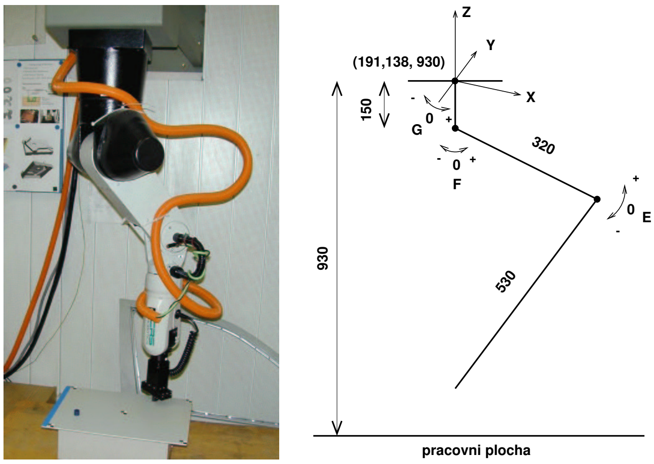
XE33IRO - Intelligent robotics - project definition

The goal of the project is to **solve an engineering problem** motivated by intelligent robotics and to **present the solution in a formally correct written form**.



(a) (b)

Figure 1: (a) A robot in a scene. (b) Robot kinematics.

Joint	Joint range in degrees	Number of steps
E	-100 to 100	0 to 100
F	-100 to 100	0 to 100
G	-170 to 170	0 to 100

Table 1: Robot joint ranges.

The situation The robot and the working area are located in a scene, as it is shown in Figure 1(a). The robot kinematics 1(b) has three degrees of freedom, which are set by step engines with parameters listed in Table 1.The pose of the robot is then determined by the three settings of the step engines. Let us call them the joint angles of the robot. For the sake of simplicity, we assume that the robot is immaterial, that is it cannot collide with any obstacles nor it can collide with itself. His movement is limited only the range and step of its joint angles.

The robot is equipped with a proximity sensor, which allows to detect whether the end effector the robot is near some obstacle. The sensor work as follows. In each position of the robot, it is possible to ask if a change in the robot pose by one single step of one step engine will result in collision with some obstacle. In other word, the sensor detects presence of obstacles in a unit distance from the robot's end effector in **L1** metric in three dimensional space of the robot joint angles space.

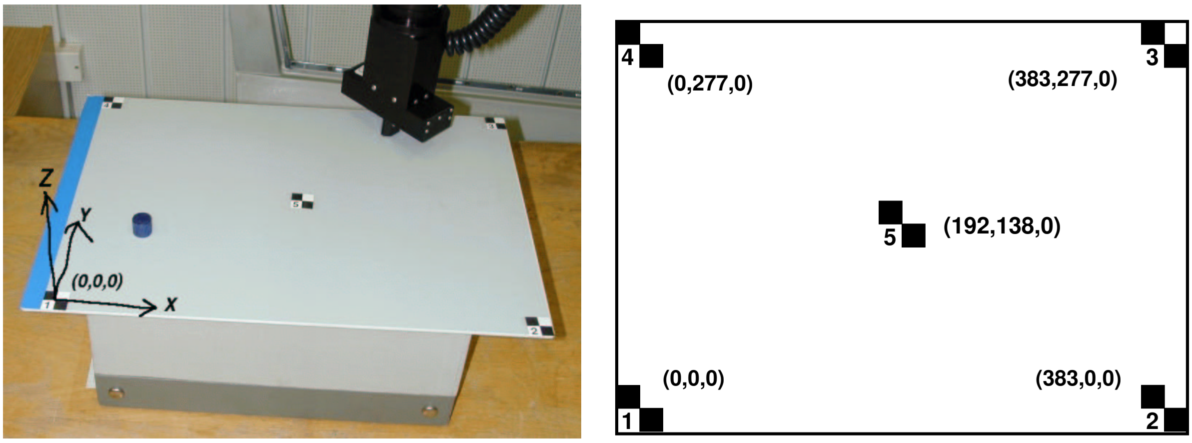


Figure 2: Coordinate system of the scene.

The robot is placed in a scene at a known position with respect to the working area, in which are placed landmarks, defining the coordinate system of the scene, see Figure 2. The basis **(x,y,z)**, which is depicted in Figure 2 is the same as the basis of the scene.

The scene is observed by an unknown perspective camera, located at an unknown fixed position. The camera observes the whole working area, therefore, all landmarks are visible in each image from the camera.

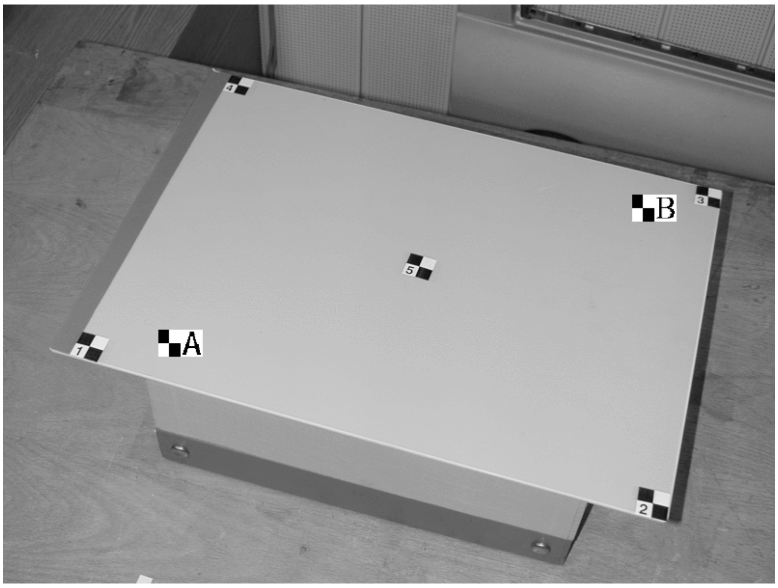


Figure 3: The observed scene.

The end effector of the robot is positioned in a known initial position denoted by the letter **A**. This position is given in a Cartesian coordinates of the robot. An object is placed at a position denoted by **B**, which is not known but which is observed by the camera. This object should be moved to the position **A**. For simplicity, we assume that the object has a form of a single material point, which can be grasped by the robot just by placing the end effector into the point **B**. While the robot is immaterial and can pass through the obstacles, the point cannot.

An obstacle can be placed into the scene between the image acquisition and movement of the robot. The information about the obstacle in some point in the scene can solely be acquired by placing the end effector close enough so that it can be detected by the proximity sensor.

Figure 4: Transfer of the object.

The task Transfer the object form position **B** into position **A** so that robot has to move on a shortest possible trajectory without colliding with some obstacle, as it is depicted in Figure 4.

Solve the problem in a general way, for any shape of the obstacle. Information about the shape of the obstacle in your concrete task will allow you to simulate the solution so that you can present your approach in an experiment. You are not allowed to use the knowledge of the shape of the obstacle in the planning of the trajectory. The robot can detect the obstacle only by "touching" it using the proximity sensor.

Parameters of the tasks Each group works on a task given by the number of the group. The parameters of the tasks are in Table 2.

Group number	Obstacle	Position of the robot and of the object
01	scb01.txt[1]	lrpp01.bmp[2] (lrpp01.gif[3])
02	scb02.txt[4]	lrpp02.bmp[5] (lrpp02.gif[6])
03	scb03.txt[7]	lrpp03.bmp[8] (lrpp03.gif[9])
04	scb04.txt[10]	lrpp04.bmp[11] (lrpp04.gif[12])
05	scb05.txt[13]	lrpp05.bmp[14] (lrpp05.gif[15])
06	scb06.txt[16]	lrpp06.bmp[17] (lrpp06.gif[18])
07	scb07.txt[19]	lrpp07.bmp[20] (lrpp07.gif[21])
08	scb08.txt[22]	lrpp08.bmp[23] (lrpp08.gif[24])
09	scb09.txt[25]	lrpp09.bmp[26] (lrpp09.gif[27])
10	scb10.txt[28]	lrpp10.bmp[29] (lrpp10.gif[30])
11	scb11.txt[31]	lrpp11.bmp[32] (lrpp11.gif[33])
12	scb12.txt[34]	lrpp12.bmp[35] (lrpp12.gif[36])
13	scb13.txt[37]	lrpp13.bmp[38] (lrpp13.gif[39])
14	scb14.txt[40]	lrpp14.bmp[41] (lrpp14.gif[42])
15	scb15.txt[43]	lrpp15.bmp[44] (lrpp15.gif[45])
16	scb16.txt[46]	lrpp16.bmp[47] (lrpp16.gif[48])
17	scb17.txt[49]	lrpp17.bmp[50] (lrpp17.gif[51])
18	scb18.txt[52]	lrpp18.bmp[53] (lrpp18.gif[54])
19	scb19.txt[55]	lrpp19.bmp[56] (lrpp19.gif[57])
20	scb20.txt[58]	lrpp20.bmp[59] (lrpp20.gif[60])
21	scb21.txt[61]	lrpp21.bmp[62] (lrpp21.gif[63])
22	scb22.txt[64]	lrpp22.bmp[65] (lrpp22.gif[66])
23	scb23.txt[67]	lrpp23.bmp[68] (lrpp23.gif[69])
24	scb24.txt[70]	lrpp24.bmp[71] (lrpp24.gif[72])
25	scb25.txt[73]	lrpp25.bmp[74] (lrpp25.gif[75])

Table 2: Task parameters.

Scene definition is given in files `scb??.txt`. The scene is composed of four blocks. The top surface of the first block defines the working area, on which are placed the landmarks and the obstacle defined by the remaining three blocks. The blocks are determined by eight vertices.

Each vertex coordinates **x y z** corresponds to one line in the file. First eight lines in the file define vertices of the first block, the second eight lines the vertices of the second block and so on. The interiors of the block are impenetrable for the object to be transfered.

Image of the working area from the perspective camera is contained in files `lrpp??.bmp`. The points **A** and **B** are shown in the image together with the landmarks with known position in the scene.