Klinikum rechts der Isar
Technische Universität München

Integrated OR-systems for laparoscopic interventions

Department of Surgery, Research Group MITI

Leon Mayer | Lars Wagner | Research Group MITI | Klinikum rechts der Isar | Technical University of Munich

MITI

Minimally-invasive Interdisciplinary Therapeutical Intervention

Research Group MITI
Minimally invasive Interdisciplinary Therapeutical Intervention

- Development of innovative diagnostic procedures and therapeutic solutions for minimally invasive surgery
- Focus on the suitability and applicability of developments in daily clinical practice
- **Interdisciplinarity**: collaboration between clinicians and research engineers

Prof. Dr. med. Dirk Wilhelm
General Director

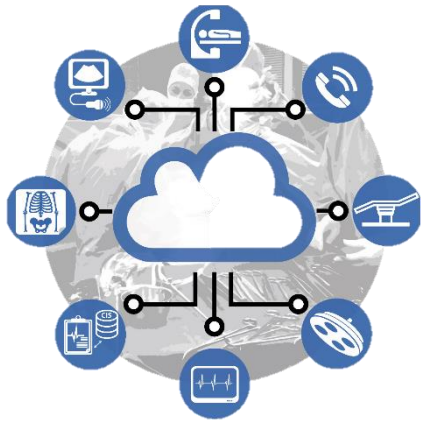
Lars Wagner
Research Engineer

Leon Mayer
Master Student

What are integrated OR-systems?

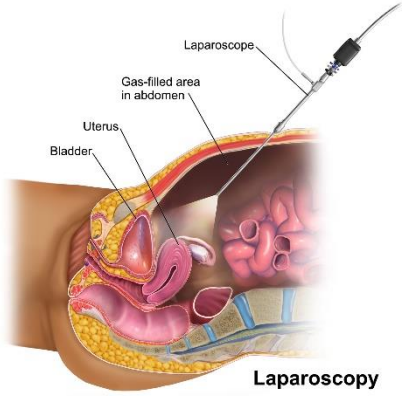
Modern operating rooms (OR) are becoming increasingly complex as new equipment, processes, surgical technologies, communication methods and the need for real-time patient data enter the clinical environment.

Integrated OR-systems are systems that support and connect functions in and around the OR.



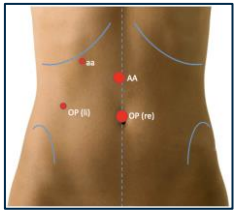
What are laparoscopic interventions?

- Surgery performed in the abdomen or pelvis using small incisions with the aid of a camera
- laparoscope aids diagnosis or therapeutic interventions with a few small cuts in the abdomen



Advantages

- reduced pain due to smaller incisions
- reduced hemorrhaging
- shorter recovery time



Roles and tasks within the OR wing

Surgeon

- Performs surgical techniques
- Leads surgical intervention

Assistant

- Performs surgical techniques
- Guides laparoscopic camera

Scrub Nurse

- Manages surgical instruments
- Prepares instrument table
- Hands over instruments to the surgeon

Circulator

- Adjusts medical devices and OR environment
- Fetches sterile materials
- Manages phones
- Helps with hygienic dressing
- Documents spent materials etc.
- …

\+ Anesthesiologist, Technicians, Cleaners …

Confined to sterile area around the patient

Moves freely in non-sterile area of OR wing

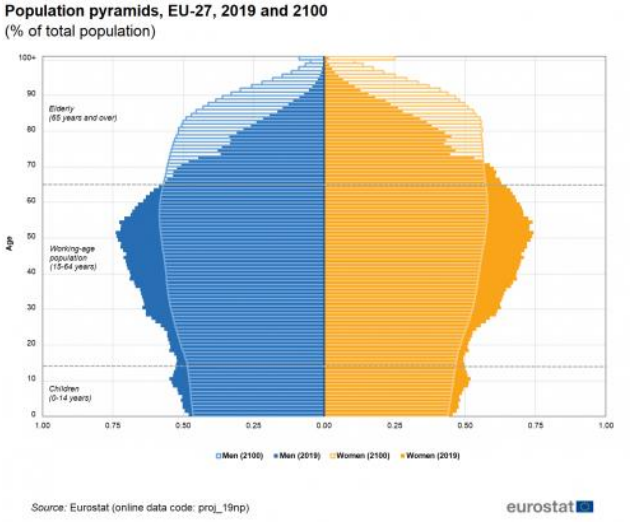
Challenges affecting the future of surgery

Demographic change

- we will have more and more morbid patients and fewer health care workers to take care of them

Staff Shortage

- limits the use of available operating capacities in hospitals
- increasing recourse to unqualified staff, whose inexperience has a significant influence on the workflow of a surgery



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\+
Anesthesiologist,
Technicians,
Cleaners
…

Robots as solution?

Strengths

Improvisation
Flexibility
Communication
Learning
Dexterity

Weaknesses

Stress resilience
Fatigue
Attention span

vs.

Strengths

Immune to stress
Precision / Repeatability
Monotonous tasks
Unergonomic tasks

Weaknesses

Improvisation
Flexibility
Human-robot communication

Surgeon’s behavior during interventions

Robot control methodology

Sense - Plan - Act

Surgeon’s behavior during interventions

Robot control methodology

Sense - Plan - Act

Surgeon's behavior during interventions

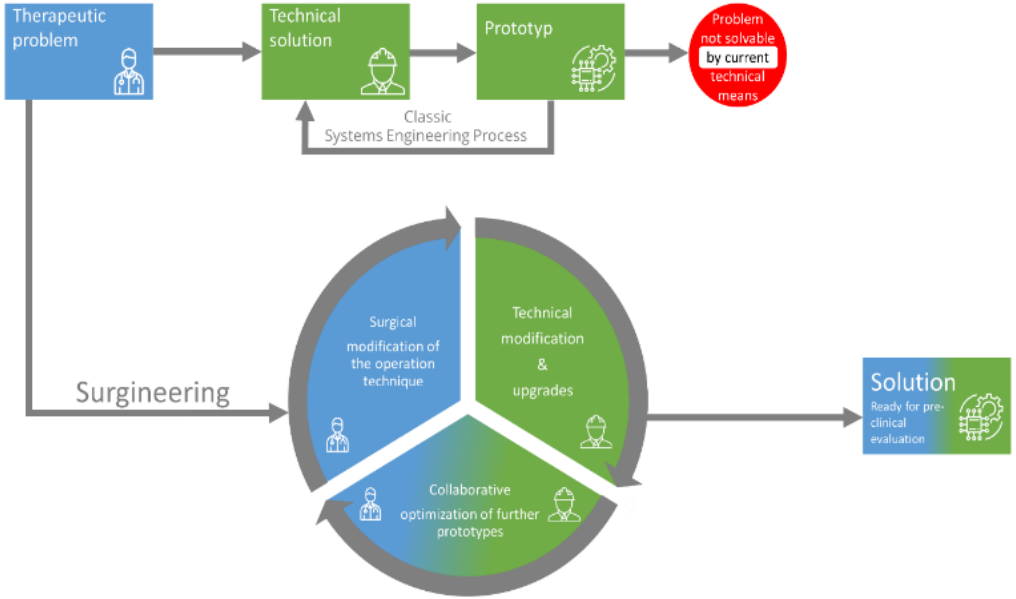
Surgeon control methodology

Plan - Act - **Sense**

Future Developments

- Collaborative approach for the establishment of new technologies in healthcare
- Close collaboration of physicians and research engineers
- Problem oriented research and development
- Involvement of industrial partners
- Model based medicine
- **Surgineering**

Surgineering



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EDITORIAL

Surgineering: a new type of collaboration among surgeons and engineers

H. Feussner[1] · D. Wilhelm[1] · N. Navab[2] · A. Knoll[3] · T. Lüth[4]

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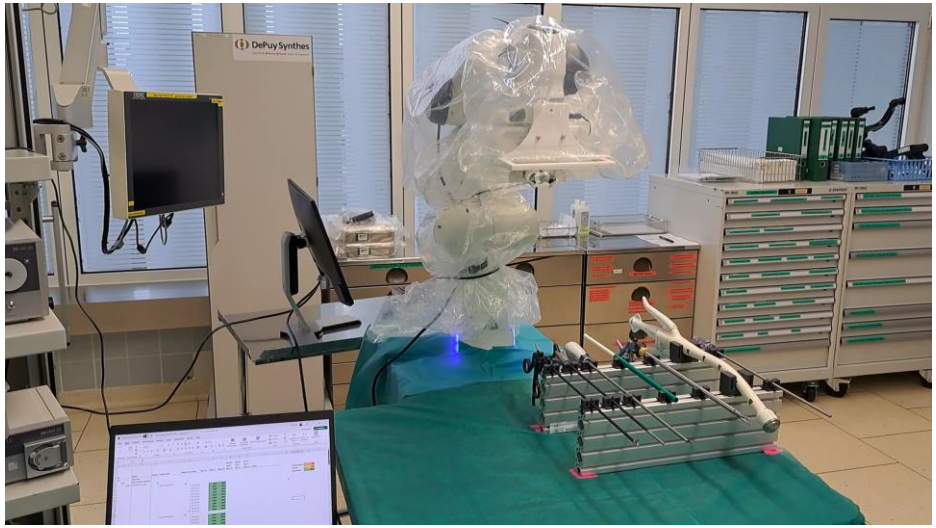
Situation Aware Sterile Handling Arm for the OR (SASHA-OR)

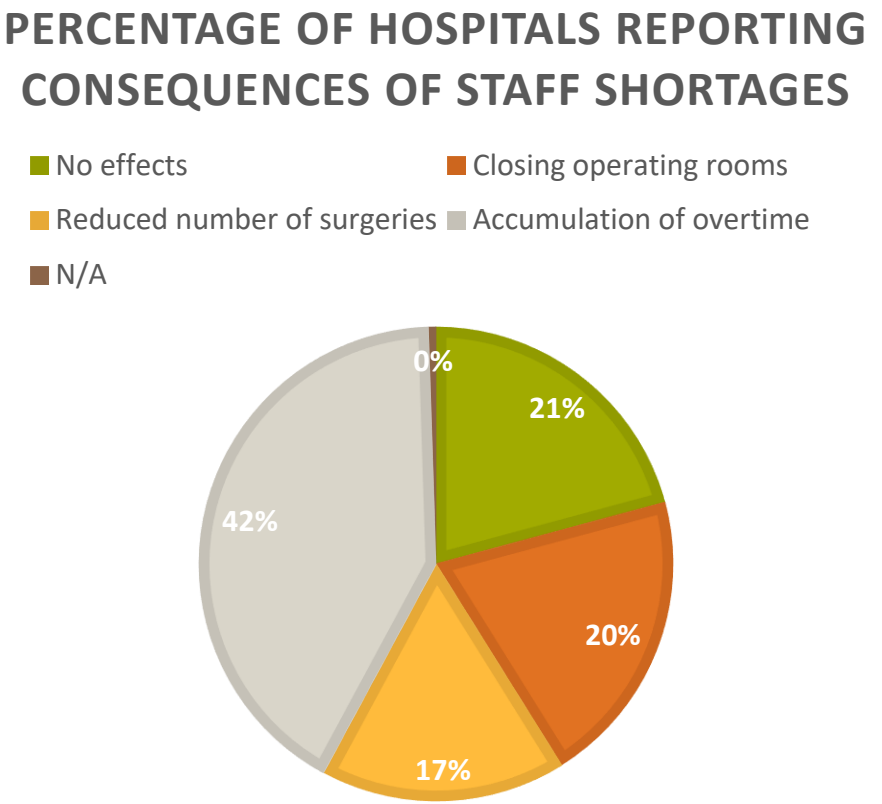
- Development of an intelligent robot arm to hand over surgical instruments
- Focus on laparoscopic cholecystectomy and sigmoid resection
- Context sensitive actions to anticipate the needs of the surgeon: **Instrument prediction**, cleaning instruments and optics, equipping clip applicators
- Interaction with non-sterile robotic surgical assistance (AURORA)



Shortage of surgical assistants

- Surgeons are heavily dependent in their work on skilled assistants
- There is a massive labor shortage when it comes to surgical staff
- Surgical assistants need to cope with long working hours, night shifts and tough physical work

- Vacancies lead to overworked staff and a decrease in the quality of patient care
- Due to population ageing, problems are expected to increase in the future



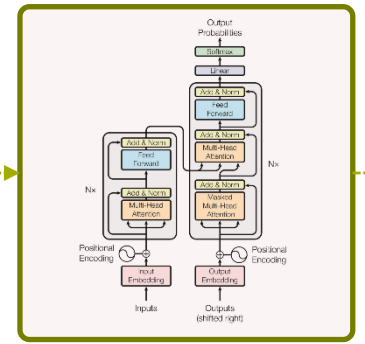
Thomas Busse. “Mangelware OP-Pflegepersonal”. In: Die Schwester Der Pfleger OP-Personalreport Pflege 2010.02/11

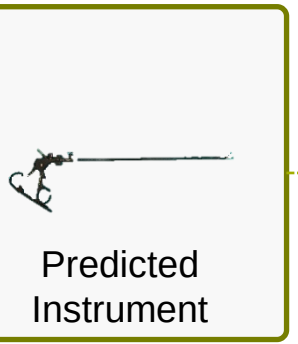
Challenges

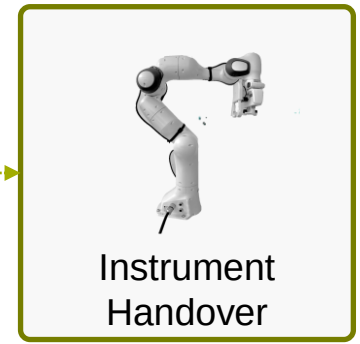
The need for a predictive system

- Anticipation of surgical actions is critical fo building a reliable robot assistant
- Use laparoscopic video as input to system

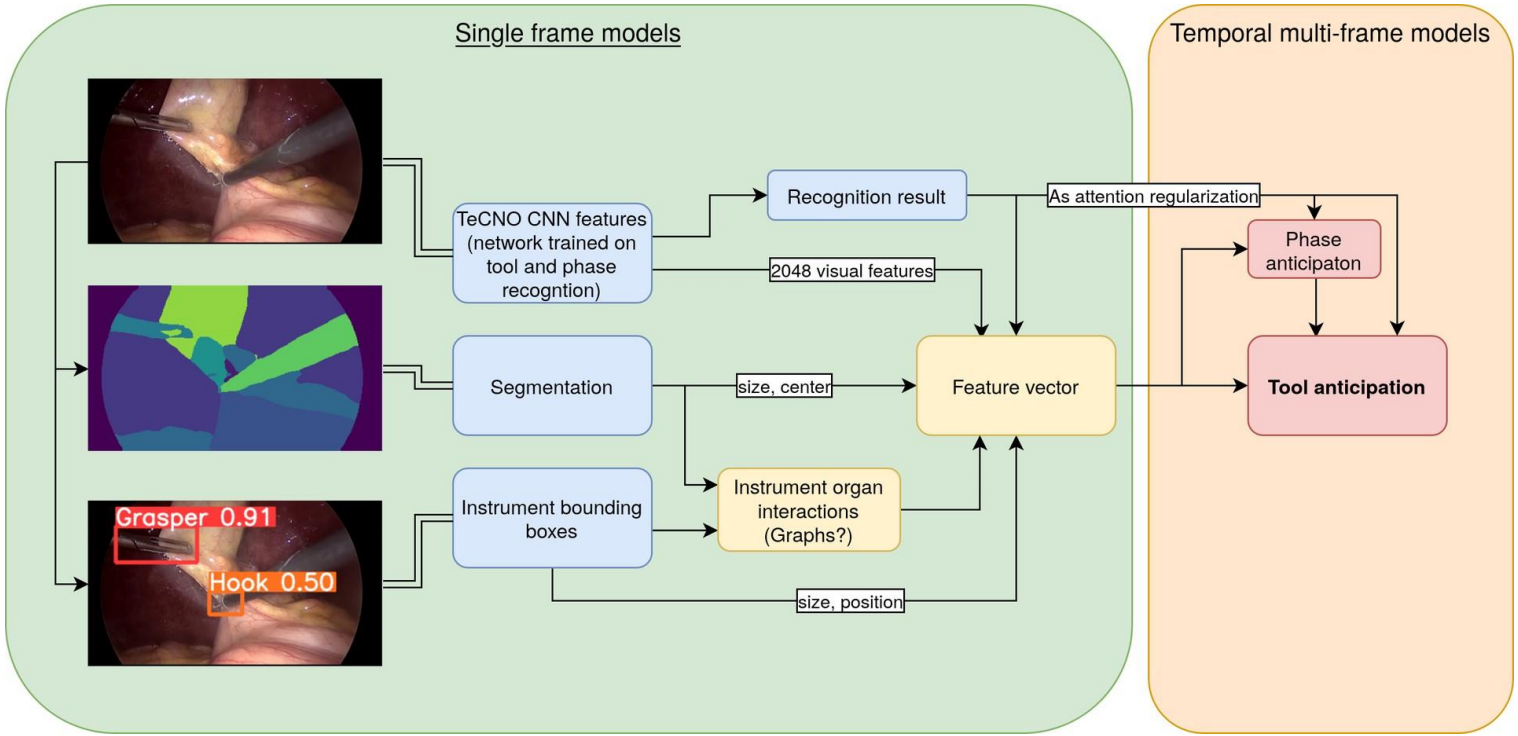
- Problem: Image data is very complex
  ⟹ Deep Learning







Internal makeup of the model



Simulating the surgeon‘s point of view

Andru P. Twinanda et al. EndoNet: A Deep Architecture for Recognition Tasks on Laparoscopic Videos. Version 2. May 23, 2016.

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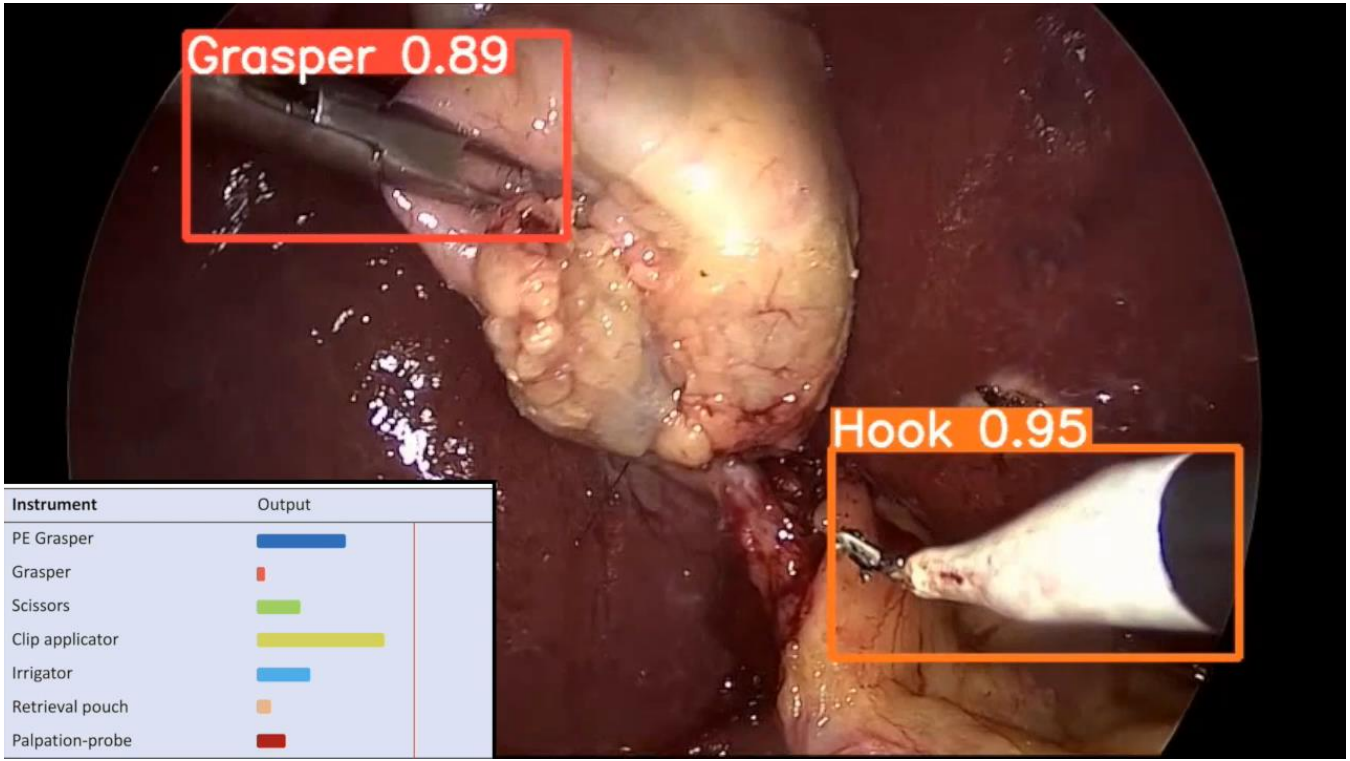
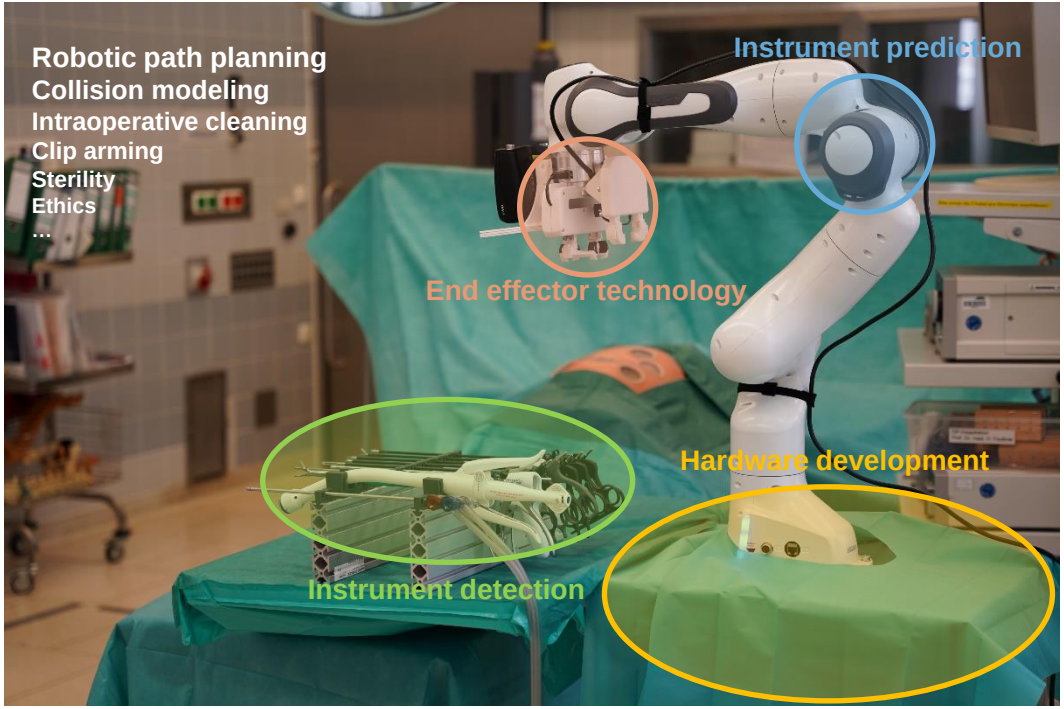
Making the system interpretable



Andru P. Twinanda et al. EndoNet: A Deep Architecture for Recognition Tasks on Laparoscopic Videos. Version 2. May 23, 2016.

A small feature in the overall system…



Questions?