

# A novel hand gesture-based image browsing system for the operating room

Gestix is an accurate and efficient device for medical imaging manipulation and allows for intuitive interaction while respecting the sterility constraint crucial in the OR environment

**H**and gestures for medical applications provide an expressive, natural and intuitive way for humans to control and interact with hospital systems. However, to successfully implement hand gesture systems within the healthcare environment significant challenges related to technical and usability aspects must be overcome, such as fast response and high recognition accuracy, as well as ease of learning and high user satisfaction.

These stringent requirements explain why these systems are not common in today's medical environment, and why there is little literature related to the topic. The current article reviews the highlights of a novel gesture-based system for medical image browsing in the OR called

"Gestix" (Figure 1). This system is based on real-time hand-tracking recognition techniques using colour distribution models, suitable for bare hands or gloves. During a brain biopsy surgery the system was validated. The surgeon's rapid intuitive interaction with an EMR database was achieved.

#### Background

Progress in the field of medical engineering has introduced innovative technologies that empower physicians, nurses and healthcare staff members to increasingly interact with medical equipment and computer systems. These advances have increased efficiency, power and productivity in the medical field. Often,

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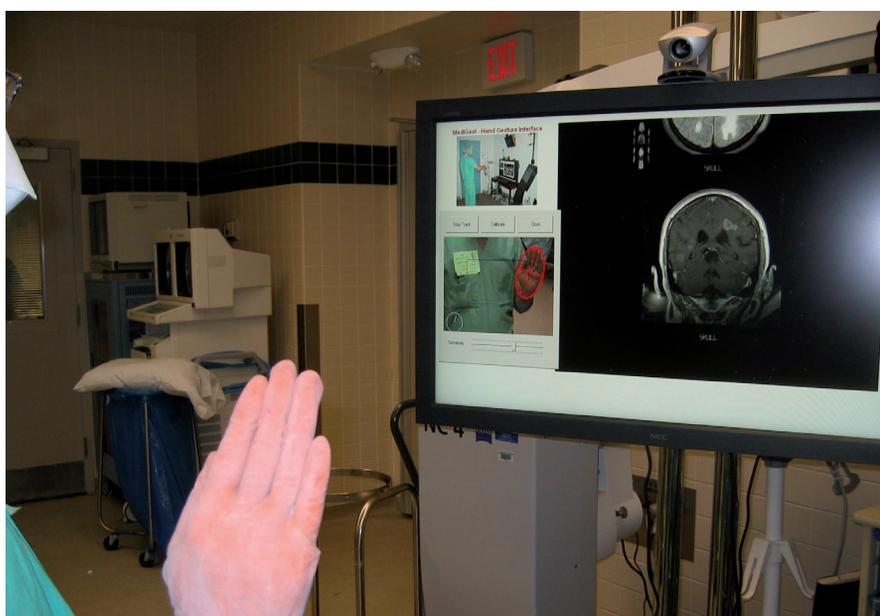


Figure 1. Use of Gestix in the OR

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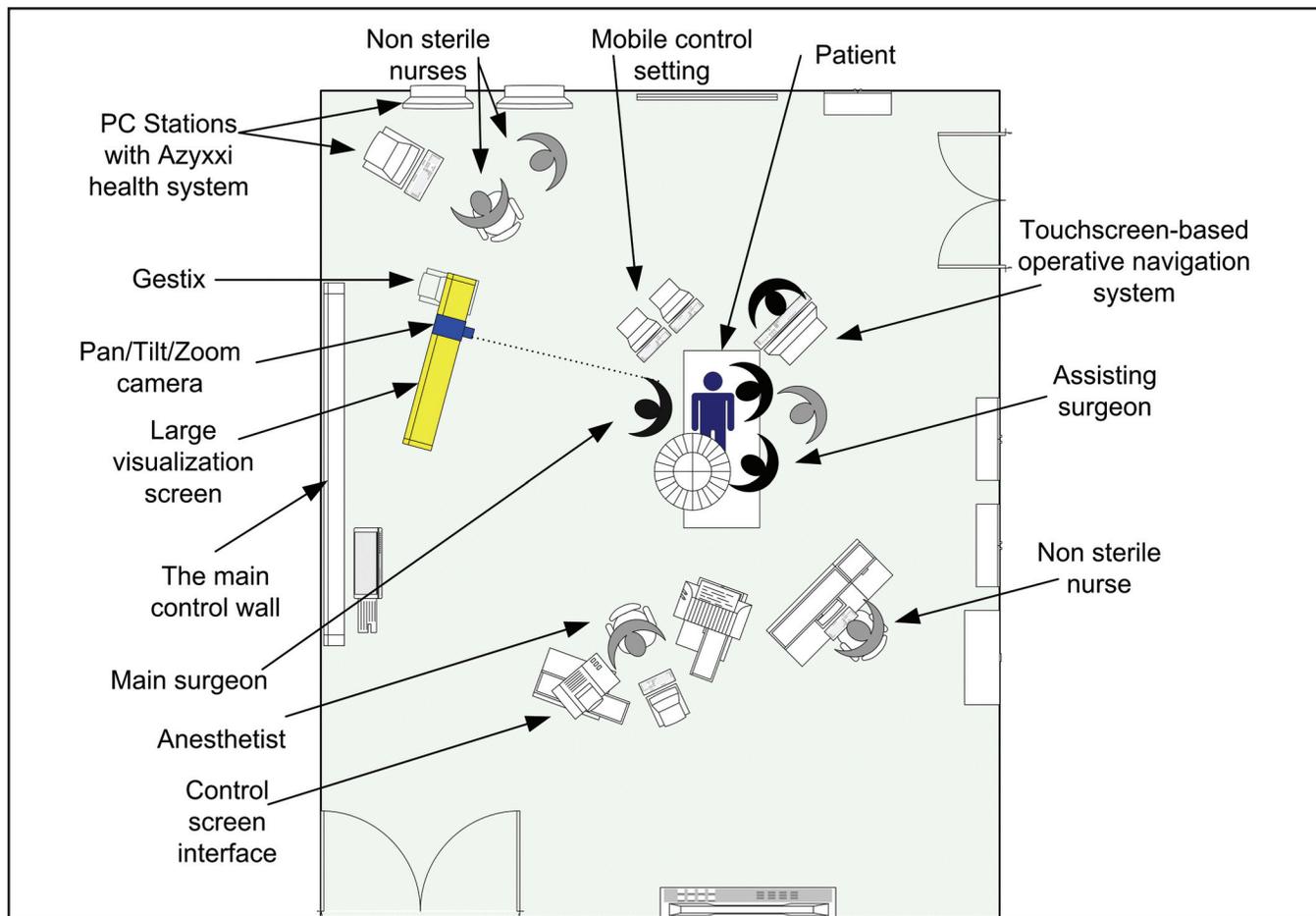


Figure 2. Layout of Gestix in an OR

however, the use of advanced technology in medicine is not user-friendly and, hence, is disregarded by many practitioners. Physicians should be free to concentrate on the medical problems, not on the utilisation of the equipment. Furthermore, the technology used must fulfill the requirements of safety and sterility needed in the hospital environment.

It was found that computer keyboards and mice were the most common way of spreading infections in intensive care units (ICUs) used by doctors and nurses.<sup>1</sup> User-friendly touchscreen kiosks bring no guarantee to stop the spread of bacteria since users may forego the washing of hands in the interest of speed.<sup>2</sup>

A gesture capture vision-based system used to manipulate MRI images through the use of a hand gestures system, denoted Gestix, was developed to assist surgeons to browse medical images in a sterile fashion. The system is user-independent, without the need of a large multi-user training set, similar to that found in *IEEE Transactions on Robotics and Automation* for face gestures.<sup>3</sup>

The operation of the gesture interface was tested at the Washington Hospital Center in Washington, DC, as an “in-vivo” neurosurgical biopsy (see Figure 1). It was found that a

sterile human-machine interface is of supreme importance since it allows surgeons to control medical visual information in an intuitive and noncontaminated fashion.

**The concept of Gestix**

The sterile gesture interface consists of a Canon VC-C4 pan/tilt/zoom camera, mounted over a large flatscreen monitor, in front of the main surgeon, midway between the patient’s bed and the main control wall (Figure 2). Additionally, an Intel Pentium IV (600MHz, OS: Windows XP) with a Matrox Standard II video-capturing device is used.

To use Gestix, a calibration process is required to capture the gamut of the surgeon’s surgical glove colours. This process is used to create a color distribution model of the surgeon’s gloved hand and is accomplished within 1–5 seconds.<sup>4</sup> The surgeon’s hand is tracked using an algorithm that segments the hand from the background using the colour model. This is followed by black/white thresholding and various morphological image processing operations to clean the image. The location of the hand is represented by the 2D coordinates of its centroid in each frame of the captured video. Superimposed over the image of the scene is a rectangular frame called the “neu-

tral area". To browse the image database, the surgeon moves the hand rapidly out of the neutral area toward any of four rectangular directions (up, down, left, right), and then back to the neutral area. Zoom is achieved by rotating the hand in a CW or CCW movement. Tracking is stopped by dropping the hand outside the camera's view, and the system is roused by waving the hand in front of the camera.

**Usability tests**

Two interviews and a questionnaire were conducted based on the performance of the surgeons before and after using Gestix.<sup>5</sup> The first, a contextual interview, was based on watching and listening to the surgeons while they operate without relying on Gestix. The main problems found were the need of accessories (eg, plastic adhesive protective covering for touchscreen) and the delay caused by the surgeon's visits to the main control wall. The second, an individual interview, showed that the surgeon preferred hand gesture control due to the fact that he/she is most proficient working with hands than other modalities. After using Gestix, a questionnaire to measure satisfaction showed that the surgeons found Gestix easy to use, fast and mastered after short learning times.

**Conclusions**

Gestix, a medical image manipulation system for the OR, uses real-time hand-tracking and recognition techniques. The system was validated in an in-vivo experiment demonstrating rapid intuitive reaction and natural interaction to an EMR database containing MRI images while keeping the interaction completely sterile.

Other characteristics validated in this system showed that Gestix was easy to use, allowed rapid reaction, unencumbered and robust operation. Evaluation of the system using two interviews and a questionnaire indicated that Gestix is an accurate and efficient device for medical imaging manipulation that allowed intuitive interaction while respecting the sterility constraint crucial in the OR environment. ■

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