

## Chapter 34

# Surgeon Assistive Augmented Reality Model with the use of Endoscopic Camera for Line of Vision Calculation

**Anastasia Daskalaki**

*University of Athens, Athens, Greece*

**Kostas Giokas**

*University of Athens, Athens, Greece*

**Dimitris Koutsouris**

*University of Athens, Athens, Greece*

### ABSTRACT

*In this paper, the authors describe a surgeon assistive Augmented Reality (AR) model for endoscopic procedures. They analyze the main parts of the model and the processes that need to be established such as, the registration of the patient, the segmentation of medical data, their 3D reconstruction, and the detection of endoscopic instruments and the camera. The authors present two graphical user interfaces, build to serve the needs of segmentation, navigation, and visualization of the final intra-operative scene. By using preoperative data of the patient (MRI-CT) and image processing techniques, the authors can provide a unique view of the surgical scene. The potentials and the advantages of endoscopic-robotic surgeries nowadays can be improved. Augmented surgery scenes with information about the patients underline structures, enables wider situation awareness, precision, and confidence.*

### INTRODUCTION

The 3D modeling of a patient from CT-scan or MRI, improves surgical planning. At the same time simulations provide the opportunity for surgical training. Nowadays, both steps can be used during

an operation because of AR evolution, which can superimpose the pre-operative image of a patient with the intra-operative image.

Modern medical imaging provides essential preoperative information for the anatomy and pathophysiology of the patient. However this information presents in 2D images which makes their deconstruction a difficult work. One of

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the most important goals of image analysis is to automatically detect, determine and visualize anatomical and pathological structures in 3D medical images, in order to guide the operating procedure. Transferring the information from 3D models to operating field, allows the development of virtual and augmented reality. Virtual reality in medicine is based on the creation of virtual patient models due to 3D modeling of anatomical and pathophysiological structures. Like that the projection and utilization of images becomes easier because of immersion, interaction and navigation. Doctors due to preoperative image optimization can provide better diagnosis and better treatment planning for each case. Also they can avoid medical inaccuracies through optimized preoperative planning. However, virtual reality limits the patient in a virtual world, even if this world is a virtual copy of reality.

In order to overcome this limitation, we have to combine information from virtual and real world. For medical applications this can be translated in two basic axons: navigation systems that use real information to control the virtual world, and augmented reality systems that superimpose the virtual information onto the real image. These two axons presuppose the registration between the virtual model of the patient and the real patient inside the surgery room. Thus, we establish a unique spatial system which connects the virtual with the real world. In this survey, we are going to work in this direction, trying to present such a model able to enhance the intraoperative visualization by superimposing information, calculated in a virtual environment

## **AUGMENTED REALITY**

Augmented reality (AR) is considered an extension of Virtual reality field. In 1994, Milgram and Kishino (1994) described the “Reality-Virtuality Continuum” in which AR is a part of a general category named Mixed reality. The main defer-

ence between AR and Virtual reality is in the background of the scene. Virtual reality acts in a virtual environment in contrast with AR which acts in a real environment. AR is a live view of a real-world environment that a human being can realize through his senses, whose elements are augmented by virtual information produced by computer-generated systems (Azuma, 1997; Bimber & Raskar, 2005; Valino, 1998; Starner et al., 1997). In order to construct a space where real and virtual world coexist, AR has to follow three basic properties (Azuma et al., 2001):

1. Harmonic synthesis between real and virtual elements, into a real environment.
2. Interactive in real-time environment.
3. Registration between real and virtual elements.

## **Augmented Reality in Surgery**

This survey focuses on AR implementations in surgery. AR has a lot of applications and surgery is a field that can significantly benefit from the growing of this technology. More specific surgical training, pre-operative planning, intra-operative navigation and augmented imaging are some fields that have been aided by AR. Utilizing augmented reality for applications in surgery has been a topic of intense research for several years. A lot of surveys have been written and a lot of systems have been developed, in this direction (Grimson et al., 1996; Raya et al., 2003; Hattori et al., 2003; Khamene et al., 2003; Janin et al., 2000). Currently, the surgeon must convert the 2D tomographic views to a 3D representation and merge it in his mind with what he physically sees. Also has to constantly change his view away from the patient in order to observe and compare the operative image with the tomographic images. AR allows the surgeon to preserve a steady field of vision on the surgical field, because does both the 2D to 3D transformation and projects the views directly onto the patient view.

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