

Program of “Robotics for Bioengineering” (Prof. Fanny Ficuciello) — 2nd term: March–June 2021

Lecture_01 — Introduction to robotics and medical robotics

Lecture_02 — Pose of rigid body, rotation matrix, composition of rotation matrices, orientation representations (Euler angles, angle and axis, unit quaternion), homogeneous transformations

Lecture_03 — Direct kinematics, Denavit-Hartenberg convention, kinematics of typical manipulator structures

Lecture_04 — Closed chain, parallelogram arm, joint space and operational space, Inverse kinematics problem

Lecture_05 — Differential kinematics, geometric Jacobian, Jacobian of typical manipulator structures

Lecture_06 — Kinematic singularities, analysis of redundancy

Lecture_07 — Use of redundancy, inverse differential kinematics, analytical Jacobian

Lecture_08 — Inverse kinematics algorithms, comparison among inverse kinematics algorithms, statics, manipulability ellipsoids

Lecture_09 — Direct dynamics and inverse dynamics, operational space dynamic model, dynamic manipulability ellipsoid

Lecture_10 — Trajectory planning: joint space, operational space

Lecture_11 — Centralized control: PD control with gravity compensation, inverse dynamics control

Lecture_12 — da Vinci Research Kit: Kinematics and Dynamics

Lecture_13 — Operational space control: PD control with gravity compensation, inverse dynamics control, comparison among various control schemes

Lecture_14 — Exoskeleton and wearable robots

Lecture_15 — Compliance control, impedance control

Lecture_16 — Exoskeleton and wearable robots

Lecture_17 — Actuators and sensors: joint actuating systems, drives, proprioceptive and exteroceptive sensors, overview of the control architecture

Lecture_18 — Distinguished lecture by Prof. Dott. Alberto Arezzo University of Torino “Robotics in surgery”

Lecture_19 — Classification of surgical robots

Lecture_20 — Teleoperation and haptics

Lecture_21 — Tank theory, semi-autonomous control strategies on the da Vinci robot

Lecture_22 — Robotic prostheses: classification, design, sensing, actuation

Lecture_23 — Overview of control principles in upper-limb prostheses

Lecture_24 — Case study: MERO Hand and PRISMA Hand II