da Vinci Research Kit
Community Research Overview

Simon DiMaio

3 April, 2019

INTUITIVE
Foundation

The *da Vinci Research Kit* Community

1 Ben Gurion University of the Negev
2 Carnegie Mellon University
3 Case Western Reserve University
4 Clemson
5 Imperial College
6 Obúda University
7 Politecnico di Milano
8 Purdue University
9 Scuola Superiore Sant'Anna
10 Seoul National University
11 Sheikh Zayed Institute for Pediatric Surgical, Children's National Health System
12 Sick Kids Children's Hospital
13 Stanford University
14 The Chinese University of Hong Kong
15 The Johns Hopkins University
16 The University of British Columbia
17 University College London
18 University of Alberta
19 University of California San Diego
20 University of California, Berkeley
21 University of Innsbruck
22 University of Leeds
23 University of Maryland
24 University of Naples Federico II
25 University of Reutlingen
26 University of Texas, Dallas
27 University of Western Ontario & CSTAR
28 Vanderbilt University
29 Wayne State University
30 Worcester Polytechnic Institute

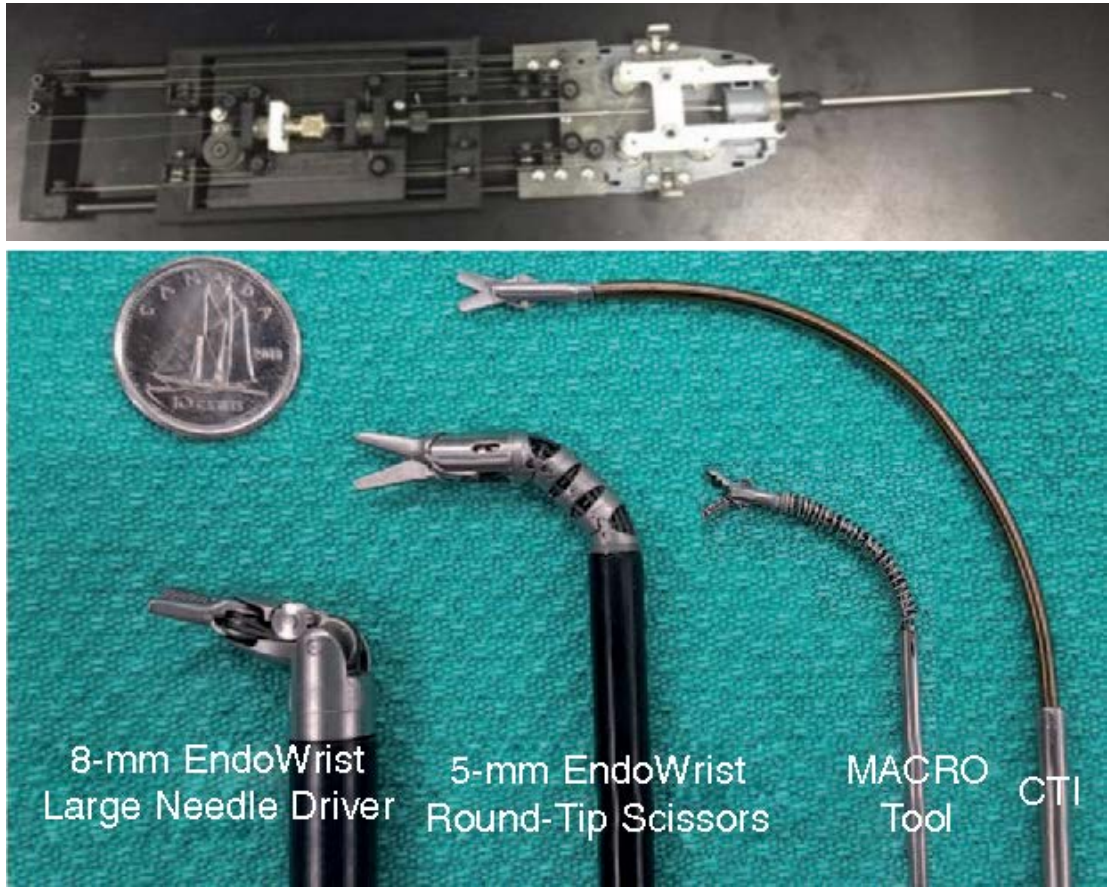
dVRK Research Themes

- Novel instruments
- Novel surgical manipulators
- Imaging and Vision
- Navigation and guidance
- User interfaces and controls
- Simulation and Training Technologies
- Intelligent systems
- Building blocks

dVRK Research Themes

- Novel instruments
- Novel surgical manipulators
- Imaging and Vision
- Navigation and guidance
- User interfaces and controls
- Simulation and Training Technologies
- Intelligent systems
- Building blocks

Sick Kids, Toronto (Drake, Looi, et al.)

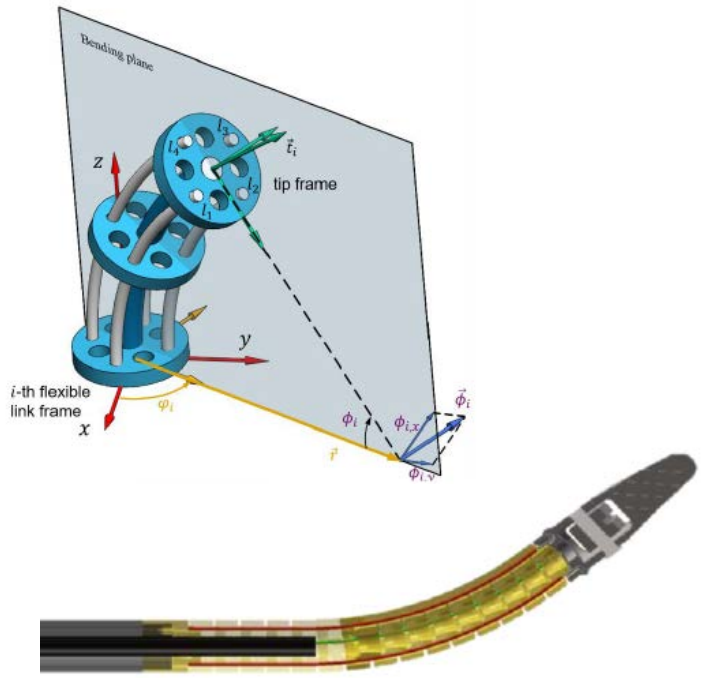


Flexible and continuum wrists

dVRK Research Themes

- Novel instruments
- Novel surgical manipulators
- Imaging and Vision
- Navigation and guidance
- User interfaces and controls
- Simulation and Training Technologies
- Intelligent systems
- Building blocks

Chinese University of Hong Kong (Au, Chiu, et al.)

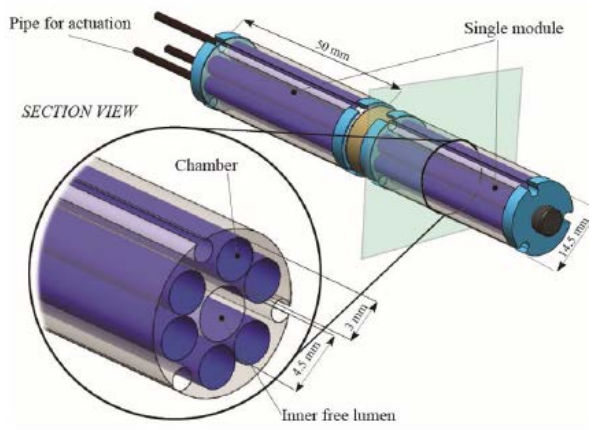


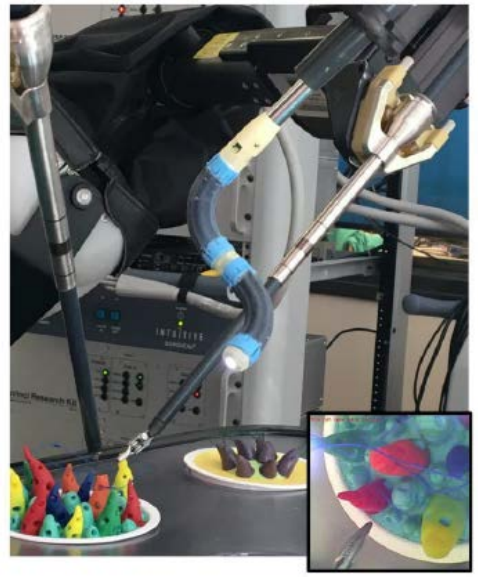
Flexible and continuum wrists

dVRK Research Themes

- Novel instruments
- Novel surgical manipulators
- Imaging and Vision
- Navigation and guidance
- User interfaces and controls
- Simulation and Training Technologies
- Intelligent systems
- Building blocks

University of Verona (Fiorini et al.)



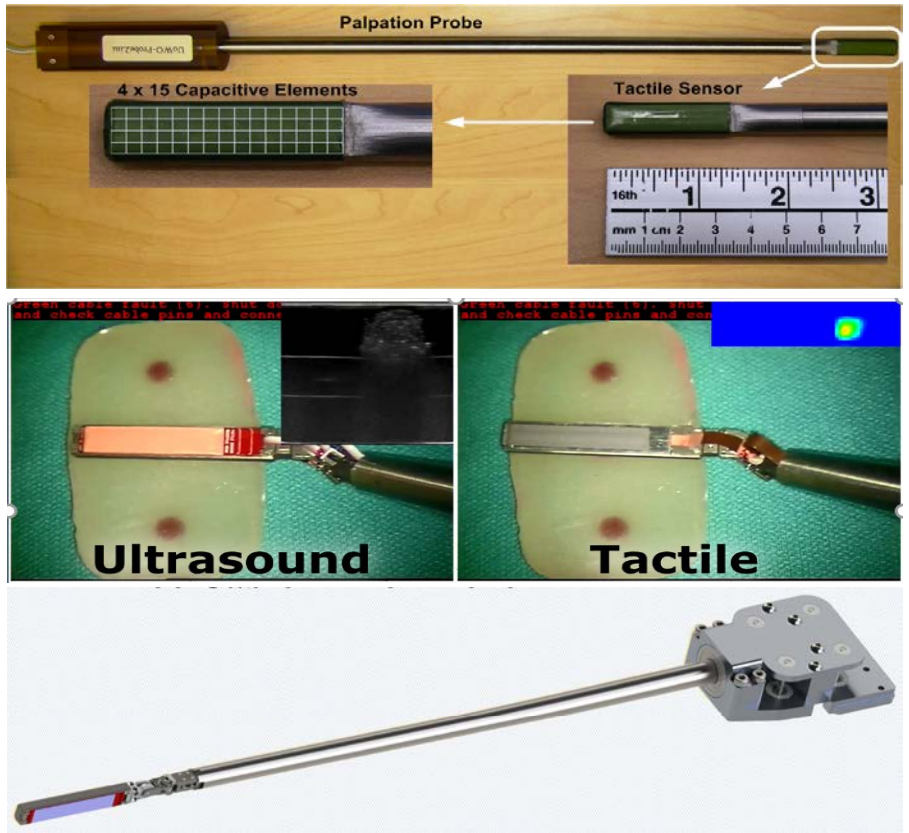


Articulated "soft robot" camera instrument

dVRK Research Themes

- Novel instruments
- Novel surgical manipulators
- Imaging and Vision
- Navigation and guidance
- User interfaces and controls
- Simulation and Training Technologies
- Intelligent systems
- Building blocks

CSTAR & University of Western Ontario (Patel et al.)



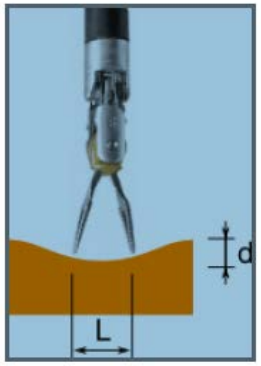
Hybrid palpation and ultrasound probe

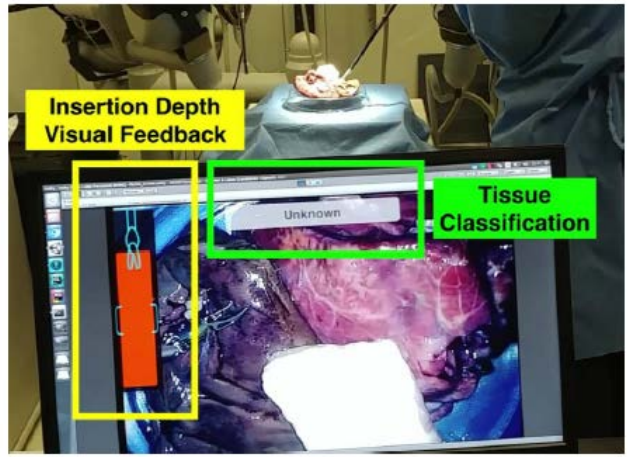
dVRK Research Themes

- Novel instruments
- Novel surgical manipulators
- Imaging and Vision
- Navigation and guidance
- User interfaces and controls
- Simulation and Training Technologies
- Intelligent systems
- Building blocks

University of Verona (Fiorini et al.)

Politecnico Milano (De Momi et al.)





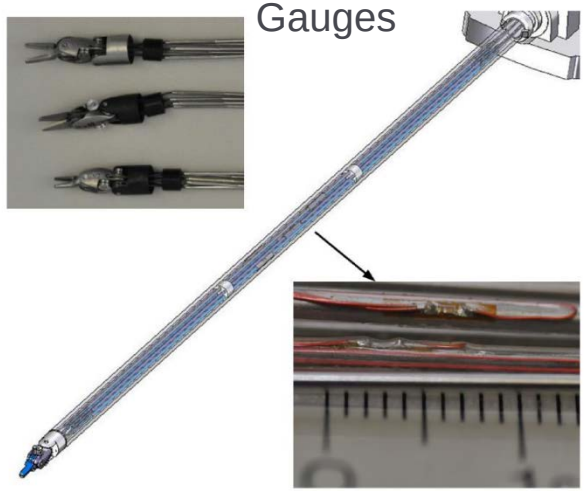
Bioimpedance tissue classification

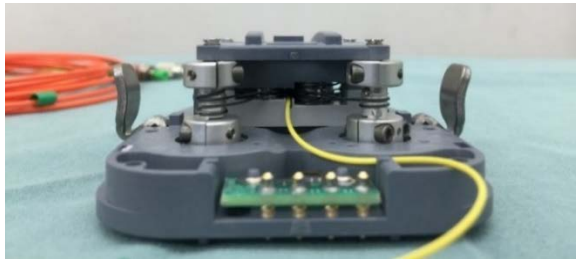
dVRK Research Themes

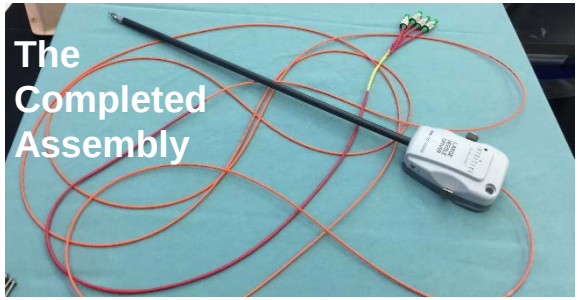
- Novel instruments
- Novel surgical manipulators
- Imaging and Vision
- Navigation and guidance
- User interfaces and controls
- Simulation and Training Technologies
- Intelligent systems
- Building blocks

CSTAR & University of Western Ontario (Patel et al.)

Cable-mounted Strain Gauges





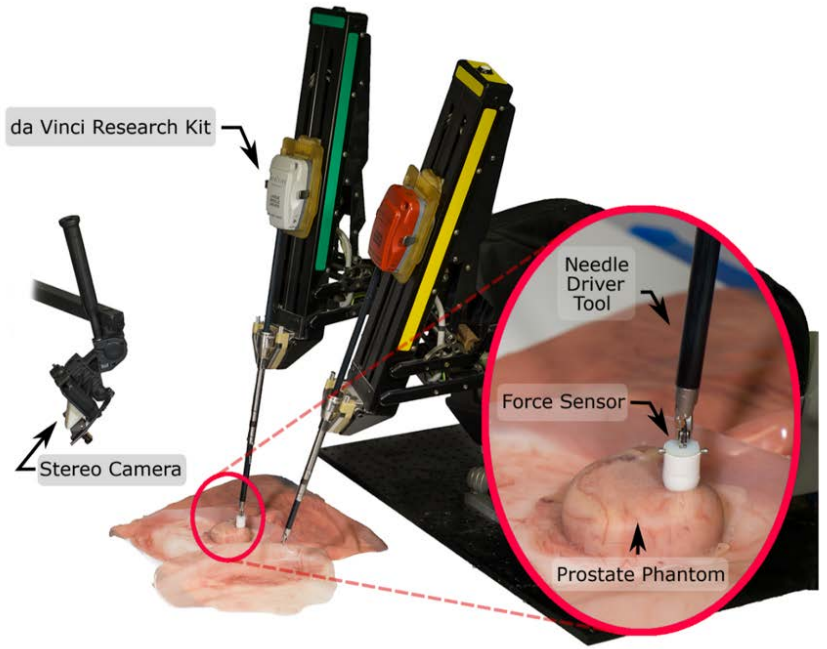


Force sensing

dVRK Research Themes

- Novel instruments
- Novel surgical manipulators
- Imaging and Vision
- Navigation and guidance
- User interfaces and controls
- Simulation and Training Technologies
- Intelligent systems
- Building blocks

Carnegie Mellon University (Choset et al.)

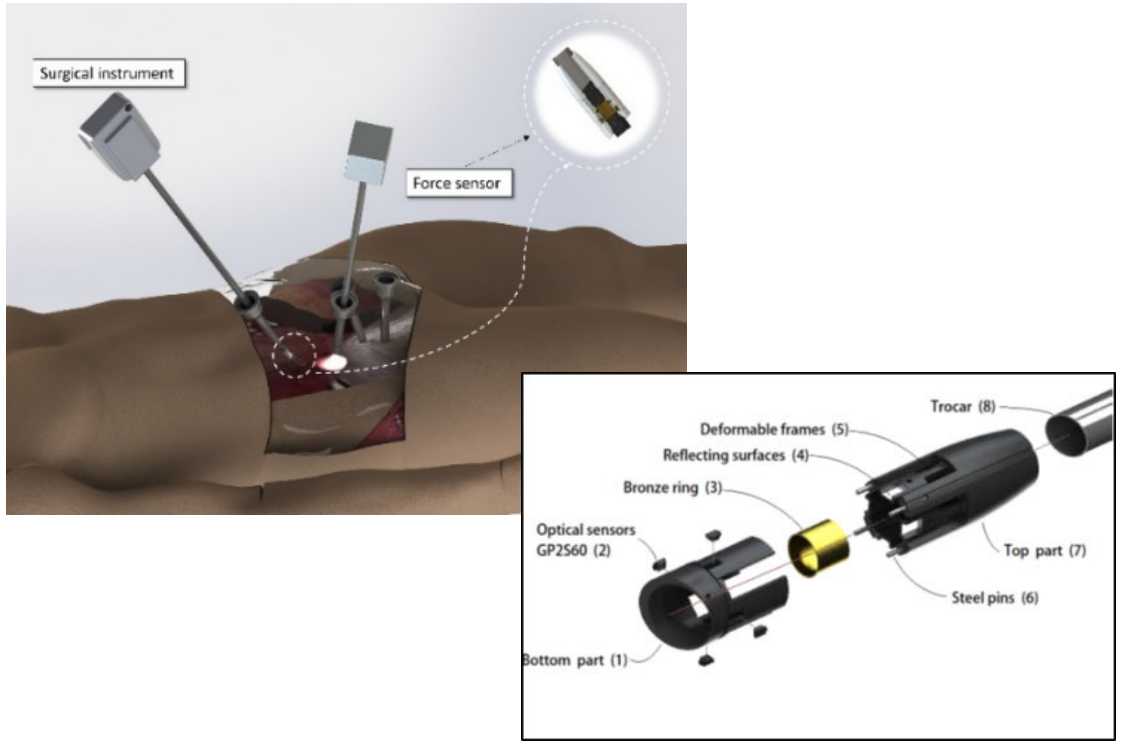


Palpation probe

dVRK Research Themes

- Novel instruments
- Novel surgical manipulators
- Imaging and Vision
- Navigation and guidance
- User interfaces and controls
- Simulation and Training Technologies
- Intelligent systems
- Building blocks

University of Naples (Siciliano et al.)

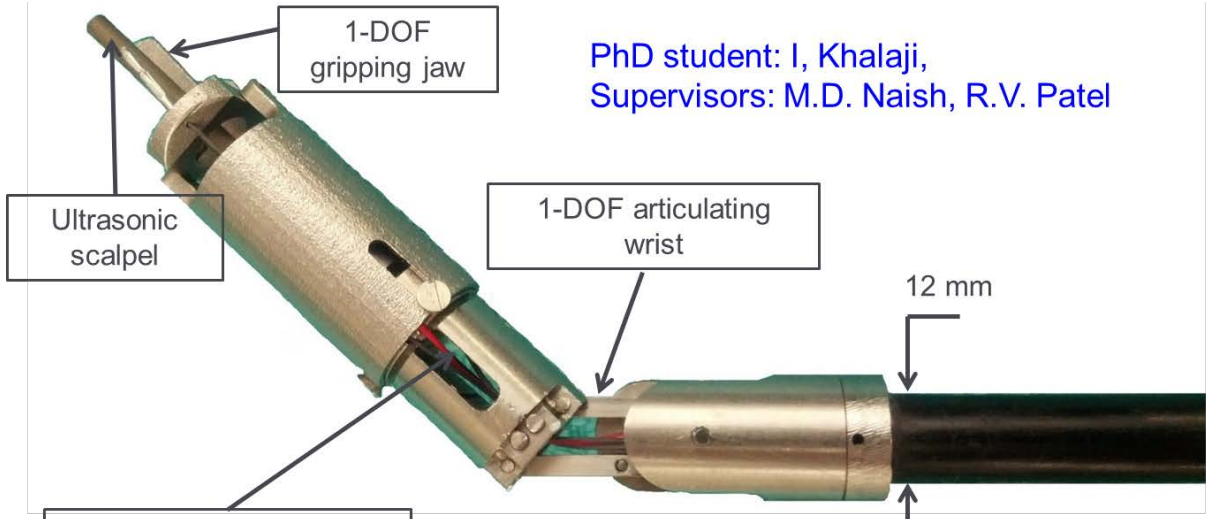


Force sensing trocar

dVRK Research Themes

- Novel instruments
- Novel surgical manipulators
- Imaging and Vision
- Navigation and guidance
- User interfaces and controls
- Simulation and Training Technologies
- Intelligent systems
- Building blocks

CSTAR & University of Western Ontario (Patel et al.)



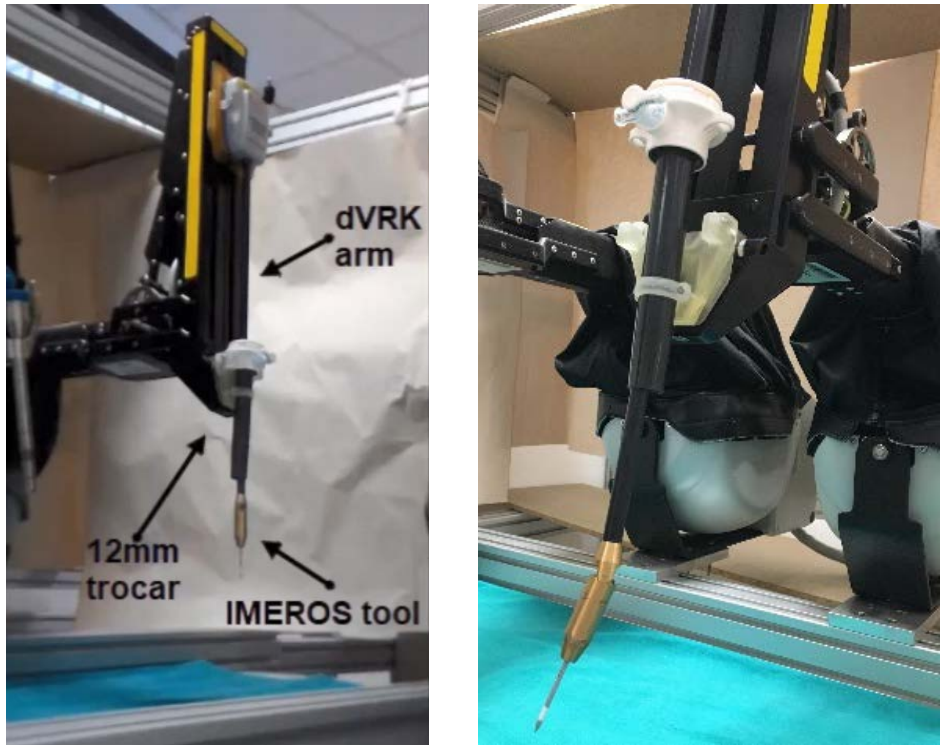
I. Khalaji, M.D. Naish, R.V. Patel, "Articulating Minimally Invasive Ultrasonic Tool for Robotics-Assisted Surgery, " *IEEE International Conference on Robotics and Automation (ICRA)*, 2015.

Articulated harmonic scalpel

dVRK Research Themes

- Novel instruments
- Novel surgical manipulators
- Imaging and Vision
- Navigation and guidance
- User interfaces and controls
- Simulation and Training Technologies
- Intelligent systems
- Building blocks

Scuola Superiore Sant'Anna (Menciassi et al.)

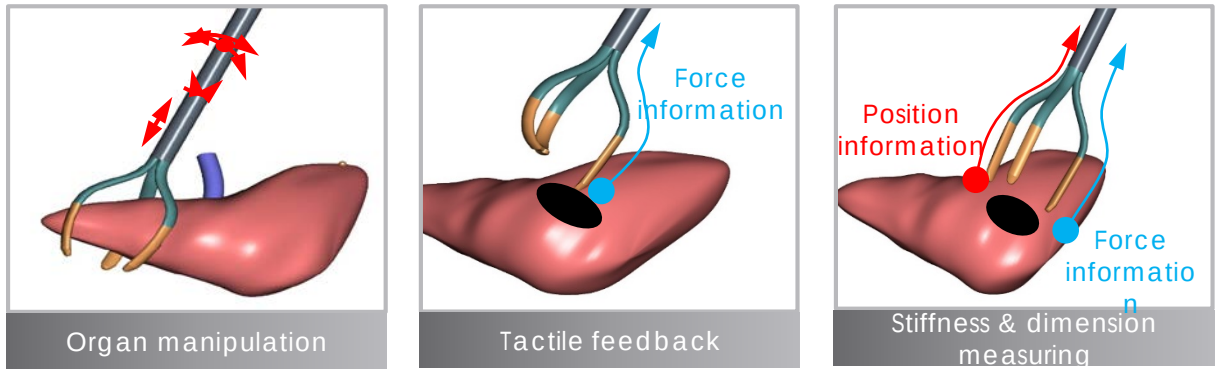


Articulated ablation instrument

dVRK Research Themes

- Novel instruments
- Novel surgical manipulators
- Imaging and Vision
- Navigation and guidance
- User interfaces and controls
- Simulation and Training Technologies
- Intelligent systems
- Building blocks

University of Naples (Siciliano et al.)



Multi-fingered organ manipulation

dVRK Research Themes

- Novel instruments
- Novel surgical manipulators
- Imaging and Vision
- Navigation and guidance
- User interfaces and controls
- Simulation and Training Technologies
- Intelligent systems
- Building blocks

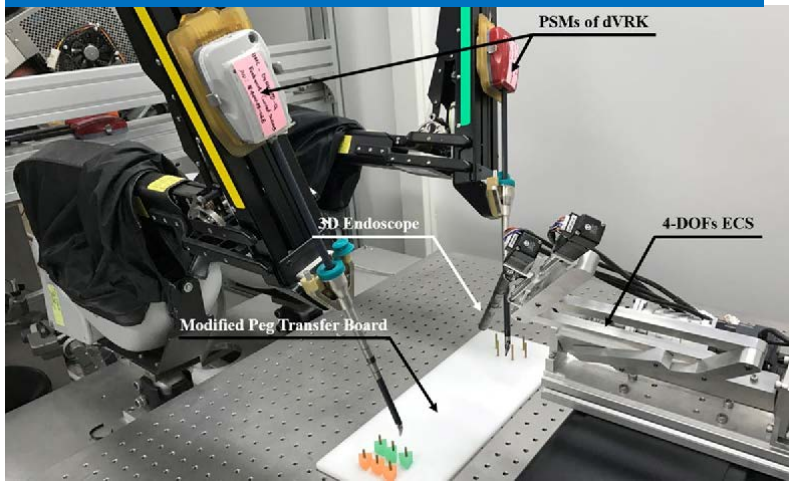
Vanderbilt University (Simaan et al.)

Continuum manipulators

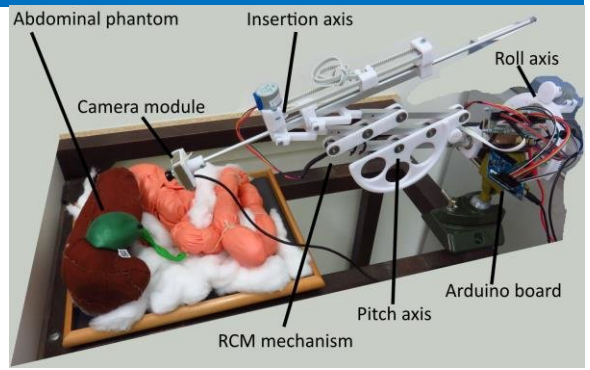
dVRK Research Themes

- Novel instruments
- Novel surgical manipulators
- Imaging and Vision
- Navigation and guidance
- User interfaces and controls
- Simulation and Training Technologies
- Intelligent systems
- Building blocks

Seoul National University (Kim et al.)



Obuda University, Hungary (Haidegger et al.)

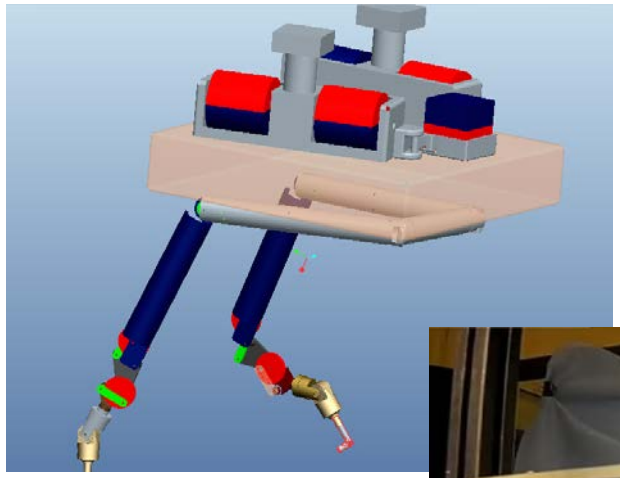


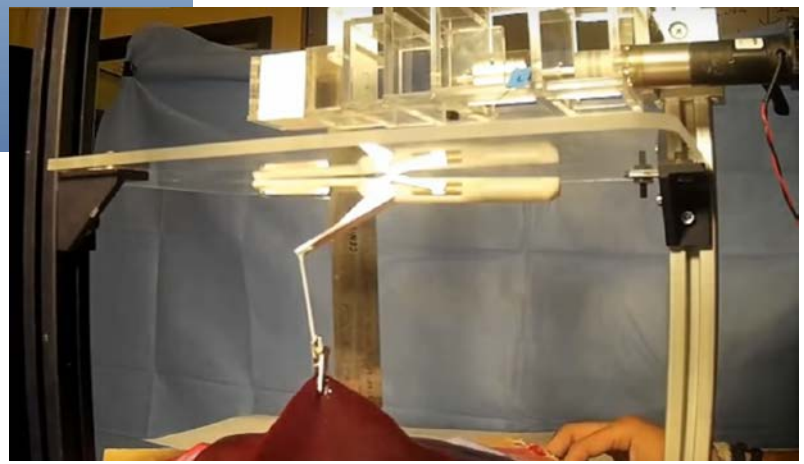
Camera manipulators

dVRK Research Themes

- Novel instruments
- Novel surgical manipulators
- Imaging and Vision
- Navigation and guidance
- User interfaces and controls
- Simulation and Training Technologies
- Intelligent systems
- Building blocks

University of Leeds (Valdastri et al.)



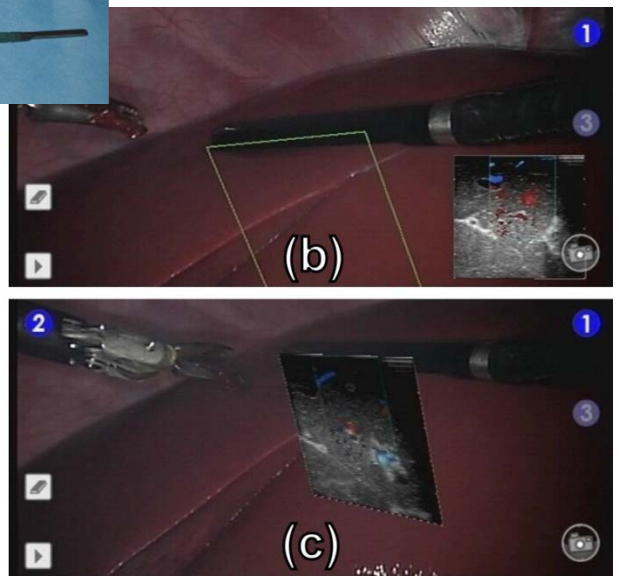


Magnetically coupled instrument manipulation

dVRK Research Themes

- Novel instruments
- Novel surgical manipulators
- Imaging and Vision
- Navigation and guidance
- User interfaces and controls
- Simulation and Training Technologies
- Intelligent systems
- Building blocks

The Johns Hopkins University (Taylor et al.)

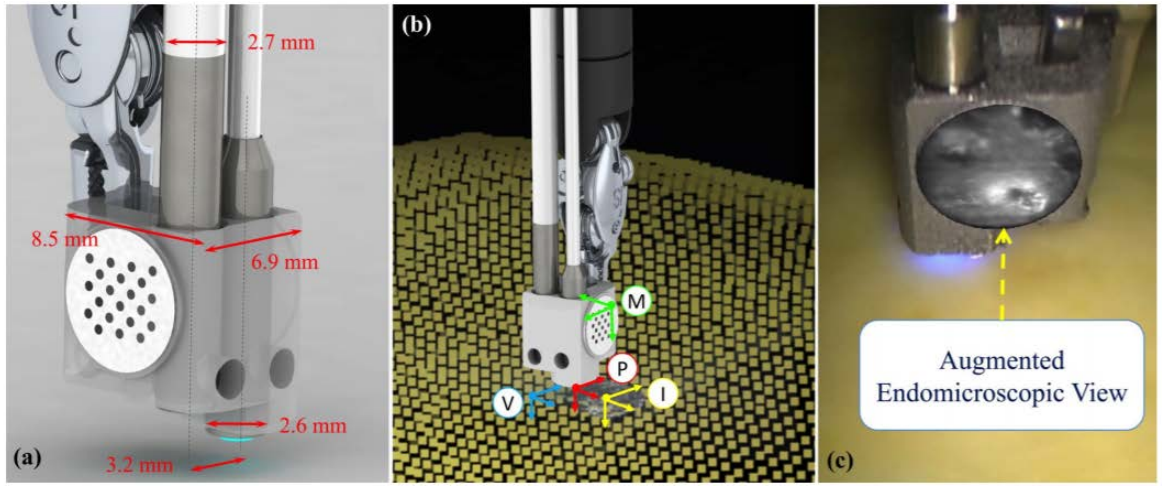


Robotic laparoscopic ultrasound

dVRK Research Themes

- Novel instruments
- Novel surgical manipulators
- Imaging and Vision
- Navigation and guidance
- User interfaces and controls
- Simulation and Training Technologies
- Intelligent systems
- Building blocks

Imperial College London (Yang et al.)

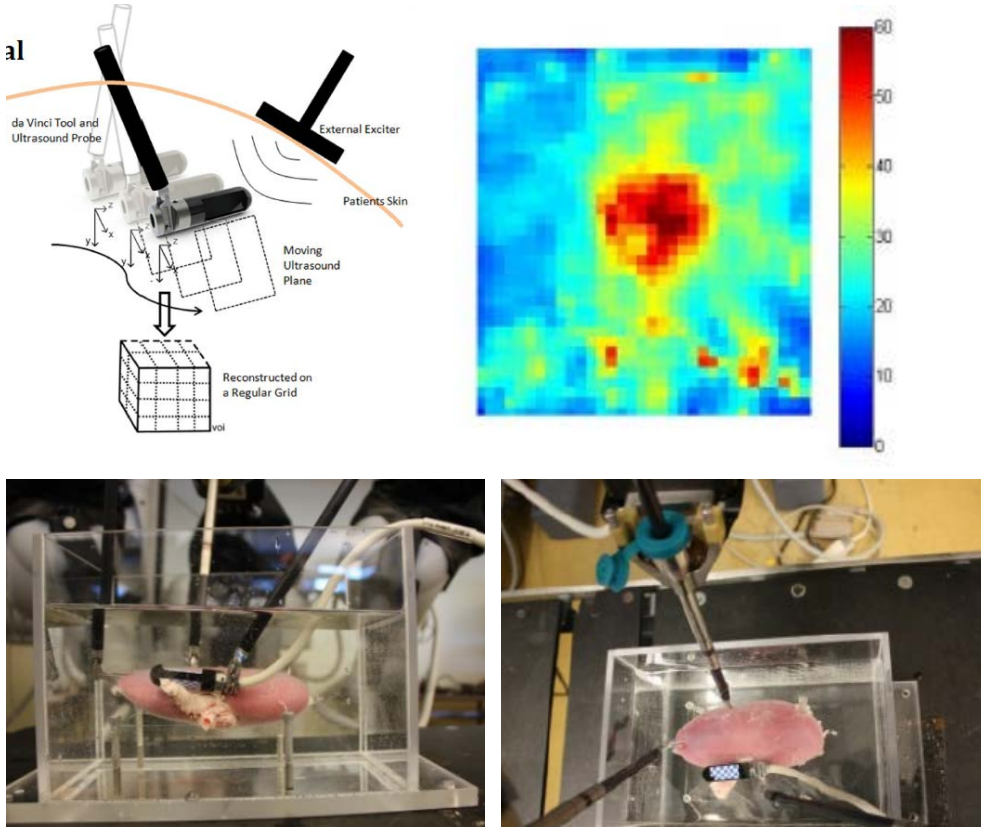


Microscopic imaging

dVRK Research Themes

- Novel instruments
- Novel surgical manipulators
- Imaging and Vision
- Navigation and guidance
- User interfaces and controls
- Simulation and Training Technologies
- Intelligent systems
- Building blocks

University of British Columbia (Salcudean et al.)

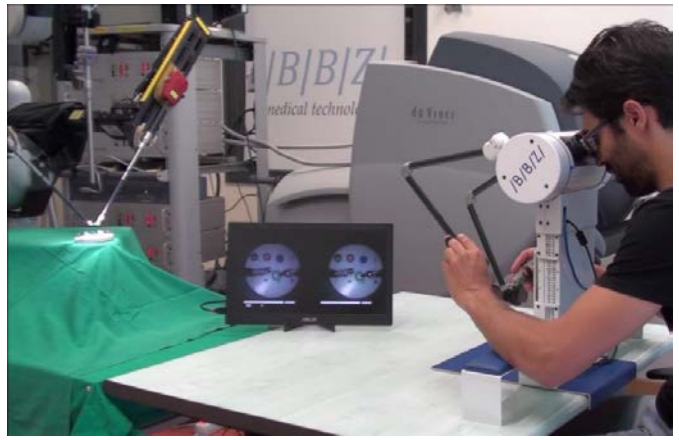
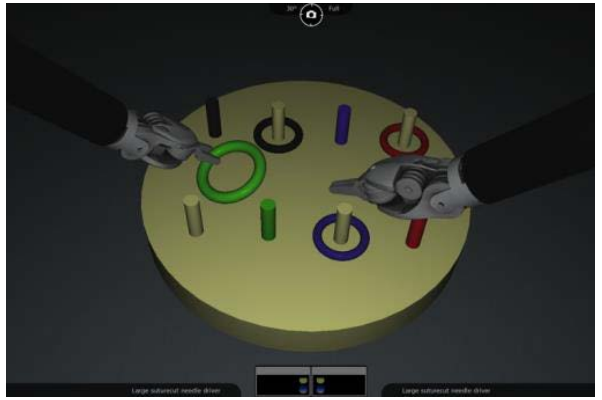


Ultrasound elastography and guidance

dVRK Research Themes

- Novel instruments
- Novel surgical manipulators
- Imaging and Vision
- Navigation and guidance
- User interfaces and controls
- Simulation and Training Technologies
- Intelligent systems
- Building blocks

University of Verona (Fiorini et al.)

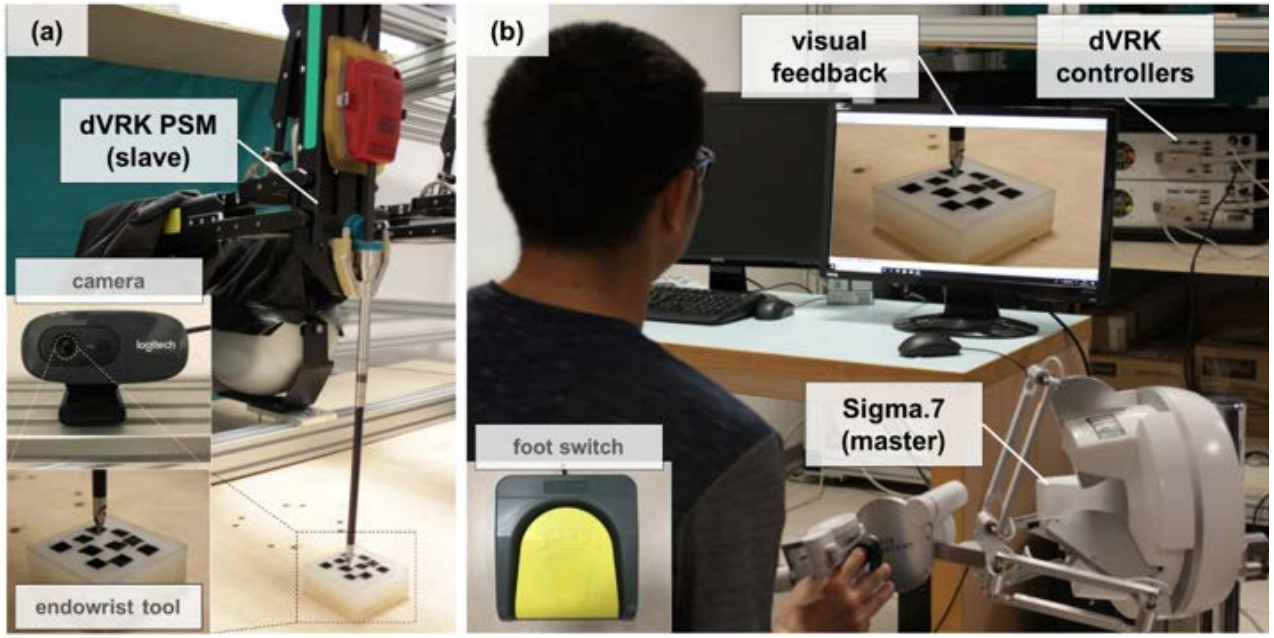





Lightweight/portable surgical console

dVRK Research Themes

- Novel instruments
- Novel surgical manipulators
- Imaging and Vision
- Navigation and guidance
- User interfaces and controls
- Simulation and Training Technologies
- Intelligent systems
- Building blocks

Scuola Superiore Sant'Anna (Menciassi et al.)

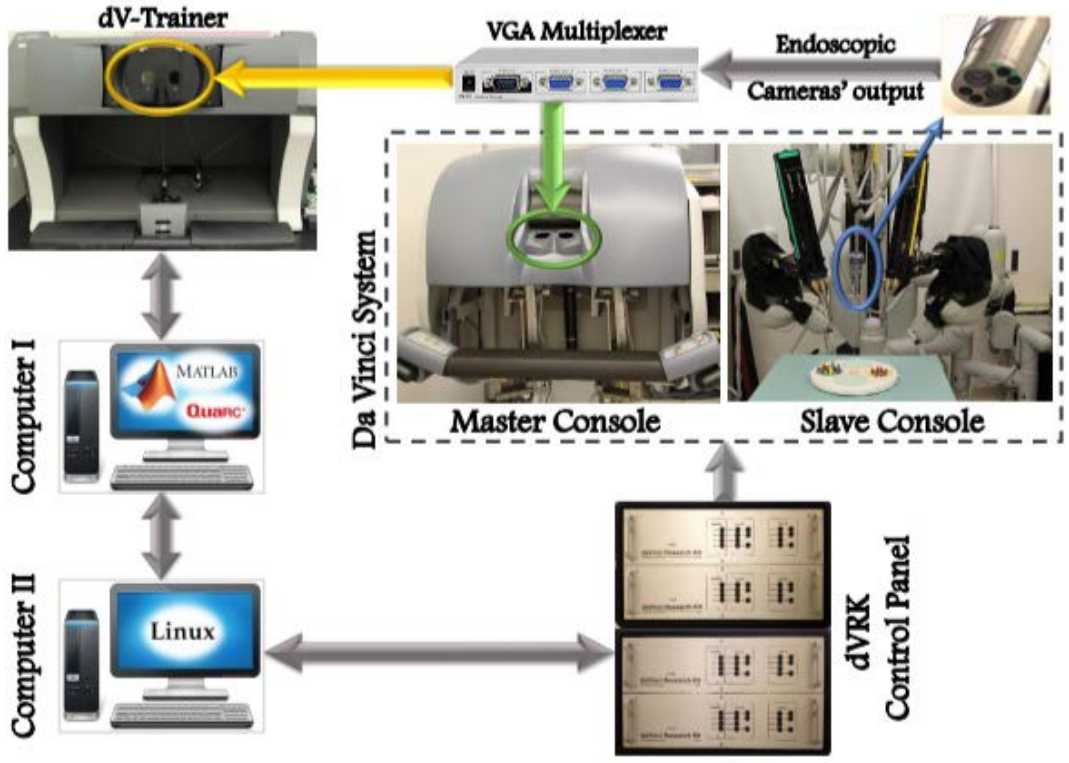


Alternative master manipulator

dVRK Research Themes

- Novel instruments
- Novel surgical manipulators
- Imaging and Vision
- Navigation and guidance
- User interfaces and controls
- Simulation and Training Technologies
- Intelligent systems
- Building blocks

CSTAR & University of Western Ontario (Patel et al.)

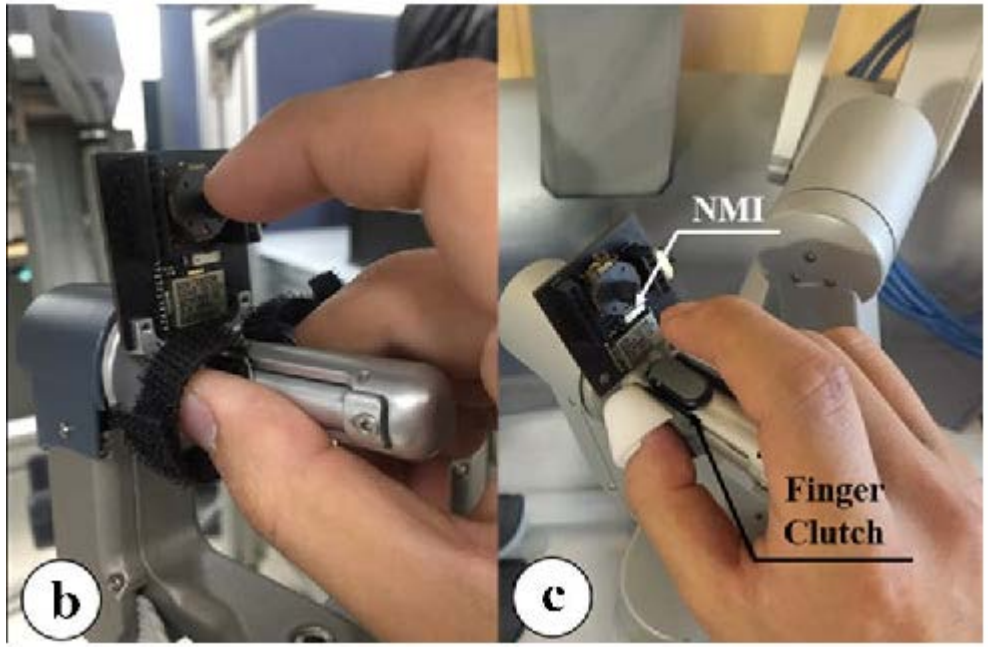


Multi-lateral dual-console teleoperation

dVRK Research Themes

- Novel instruments
- Novel surgical manipulators
- Imaging and Vision
- Navigation and guidance
- User interfaces and controls
- Simulation and Training Technologies
- Intelligent systems
- Building blocks

Seoul National University (Kim et al.)

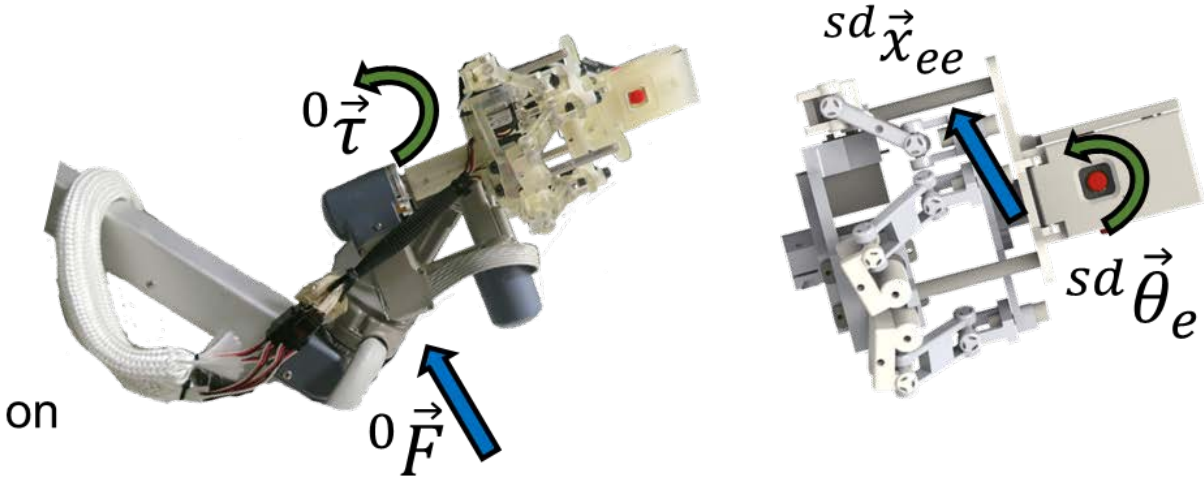


Novel master interface controls

dVRK Research Themes

- Novel instruments
- Novel surgical manipulators
- Imaging and Vision
- Navigation and guidance
- User interfaces and controls
- Simulation and Training Technologies
- Intelligent systems
- Building blocks

Stanford University (Okamura et al.)

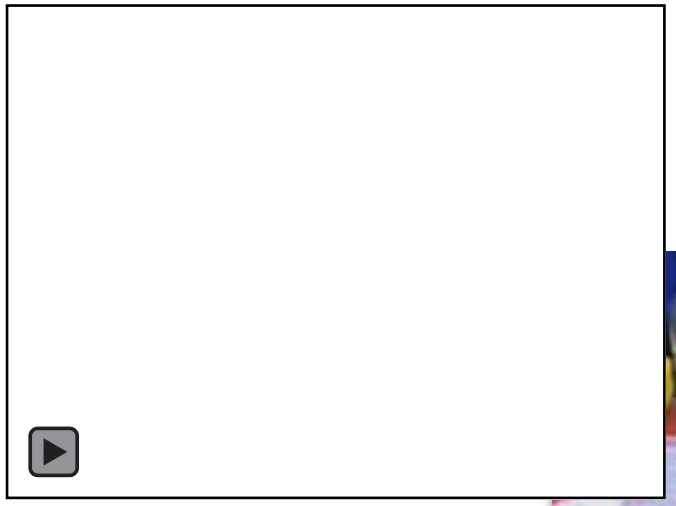


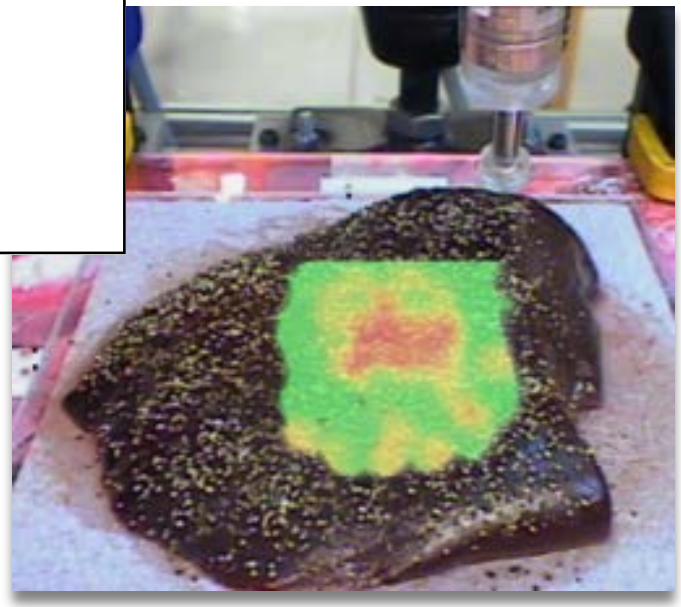
Skin stretch force display

dVRK Research Themes

- Novel instruments
- Novel surgical manipulators
- Imaging and Vision
- Navigation and guidance
- User interfaces and controls
- Simulation and Training Technologies
- Intelligent systems
- Building blocks

The Johns Hopkins University (Okamura et al.)



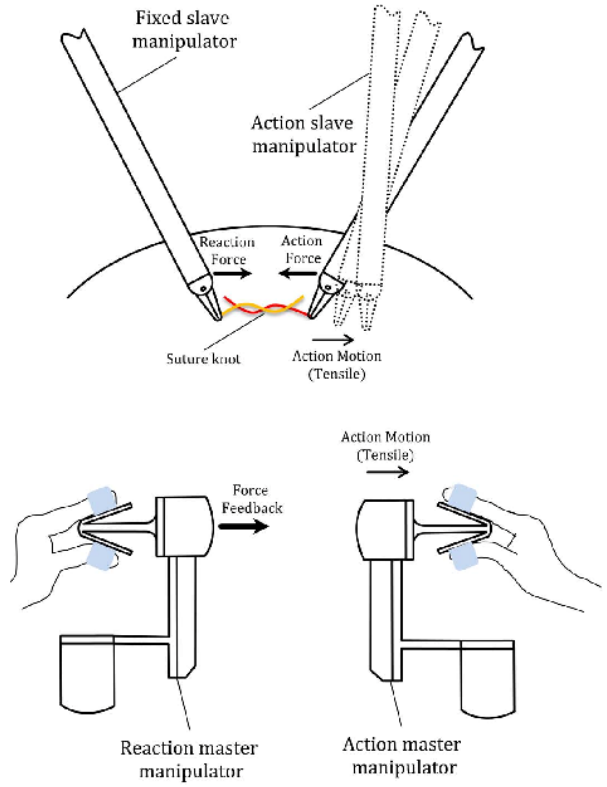


Palpation and force/stiffness feedback

dVRK Research Themes

- Novel instruments
- Novel surgical manipulators
- Imaging and Vision
- Navigation and guidance
- User interfaces and controls
- Simulation and Training Technologies
- Intelligent systems
- Building blocks

University of British Columbia (Salcudean et al.)

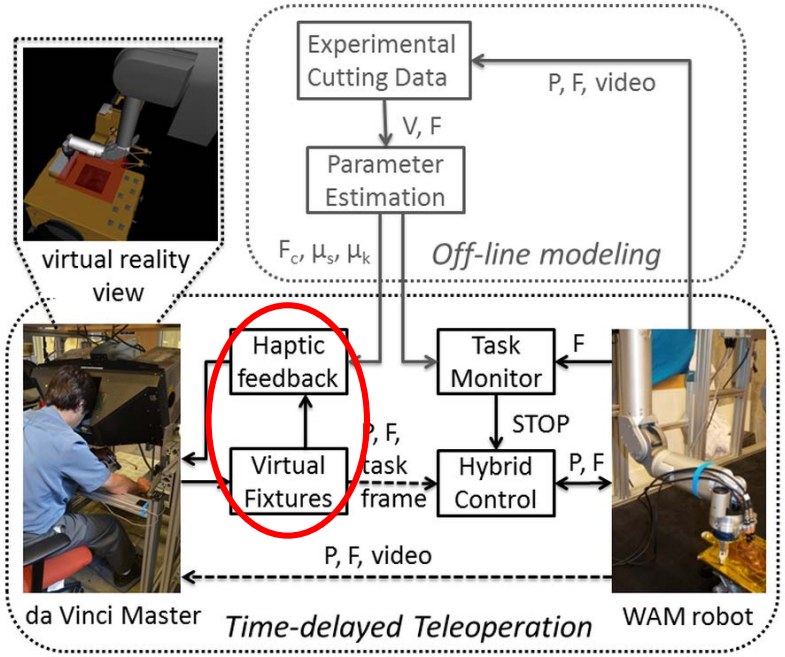


Asymmetric Force Feedback

dVRK Research Themes

- Novel instruments
- Novel surgical manipulators
- Imaging and Vision
- Navigation and guidance
- User interfaces and controls
- Simulation and Training Technologies
- Intelligent systems
- Building blocks

JHU (Kazanzides, Taylor, at al.)



Virtual Fixtures

dVRK Research Themes

- Novel instruments
- Novel surgical manipulators
- Imaging and Vision
- Navigation and guidance
- User interfaces and controls
- Simulation and Training Technologies
- Intelligent systems
- Building blocks

University of Naples (Siciliano et al.)

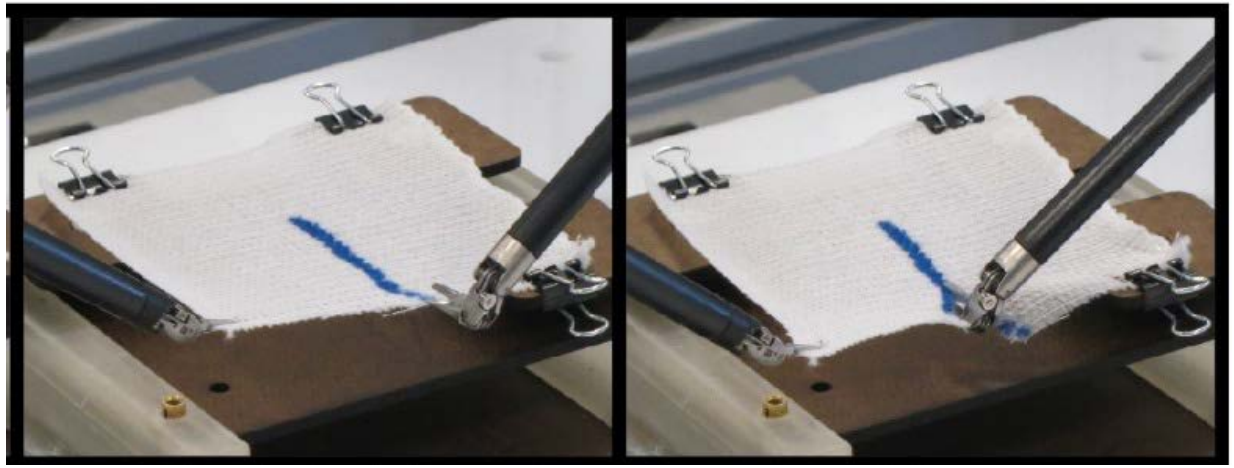
Imperial College London (Yang et al.)

Virtual Fixtures

dVRK Research Themes

- Novel instruments
- Novel surgical manipulators
- Imaging and Vision
- Navigation and guidance
- User interfaces and controls
- Simulation and Training Technologies
- Intelligent systems
- Building blocks

Stanford University (Okamura et al.)

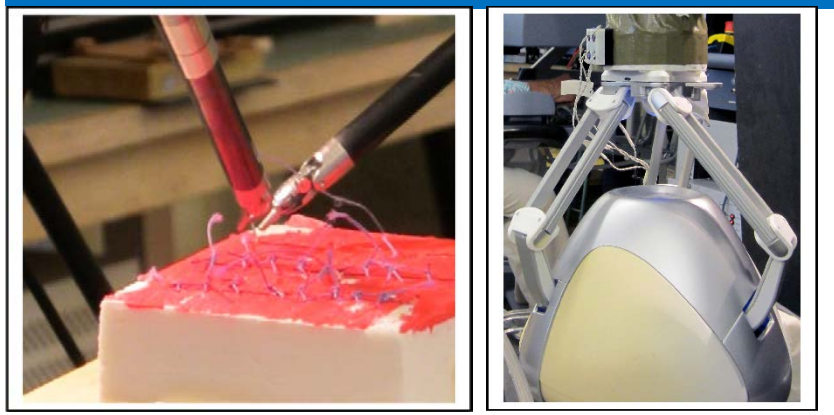


Collaborative teleoperation

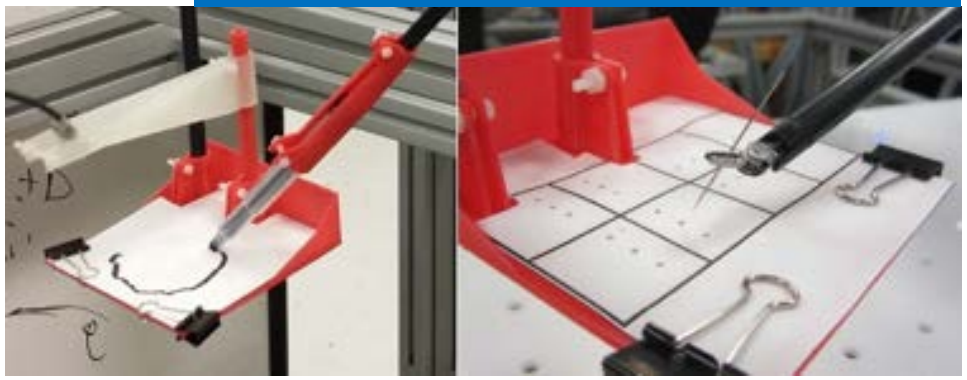
dVRK Research Themes

- Novel instruments
- Novel surgical manipulators
- Imaging and Vision
- Navigation and guidance
- User interfaces and controls
- Simulation and Training Technologies
- Intelligent systems
- Building blocks

University of British Columbia (Salcudean et al.)



Stanford University (Okamura et al.)

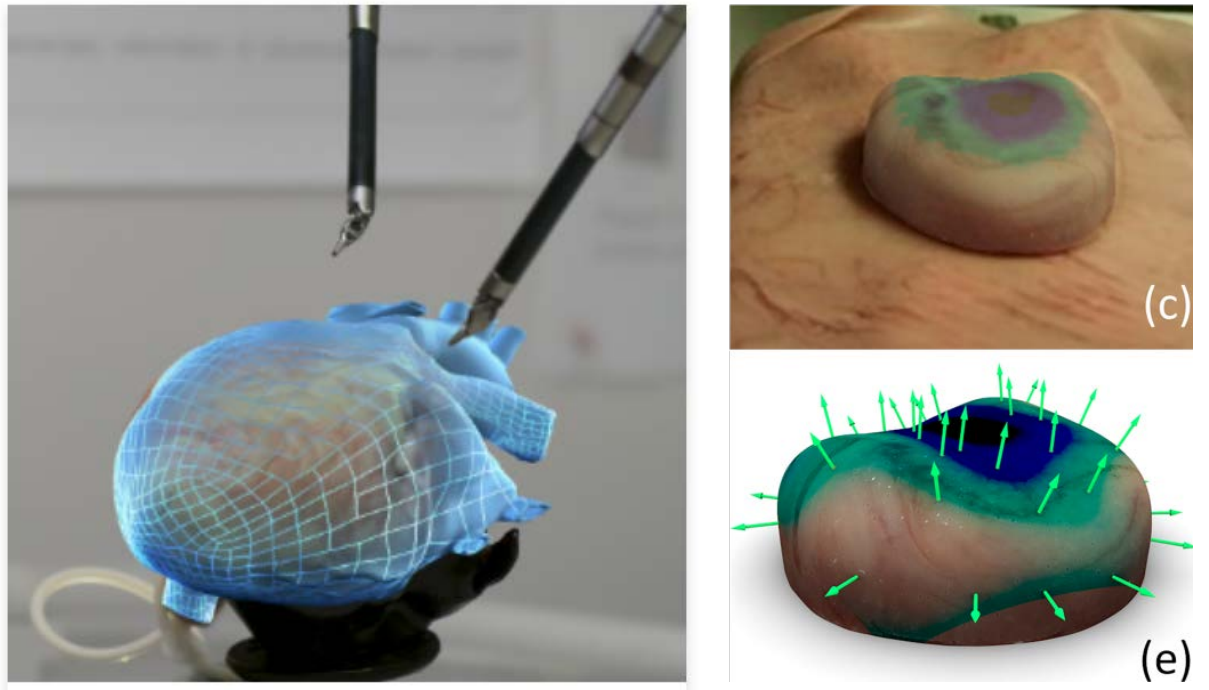


Physiological motion compensation

dVRK Research Themes

- Novel instruments
- Novel surgical manipulators
- Imaging and Vision
- Navigation and guidance
- User interfaces and controls
- Simulation and Training Technologies
- Intelligent systems
- Building blocks

Carnegie Mellon University (Choset et al.)

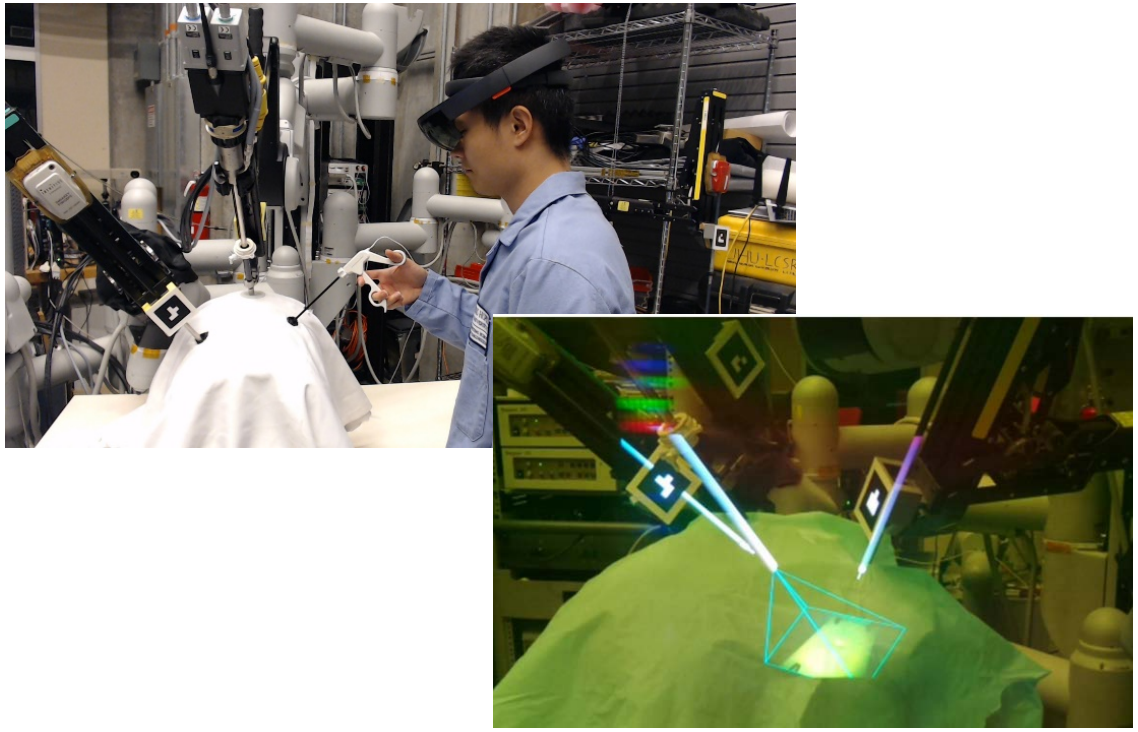


Augmented Reality (tissue property overlay)

dVRK Research Themes

- Novel instruments
- Novel surgical manipulators
- Imaging and Vision
- Navigation and guidance
- User interfaces and controls
- Simulation and Training Technologies
- Intelligent systems
- Building blocks

The Johns Hopkins University (Kazanzides et al.)

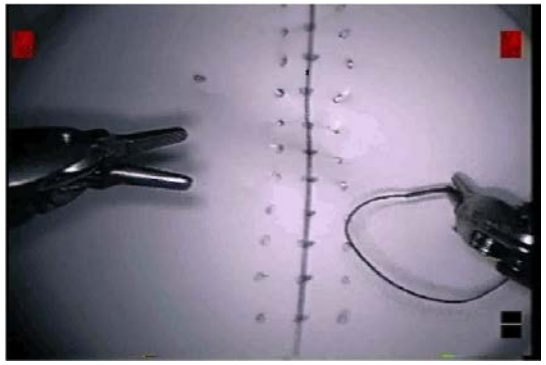


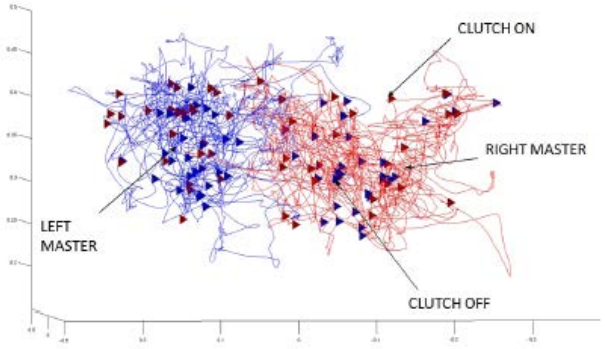
Mixed Reality visualization for first assistant

dVRK Research Themes

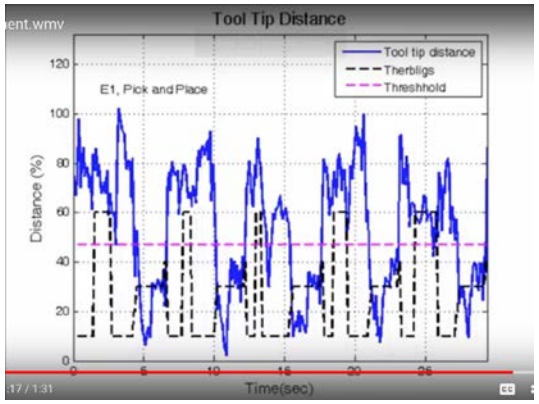
- Novel instruments
- Novel surgical manipulators
- Imaging and Vision
- Navigation and guidance
- User interfaces and controls
- Simulation and Training Technologies
- Intelligent systems
- Building blocks

The Johns Hopkins University (Hager et al.)





SUNY Buffalo (Krovi et al.)

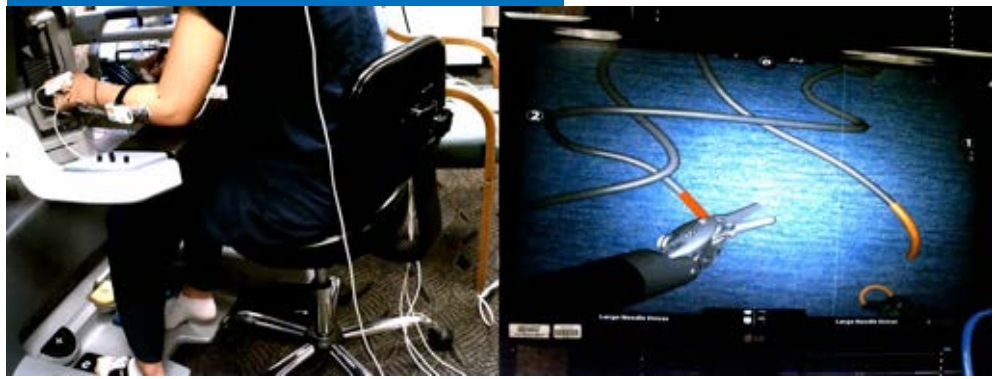


Surgical skills assessment

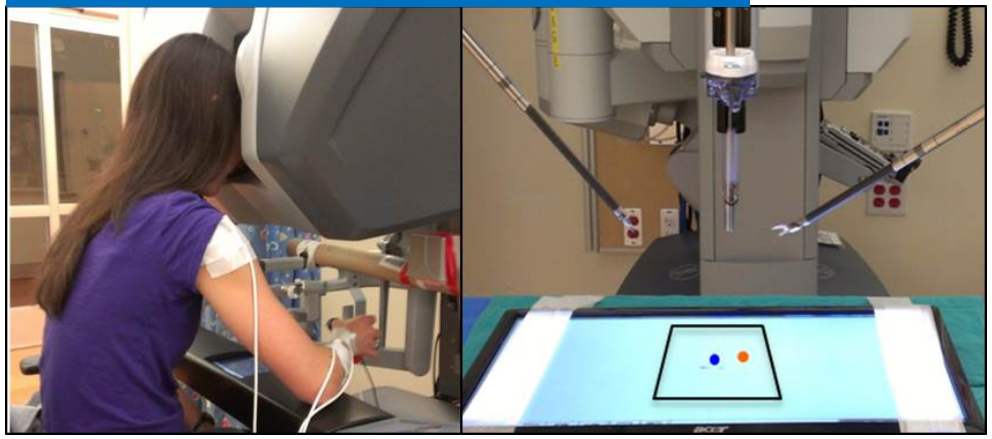
dVRK Research Themes

- Novel instruments
- Novel surgical manipulators
- Imaging and Vision
- Navigation and guidance
- User interfaces and controls
- Simulation and Training Technologies
- Intelligent systems
- Building blocks

UT Dallas (Majewicz et al.)



Ben Gurion University, (Nisky et al.)

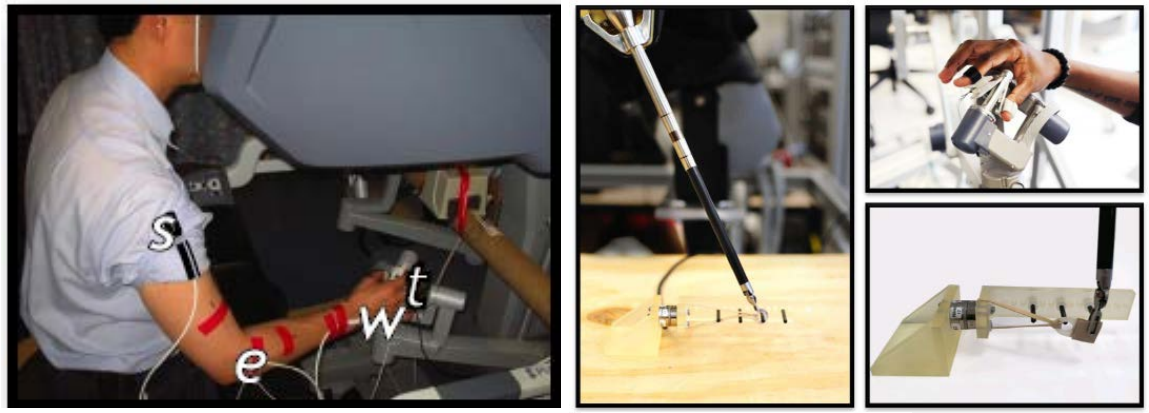


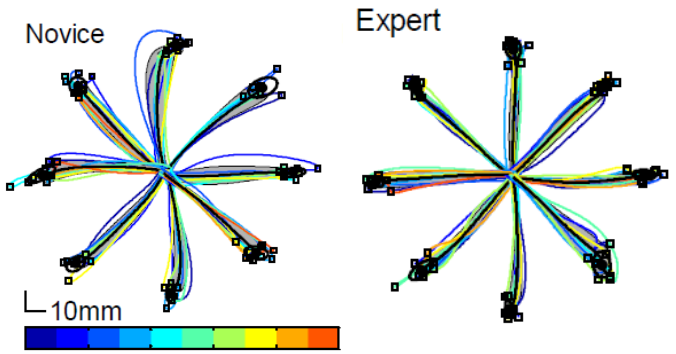
Surgical skills assessment

dVRK Research Themes

- Novel instruments
- Novel surgical manipulators
- Imaging and Vision
- Navigation and guidance
- User interfaces and controls
- Simulation and Training Technologies
- Intelligent systems
- Building blocks

Stanford University (Okamura at al.)



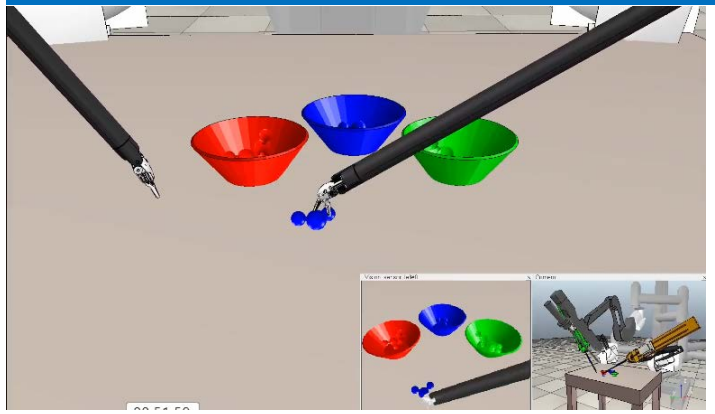


Surgeon sensorimotor performance assessment

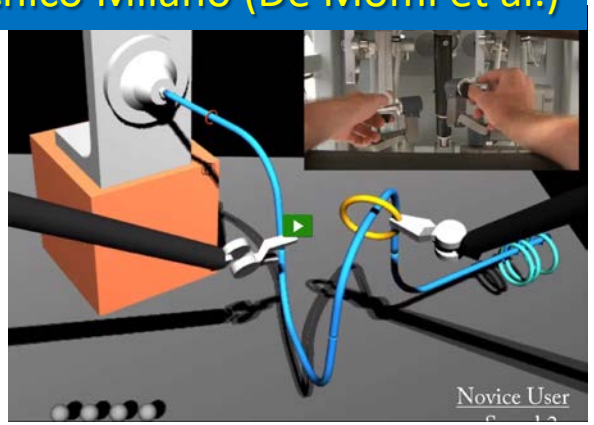
dVRK Research Themes

- Novel instruments
- Novel surgical manipulators
- Imaging and Vision
- Navigation and guidance
- User interfaces and controls
- Simulation and Training Technologies
- Intelligent systems
- Building blocks

University of Naples (Siciliano et al.)



Politecnico Milano (De Momi et al.)

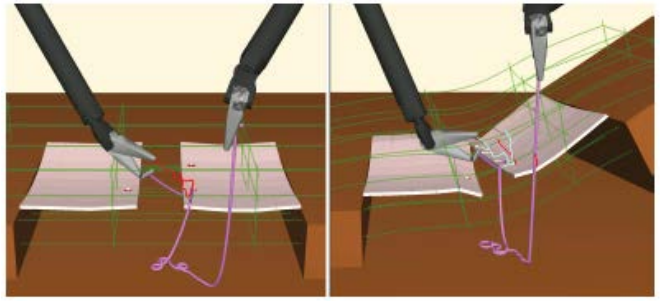


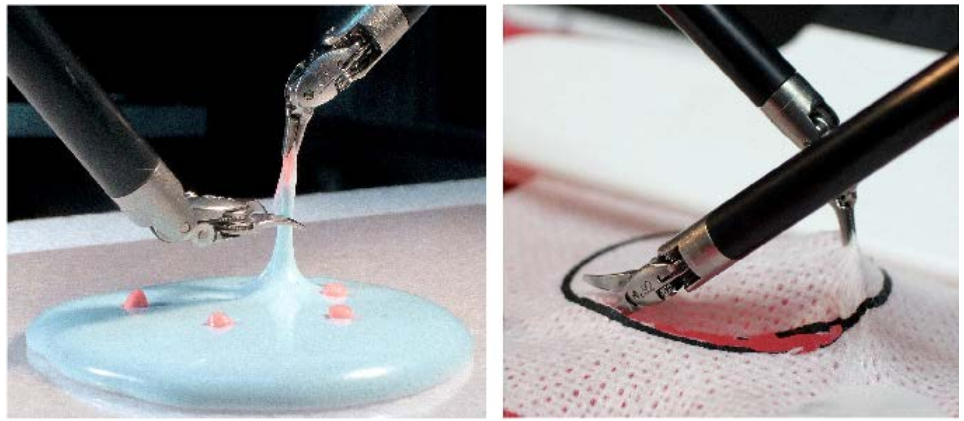
Surgical skills sim and ML-based adaptive training

dVRK Research Themes

- Novel instruments
- Novel surgical manipulators
- Imaging and Vision
- Navigation and guidance
- User interfaces and controls
- Simulation and Training Technologies
- Intelligent systems
- Building blocks

UC Berkeley (Abbeel/Goldberg)



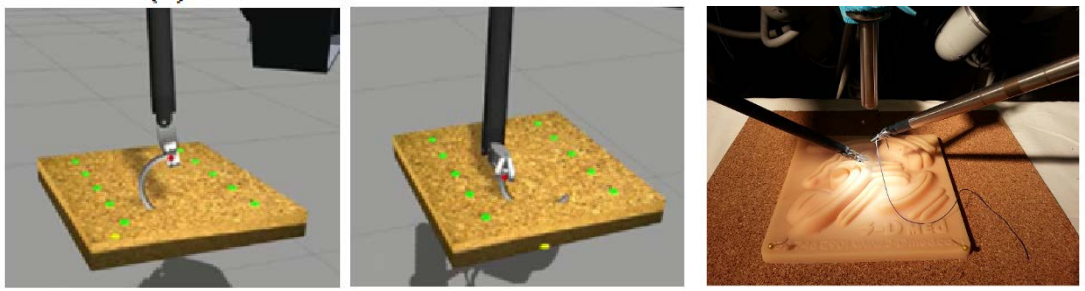


Surgical task autonomy

dVRK Research Themes

- Novel instruments
- Novel surgical manipulators
- Imaging and Vision
- Navigation and guidance
- User interfaces and controls
- Simulation and Training Technologies
- Intelligent systems
- Building blocks

Case Western Reserve (ÇAVUŞOĞLU et al.)



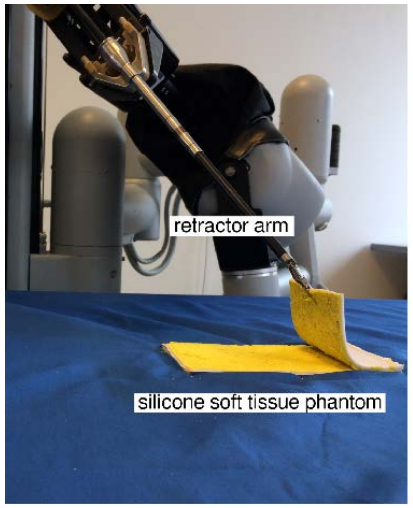
UC San Diego (Yip et al.)

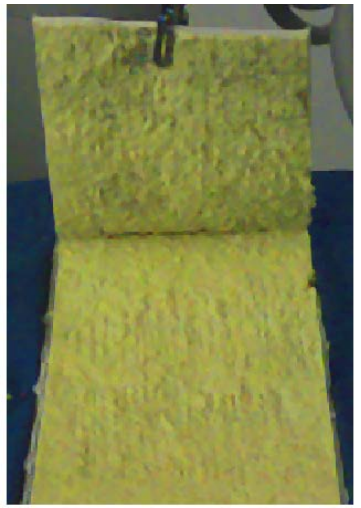
Supervisory control and surgical autonomy

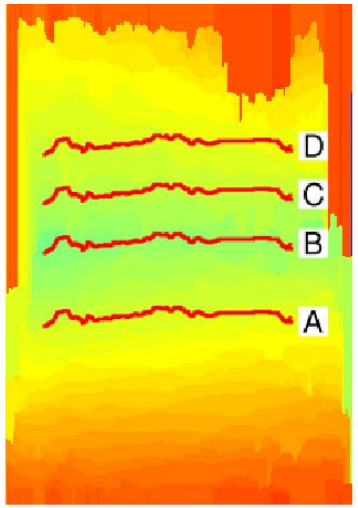
dVRK Research Themes

- Novel instruments
- Novel surgical manipulators
- Imaging and Vision
- Navigation and guidance
- User interfaces and controls
- Simulation and Training Technologies
- Intelligent systems
- Building blocks

Obuda University, Hungary (Haidegger et al.)





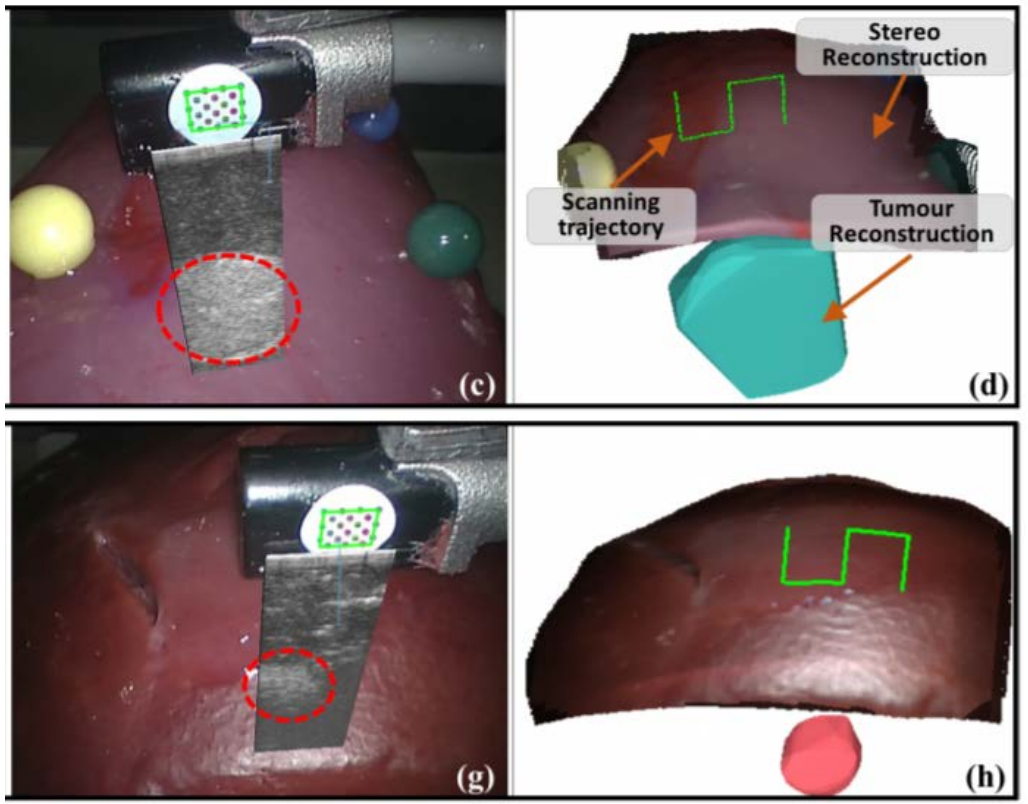


Surgical task autonomy
(traction, retraction and dissection)

dVRK Research Themes

- Novel instruments
- Novel surgical manipulators
- Imaging and Vision
- Navigation and guidance
- User interfaces and controls
- Simulation and Training Technologies
- Intelligent systems
- Building blocks

Imperial College London (Yang et al.)

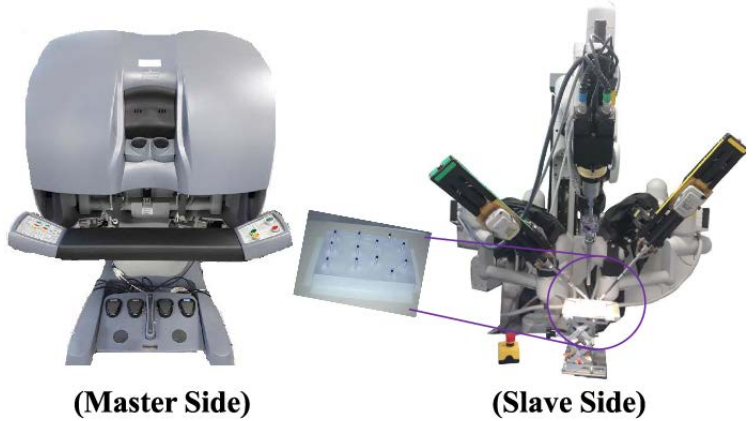


Automated ultrasound imaging

dVRK Research Themes

- Novel instruments
- Novel surgical manipulators
- Imaging and Vision
- Navigation and guidance
- User interfaces and controls
- Simulation and Training Technologies
- Intelligent systems
- Building blocks

Wayne State University (Pandya et al.)



Adaptive motion scaling

dVRK Research Themes

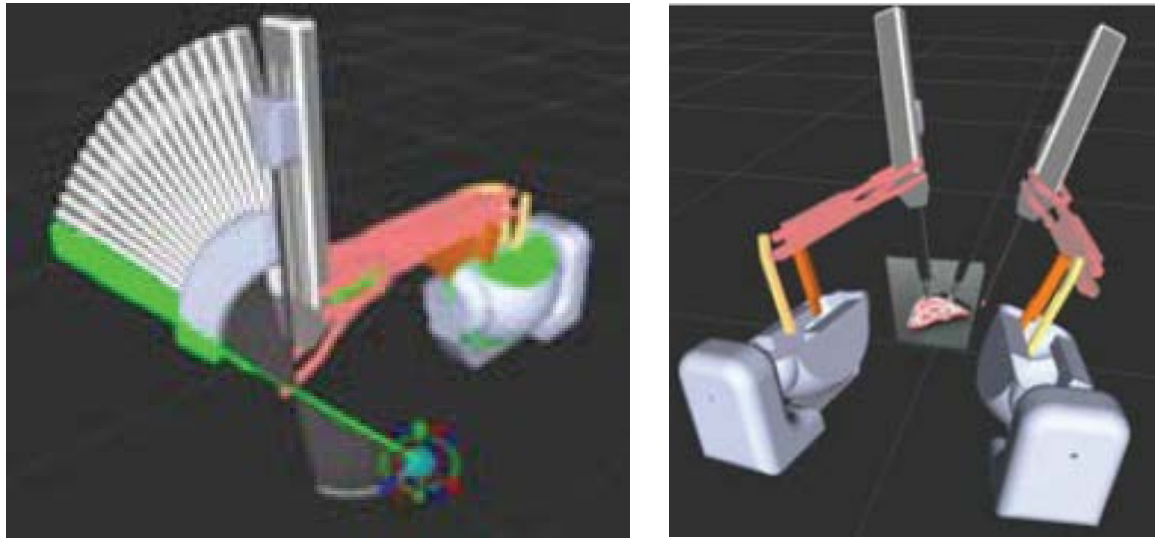
- Novel instruments
- Novel surgical manipulators
- Imaging and Vision
- Navigation and guidance
- User interfaces and controls
- Simulation and Training Technologies
- Intelligent systems
- Building blocks

- ***da Vinci system hardware***
- ***da Vinci instruments & accessories***
- ***Manipulator controller hardware***
- ***Core software framework and libraries***
- ***Video pipeline***
- ***Set-up joint controller***
- ***Manipulator calibration algorithms***
- ***Teleoperation modes (instrument & camera control)***
- ***Master manipulator gravity compensation***
- ***da Vinci S PSM support (in progress)***
- ***…***

dVRK Research Themes

- Novel instruments
- Novel surgical manipulators
- Imaging and Vision
- Navigation and guidance
- User interfaces and controls
- Simulation and Training Technologies
- Intelligent systems
- Building blocks

Worcester Polytechnic Institute (Fischer at al.)

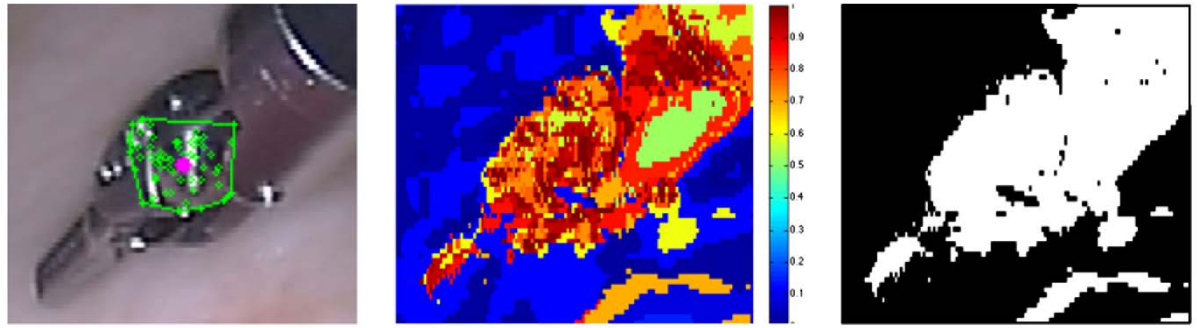


Motion planning and simulation

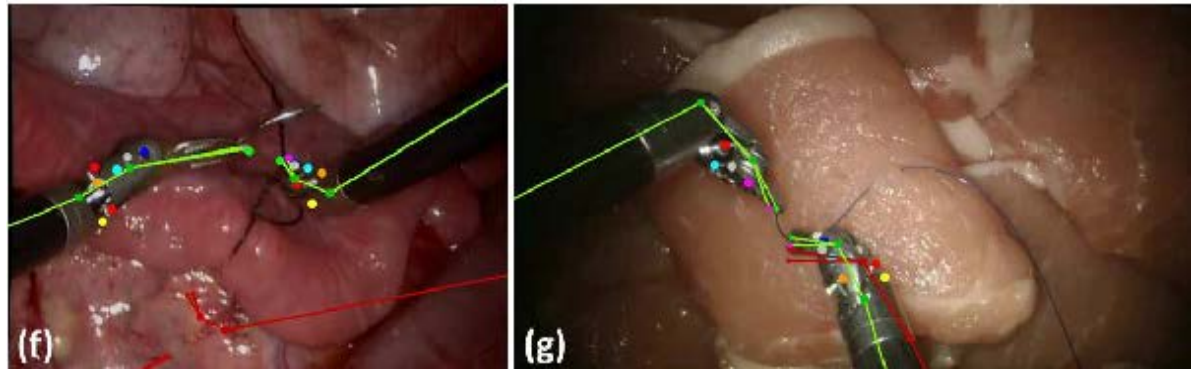
dVRK Research Themes

- Novel instruments
- Novel surgical manipulators
- Imaging and Vision
- Navigation and guidance
- User interfaces and controls
- Simulation and Training Technologies
- Intelligent systems
- Building blocks

University College London (Stoyanov et al.)



Imperial College London (Yang et al.)

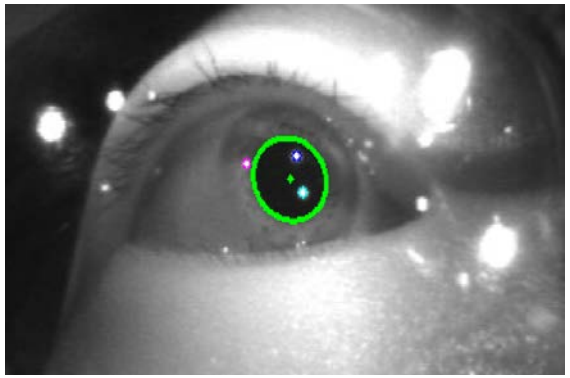


Video-based instrument tracking

dVRK Research Themes

- Novel instruments
- Novel surgical manipulators
- Imaging and Vision
- Navigation and guidance
- User interfaces and controls
- Simulation and Training Technologies
- Intelligent systems
- Building blocks

University of British Columbia (Salcudean et al.)

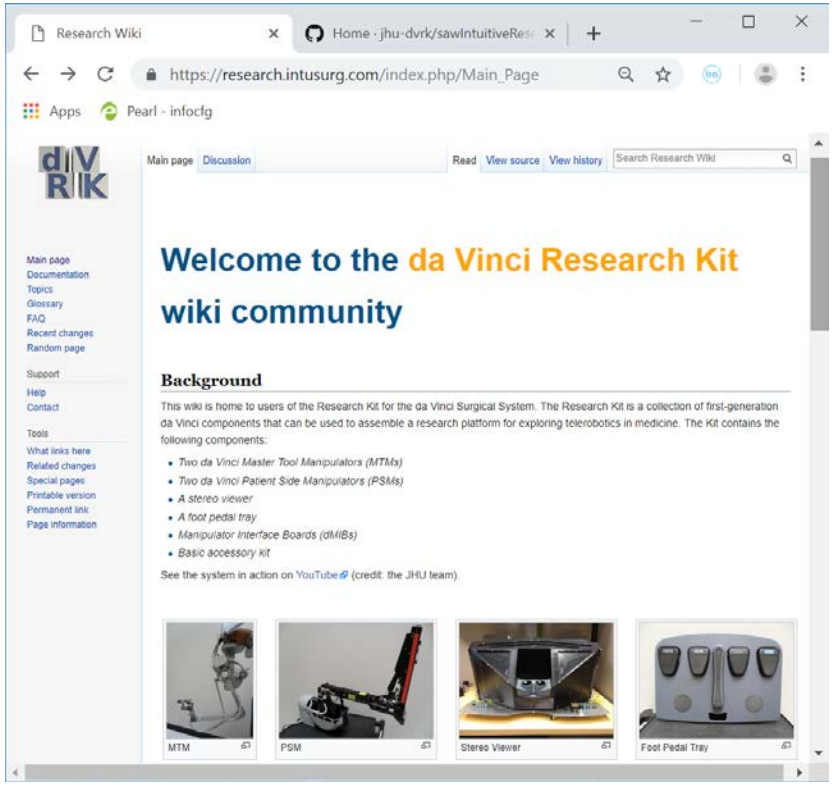


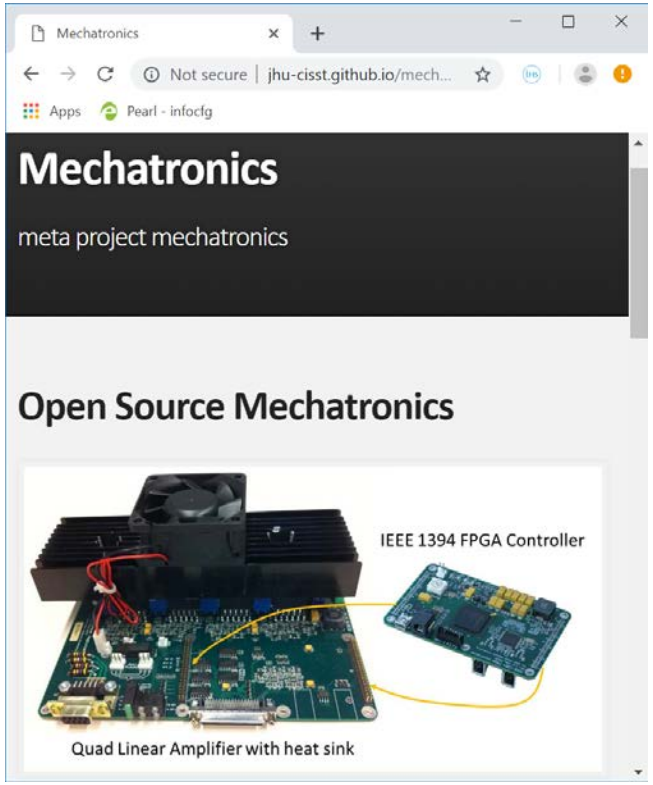
Eye gaze tracking

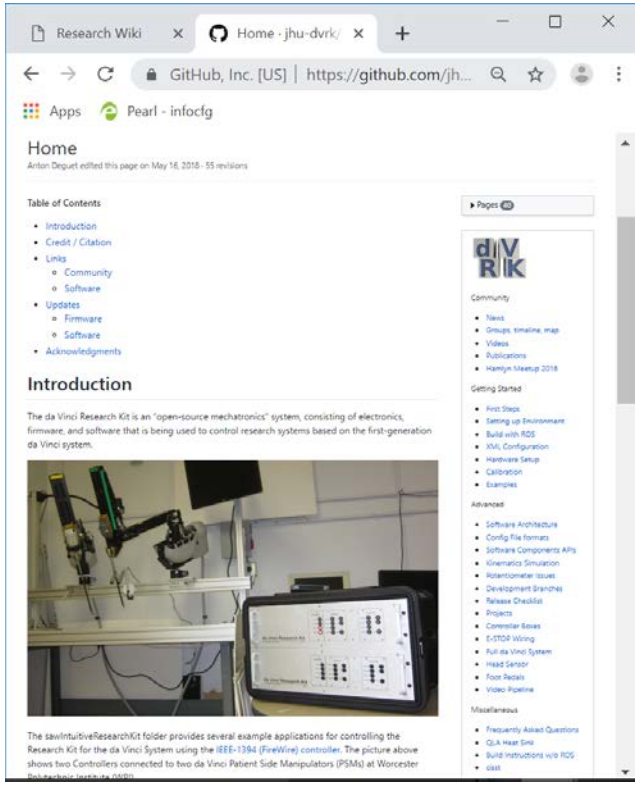
Online References

- dVRK Wiki's

  da Vinci hardware: http://research.intusurg.com/dvrk
  Controller mechatronics: http://jhu-cisst.github.io/mechatronics/
  Software framework: https://github.com/jhu-dvrk/sawIntuitiveResearchKit/wiki








dVRK