2

Human and Robot Interaction Laboratory
Advanced Robotics
Decouple Serial Robots

Introduction

The main concepts of Chapter 4 is Forward & Inverse Kinematic Problem (FKP and IKP) of decoupled serial robots, which you will comprehend by solving the "FKP" & "IKP" of commercial industrial robots.

Brief Information About FKP & IKP

FKP Goal

The goal of FKP consists in determining the position and orientation of *EE* when the actuator's angles are prescribed.

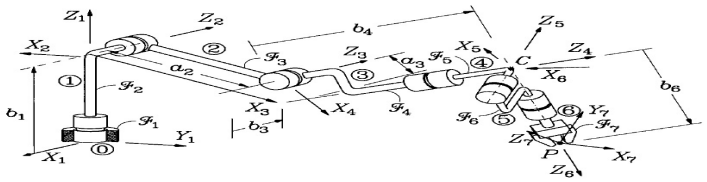

Figure 2.1: 6 DOF Decouple Serial Robot

★ The FKP in serial robots has one unique answer.

IKP Goal

The Goal of Inverse Kinematic Problem is to determine the actuator's angles when the position and orientation of *EE* are known.
★ The FKP of decoupled serial robots admit up to 8 solutions.

Problem Definition

As the first step, you have to go through the FKP and IKP concept described in tour text; then you should solve these problems on your case study (Specified in table 2.1 for each group). Then using either "MATLAB" or "Qt" you have to provide a GUI which provides the following information:

1. One "Tab", providing the "Denavit-Hartenberge" parameters, figure and brief information of the manipulator.

2. One "Tab", solving the FKP problem which would help user by the Inputs and Outputs of :

   (a) Inputs

      i. Each of the actuator's angles through time as the function of time. 2.1 .

      $$\theta_i = (a_2 * t^2 + a_1 * t + a_0) + b_0 * \sin(\omega t) + c_0 * cos(\omega t) \quad (2.1)$$

      ii. Time domain from T_{start} to T_{end}.

   (b) Outputs

i. 6 Plots which provide the position (x, y, z) and orientation $(\theta\phi\psi)$ through time T_{start} to T_{end} using "MATLAB Robotic Toolbax".

ii. 6 Plots which provide the position (x, y, z) and Orientation $(\theta\phi\psi)$ through time T_{start} to T_{end} using your "Analytic Solution".

iii. 6 Plots which provide the difference between your analytic solution and "MATLAB Robotic solution"

3. One "Tab", solving the IKP problem which would help user by the Inputs and Outputs of :

   (a) Inputs

   i. Each of the position elements $p = (x, y, z)$ through time as the function 2.2 .

   $$p_i = (a_2 * t^2 + a_1 * t + a_0) + b_0 * \sin(\omega t) + c_0 * cos(\omega t) \quad (2.2)$$

   ii. Each of the orientation elements (Two of $q = (q_1, q_2, q_3)$ and q_0 through time as the function 2.3.

   $$q_i = (a_2 * t^2 + a_1 * t + a_0) + b_0 * \sin(\omega t) + c_0 * cos(\omega t) \quad (2.3)$$

   iii. Time domain from T_{start} to T_{end}.

   (b) Outputs

   i. 6 plots which provide the actuators $\theta_i^{i=1:6}$ through Time T_{start} to T_{end} using "MATLAB Robotic Toolbax".

   ii. 6 plots which provide the actuators $\theta_i^{i=1:6}$ through Time T_{start} to T_{end} using "Analytic solution".

   iii. 6 plots which provide the difference between your analytic solution and "MATLAB Robotic Solution"

Groups - Methods

Due to Sortition, the Members & Robots are determined as Table 2.1.

Group number	Members	Robot
1	Nima & Mojtaba	ABB
2	Zeinab & Ali	FANUC
3	Amir & Behzad	KUKA

Table 2.1: Team Selection Table

Introduction Class

I **held** a class about FKP and IKP in decouple serial manipulators on Tuesday March 10th.

Extra Points

Add an 3D figure to your GUI in which the manipulator moves through time T_{start} to T_{end}. due to given Functions. To do so you can use CAD2MAT (Ask Behzad Danai for further assistance.)

Deadline

End of April 17th. This is a strict deadline.

Robots Under Study

ABB IRB 6400

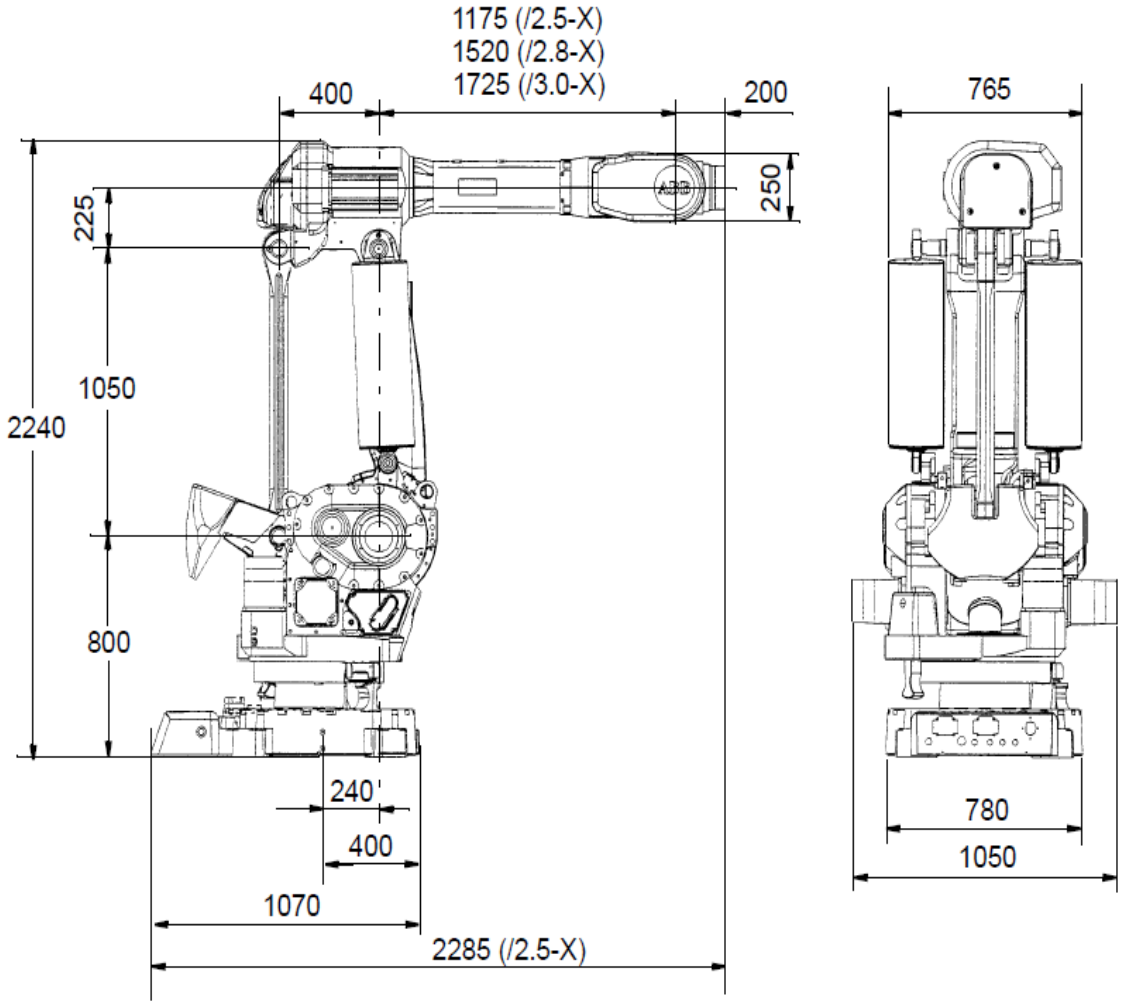

Figure 2.2: ABB Industrial Robot

FANUC M900*i*A/600

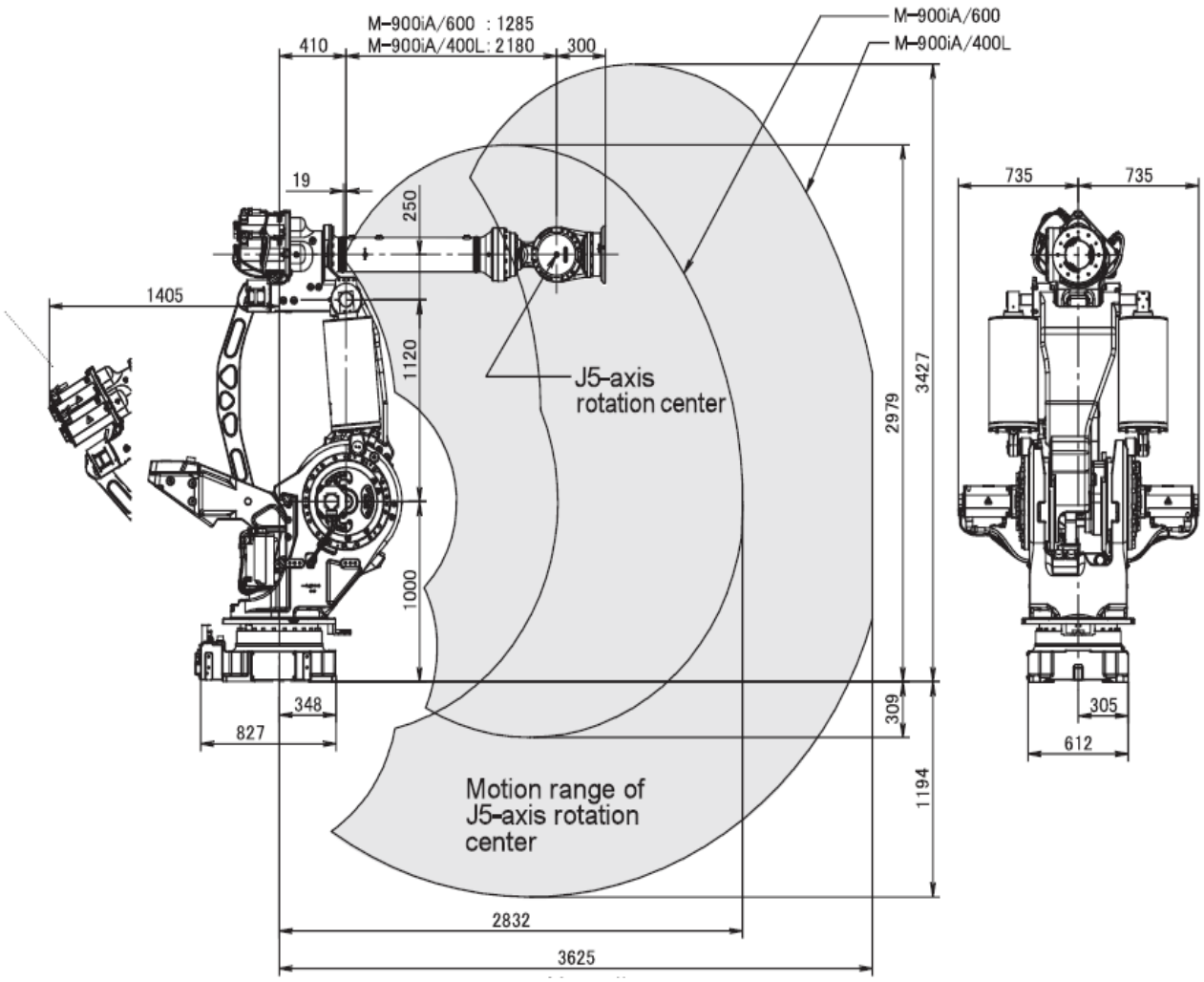

Figure 2.3: FANUC Industrial Robot.

KUKA KR 1000 titan

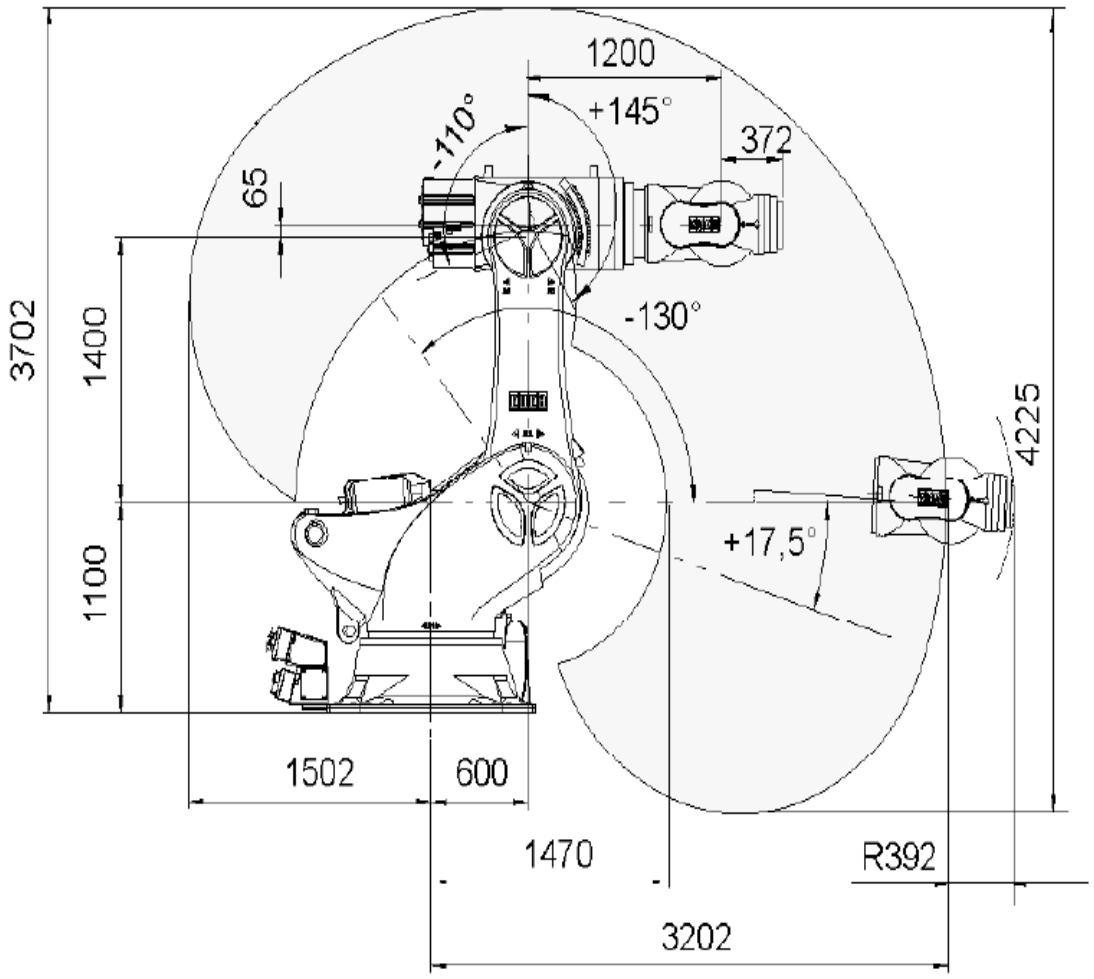

Figure 2.4: KUKA Industrial Robot.