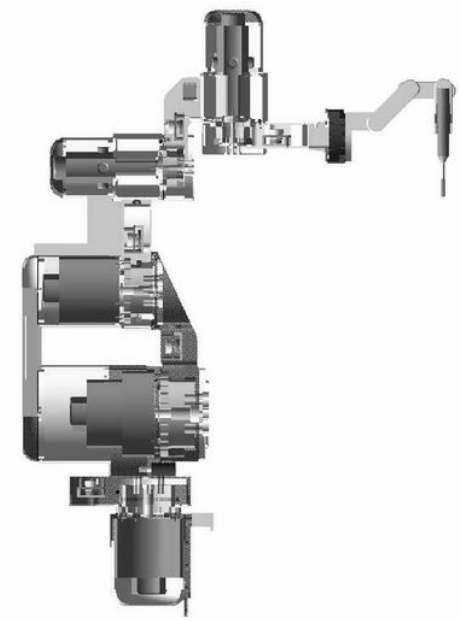
A new Robot for Surgical Applications

Our surgical robot was designed to satisfy the following requirements:

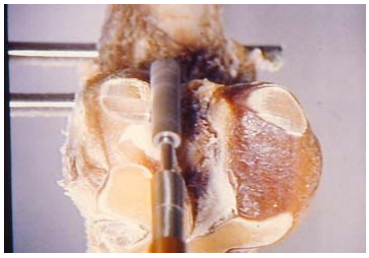
- Accuracy: a fundamental feature in orthopaedic interventions.
- Flexibility and ease of assembly: all components should be conceived for rapid assembly or disassembly to simplify set-up and cleaning procedures.
- High degree of rigidity: an essential requirement, especially in cutting operations when considerable force is applied to the patient's limb and could produce significant motion.
- Ergonomics: the device should allow the natural use of pre-existing structures in the operating room such as the operating table, care instrumentation and scrubber table, and preserve the visibility of the surgical area. Moreover, its interaction with users and patient has to be simple and easily understandable.



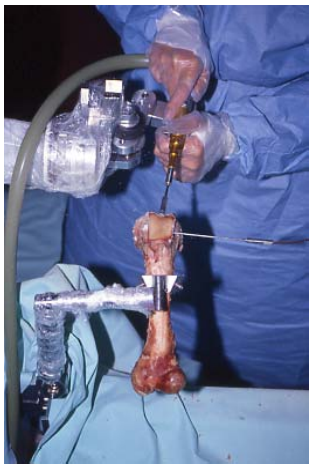
The resulting system is composed of interacting mechanical modules, which can be independently modified and are logically organised according to their function. All components were designed in a modular fashion in order to allow rapid maintenance and tool upgrading, and their reciprocal connections were realised by quick locking systems.
The robot is a five-degree of freedom custom-made manipulator and it is locked on the trolley with a steel plate. It was designed to improve execution safety and quality, to simplify the interaction with the surgical team, to ensure an unobstructed view of the operative field, both at rest and during resection, and to allow the free movement of the surgical team.
The controller is based on a parallel architecture with two industrial PCs, and a milling tool is used to perform the cutting operation instead of standard TKR saws. It is a nitrogen gas fed mill, with high rotation speed (80000 - 100000 rpm) installed on a three joint planar arm, and is used by the surgeon to make all the resections following a semi-automatic approach.

Some results obtained testing the developed system

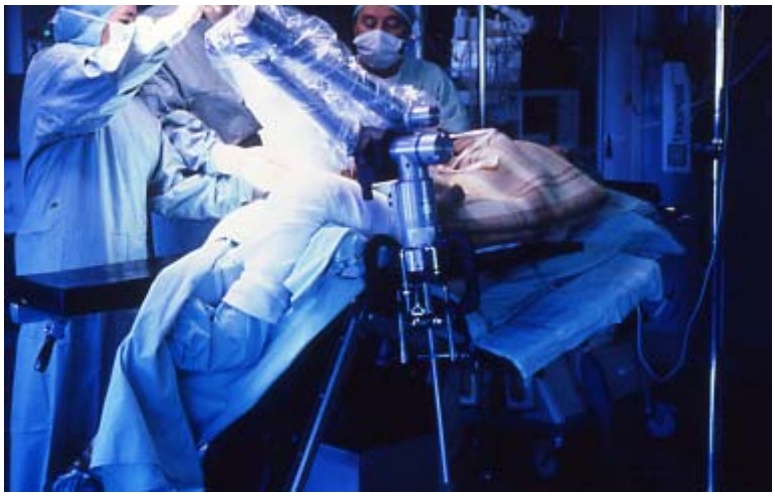
Esecuzione assistita dal robot	
Positioning accuracy	**<1mm / 2°**
Resection Roughness	**0.245mm**
Resection Flatness	**0.042mm**
Bone temperature	**<44°C**
Intraoperative Time	**40min**
Surgeon satisfaction	**GOOD**
Usability	**EXCELLENT**



analysis resection quality (using the milling tool instead of the saw)



analysis bone temperature during cutting



in-vivo registration

analysis of resection accuracy