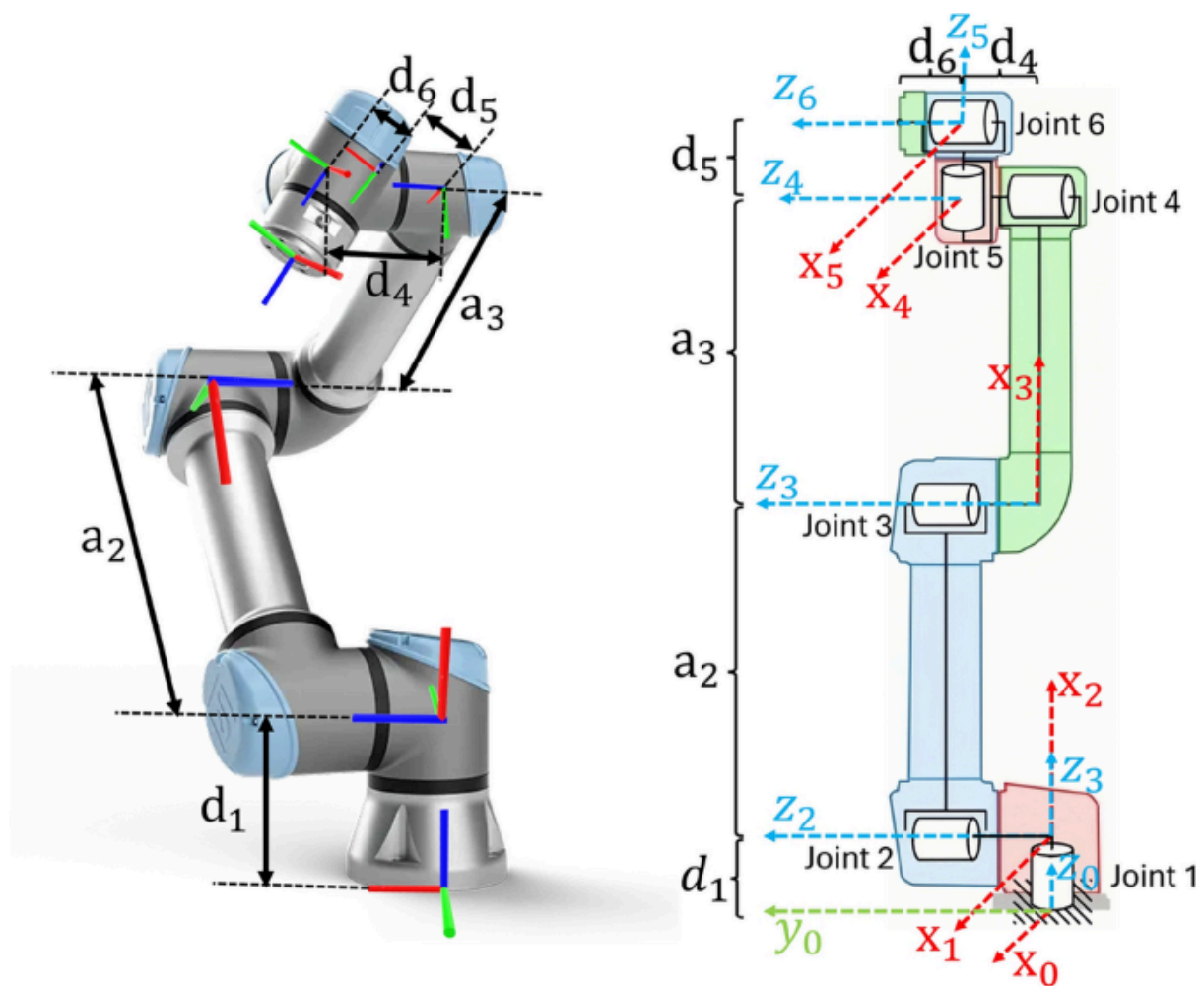


UR5 Robotic Arm – Inverse Kinematics Verification Tool

Mini Project / Assignment Problem Statement



1. Problem Statement

Design and implement a **UR5 Inverse Kinematics Verification Tool** that:

- Models the UR5 robotic arm using DH parameters
- Computes forward kinematics for given joint angles
- Computes inverse kinematics for a desired end-effector pose
- Verifies IK solutions using forward kinematics

- Computes the Jacobian matrix and identifies singularities

The tool must clearly indicate whether an IK solution is valid.

2. Tasks / Questions to Be Solved

Question 1: DH Parameter Modeling

Construct the **standard DH table** for the UR5 robotic arm by identifying the parameters (a_i , α_i , d_i , θ_i).

Deliverable: DH table and individual homogeneous transformation matrices.

Question 2: Forward Kinematics

Using the DH parameters, compute the overall transformation matrix from the base frame to the end-effector frame.

Question:

Given a joint vector ($q = [q_1, q_2, q_3, q_4, q_5, q_6]$), determine the end-effector position and orientation using forward kinematics.

Question 3: Inverse Kinematics

Implement an inverse kinematics solution (analytical or numerical).

Question:

For a given desired end-effector pose (T_{desired}), compute the corresponding joint angles of the UR5 robot.

Question 4: IK Verification

Verify the computed inverse kinematics solution.

Question:

Apply forward kinematics to the IK-derived joint angles and compute the position and orientation error with respect to (T_{desired}).

3. General Guidelines

- The project must be implemented with **software and hand written calculations**.
- Code should be modular (DH, FK, IK, Jacobian, verification)

- Clear numerical outputs are required for validation

No physical robot or hardware is required.

4. Submission Guidelines

Files to Be Submitted

1. **Project Report (PDF)**
 - Problem statement
 - DH table
 - FK, IK, and Jacobian results
 - Verification results
2. **Source Code**
 - Python (.py) files

Submission Format

- Submit a single google drive with all files named:

UR5_IK_Verification_<StudentName>.zip

Folder Structure

```
UR5_IK_Verification/  
|— report.pdf  
|— code/  
|— results/
```

5. Evaluation Criteria

- Correct DH modeling
- Accuracy of FK and IK
- Proper IK verification
- Code clarity and report quality