Prof. Chao-Chieh Lan
(Dynamics, Mechatronics, Robotics, and Mechanical Design)

- A gravity-balanced exoskeleton to support & enhance the motion of an injured upper limb, lightweight and fits human body for rehabilitation
- Linear variable stiffness actuator with large stiffness variation, suitable for parallel robots.
- Simulation and experiment of engine timing chain system for improved performance at high speeds.

- Multi-DOF bio-inspired robotic manipulators with compact size, high torque density, and human friendly interaction
A Lightweight Gravity-Balanced Exoskeleton for Home Rehabilitation of Upper Limbs

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• An optimized 5R spherical mechanism mounted on the shoulder. With two linear actuators, the exoskeleton can support and enhance the motion of an injured upper limb.

• A spring to balance the mechanism/limb weight so that actuator size can be minimized.

• The device is lightweight and fits human body. Suitable for home rehabilitation.
A Novel Linear Variable-Stiffness Mechanism Using Preloaded Curved Beams

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• Combine a lateral curved beam with an axial spring. Through preload adjustment of the curved beam, the output force-to-displacement curves have different stiffnesses.

• Very large stiffness variation can be achieved in a compact space. The stiffness may even be tuned to zero by assigning a proper stiffness to the axial spring.

• Suitable for parallel robots that require linear variable-stiffness actuators.

Linear Variable Stiffness Actuator
This paper presents a robotic wrist whose size, range, and torque output are comparable to those of a human wrist.

To achieve two collocated and perpendicular axes of compliant actuation, two linear compliant couplers are proposed.

Through slider crank and spherical mechanisms, the linear elasticity is converted to rotary elasticity to control the pitch and yaw torques at the same time.

Applications include human-robot interaction that requires high force control quality in multiple directions.
A 2-dof manipulator actuated by two pairs of antagonistic SMA wire actuators.

The manipulator has a 14×14 mm cross-section and can provide two perpendicular axes of rotations, each with range up to ±40°.

Output rotation range is proportional to the amount of prestrain. Applying a sufficient prestrain can increase the workspace of the manipulator without using lengthy wires.

Achieves a bandwidth of 0.747 Hz. Adding springs in series with the actuators resulted in the same output range for prestrain less than 1.67%. Springs should be used for antagonistic actuation to prevent actuator overstress.
Development of a Compact Wrist Mechanism with High Torque Density

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• We focus on a compact design that can provide high output pitch and yaw torque densities, while the workspace and speed are not compromised.

• Inspired by human muscle-tendon actuation, the proposed mechanism consists of two parallel placed linear motors. Their motions are transmitted to two perpendicular rotations through a 5R spherical mechanism and two slider crank mechanisms.

• Pitch range: \(-59.12^\circ \sim 45.09^\circ\)
  Yaw range: \(-45.77^\circ \sim 54.78^\circ\)
  Maximal torque density: 8.38 Nm/kg
Design of a Compact Camera-Orienting Mechanism with Flexural Pan and Tilt Axes

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• Design and prototype of a camera-orienting mechanism is proposed. Pan-tilt motion is achieved by using parallel placed flexural beams to actuate a spherical 5-bar mechanism.

• Flexible mechanism design can reduce the number of parts, avoid joint clearance, achieve linear output-input relation, and fit irregular design domain.

• Mechanism specifications
  - Size: 42×43×116 mm
  - Weight: 140 g
  - Pan range: ±35°
  - Tilt range: ±33°
  - Resolution: 0.2°
  - Max. speed: 150°/s