University of Basel

Department of Biomedical Engineering

Robotic System for Accurate Minimally Invasive Laser Osteotomy

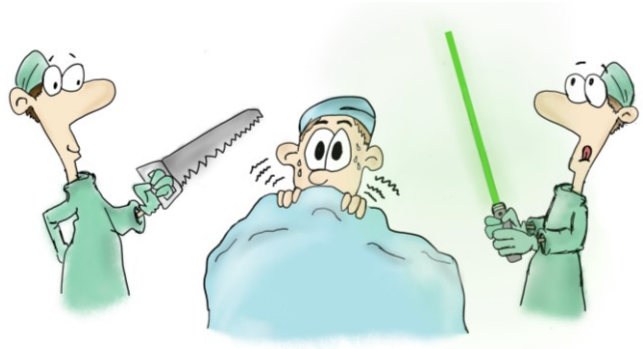

Figure 1: Have you decided whether you want conventional or laser surgery? (Picture by M. Eugster)

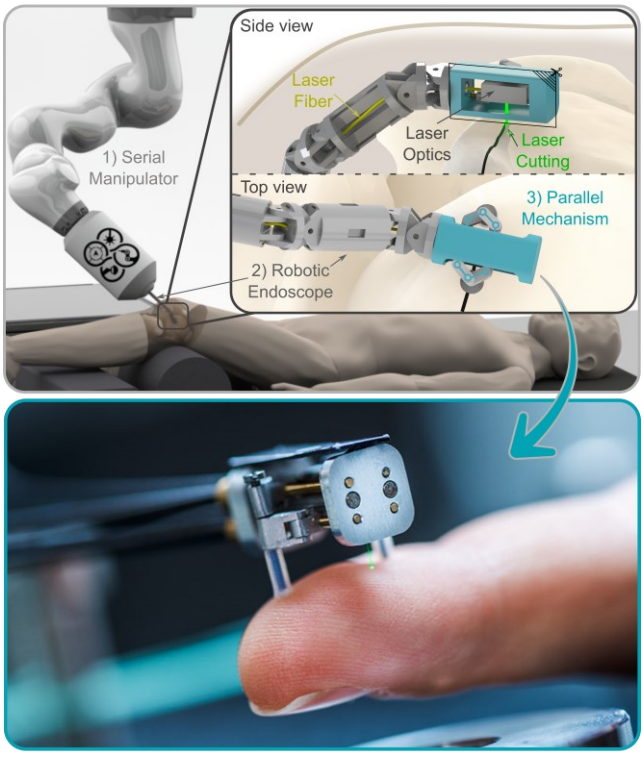

Figure 2: The developed robotic system for accurate minimally invasive laser osteotomy. (Bottom photography by Werner Siemens-Stiftung, Frank Brüderli, other picture content by M. Eugster).

PhD Thesis by Manuela Eugster at the Bio-Inspired RObots for MEDicine-Laboratory (BIROMED-Lab), Department of Biomedical Engineering (DBE), University of Basel.

Bone cutting, so-called osteotomy, is an essential part of many surgical procedures. Nowadays, bone cutting is mainly performed using mechanical devices such as milling cutters, drills, and saws. Laser osteotomy is a novel alternative for cutting bone with several advantages compared to conventional methods. However, existing devices for cutting bone with laser require direct access to the entire bone, i.e., are not minimally invasive.

This PhD project is part of an overall project called Minimally Invasive Robot-Assisted Computer-guided LaserosteotomE (MIRACLE), aiming to make minimally invasive bone cutting possible. My PhD thesis [1] focussed on the challenges in robotics in developing a system for minimally invasive insertion and accurate positioning of a laser for cutting bone in Unicompartmental Knee Arthroplasty (UKA) [2]. One of the main challenges in developing such a system is to achieve the desired high positioning accuracy of the laser with a dexterous device with a small diameter suitable for minimally invasive interventions.

We developed and evaluated a concept and first prototype of a robotic system consisting of 1) a serial manipulator guiding 2) a robotic endoscope for minimally invasive insertion of the laser fiber, and 3) a bone-mounted parallel mechanism [3] integrated at the robotic endoscope's tip, which will allow accurate positioning of the laser optics, i.e., of the laser on the bone during cutting.

Project MIRACLE
Medical Robotics and Mechatronics
BIROMED-Lab

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References:
[1] M. Eugster, "*Robotic System for Accurate Minimally Invasive Laser Osteotomy.*" Doctoral Thesis, University of Basel, 2021.
[2] M. Eugster et al., "*Quantitative Evaluation of the Thickness of the Available Manipulation Volume Inside the Knee Joint Capsule for Minimally Invasive Robotic Unicondylar Knee Arthroplasty*," in *IEEE Transactions on Biomedical Engineering*.
[3] M. Eugster et al., "*Miniature parallel robot with submillimeter positioning accuracy for minimally invasive laser osteotomy*," in *Robotica*, 2021.