



Novel strategies for safe and accurate catheter guidance and manipulation



Modern medicine is irreversibly shifting towards less invasive surgical procedures. **Conventional open surgery** approaches are systematically **being replaced** by interventions that **reduce access trauma** and thereby **minimise pain and hospitalisation periods**. The downside is that the restricted access and view on the site of the intervention make such procedures complex, time-consuming and highly demanding, entailing increased risks for patient. Moreover, most of the interventional procedures use x-ray based images for the visualization of organs and tools, delivery in such a way an elevated dose of ionizing radiation to the patient.

In the perspective of patient safety, SCATH aims at minimizing these drawbacks specifically for a series of promising catheterization procedures with as common denominator **treatment of cardiovascular disease, the main cause of death in the EU**. Targeted procedures are placement of endografts, transcatheter aortic valve replacement, endoclamp balloon placement (Figure 1) and transcatheter cardiac ablation.

SCATH aims to reduce the surgical risks through developing complementary technology to

- help the surgeon to realize an **accurate patient-specific pre-operative planning**;
- **reduce** the amount of **ionizing radiation**;
- **assist the surgeon** during the procedure;



Figure 1 View of the Endoclamp balloon

Immersion plays a central role in SCATH. Sensory devices embedded in the catheter capture different facets of the reality of the catheter inside the human body. Through real-time modeling, visual and haptic feedback, this reality is presented in an intuitive manner to the interventionalist who will feel as though navigating him/herself through the vessel. The catheters are steered robotically under shared autonomy towards the correct position.

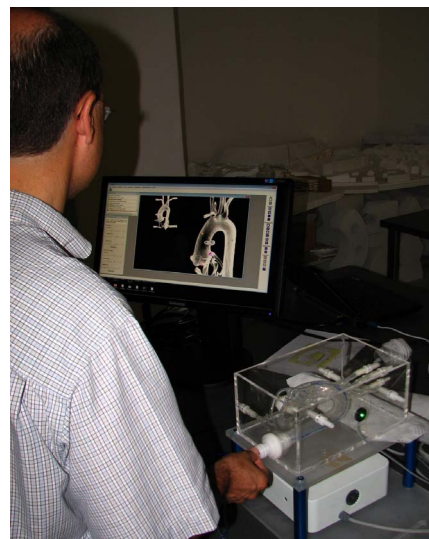


Figure 2. Usability tests of integrated SCATH platform

SCATH's *smart catheters* with integrated sensing have access to real-time local information, allowing faster response to critical events and at the same time restricting excessive use of ionizing radiation and contrast agent used nowadays to try to locate the position of the catheter in the patient's body.

After 1 year of SCATH these concepts were already materialized in a **first basic SCATH platform** (Figure 2), **tested** positively by a group of expert interventional surgeons.

The SCATH platform

The final product of SCATH will be a single software framework and robotic platform that integrates all the technological tools developed during the project. The first version of the platform presents a basic navigation method with robotic controls of the catheter's insertion.

The platform handles all pre- and intra-operative data, coordinates catheter motion to improve the navigation of catheters during the surgical procedures.

In the first prototype, the fundamentals of the navigation software have been implemented: a visualization interface (Figure 3) and a basic navigation method. In the future implementation of a vessel tree map will be automatically generated. New algorithms for model generation based on pre-operative medical images (CT or MRI) are in development. Parallel, simultaneous localization and mapping (SLAM) methods are explored to construct real-time models from bottom-up, using them to improve the alignment with the patient body, incorporating local deformations in the virtual vascular model.

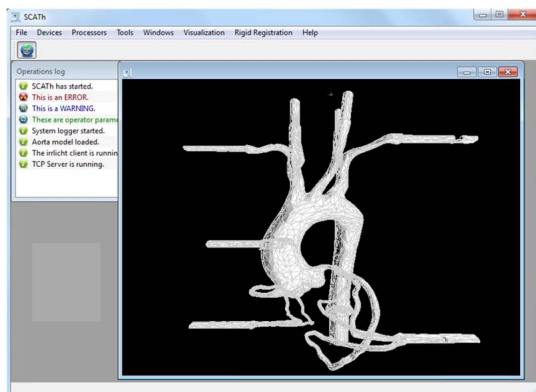


Figure 3 Navigation interface of basic SCATH platform.

The platform acquires and handles intra-operative data, compares them with mechanical and physiological models to improve the safety during the procedures.

In the next version of the platform the catheters will integrate sensing technologies like flow measurements, tracking and image acquisition. This last feature will use intravascular ultrasound technologies. A novel sensor for vision through blood using infrared light is currently under development. Models of the aortic wall (Figure 4) will support the surgeon in quantifying the risks

Further information

ICT for Health website http://ec.europa.eu/information_society/ehealth

Project website <http://www.scath.net>

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of damage to anatomical structures and occurrence of adverse events (e.g. the mobilization of an intraortic device or implant).

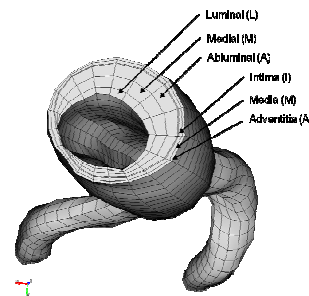


Figure 4 Mesh model of a pathological aortic wall.

The platform features robotic catheter insertion through teleoperation control, real-time catheter position tracking and an intuitive graphical user interface.

A robot for the manipulation of the catheter has been developed. The first version is only capable to control the insertion motion. A second design manages to control also axial rotation and bending of the catheter distal end. New concepts for *smart* cardiovascular catheters incorporating sensors that acquire physiological, image and tracking data have been developed. Constraints on miniaturization and biocompatibility are tackled here. Figure 5 shows a catheter prototype integrating multiple tracking sensors.

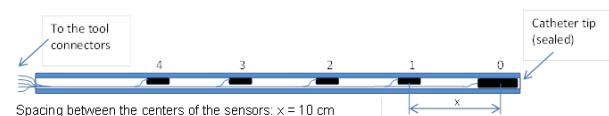


Figure 5 Catheter with multiple tracking sensors.

Since all information is centralized in the SCATH platform all the events happening during the surgical procedures can be logged and used for assessment and training purposes.

Major dissemination events

- **July 2011**, SCATH Summer School 2011 - Graz, Austria.
- **July 2012**, SCATH Summer School 2012 - Madrid, Spain.

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