# PRESENTATION on Learnings from Tasks

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MATLAB program of Forward Kinematics Inverse Kinematics for 2 & 3 planar manipulator

- **Stage 3 Motion Planning** •
- **Stage 4 Final Execution** •

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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 ( $\theta$ ) deg
- 3. Link length (a) m
- 4. Twist angle ( $\alpha$ ) deg



### **Inverse Kinematics**

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



#### Motion video of 3DOF PRP

t 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
natic	Variable	90	0.2	135	0.1	0.2
olute	0.15	Variable	0.2	180	90	180
natic	Variable	90	0.3	90	0.1	0.2



Output of Inverse Kinematics

## Forward Kinematics of a Two-link Planar Arm

cosθ	-sin0	0	Px
sinθ	cosθ	0	Ру
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
sin0	cosθ	0	Ру
0	0	1	0
0	0	0	1

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







## 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:

$$S_{12} = n_{\gamma} \text{ and } C_{12} = n_{x} \to \theta_{12} = ATAN2 (n_{y}, n_{x})$$

$$a_{2}C_{12} + a_{1}C_{1} = p_{x} \text{ or } a_{2}n_{x} + a_{1}C_{1} = p_{x} \to C_{1} = \frac{p_{x} - a_{2}n_{x}}{a_{1}}$$

$$a_{2}S_{12} + a_{1}S_{1} = p_{\gamma} \text{ or } a_{2}n_{\gamma} + a_{1}S_{1} = p_{\gamma} \to S_{1} = \frac{p_{\gamma} - a_{2}n_{\gamma}}{a_{1}}$$

$$\theta_{1} = ATAN2(S_{1}, C_{1}) = ATAN2\left(\frac{p_{\gamma} - a_{2}n_{\gamma}}{a_{1}}, \frac{p_{x} - a_{2}n_{x}}{a_{1}}\right)$$

Since  $\theta_1$  and  $\theta_{12}$  are known,  $\theta_2$  can also be calculated.

### Motion Planning of Three-link Arm to form a Circle

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## 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.

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

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## **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.







# THANK YOU

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