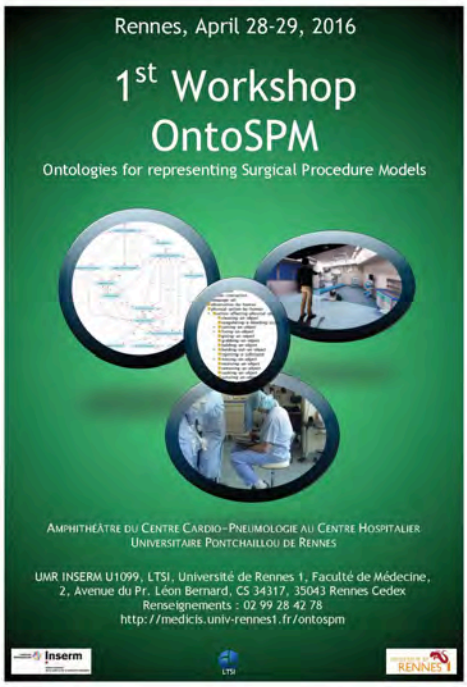


OntoSPM
"Ontologies for representing Surgical Procedure Models"

Rennes (France)

28-29 April, 2016

University Hospital

This workshop will gather a community of researchers interested in developing and using ontologies in the area of computer assisted surgery. The meeting aims at presenting concepts and prototype implementations in this area, to share experience and expectations. Different applicative contexts may benefit from such ontologies, including:

- development of context-aware systems (activity recognition, monitoring of complex equipment setup, context-dependent actions management, emergency situations management, ergonomy and human factors, recognition and anticipation of surgical errors, etc.)
- development of simulation systems for surgical training (rehearsal of procedures, training of medical staff, etc.)
- creation of annotated datasets (e.g. video recordings of surgeries, recordings of surgical equipment movements) for algorithmic development, and performance assessment
- semantic annotation of clinical or research datasets pertaining to specific domains of surgery, for research, decision support (case-based reasoning), quality management (prevention of adverse events), guidelines development, etc.

The basic objective is to discuss and share views on 1) motivations to develop such ontological models, 2) feasibility of defining a common core ontology underlying more specific ones (dedicated to particular applications), 3) ways to co-develop such ontologies, 4) to validate them and assess their added value.

The global objective is to build from this first event a working group interested in working together for developing such ontologies in the area of computer assisted interventions.

General Chairs: Dr. Bernard Gibaud, Dr. Pierre Jannin
Advisory committee: Dr. Stefanie Speidel (Karlsruhe Insitute of Technology, Germany), Dr. Lena Maier-Hein (University of Heidelberg, Germany), Pr. Gregory Hager (John Hopkin University, USA), Pr. Xavier Morandi (University of Rennes 1, France), Pr. Hubertus Feussner (Technische Universitat Munchen, Germany), Pr. Laurent Riffaud (University of Rennes 1, France), Pr. Guang-Zhong Yang (Imperial College London, Great Britain), Dr. Germain Forestier (Université de Haute Alsace, France)
Local Organizing Committee: F. Belarbi, J. Rojas Balderrama

Program:

First day April 28th

- 13:00 Welcome of participants

- 14:00 Introduction (Bernard Gibaud, Pierre Jannin)

- 14:15-16:00 Knowing each other: Short 5' talk (Chair: Pierre Jannin)
    - Introduction of participants labs: each participating site is invited to briefly introduce - in 5 minutes – his/her activities and interest in this area
        - Imperial College London, London, UK
        - DKFZ Heidelberg, Germany
        - KIT Karlsruhe, Germany
        - ICCAS, Leipzig, Germany
        - UJF Grenoble
        - Politecnico Milano, Italy
        - Polytechnic Institute of Castelo Branco, Castelo Branco, Portugal
        - MITI, TUM, Germany
        - B<>com, Rennes
        - Université Haute Alsace, France
        - SINTEF, Norway
        - INSERM University of Rennes 1, France

- 16:00 Coffee break

- 16:30-18:00 Invited presentations (4 x 20-minute talks (15+5)) (Chair: Lena Maier-Hein)

1. Elena de Momi (Politecnico Milano, Italy): Ontologies in surgical assistance systems
2. Bernard Gibaud (Inserm, Rennes): OntoSPM, a core ontology for surgical process models: motivations, working assumptions and current status
3. Darko Katic (KIT Karlsruhe, Germany) : Understanding Practice through Knowledge – Bridging the Knowledge Gap for Surgical Phase Recognition in Laparoscopy with LapOntoSPM
4. Paulo J.S. Goncalves (Polytechnic Institute of Castelo Branco, Castelo Branco, Portugal): Knowledge representation applied to robotic orthopedic surgery

- 18:00-19:00: Drinks and demonstrations
    - Olga Dergachyova (LTSI/Inserm): AdCAS
    - Javier Rojas Balderamma (LTSI/Inserm): S3PM

- 19:30 Diner at Crêperie

Second day April 29th

- 9:00-10:00 Invited presentations (3 x 20-minute talks (15+5)) (Chair: Germain Forestier)

5. Guang Zhong Yang, Valentina Vitiello (Imperial College London, UK): Ontologies for enhanced man-robot collaboration
6. Lena Maier Heinz and Keno März (DKFZ Heidelberg, Germany): Holistic data modeling and decision making in a large collaborative research center
7. Paulo J.S. Goncalves (Polytechnic Institute of Castelo Branco, Castelo Branco, Portugal): IEEE-RAS Ontologies for Robotics and Automation
8. Armin Schneider (MITI, TUM, Germany): Operating room sensor data and ontology for workflow analysis

- 10:30 Coffee break

- 11:00-11:40 Invited presentations (2 x 20-minute talks (15+5)) (Chair: Stefanie Speidel)

9. Alexandre Moreau Gaudry (UJF Grenoble): Ontology for CAS technology assessment
10. Juliane Neumann (ICCAS, Leipzig, Germany): Ontologies for surgery at ICCAS – Experiences from 2005 to 2015

- 12:30 Lunch break

- 13:30-15:00 Building together - open discussion: how to proceed ? Part 1 (Chairs: Paulo J.S. Goncalves, Bernard Gibaud, Pierre Jannin)
  (discussions along predefined topics, e.g.
  - synthesis on motivations
  - definition of scope and main steps
  - main contributors
  - co-development methods and tools
)

- 15:00 Coffee break

- 15:30-16:30 Building together - open discussion: how to proceed ? Part 2 (Chairs: Guang Zhong Yang, Bernard Gibaud, Pierre Jannin)
  (discussions along predefined topics
  - dissemination strategy
  - agenda
)

- 16:30 Workshop closing session

ABSTRACTS

Lena Maier Heinz and Keno März (DKFZ Heidelberg, Germany): Holistic data modeling and decision making in a large collaborative research center	

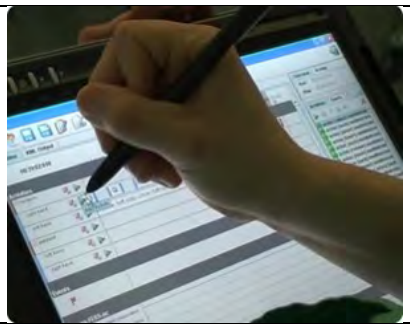
Surgical treatment decisions depend on highly heterogeneous information: (1) Patient-individual knowledge, such as lab reports, medical history and imaging data (2) factual knowledge that models written information from clinical studies and guidelines and (3) practical knowledge that represents surgical experience from case data. In this talk, we present concepts for modelling and processing heterogenous data in the context of surgical decision making within the scope of collaborative research center (SFB) Cognition-guided Surgery.

Darko Katic (KIT Karlsruhe, Germany) : Understanding Practice through Knowledge – Bridging the Knowledge Gap for Surgical Phase Recognition in Laparoscopy with LapOntoSPM	

Analysis of surgical workflows, specifically the intraoperative recognition of surgical phases based on intraoperative sensors, is a major component of the surgery of the future. It allows intelligent and automatic integration and interoperability of assistance systems. For instance, it enables surgeons to make full use of available information via intelligent information filtering, based on the online recognition of surgical phases.
However, a lack of knowledge about the surgical procedure and the medical background is a salient obstacle to understanding and analysis. Without knowledge the proper context within which to interpret the incoming sensor data, is missing. Ontologies can bridge this knowledge gap by direct incorporation and formalization of available medical expertise. This has the distinct advantage of requiring fewer labelled training samples. Such samples are hard to acquire in the medical domain, since the labelling needs to be done by experts. Furthermore, ontologies provide a precise language for capturing surgical workflows. They thus are the basis for both the conservation of surgical experience and common evaluation data sets for the research community.
We present LapOntoSPM, a sub-ontology of OntoSPM for laparascopic procedures, as a means to bridge the knowledge gap in the considered domain. We applied LapOntoSPM to surgical phase recognition in clinically relevant scenarios and present the corresponding evaluation. Additionally, we show the feasibility of combined analysis of highly heterogeneous sensor data obtained from surgical devices and computer vision for surgical phase recognition with LapOntoSPM. This way, we demonstrate that LapOntoSPM is fit for use in realistic scenarios to analyse surgical workflows based on real-world data.

Bernard Gibaud (Inserm, Rennes, France): OntoSPM, a core ontology for surgical process models: motivations, working assumptions and current status	

In this presentation, we will summarize the motivations for developing a core ontology of surgical process models, aimed at providing a meaningful starting point, beneficial to the numerous applications and communities concerned by surgical process models. We will present the current status of the work: in particular, we will explain how we managed to reuse existing ontologies and integrate them into a consistent whole. We will illustrate how it is used currently in the S3PM project (Synthesis and Simulation of Surgical Process Models), especially for the design of realistic scenarios for the training of the surgical staff using Virtual Reality systems. We will finally discuss the main assumptions underlying the design and maintenance of OntoSPM, something important with regards to extending this effort to a genuine community-wide effort.

Juliane Neumann (ICCAS, Leipzig, Germany): Ontologies for surgery at ICCAS – Experiences from 2005 to 2015	

ICCAS developed in 2005 a surgical ontology and a software tool to support observation-based recording of surgical procedures. The developed concepts were used to recorded more than 1,000 surgical procedures until now. During the talk we will present the ontology-related projects at ICCAS and share our experience from the last 10 years.

Alexandre Moreau Gaudry (UJF Grenoble, France): Ontology for CAS technology assessment	

There is a need to evaluate medical devices (MD) used daily in clinical practice in the field of Computer-Assisted Surgery (CAS) in order to assess the added clinical value of the device. It is in this context that a virtual observatory is being developed, in order to collect log file data generated during surgery, to then be analyzed in addition to the 'classical' clinical data. The aim is to better follow and therefore understand the sequence of events that constitute the surgery, how and when the MD was used by the surgeon during the intervention and finally to estimate the added clinical value of the MD

in terms of patient care improvement. In this talk, we will present a first model of the structured knowledge that can be obtained from the log files and then, in terms of perspectives, what could be relevant in order to estimate first good clinical practice recommendations for the use of the device in the field of CAS.

Elena de Momi (Politecnico Milano, Italy): Ontologies in surgical assistance systems	

Ontologies can provide assistance in the diagnosis process, allowing implementing pathologies classification tools based on symptoms (e.g. in the case of epilepsy type). They can also be used for surgical robotic systems workflow management, as we did within the EuRoSurge European Coordination Action. Within the project, ontologies were used for describing the system components and the tasks included in the workflow. We have recently started research activities on surgical assistant systems for automatic detection of surgical instruments, classification and contextualization within the surgical workflow.

Paulo J.S. Goncalves (Polytechnic Institute of Castelo Branco, Castelo Branco, Portugal): Knowledge representation applied to robotic orthopedic surgery	

Efforts and methods used in the past years to represent knowledge in the biomedical field and to obtain a conceptual model of the Ontology for Robotic Orthopedic Surgery (OROSU), are presented. The proposed model to represent the knowledge is to be used, in a machine readable format, during surgeries. Since ontologies in the biomedical filed are relatively mature and have been widely used, this is a perfect field to show the interest of using ontologies to represent robotic knowledge and its use, directly with humans (surgeons, nurses, technicians, and so on). From the biomedical ontologies that already exist, the conceptual model of OROSU is defined. The base ontologies were merged to obtain the OROSU ontology, and applied to Hip Surgery surgical procedures. It was then implemented using the KnowRob framework. Results on tasks definitions and reasoning using the presented ontology will be presented, for Hip Surgery surgical procedures.

Paulo J.S. Goncalves (Polytechnic Institute of Castelo Branco, Castelo Branco, Portugal): IEEE-RAS Ontologies for Robotics and Automation	

The IEEE RAS Ontologies for Robotics and Automation working group worked from 2011 to 2015 to develop a set of standard ontologies in Robotics and Automation (R&A).

Its work resulted in the 1872-2015 - IEEE Standard Ontologies for Robotics and Automation. IEEE 1872-2015 defines a set of ontologies aimed at formalizing some central notions in the R&A field. The main ontology in this set is CORA which specifies concepts and relations that are core to the whole R&A field. One of its objectives is to serve as a basis for future ontology development efforts. Such efforts are currently being explored in the fields of Industrial, Autonomous, and Surgical Robotics. In the talk, we will present the IEEE 1872-2015 standard and future development efforts in the three previously defined robotic ontologies sub-domains.

Guang Zhong Yang (Imperial College London, UK): Ontologies for enhanced man-robot collaboration	

Advances in robot-assisted intervention have offered improved intraoperative manipulation and instrument control, allowing for example, online learning from demonstration and context-aware playback from a pre-programmed library of manoeuvres. The purpose of this talk is to discuss the role of ontologies for enhanced human robot collaboration and how it can be more effectively used for dealing with subject specific variations in the general learning framework.

Armin Schneider (MITI, TUM, Germany): Operating room sensor data and ontology for workflow analysis	

Identification of the course of surgical interventions is one important scientific field for the development of the operating room of the future. If this surgical workflow is well recognized, predictions can be made which further can automate steps i.e. calling of the next patient or notify on upcoming activities. To achieve such a workflow recognition, we installed in one operating room a dedicated network to record different parameters from the medical-technical devices. Additionally, several sensors are in use to track the personnel and gather data from devices that are not network-compatible. Analysis and interpretation of the relations between different sensor values is done with dedicated workflow ontologies.