for modeling the control of a mobile manipulation robot

The software implementation of the "move" command to move the mobile manipulation robot is implemented as the following function, which is shown in Figure 4.

```
public void Move(string param)
{
    var q = param.Split(',');
    platform.transform.DOMove(new Vector3(Convert.ToInt32(q[0].Trim(' ')),
        platform.transform.position.y ,Convert.ToInt32(q[1].Trim(' '))), 3);
    Debug.Log(Convert.ToInt32(q[0]));
    Debug.Log(Convert.ToInt32(q[1]));
}
```

Figure 4

Fragment of the software implementation of the "move" command

In the future, the authors plan, within the framework of these studies, to implement in the program a method for constructing a movement route, taking into account the minimization of electricity consumption to achieve the goals.

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