Miniature In-Parallel Positioning System MIPS for Minimally Invasive Surgery

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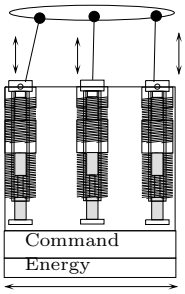
Micro robotics systems play an important role in the future of minimally invasive surgery. A small scale mechanical device should rely for its motion on the deformation of its geometrical structure. A new type of mechanical architecture for robots, the so-called *parallel architecture*, rely exactly on this paradigm and have been able to perform equally well at very different scales.

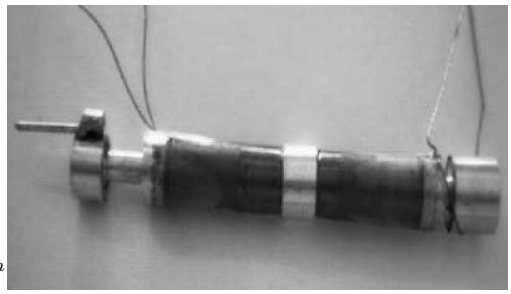
For the applications we are considering the robot will act as an active head mounted on some other positioning system. For example it could be mounted as the end of an endoscope for insuring the fine positioning of surgical tools For this kind of tasks only 3 d.o.f. are necessary. Our objectives are: an overall diameter of the robot in the range of 1cm with a minimum height and an autonomous and modular robot with respect to actuation, control and energy.

Among all the possible 3-d.o.f. parallel robots one of the most promising structure has been proposed by Lee. In this system each leg is connected to the base with a revolute joint and to the platform with an universal joint. A linear actuator enables to change the leg length and by changing the three leg lengths 3 d.o.f. for the platform are obtained: a translation along the vertical direction and two orientations. We have decided to use this idea in our prototype (called MIPS for Miniature In-Parallel Positioning System) but without having the actuator in the legs: instead the joints close to the base are moving along a vertical direction while the legs have a fixed length.

Magnetic actuation has been chosen: a permanent magnet which can slide into a solenoid leads to a very simple linear actuator. The force that can be exerted by such an actuator is sufficient as long as the range of motion is not too large and the control is basically simple. Our current linear actuators are constituted of mini-magnet coated with Teflon. Each magnet plunges into two solenoids connected to the base. Each solenoid is surrounded by a film of ferrite polymer to increase the magnetic field. The mass of the actuator is about 20 grams and the diameter is about 0.6 mm for a stroke of 5 mm.



$\oslash \leq 1.3cm$



The actuators have been tested and a CAD system has been designed for optimizing the performances of the robot.