PRESENTATION on Learnings from Tasks

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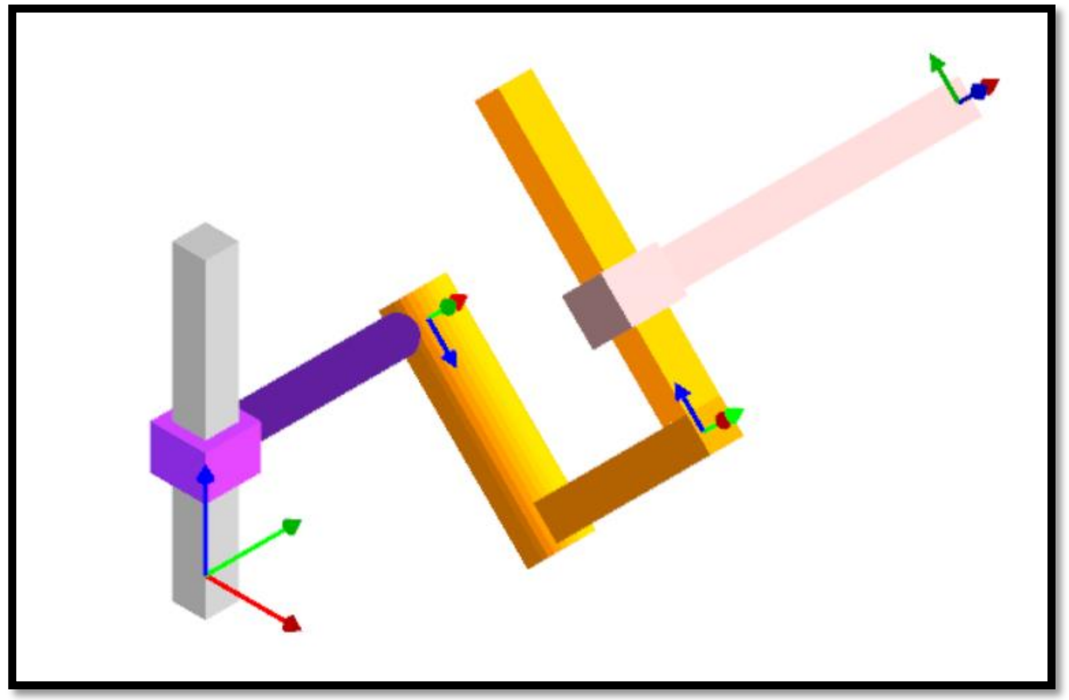
RoboAnalyzer Online Competition 2021

Team A3

Forward Kinematics

In forward kinematics for positions, the joint positions, i.e., the angles of revolute joints and the displacements of prismatic joints, are prescribed. The task is to find the end-effector's configuration or pose, i.e., its position and orientation.

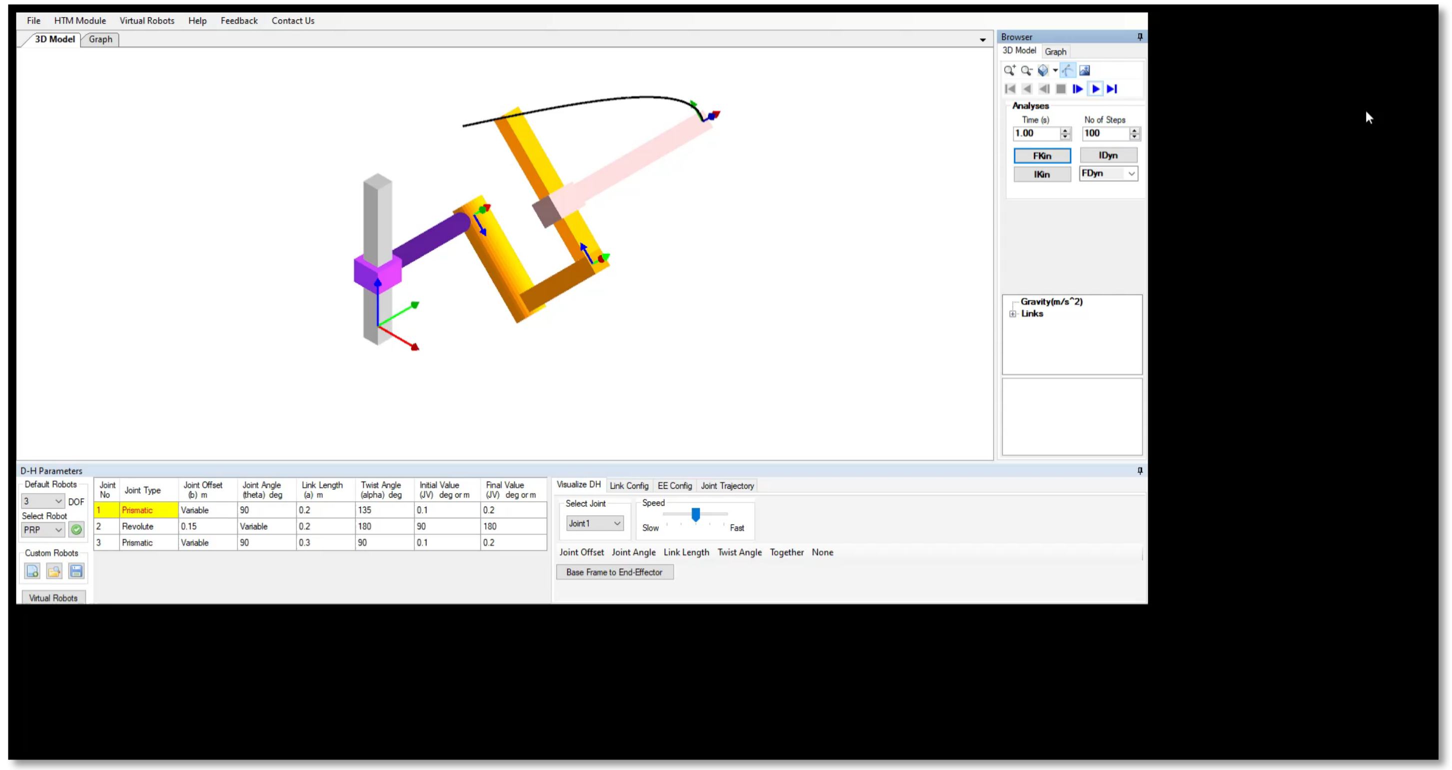
We define D-H Parameters.



3 DOF with PRP configuration

Four D-H Parameter

1. Joint offset (b) m
2. Joint Angle (θ) deg
3. Link length (a) m
4. Twist angle (α) deg



Motion video of 3DOF PRP

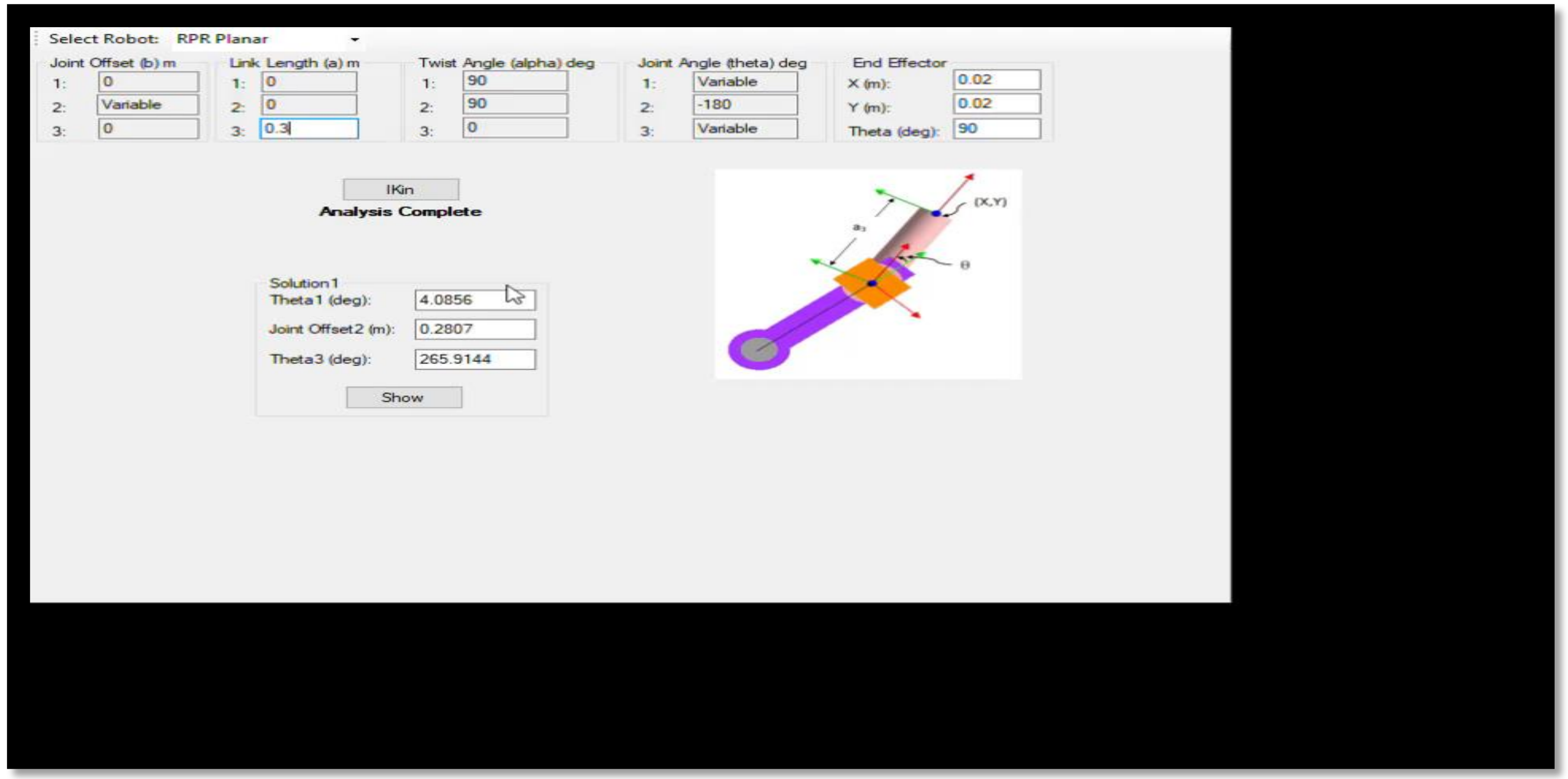
D-H Parameters

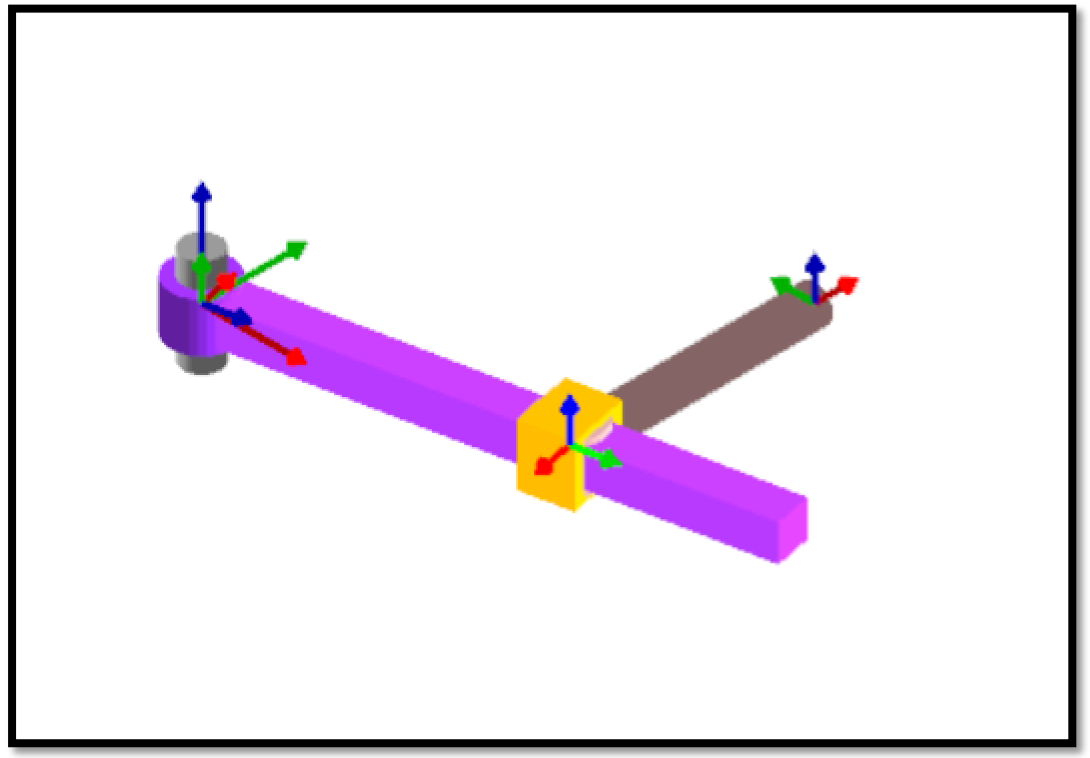
Default Robots: 3 DOF
Select Robot: PRP

Joint No	Joint Type	Joint Offset (b) m	Joint Angle (theta) deg	Link Length (a) m	Twist Angle (alpha) deg	Initial Value (JV) deg or m	Final Value (JV) deg or m
1	Prismatic	Variable	90	0.2	135	0.1	0.2
2	Revolute	0.15	Variable	0.2	180	90	180
3	Prismatic	Variable	90	0.3	90	0.1	0.2

Inverse Kinematics

The inverse kinematics problem consists of the determination of the joint variables corresponding to a given end-effector's orientation and position



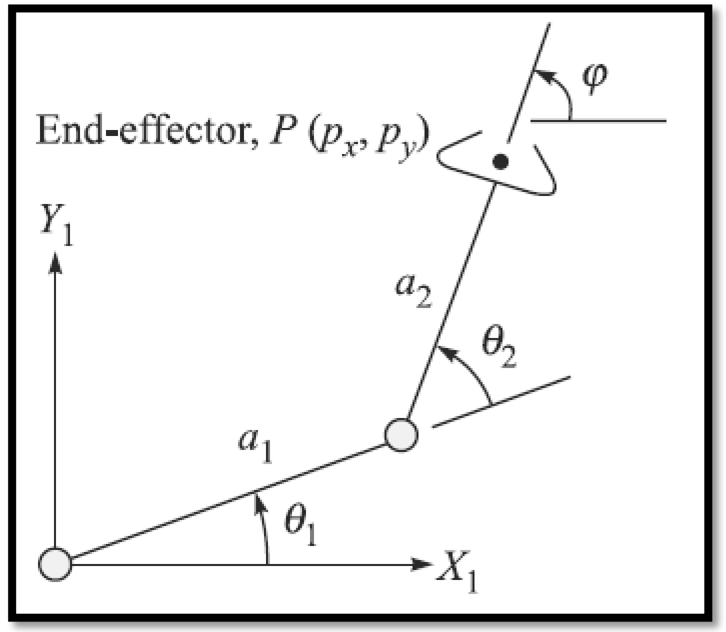


Output of Inverse Kinematics

Forward Kinematics of a Two-link Planar Arm

cosθ	-sinθ	0	Px
sinθ	cosθ	0	Py
0	0	1	0
0	0	0	1

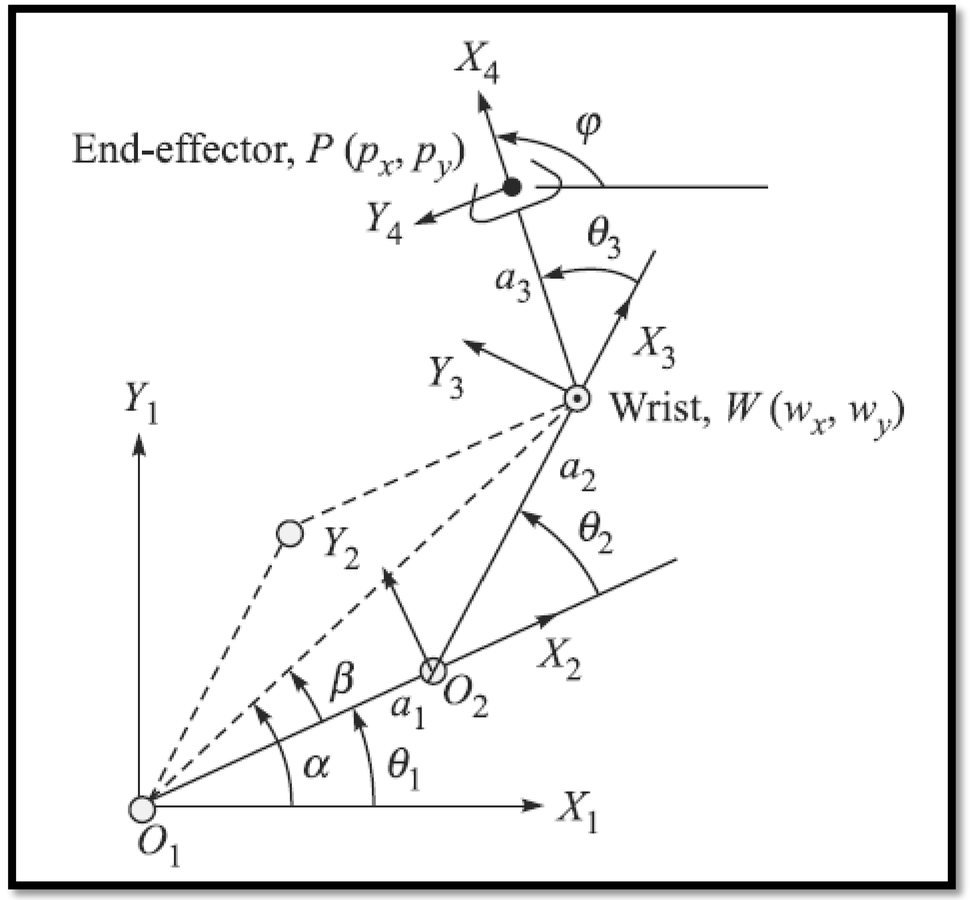
$Px = a_1.\cos\theta_1 + a_2.\cos\theta_{12}$
$Py = a_1.\sin\theta_1 + a2.\sin\theta_{12}$
$\theta_{12} = \theta_1 + \theta_2 - \theta_i$



Forward Kinematics of a Three-link Planar Arm

cosθ	-sinθ	0	Px
sinθ	cosθ	0	Py
0	0	1	0
0	0	0	1

$Px = a_1.\cos\theta_1 + a_2.\cos\theta_{12} + a_3.\cos\theta_{123}$
$Py = a_1.\sin\theta_1 + a_2.\sin\theta_{12} + a_3.\cos\theta_{123}$
$\theta_{12} = \theta_1 + \theta_2 - \theta_i$
$\theta_{123} = \theta_{12} + \theta_3$



Inverse Kinematics of a Two-link Planar Arm

I. Algebraic solution: Equating elements (2,1), (1,1), (1,4), and (2,4) of the two matrices, we get:

$$S_{12} = n_y \text{ and } C_{12} = n_x \rightarrow \theta_{12} = ATAN2\,(n_y, n_x)$$

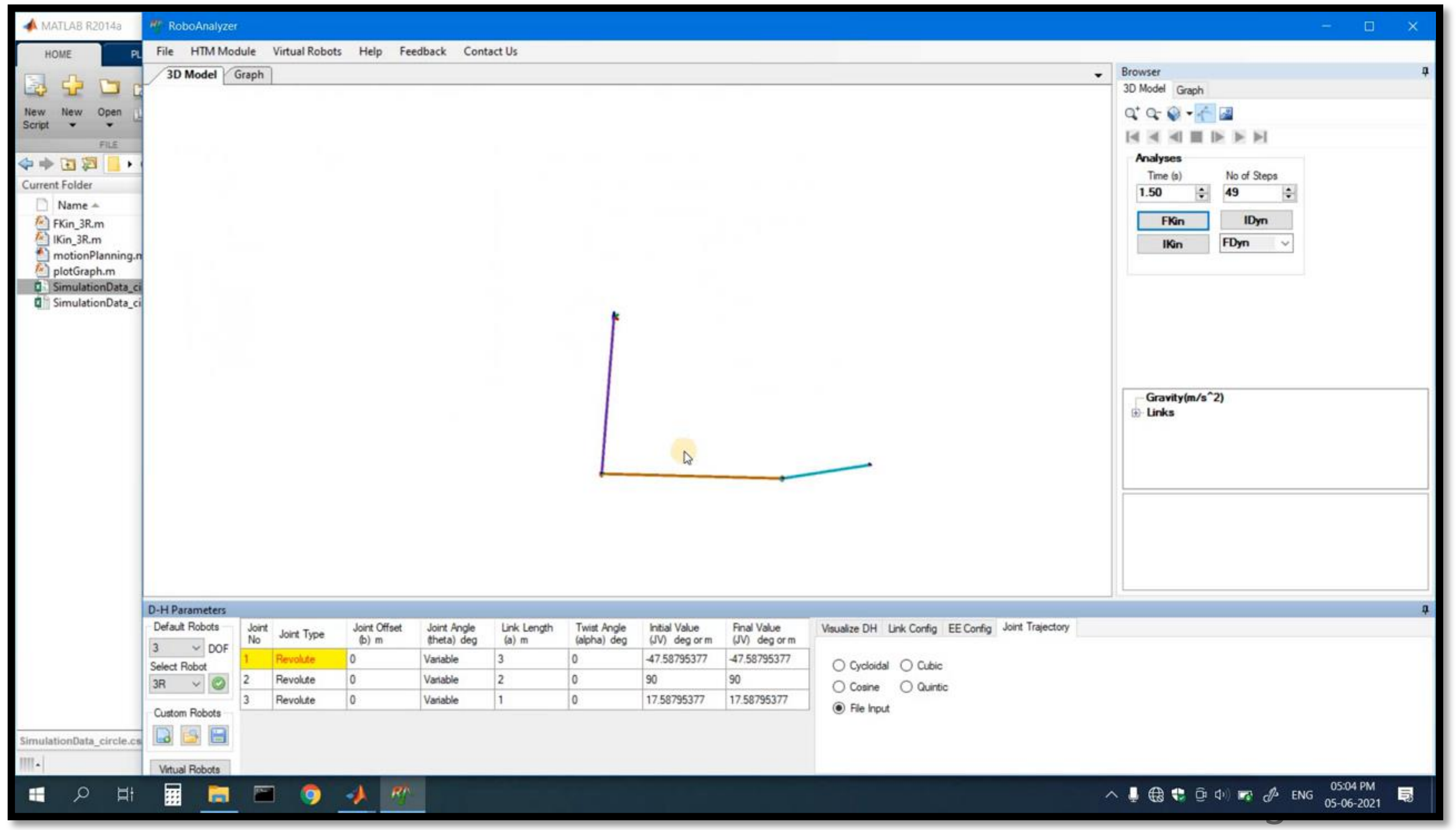
$$a_2C_{12} + a_1C_1 = p_x \text{ or } a_2n_x + a_1C_1 = p_x \rightarrow C_1 = \frac{p_x - a_2n_x}{a_1}$$

$$a_2S_{12} + a_1S_1 = p_y \text{ or } a_2n_y + a_1S_1 = p_y \rightarrow S_1 = \frac{p_y - a_2n_y}{a_1}$$

$$\theta_1 = ATAN2(S_1, C_1) = ATAN2\left(\frac{p_y - a_2n_y}{a_1}, \frac{p_x - a_2n_x}{a_1}\right)$$

Since θ_1 and θ_{12} are known, θ_2 can also be calculated.

Motion Planning of Three-link Arm to form a Circle



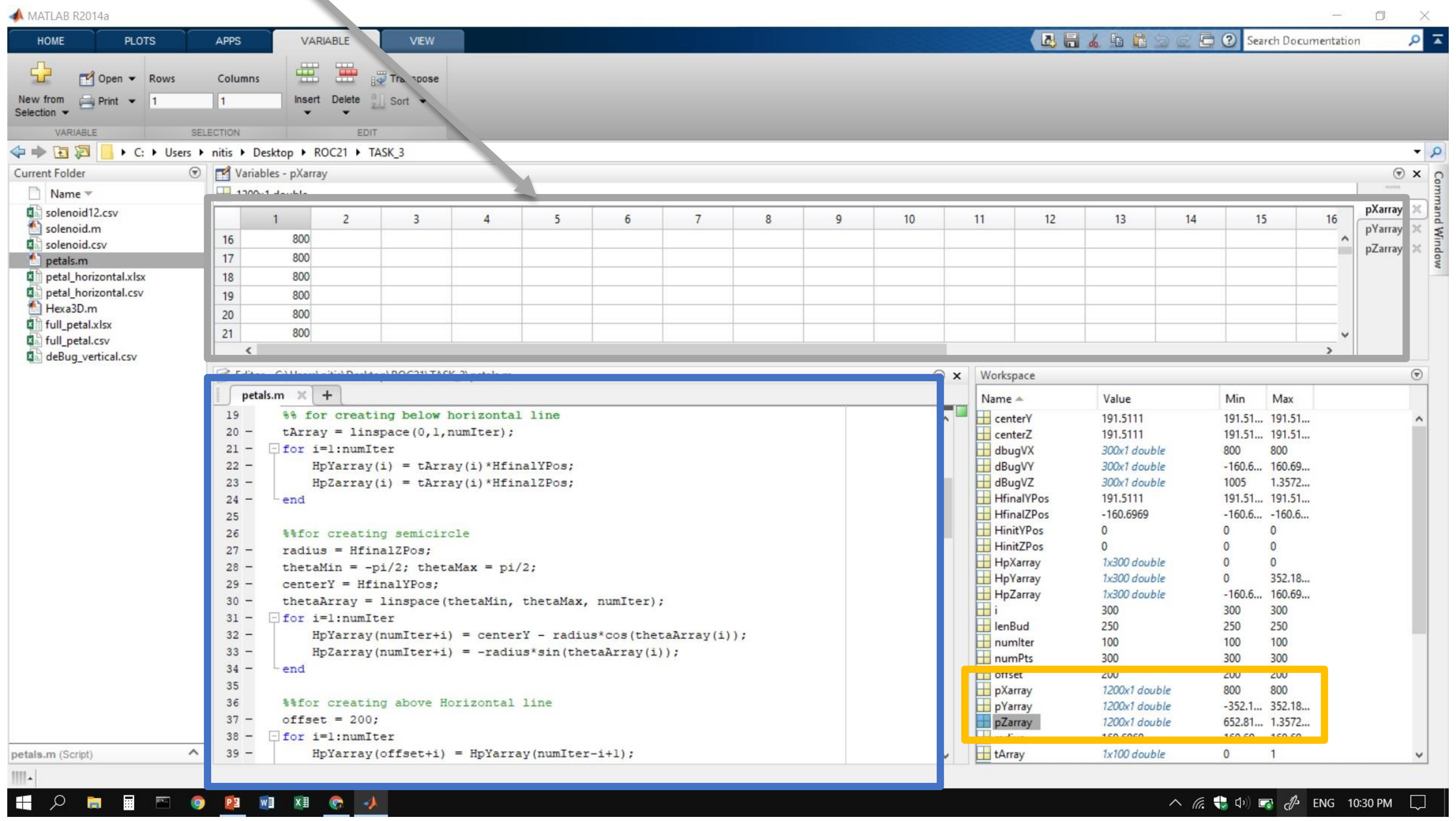
Stage 3 Motion Planning

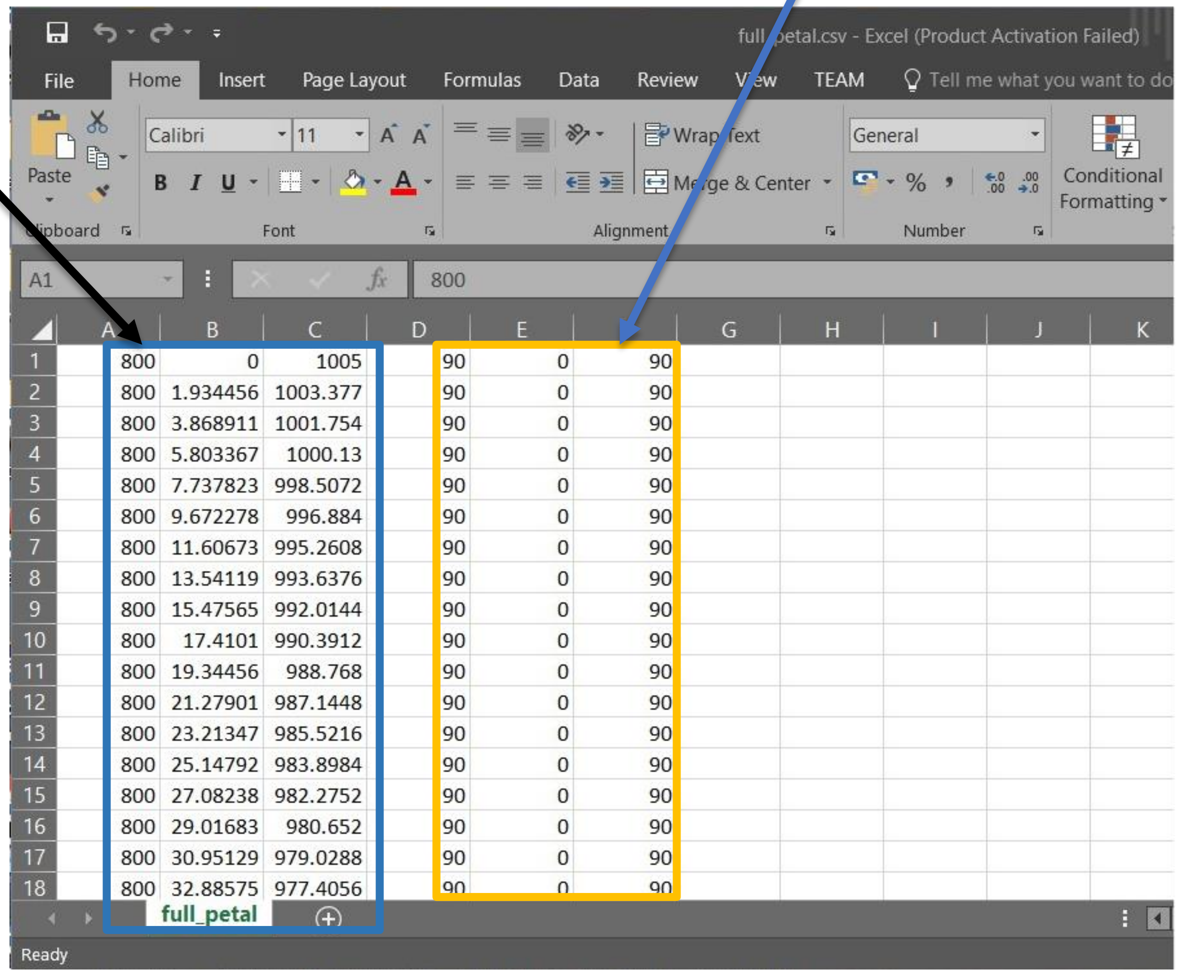
With the help of MATLAB we create an csv file which has geometry file which can be drawn through robot in RoboAnalyzer Software.

End effector angles(does not changed in current program)

This this the variable value which will be exported to csv to be use in Roboanlyser

X, Y and Z Coordinates

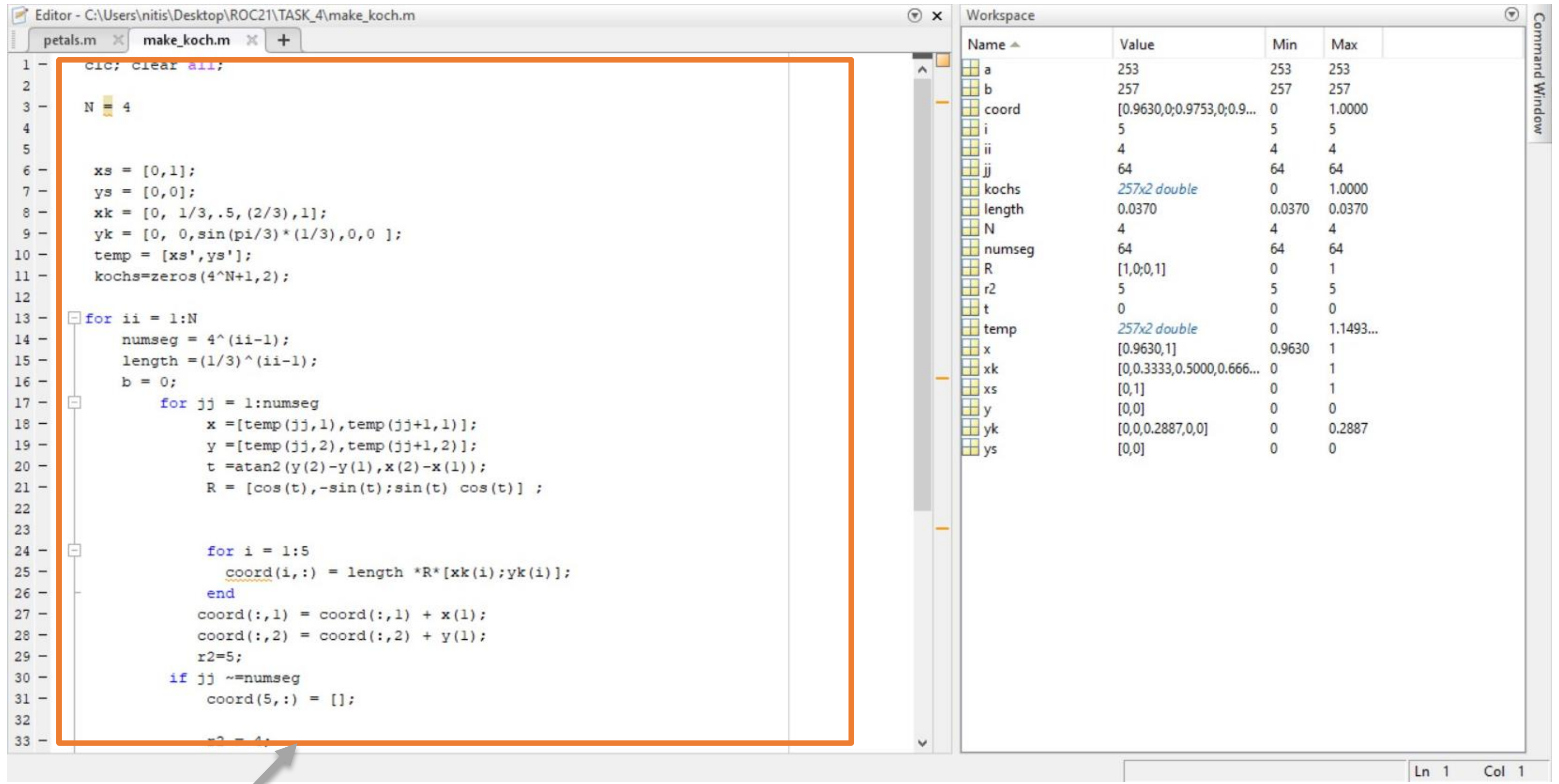




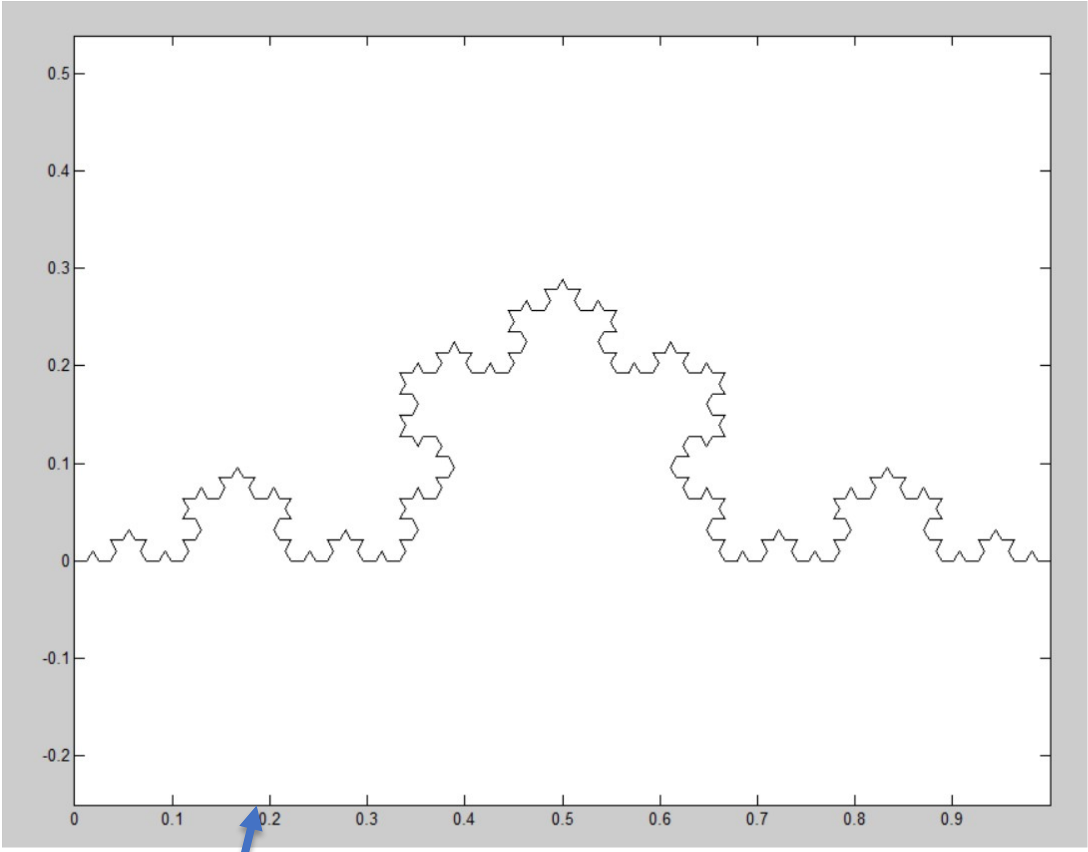
	A	B	C	D	E	F
1	800	0	1005	90	0	90
2	800	1.934456	1003.377	90	0	90
3	800	3.868911	1001.754	90	0	90
4	800	5.803367	1000.13	90	0	90
5	800	7.737823	998.5072	90	0	90
6	800	9.672278	996.884	90	0	90
7	800	11.60673	995.2608	90	0	90
8	800	13.54119	993.6376	90	0	90
9	800	15.47565	992.0144	90	0	90
10	800	17.4101	990.3912	90	0	90
11	800	19.34456	988.768	90	0	90
12	800	21.27901	987.1448	90	0	90
13	800	23.21347	985.5216	90	0	90
14	800	25.14792	983.8984	90	0	90
15	800	27.08238	982.2752	90	0	90
16	800	29.01683	980.652	90	0	90
17	800	30.95129	979.0288	90	0	90
18	800	32.88575	977.4056	90	0	90

Stage 4 Final Execution

In Final submission we executed the motion Planning again for Artistic Design with the help of MATLAB & csv file which we imported to Virtual Robot Manipulator. We are creating a fractal pattern Koch curve from matlab and importing the csv file containing the x, y and z coordinates of curve to Roboanalyser.

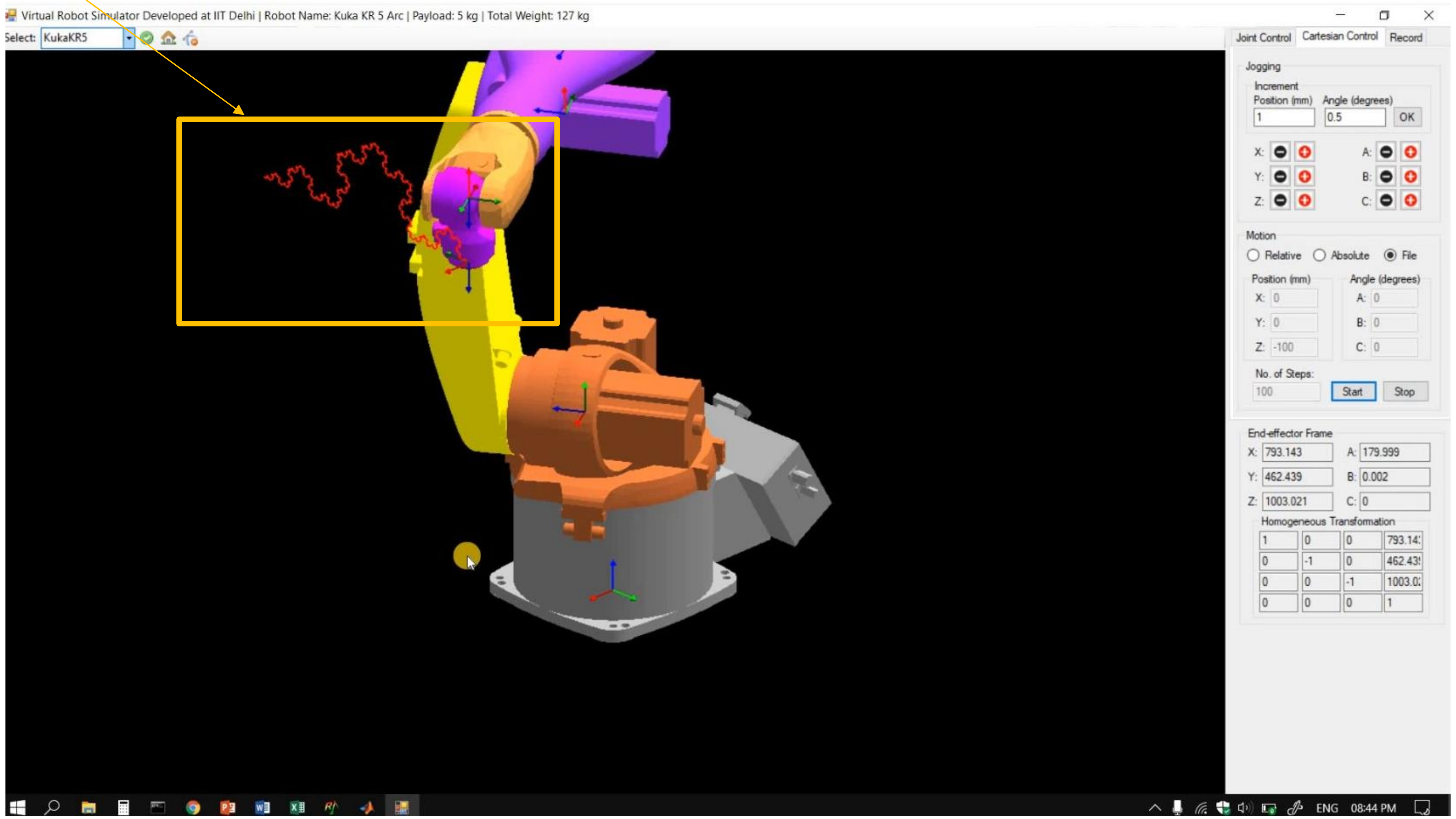


Matlab program to create Koch curve



Fractal pattern created by matlab program. This will be then scaled and exported to csv file and then will be used in Roboanalyser.

Generating Koch curve using csv file from the matlab program



THANK YOU