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Development of medical devices based on mechanical control

1. **Forceps manipulator for minimally invasive surgery**
2. **Power-assist device using pneumatic artificial rubber muscle**
3. **Development of soft actuators and their application to medical devices**
4. **Evaluation of surgical robot system**
5. **Teleoperation of robots using biological information**

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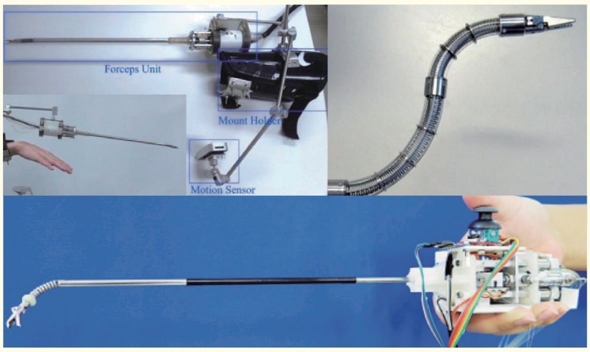
Kawashima Laboratory focuses on the development of medical devices and systems based on control engineering, robotics and fluid dynamics. Our keywords are integration of hardware and software, electrical and pneumatic actuation, human and machine.

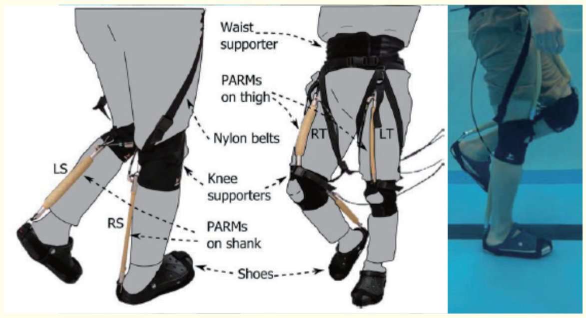
Forceps manipulator for surgical robot

We are developing forceps manipulators that are driven by pneumatic actuators. The forceps manipulator has a highly simplified flexible distal joint, which is actuated by push–pull motions of superelastic wires. The pneumatic system is backdrivable and suitable for applications that need force control. Furthermore, force can be measured using pressure sensors at the cylinder, without mounting a force sensor on the tip of the forceps.



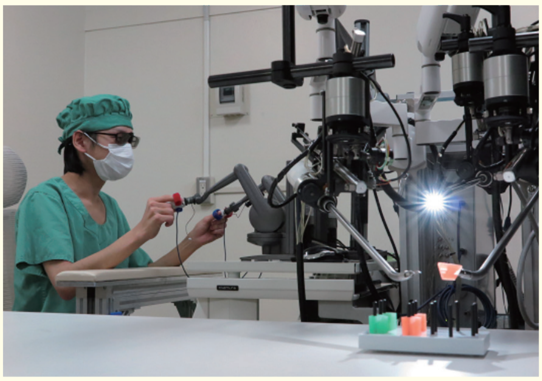
Assist device using pneumatic artificial rubber muscle

We are developing a soft, wearable gait-assistive suit. The gait-assistive suit is driven by pneumatic artificial rubber muscles (PARMs). The walking phase is detected from the pressure derivative in the PARMs, and the suit assists walking when the legs are swinging. Since the suit has no sensors on its attachment parts, users can easily wear, use, and remove the suit. In addition, the suit is available for underwater training with a weight-bearing effect, which is popular with elderly people and those undergoing rehabilitation.



Surgical robot system

We are developing a pneumatically driven surgical robot system. We are evaluating its performance with *in vitro* and *in vivo* experiments.



Soft actuator made of silicone

We are developing a soft actuator made of silicone. The actuator consists of a soft silicone rubber tube covered with a metal spring. The spring acts to restrain expansion of the actuator in the radial direction during pressurization, and to generate pulling force during depressurization. Furthermore, the use of the spring facilitates the manufacture of the actuator. We are applying the actuator to drive robotic hands and forceps.