

THEMIS: A NEW VIDEO AND IMAGE GUIDED NAVIGATION SYSTEM

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Background: Technical and computational advances are constantly giving rise to new minimally invasive surgical concepts and techniques. By extending the surgeon's ability to plan and carry out interventions more accurately and less invasively, image guided surgical navigation systems will address a crucial need to reduce medical procedure costs, improve clinical outcome and thus the efficiency of health care delivery. This research proposes a video-based navigation system for liver resection procedures, extending the range of applications for computer-assistance from diagnosis and planning to actual therapy support.

Methodology: THEMIS provides surgical guidance during the intervention, strongly relying in the information conveyed by the endoscope to track all elements in the surgical scene. Preoperative planning, intraoperative imaging, video-based processing and biomechanical models are incorporated in a system enabling a new navigation paradigm in the challenging field of soft-tissue surgical navigation. THEMIS has a flexible design to facilitate its integration into surgical workflow, using non-intrusive technologies to minimize disturbances to surgeons during the surgical procedure. Video-endoscopic image is analyzed for extraction of relevant information of the surgical workspace and creating image-guided surgical aids. In this fashion, tools, organs and endoscope tracking can be achieved by means of its analysis. Organs' biomechanical modeling is also exploited to predict deformations during resection in a 3D liver model of patient-specific anatomic structures obtained from preoperative studies. Thus, deformation of virtual models during surgical intervention can be achieved.

Results and discussion: Technical verification has been carried out where functionalities, reliability and robustness have been tested. User validation in laboratory settings has also been performed by seven expert laparoscopic surgeons with good results. Results have shed light on the need of establishing adaptation periods of the system in the OR, with an associated learning curve.

Conclusions: Preliminary validation of the THEMIS concept has shown the need for new unobtrusive surgical aids for MIS interventions such as liver resection. As one of the main intraoperative information sources, the

relevance of video endoscopic images is key to the innovation provided. This leads to a new concept in surgical navigation: video and image guided surgery (VIGS).