

Physiological Motion Compensation for Minimally Invasive Surgery

Juan Manuel Florez - PhD Student

Advisors: Guillaume Morel, Delphine Bellot, Jérôme Szewczyk

Institut des Systèmes Intelligents et de Robotique
Université Pierre et Marie Curie
Paris VI

AGATHE group
Assistance to Gesture with Application to THERapy

www.isir.fr

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Epicardial Lead Implantation through Minimally Invasive Surgery



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- Targets infants and neonates but also adult patients with aberrant anatomy or limited transvenous access .
- Requires a very performant control law in order to provide the surgeon with transparent force feedback ergo an enhanced precision capacity → MIS

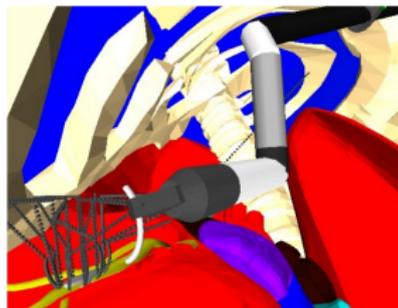
¹ MEDTRONIC Sprint Fidelis Lead

² Maginot et al. Progress in Pediatric Cardiology

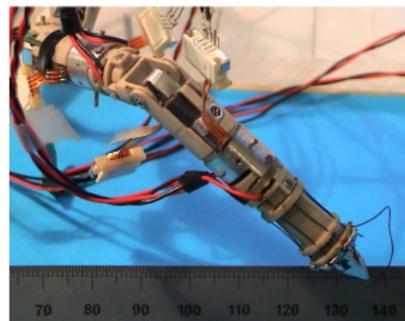
ISIR's Know-How



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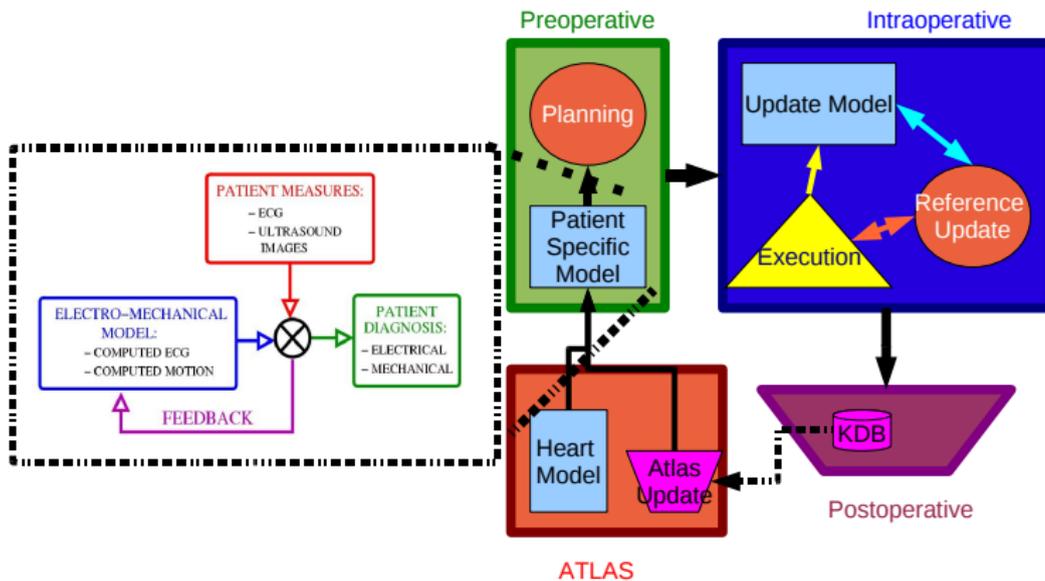
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³Zemiti 2005 - Force Control of Robotical Systems for MIS

⁴Cagneau 2008 - Force Control Contributions for Surgical Robotics

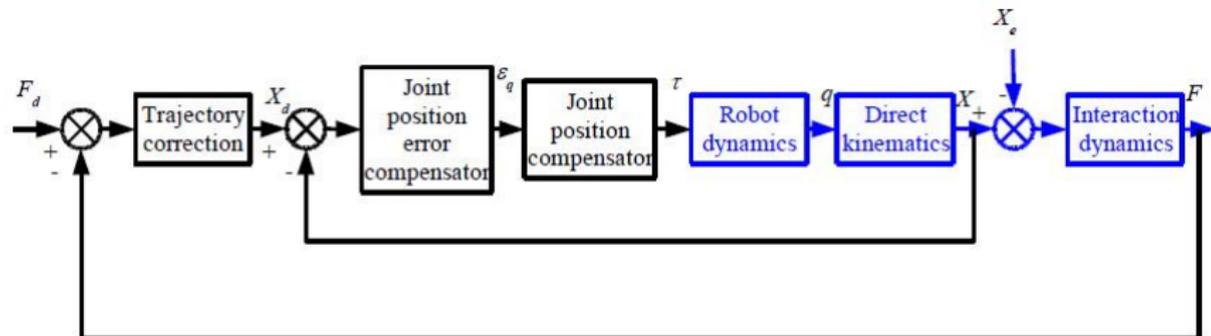
⁵Sallé 2004 - Optimal Conception of High Mobility Robotical Instruments for MIS

Modeling in the Big loop



⁶Left: Sermesant et al.

Modeling in the intraoperative scene



Predictive Control →

Interaction Dynamics Modeling →

Mechanical Impedance Cancellation →

Novel Estimation Methods



Estimation for RT model update

Parametric Estimation	Non Parametric Id Methods
equation $F=K_c(x(t) - d_c(t))+$ $f_c(\dot{x}(t) - \dot{d}_c(t)) +$ $m_c(x(t) - d_c(t)) + cte$	NO EQ
Very Fast Not excitable system Not Very Accurate	More Computationally Expensive Input/Output Dependable RT updatability

Incremental Online Learning Techniques

Non Parametric State Space Identification Methods



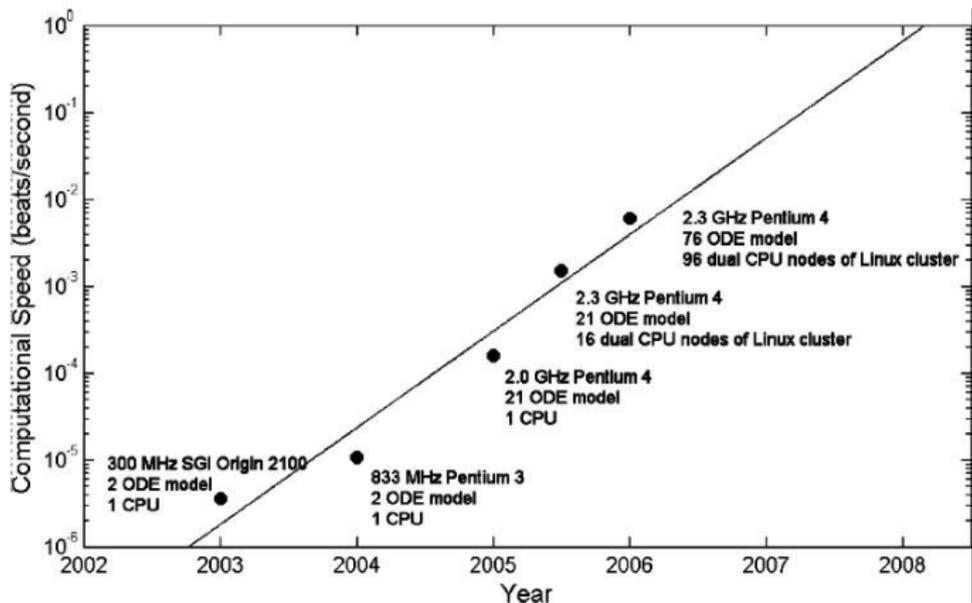
Perspectives

- Identification of time varying pseudo-periodic system with in vivo measurements.
- Enhancements on a Model Predictive Control Law.
- Dexterous Surgical Instrument Design.



Great Expectations

- Multi-scale Heart Modeling.



⁷Kerckhoffs 2006 - Computational Methods for Cardiac Electromechanics.

Thank You



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