Image guided treatments and simulation

Dott. Armando Cuttano, Vincenzo Ferrari Phd
EndoCAS – University of Pisa

- Director Prof. Mauro Ferrari
- Coordinator Eng. Vincenzo Ferrari, Phd
- The Research team involves: 13 Engineers, Surgeons (& other Clinicians), Radiologists, Residents, Economists
The mission of EndoCAS is to develop breakthrough technologies based on engineering and information technologies to improve the current medical procedures and reduce their invasiveness by means of an optimal use of medical imaging.

The main research areas are:

Planning  Navigation  Simulation
Segmentation pipeline for surgical planning

Project financed by CariPisa Fondazione
Planning for general surgery...

Value of multidetector computed tomography image segmentation for preoperative planning in general surgery.

EndoCAS Center, Università di Pisa, Edificio 102, Ospedale di Cisanello, Via Paradisi 2, 56124, Pisa, Italy, vincenzo.ferrari@endocas.org

Abstract

BACKGROUND: Using practical examples, this report aims to highlight the clinical value of patient-specific three-dimensional (3D) models, obtained segmenting multidetector computed tomography (MDCT) images, for preoperative planning in general surgery.

METHODS: In this study, segmentation and 3D model generation were performed using a semiautomatic tool developed in the authors' laboratory. Their segmentation procedure is based on the neighborhood connected region-growing algorithm that, appropriately parameterized for the anatomy of interest and combined with the optimal segmentation sequence, generates good-quality 3D images coupled with high usability. Using a touch-screen monitor, manual refining can be added to segment structures unsuitable for automatic reconstruction. Two dimensional models of 10 candidates for major general surgery procedures were presented to the operating surgeons for evaluation. A questionnaire then was administered after surgery to assess the perceived added value of the new technology. The questionnaires' results were very positive. The authors recorded the diffuse opinion that planning the procedure using a segmented data set allows the surgeons and plan critical interventions with better awareness of the specific patient anatomy and consequently facilitates choosing the best surgical approach.

CONCLUSIONS: The benefits shown in this report support a wider use of segmentation software in clinical practice, even taking into account the extra time and effort required to segment and use these models.

Computer tomography prototyping and virtual procedure simulation in difficult cases of hip replacement surgery.

Parchi PD, Ferrari V, Piolanti N, Andreani L, Condino S, Evangelisti G, Lisanti P.

Anatomical localization of deep infiltrating endometriosis: 3D MRI reconstructions.

Giusti S, Forasassi F, Bastiani L, Cela V, Pluchino N, Ferrari V, Fruzetti E, Caramella D, Bartolozzi C.

Department of Radiology, University of Pisa, Pisa, Italy, s.giusti@med.unipi.it.

Patient-Specific 3D Surgical Planning To Perform Cutting Edge Robotic Surgery


1EndoCAS – University Hospital of Pisa,
Image Guided Surgery
A 3-D mixed-reality system for stereoscopic visualization of medical dataset.

Ferrari V¹, Megali G, Troia E, Pietrabissa A, Mosca F.
Electromagnetic navigation platform for endovascular surgery: how to develop sensorized catheters and guidewires

S. Condino¹*
V. Ferrari¹
C. Freschi¹
A. Alberti²
R. Berchiolli²
F. Mosca¹
M. Ferrari¹,²
Customized surgical templates, radiological images-derived

The surgeon preoperative plan is transferred to the operative site, guiding the surgical drill to the optimal entry point and along the best trajectory.

An optimal design for patient-specific templates for pedicle spine screws placement.

Ferrari V¹, Parchi P, Condino S, Carbone M, Baluganti A, Ferrari M, Mosca F, Lisanti M.
Patient Specific Phantoms for simulation

1. Organ segmentation
2. Mould design
3. Mould prototyping
4. Silicone replica
The ARAKNES (Array of Robots Augmenting the Kinematics of Endoluminal Surgery) Project has received funding from the European Community's Seventh Framework Programme (FP7/2007-2013) under grant agreement num. 224565.
Other physical simulators @ EndoCAS

- US Breast Elastography phantom
- US PATIENT SPECIFIC Liver biopsy phantom
- Endovascular procedures PATIENT SPECIFIC phantom
Our phantoms in our training center
Distribution of innate ability for surgery amongst medical students assessed by an advanced virtual reality surgical simulator

Andrea Meglia · Vincenzo Ferrari · Luca Morelli · Franca Melfi · Mauro Ferrari · Franco Mosca · Alfred Cuschieri
BLS & ACLS programs

More than 700 participants per year
U.O. Neonatologia - Ospedale S. Chiara (Pisa)
Direttore: Prof. Antonio Boldrini

Centro di Formazione e Simulazione Neonatale

Responsabile: Dott. Armando Cuttano
MERESSINA
(MEchatronic Respiratory System SIMulator for Neonatal Applications)

Research Partners:
Neonatologia e Terapia Intensiva Neonatale, Azienda Ospedaliero-Universitaria Pisana
Dr. Armando Cuttano
Dr. Massimiliano Ciantelli
Dr. Rosa T. Scaramuzzo
Dr.ssa Marzia Gentile
Dr. Emilio Sigali
Dr. Paolo Ghirri
Prof. Antonio Boldrini

The BioRobotics Institute,
Scuola Superiore Sant’Anna
Prof. Cecilia Laschi
Prof. Arianna Menciassi
Selene Tognarelli
Francesca Cecchi
Ilaria Baldoli

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Starting date: March 19th, 2012
Duration: 18 months
Scientific coordinator: Dr. Armando Cuttano
Background: Respiratory diseases in newborns

Respiratory problems are among the main causes of mortality for preterm newborns.

- A continuous education program is necessary to train nurses and neonatologists.
- **HIGH-FIDELITY SIMULATION** is the best strategy to reach the aim.

State of the art – Neonatal respiratory simulators

- Commercially available:
  - IngMar Adult/Pediatric Lung Model
  - IngMar ASL 5000 Adult/Neonatal Breathing Simulator
  - Premi HAL®S3009 and Newborn Hall®S3010 by Gaumard
  - SimNewB by Laerdal

- In research field:
  - Cappa’s neonatal breathing simulator, 2002
  - Silvestri’s open-loop controlled active lung simulator for preterm infants, 2011

- No complex breathing patterns
- Positive pressure spontaneous breathing (a dynamic interaction with mechanical ventilators for triggered ventilation is not allowed)
- Based on single or double compartments models

Project goal

- Development of an high-fidelity and versatile **neonatal lung simulator**:
  - Able to reproduce both autonomous and mechanically assisted breathing
  - Good at simulating a wide range of pulmonary conditions
  - User-friendly for clinicians’ training sessions
  - Suitable to be integrated into phantoms

Risk of complications or side effects (e.g. Broncho Pulmonary Dysplasia)
1. Hardware:

Scaramuzzo et al., Med Devices (Auckl). 2013 Aug 8;6:115-21
MERESSINA prototype

2. Software:

- Management of simulation:
  - authonomous breathing
  - controlled ventilation
  - assisted/triggered ventilation

- 5 sheets collecting:
  - physiological parameters controls
  - graphic, numeric and LED indicators
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