STIFFness controllable Flexible and Learn-able Manipulator for surgical Operations
STIFF-FLOP

In minimally invasive surgery (MIS), tools go through narrow openings and manipulate soft organs that can move, deform, or change stiffness. There are limitations on modern laparoscopic and robot-assisted surgical systems due to restricted access through Trocar ports, lack of haptic feedback, and difficulties with rigid robot tools operating inside a confined space filled with healthy organs. Also, many control algorithms suffer from stability problems in the presence of unexpected conditions.

Departing from the traditional robotic manipulation concepts that rely on fixed stiffness distributions, the STIFF-FLOP project takes inspiration from biological "manipulation and actuation" principles as they are, for example, found in the octopus who can turn its links from a completely soft state into a state of precise and, if needed, powerful articulation – an approach that combines advantages associated with both soft and hard systems by selectively controlling the stiffness of various parts of the body depending on the task requirements. There are many advantages: the ability to squeeze through narrow gaps and openings, inherent compliance leading to increased safety especially when in contact with humans, hyper-redundancy for improved reachability in an obstacle-cluttered environment and increased adaptability to and stability in a possibly unpredictable environment.

In order to realise the envisaged soft manipulator, distributed sensing mechanisms are of vital importance for the system to perceive the physical interactions between the robot and the environment to enable the robot to understand the environment it is operating in and to learn appropriate control strategies.

The internal sensing modalities will be complemented by outside vision sensors to enhance the estimation of the pose of the manipulator. The human operator's input commands will be sensed by means of an operator console integrated with a 3D haptic feedback sack. All sensor signals will be used for learning – learning pose and interaction dynamics as well as relationship between operator input and the manipulator in its environment.

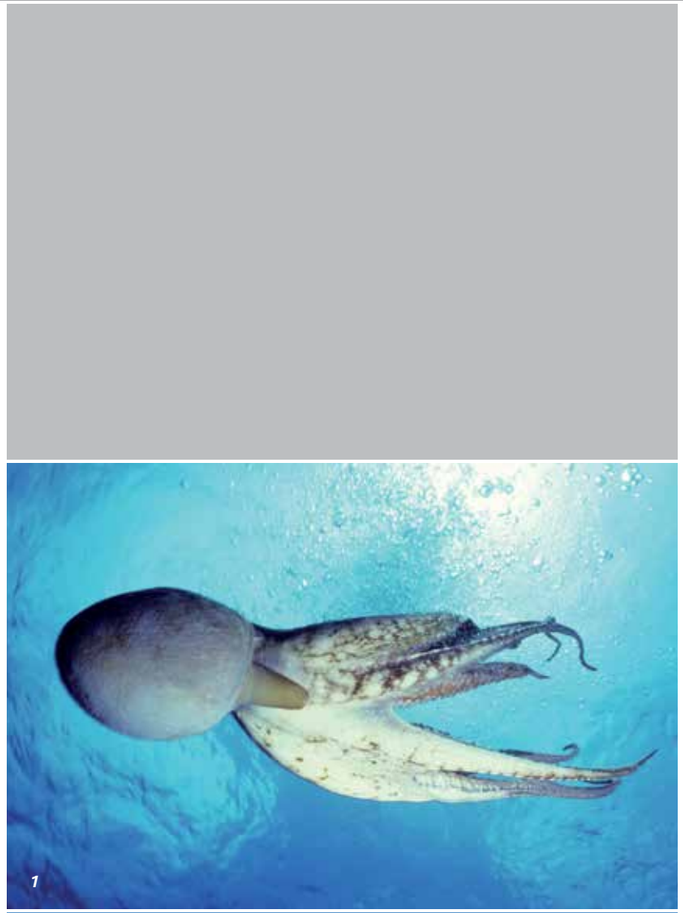

Fig. 1
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I Project Management and Execution

King's College London (KCL),
University of London

Prof. Kaspar Althoefer

Local Coordinator / Contact Person:

Universität Siegen
Prof. Dr.-Ing. Hubert Roth

Department Elektrotechnik und Informatik
Lehrstuhl für Regelungs- und Steuerungstechnik (RST)
Hölderlinstr. 3
D-57068 Siegen

E-Mail: hubert.roth@uni-siegen.de
Web: http://www.uni-siegen.de/fb12/rst/

Telefon: +49 0()271 740 4439
Fax: +49 (0)271 740 4382