Design of a Lightweight Forearm Exoskeleton for Fine-Motion Rehabilitation

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• Compared with other human joints, designing an elbow-wrist exoskeleton is more challenging in terms of size and weight.
• The 3-kg exoskeleton includes the 2-DoF elbow module and 3-DoF wrist module. Each joint provides series elastic actuation and force sensing.
• The motors are placed parallel to the upper limb. Experiment results show good force and impedance control speed and accuracy.
High-Performance Series Elastic Stepper Motors for Interaction Force Control

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• Stepper motors have a higher torque-to-weight ratio than brushed or brushless DC motors. With proper rotor position feedback, stepper motors can achieve smooth and accurate dynamic response.

• Coaxial input and output motion makes the series elastic stepper motor compact.

• Forward and inverse force tracking responses up to 5 Hz demonstrate the force control performance.
An Accurate Force Regulation Mechanism for Handling Fragile Objects Using Pneumatic Grippers

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• Without using additional sensors and control, the force regulation mechanism can passively produce an adjustable contact force between the jaws and objects of variable sizes.

• Gripping force independent of air pressure. Gripping force from 0 to 10 N can be adjusted by a screw.

• Faster, more reliable, and less expensive than the use of force-controlled electric grippers.
Design of an Adaptive Exoskeleton for Safe Robotic Shoulder Rehabilitation

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- 2-DOF motion using 5R parallel spherical mechanism. A gravity balancing mechanism to reduce the actuator load.
- An adaptive mechanism to compensate for the misalignment between exoskeleton and human upper limb.
- Series elastic linear motors are stationary and placed side by side. Wearability and safety improved.
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.
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.
Design and Control of a Robotic Wrist with Two Collocated Axes of Compliant Actuation

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• 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.
Design of a Miniature Manipulator Actuated by Antagonistic Shape Memory Alloys

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• 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