Sirius University of Science and Technology

Scientific Center for Information Technologies and Artificial Intelligence

ABB Robot Studio, using a pen tool

Author: Artem Kondratev

E-mail: artemkondratev5@gmail.com

November 22, 2024

Sirius, 2024

1 Introduction

The task is to write the first letters of a name and surname using manipulator and pen tool. In this lab these letters are "A" and "K" (Artem Kondratev). To complete this task, ABB Robot Studio was used to simulate RAPID instructions for the manipulator and to visualize the robot's movement.

2 Methods

2.1 Simulation

Firstly, a simulation was created using the ABB IRB 1600 manipulator. A pen was used as a tool, and a table with paper was added to the simulation environment (shown in Figure 1). To test the generated RAPID code, a virtual controller identical to the real ABB controller in the laboratory was created.

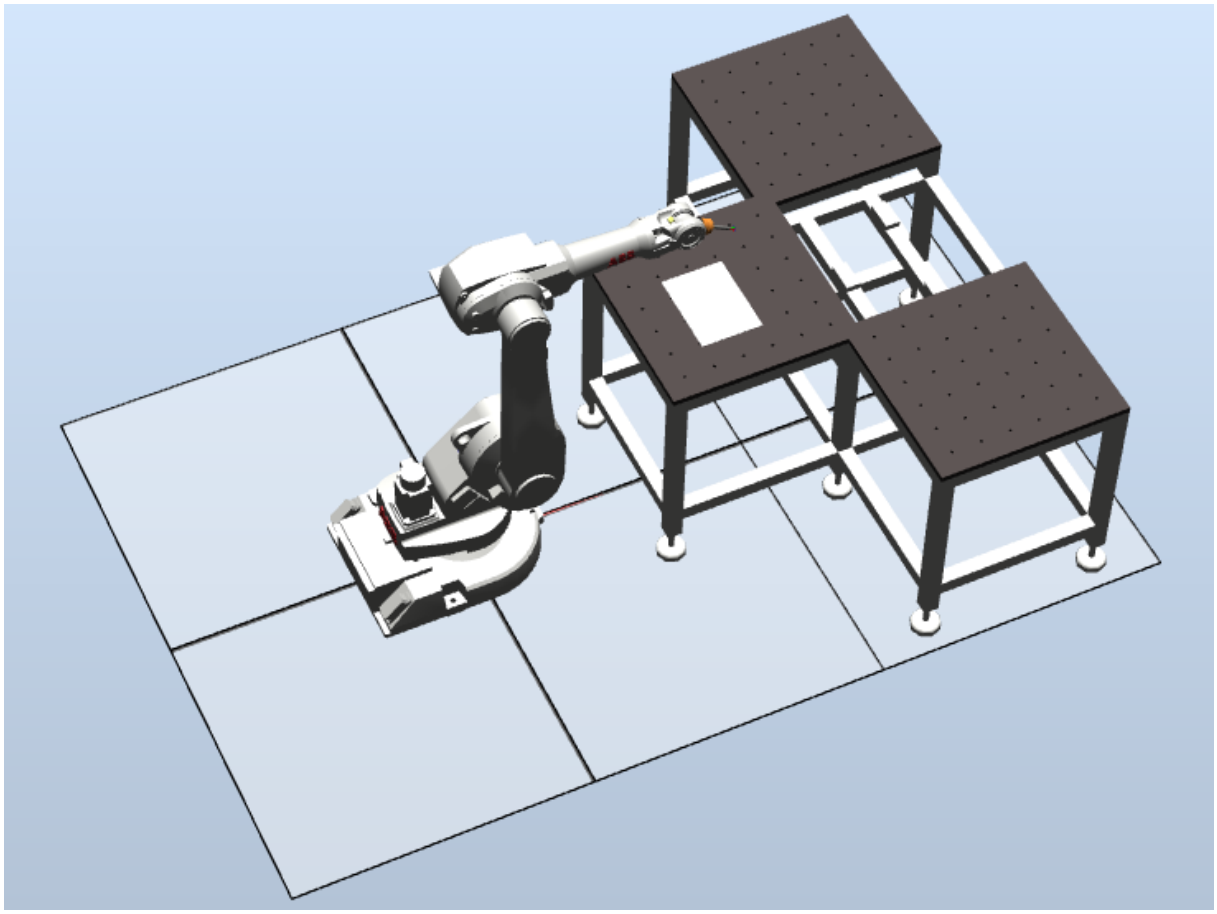

Figure 1: Simulation environment setup

Secondly, a new Workobject attached to the paper was created via three points on the paper surface (shown in Figure 2).

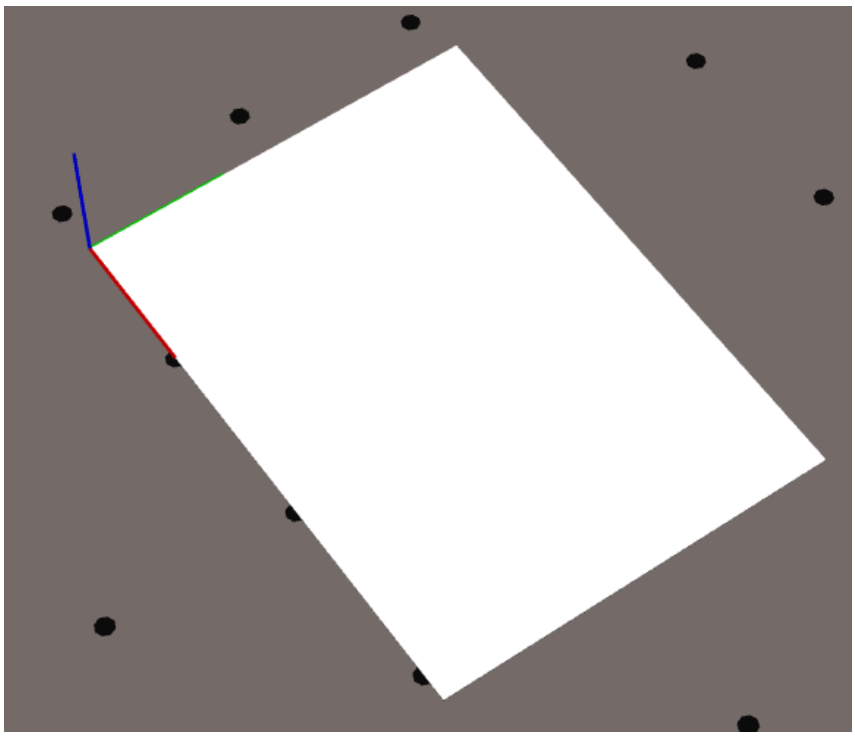

Figure 2: Paper Workobject

Points representing the required letters were created in the paper Workobject (shown in Figure 3). The MoveJ and MoveL instructions were used to draw lines between created points. The MoveJ is used to move the robot from one point to another when that movement does not need to follow a straight line. The MoveL is used to move the tool center point (TCP) linearly from one point to another.

To describe the robot's trajectory, a velocity of 100 mm/s was set. Additionally, a zone of 200 was configured to ensure smoothness in the trajectory.

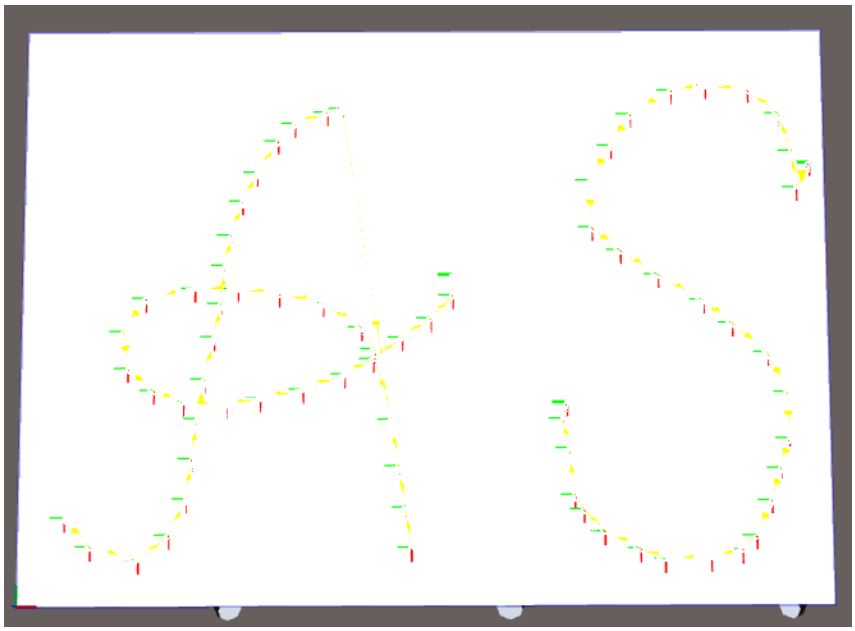

Figure 3: Letter points

2.2 Transfer program to reality

To provide the program to the real robot controller, the laptop was connected via Ethernet and a one-click connection was established. This approach allows to correct program online, both from the laptop and directly via the FlexPendant.

The main challenge in transferring the prepared program to reality is that the paper Workobject in the real setup differs from the Workobject in the simulation. Therefore, the translation vector of the paper Workobject needs to be corrected. To determine the translation error, jogging in manual mode was used. The simulated equivalent of the jogging mode in the FlexPendant is shown in Figure 4).

The correction of the translation vector is performed in the ProgramData mode in the FlexPendant. After the paper Workobject pose correction, the program is transferred to the robot.

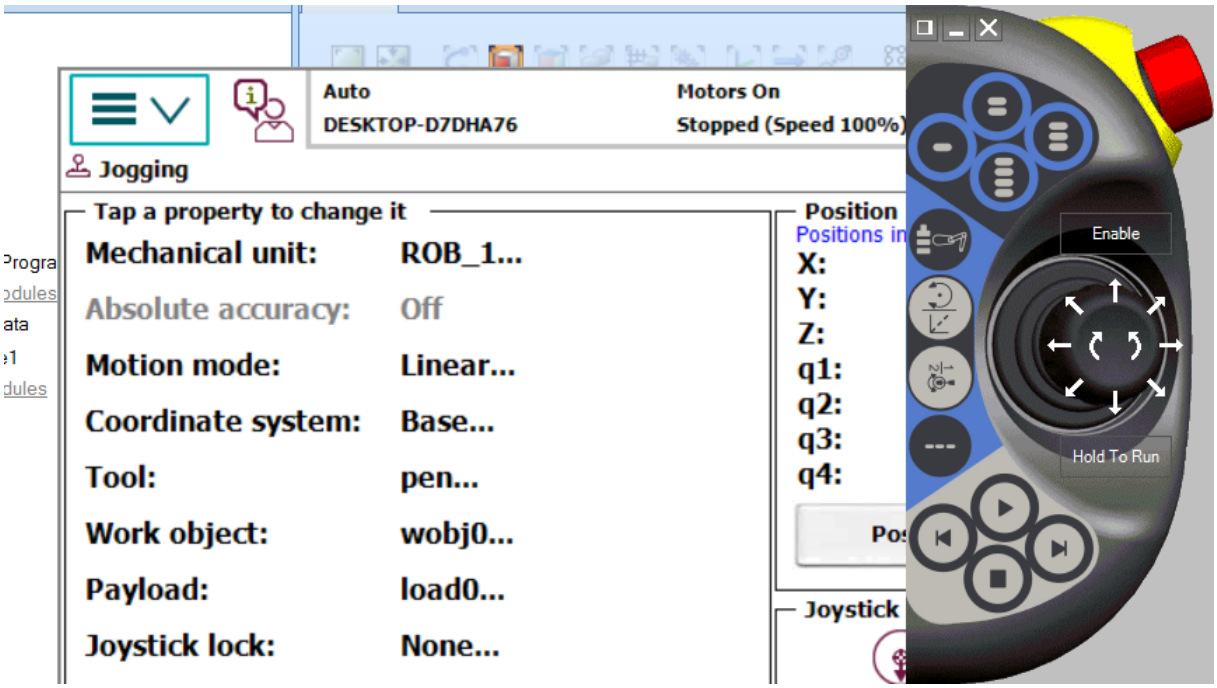

Figure 4: Jogging mode in FlexPendant

3 Results

The results are shown in Figure 5. The height of the paper Workobject in the base frame is 273 mm. The final code is provided in Appendix A. A video demonstration is available via the following demonstration.

The thickness of drawn lines depends on the pencil pressure which can be adjusted by using a spring.

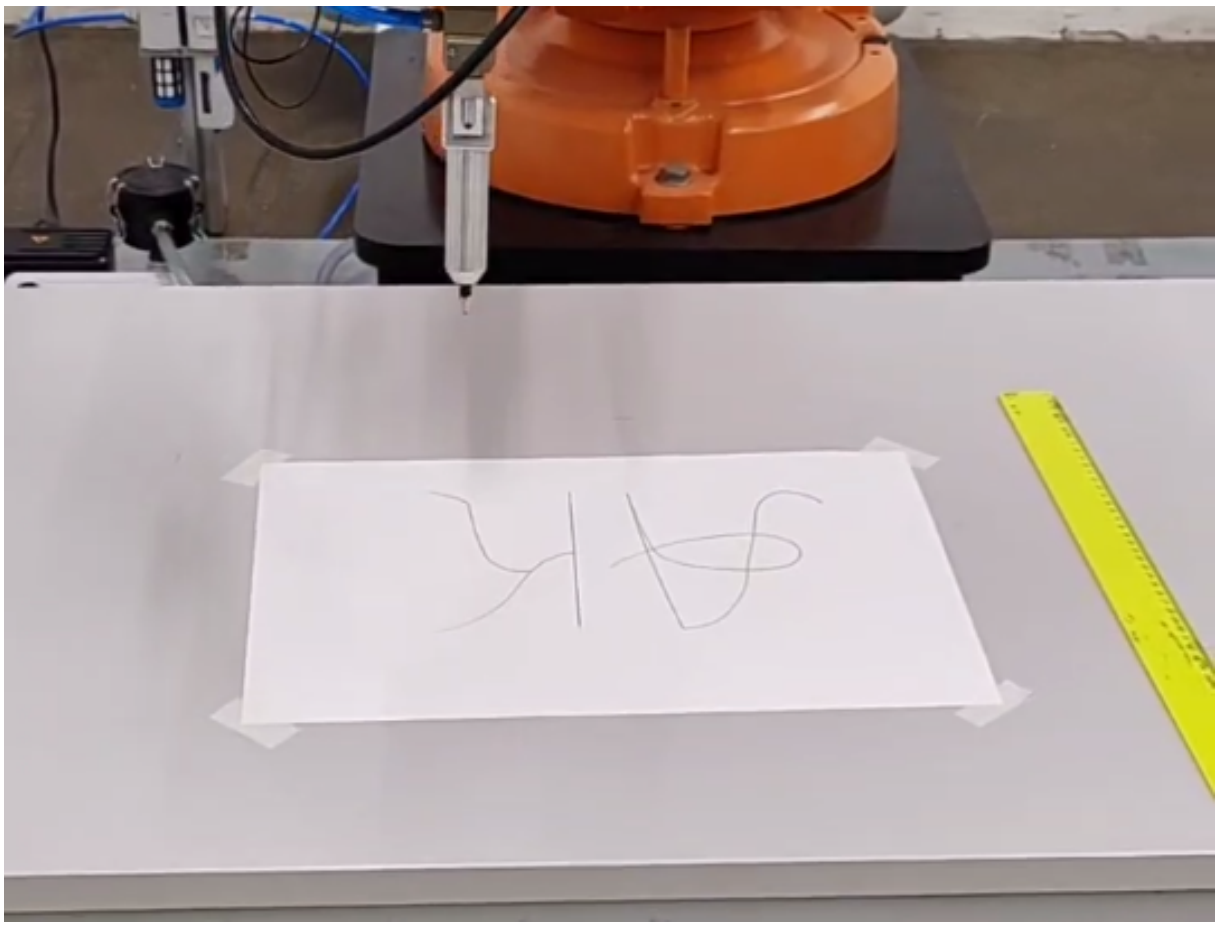

Figure 5: Results

4 Discussion

Creating points within the paper Workobject is useful, because in this case it allows the paper's position to be changed without requiring corrections to the points' coordinates. if points are created in the base Workobject, any movement of the paper would necessitate adjusting the points' coordinates.

The spring is an essential component of the tool, because in reality the table is not perfectly flat—it is a surface with irregularities. So, in some points, which are created under the assumption that the table is an ideal plane, pencil contact cannot be achieved. In this case, the quality of the lettering may be unclear.

References

1. University of Skövde, "Welcome to the RobotStudio video tutorials library," [Online]. Available: `https://his.instructure.com/courses/3328/pages/welcome-to-the-robotstudio-video-tutorials-library-of-university-of-skovde-sweden`. [Accessed: Nov. 22, 2024].

2. ABB Library, [Online]. Available: `https://library.abb.com`. [Accessed: Nov. 22, 2024].

Appendix A: The RAPID code

```
MODULE Module1
        CONST robtarget Target_10:=[[16.37,31.293,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_20:=[[25.662,21.05,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_30:=[[42.851,16.33,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_40:=[[53.55,25.077,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_50:=[[59.613,38.027,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_60:=[[61.498,52.402,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_70:=[[63.384,66.792,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_80:=[[65.738,81.194,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_90:=[[69.028,96.536,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_100:=[[71.382,108.637,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_110:=[[72.809,122.618,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_120:=[[74.699,133.809,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_130:=[[78.926,146.398,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_140:=[[84.086,157.122,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_150:=[[91.588,168.779,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_160:=[[97.679,175.301,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_170:=[[109.372,179.455,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_180:=[[114.984,180.831,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_190:=[[139.977,20.464,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_200:=[[138.04,34.832,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_210:=[[135.501,49.671,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_220:=[[132.972,66.385,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_240:=[[126.702,92.009,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_250:=[[122.154,99.99,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_260:=[[108.205,108.914,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_270:=[[92.366,112.258,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_280:=[[77.454,114.199,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_290:=[[62.07,114.278,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_300:=[[44.351,110.64,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_310:=[[36.416,98.566,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_320:=[[38.268,85.057,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_330:=[[47.572,77.101,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_340:=[[58.274,72.861,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_350:=[[73.634,71.853,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_360:=[[85.743,74.115,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_370:=[[101.116,77.292,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_380:=[[116.035,82.797,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_390:=[[126.302,88.328,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_400:=[[136.583,96.19,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_410:=[[146.865,103.124,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_420:=[[154.828,111.472,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_421:=[[154.828,111.472,40],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_430:=[[279.655,150.977,40],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_431:=[[279.655,150.977,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_440:=[[278.378,164.546,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_450:=[[273.834,178.612,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_460:=[[262.697,187.57,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_470:=[[247.285,189.055,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_480:=[[234.651,187.245,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_490:=[[219.633,178.422,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_500:=[[212.545,166.755,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_510:=[[204.519,153.7,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_520:=[[205.338,136.408,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_530:=[[215.544,127.952,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_540:=[[229.004,119.019,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_550:=[[245.249,109.61,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_560:=[[255.434,101.17,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_570:=[[267.922,90.396,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_580:=[[274.779,75.937,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_590:=[[275.094,59.203,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_600:=[[271.742,48.54,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_610:=[[268.384,36.957,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_620:=[[262.696,24.469,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_630:=[[257.541,19.398,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_640:=[[246.366,16.676,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_650:=[[230.1,16.297,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_660:=[[221.299,20.047,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_670:=[[208.793,26.135,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_680:=[[201.407,34.054,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_690:=[[198.185,39.172,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_700:=[[196.431,55.89,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_710:=[[194.171,66.587,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget home:=[[926.69182372,0,1084.5],[0.5,0,0.866025404,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_711:=[[194.171,66.587,40],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_720:=[[174.987,178.024,20],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_721:=[[174.987,178.024,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_731:=[[176.193,16.648,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_732:=[[176.193,16.648,20],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_741:=[[175.827,92.23,20],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_742:=[[175.827,92.23,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_751:=[[185.577,96.1,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_761:=[[194.46,103.362,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_771:=[[199.101,109.755,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_781:=[[202.05,114.866,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_791:=[[208.363,126.789,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_801:=[[210.879,133.597,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_811:=[[216.342,145.941,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_821:=[[219.709,152.328,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_831:=[[228.153,162.988,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_841:=[[237.457,171.529,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_851:=[[248.885,180.08,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_861:=[[261.184,183.963,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_862:=[[261.184,183.963,20],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_863:=[[202.05,114.866,20],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_864:=[[202.05,114.866,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_871:=[[209.268,115.326,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_881:=[[217.349,112.816,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
        CONST robtarget Target_891:=[[227.589,103.098,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
```

```
    CONST robtarget Target_901:=[[231.915,86.556,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
    CONST robtarget Target_911:=[[234.515,75.527,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
    CONST robtarget Target_921:=[[236.703,61.949,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
    CONST robtarget Target_931:=[[238.897,47.097,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
    CONST robtarget Target_941:=[[240.246,31.393,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
    CONST robtarget Target_951:=[[247.497,24.635,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
    CONST robtarget Target_961:=[[258.982,20.444,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
    CONST robtarget Target_971:=[[268.348,15.395,0],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
    CONST robtarget Target_972:=[[268.348,15.395,20],[0,-0.707106781,0.707106781,0],[0,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
    PROC draw_A()
        MoveJ Target_10,v100,z200,pen\WObj:=wobjPaper;
        MoveJ Target_20,v100,z200,pen\WObj:=wobjPaper;
        MoveJ Target_30,v100,z200,pen\WObj:=wobjPaper;
        MoveJ Target_40,v100,z200,pen\WObj:=wobjPaper;
        MoveJ Target_50,v100,z200,pen\WObj:=wobjPaper;
        MoveJ Target_60,v100,z200,pen\WObj:=wobjPaper;
        MoveJ Target_70,v100,z200,pen\WObj:=wobjPaper;
        MoveJ Target_80,v100,z200,pen\WObj:=wobjPaper;
        MoveJ Target_90,v100,z200,pen\WObj:=wobjPaper;
        MoveJ Target_100,v100,z200,pen\WObj:=wobjPaper;
        MoveJ Target_110,v100,z200,pen\WObj:=wobjPaper;
        MoveJ Target_120,v100,z200,pen\WObj:=wobjPaper;
        MoveJ Target_130,v100,z200,pen\WObj:=wobjPaper;
        MoveJ Target_140,v100,z200,pen\WObj:=wobjPaper;
        MoveJ Target_150,v100,z200,pen\WObj:=wobjPaper;
        MoveJ Target_160,v100,z200,pen\WObj:=wobjPaper;
        MoveJ Target_170,v100,z200,pen\WObj:=wobjPaper;
        MoveJ Target_180,v100,z200,pen\WObj:=wobjPaper;
        MoveJ Target_190,v100,fine,pen\WObj:=wobjPaper;
        MoveJ Target_200,v100,z200,pen\WObj:=wobjPaper;
        MoveJ Target_210,v100,z200,pen\WObj:=wobjPaper;
        MoveJ Target_220,v100,z200,pen\WObj:=wobjPaper;
        MoveJ Target_240,v100,z200,pen\WObj:=wobjPaper;
        MoveJ Target_250,v100,z200,pen\WObj:=wobjPaper;
        MoveJ Target_260,v100,z200,pen\WObj:=wobjPaper;
        MoveJ Target_270,v100,z200,pen\WObj:=wobjPaper;
        MoveJ Target_280,v100,z200,pen\WObj:=wobjPaper;
        MoveJ Target_290,v100,z200,pen\WObj:=wobjPaper;
        MoveJ Target_300,v100,z200,pen\WObj:=wobjPaper;
        MoveJ Target_310,v100,z200,pen\WObj:=wobjPaper;
        MoveJ Target_320,v100,z200,pen\WObj:=wobjPaper;
        MoveJ Target_330,v100,z200,pen\WObj:=wobjPaper;
        MoveJ Target_340,v100,z200,pen\WObj:=wobjPaper;
        MoveJ Target_350,v100,z200,pen\WObj:=wobjPaper;
        MoveJ Target_360,v100,z200,pen\WObj:=wobjPaper;
        MoveJ Target_370,v100,z200,pen\WObj:=wobjPaper;
        MoveJ Target_380,v100,z200,pen\WObj:=wobjPaper;
        MoveJ Target_390,v100,z200,pen\WObj:=wobjPaper;
        MoveJ Target_400,v100,z200,pen\WObj:=wobjPaper;
        MoveJ Target_410,v100,z200,pen\WObj:=wobjPaper;
        MoveJ Target_420,v100,z200,pen\WObj:=wobjPaper;
        MoveJ Target_421,v100,z200,pen\WObj:=wobjPaper;
    ENDPROC
    PROC go_home()
        MoveJ home,v100,fine,pen\WObj:=wobj0;
    ENDPROC
    PROC main()
        go_home;
        draw_A;
        draw_K;
        go_home;
    ENDPROC
    PROC draw_K()
        MoveJ Target_720,v100,z200,pen\WObj:=wobjPaper;
        MoveL Target_721,v100,fine,pen\WObj:=wobjPaper;
        MoveL Target_731,v100,fine,pen\WObj:=wobjPaper;
        MoveJ Target_732,v100,fine,pen\WObj:=wobjPaper;
        MoveJ Target_741,v100,fine,pen\WObj:=wobjPaper;
        MoveJ Target_742,v100,fine,pen\WObj:=wobjPaper;
        MoveJ Target_751,v100,z200,pen\WObj:=wobjPaper;
        MoveJ Target_761,v100,z200,pen\WObj:=wobjPaper;
        MoveJ Target_771,v100,z200,pen\WObj:=wobjPaper;
        MoveJ Target_781,v100,z200,pen\WObj:=wobjPaper;
        MoveJ Target_791,v100,z200,pen\WObj:=wobjPaper;
        MoveJ Target_801,v100,z200,pen\WObj:=wobjPaper;
        MoveJ Target_811,v100,z200,pen\WObj:=wobjPaper;
        MoveJ Target_821,v100,z200,pen\WObj:=wobjPaper;
        MoveJ Target_831,v100,z200,pen\WObj:=wobjPaper;
        MoveJ Target_841,v100,z200,pen\WObj:=wobjPaper;
        MoveJ Target_851,v100,z200,pen\WObj:=wobjPaper;
        MoveJ Target_861,v100,z200,pen\WObj:=wobjPaper;
        MoveJ Target_862,v100,fine,pen\WObj:=wobjPaper;
        MoveJ Target_863,v100,fine,pen\WObj:=wobjPaper;
        MoveJ Target_864,v100,fine,pen\WObj:=wobjPaper;
        MoveJ Target_871,v100,z200,pen\WObj:=wobjPaper;
        MoveJ Target_881,v100,z200,pen\WObj:=wobjPaper;
        MoveJ Target_891,v100,z200,pen\WObj:=wobjPaper;
        MoveJ Target_901,v100,z200,pen\WObj:=wobjPaper;
        MoveJ Target_911,v100,z200,pen\WObj:=wobjPaper;
        MoveJ Target_921,v100,z200,pen\WObj:=wobjPaper;
        MoveJ Target_931,v100,z200,pen\WObj:=wobjPaper;
        MoveJ Target_941,v100,z200,pen\WObj:=wobjPaper;
        MoveJ Target_951,v100,z200,pen\WObj:=wobjPaper;
        MoveJ Target_961,v100,z200,pen\WObj:=wobjPaper;
        MoveJ Target_971,v100,z200,pen\WObj:=wobjPaper;
        MoveJ Target_972,v100,fine,pen\WObj:=wobjPaper;
    ENDPROC
ENDMODULE
```