

Clinical Challenges

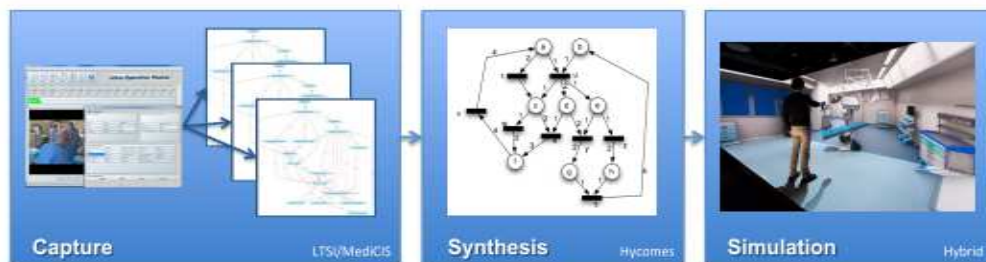
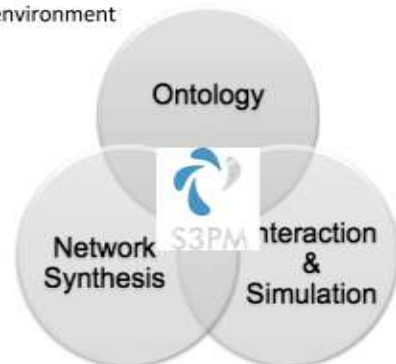
- 6-8 millions of surgical procedures /y in France
- 30 000-45 000 avoidable serious adverse events occurring during peri-operative stage
- Errors related to non technical skills issues
- Need for better surgical training and evaluation with medical simulators (1,2)
 - « Never the first time on a patient »
- Application focus: Scrub nurses in neurosurgery
 - "Giving the right instrument at the right time"
 - Access to rare and realistic surgical scenarios

Solution

- Non-organic Virtual Reality training system for procedural knowledge acquisition and assessment (3)
- With scenarios generated from observations
- Based on Surgical Process Modeling (4)

Methodological Challenges

- Surgical ontology based on a foundational ontology
- Computation and synthesis of realistic, multi-actor and multi-level surgical scenarios
- Collaborative and immersive virtual environment



Simulation

Capture of Surgical Processes

From observations and interviews with scrub nurses, we defined an ontology **OntoSPM** (5).



OntoSPM ontology

OntoSPM serves as a language for describing individual procedures



Observer-based SPM acquisition in the OR

Synthesis of Surgical Process Models

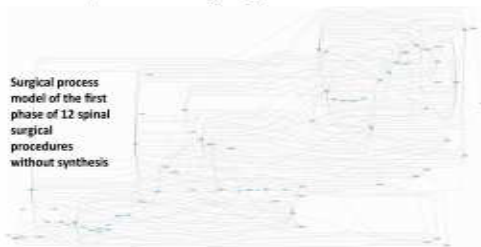
Process models :

- Automatic inference from a set of surgical procedure recordings
- Concise representation of concurrency, causality and conflict relations between actions
- Expected to work from a small set of recordings
- Process models expected to generalize recorded procedures - allows unrecorded but meaningful scenarios.

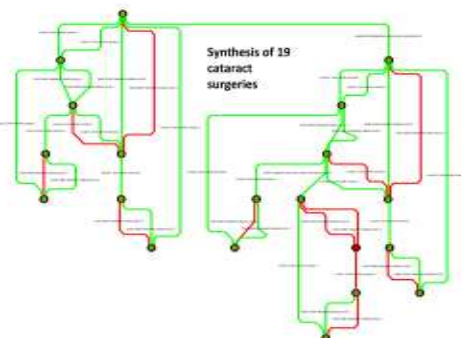
Petri net synthesis:

- Test and Flip nets (T&FN)
- Well suited to model surgical procedures.
- Region-based Petri net synthesis algorithms (6) tailored to T&FN (7)
- Uses linear algebra in the Boolean ring
- Allows inference of generic surgical process models, with meaningful generalization

Surgical process model of the first phase of 12 spinal surgical procedures without synthesis



Synthesis of 19 cataract surgeries



#SEVEN: scenario engine (8) offers

- Collaboration between multiple users and virtual humans
- Interaction with the virtual environment
- Multiple guidance level
- Extensible to be compatible with any virtual environment framework

Realization of a first prototype running on the Immersia platform



S3PM virtual operating room in the Immersia platform



Next Steps

- Data acquisition of opening phase of brain tumor surgery
- Ontology v. 1.0
- Extension of T&FN synthesis to support: (i) multi-actor decomposition and (ii) hierarchical models, with several granularity levels.
- Visualisation/interaction/validation of models
- 3D models of instruments and actors and corresponding behaviors
- Implementation of clinical scenarios
- Tests with scrub nurses

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