A Gesture-based Tool for Sterile Browsing of Radiology Images

LITERATURE SURVEY

The hand gesture control system “Gestix” developed by the authors helped the doctor to rema inin place during the entire operation, without any need to move to the main control wall sinc e allthe commands were performed using hand gestures.The sterile gesture interface consists of aCanon VCC4 camera, whose pan/tilt/zoom can be initially set using n infrared (IR) remot e.This camera is placed just over a large flat screen monitor . Additionally, an Intel Pentium I V, (600MHz, OS: Windows XP) with a Matrix Standard II video-capturing device is used.

The “Gibson” image browser is a 3D visualization medical tool that enables examination of Images, such as: MRIs, CT scans and Xrays. The images are arranged over a multiple layer 3 D Cylinder. The image of interest is found through rotating the cylinder in the four cardinal Directions. To interface the gesture recognition routines with the “Gibson” system, informati Such as the centroid of the hand, its size, and orientation are used to enable screen operations inThe “Gibson” graphical user interface.

Fernando Alvarez-Lopez, Marcelo Maina, Frances Saigí-Rubió.”Use of commercial off-the-shelf devices for detection of manual gestures in surgery”. A Systematic Literature.

Early attempts in the use of touchless gestures in minimally invasive surgery (MIS) used hand and facial gestures. Gesture recognition systems with web and video cameras were later described , using the Time-Of-Flight principle and achieving interaction with the OsiriX viewer . These systems, though, were very expensive, inaccurate and required calibration and complex set up, making them impractical for use in the OR . The surgeons rated the system as easy to use, with rapid response, and useful in the surgical environment. To evaluate the 'Gestix’ system. User testing.

The use of commercial devices for detecting manual gestures in surgery is a very topical issue, given the need to manipulate medical images and for real-time 3D reconstructions during procedures, without breaking asepsis and antisepsis protocols. Early studies published on this possibility used COTS systems with webcams, cameras with CMOS sensors and commercial digital cameras . These pioneering studies showed that interaction with images and medical information was possible without physical contact using low-cost devices in environments such as ORs.

Dominic Canare,Barbara S Chaparra,jibo He."A Comparison of Gaze-Based and Gesture-Based Input for a Point-and-Click Task".

Alternatives to the mouse have been created and suggest the possibility of more intuitive interfaces to provide better access for a variety of populations. Other devices solve more specific problems, such as allowing access to data in sterile environments, overcoming physical handicaps, and exploring big data. Sterile environments exist for users in surgical settings, where accessing a keyboard and mouse would require rescrubbing, a process that can take significant time and is critical to patient safety.

A study of this system found that, with just ten minutes of training, performance was similar to standard mouse usage. Wachs et al. developed a gesture-controlled interface through which surgeons could browse radiological images in a sterile environment while avoiding many of the typical drawbacks (rescrubbing, change in focus of attention, etc.) . Their usability tests indicated that users found the system to be "easy to use, with fast response and quick training times"

Two papers with the same content as Wachs et al. (2008) and one paper similar to Jacob et al. (2014)were excluded, because those did not make a contribution to the research. We decided to include the latest and most valuable of these publications in this literature review.

Health informat J,Sean Cronin , Govin Doherty "Touchless computer interfaces in hospitals".

Complications and infections caused by non-sterile interactions can be very costly, 4 with both financial and human costs. It is noted by Wachs et al. 5 that the current most prevalent means of HCI in hospitals remains the mouse and keyboard. Keyboards and mice are a potential source of contamination (up to 95% of keyboards have been shown to be contaminated 6). ...

As can be seen, the most common system application for touchless, gesture-driven interfaces has been various forms of image navigation, closely aligned with the OR and interventional radiology contexts listed above. Medical image navigation is the goal in seventeen papers, with the more specific subset of magnetic resonance imaging (MRI) image navigation being the goal , Task context was also significant in identifying tasks for testing the systems implemented, such as measuring a lesion on MRI images.

Medical image navigation is the goal in seventeen papers, with the more specific subset of magnetic resonance imaging (MRI) image navigation being the goal . Task context was also significant in identifying tasks for testing the systems implemented, such as measuring a lesion on MRI images. Context-sensitive systems.

Anke Reinschluessel ,Luca Rainondo,Lars Reising ,"Virtual Reality for User-Centered Design and Evaluation of Touch-free Interaction Techniques for Navigating Medical Images in the Operating Room".

In order to provide surgeons with a more efficient, comfortable, precise, and sterile interaction technique, the feet and hands can be an effective means of accomplishing this goal in comparison to other modalities, such as voice or gaze interaction. Touch-less gesture interaction is an option to interact with imaging systems, displays, and controllers without breaking the sterility barrier. 42 % of the surgeons intuitively use both hands for gestures capable to browse through images .

Our observations showed that during retrieving information from the images, the surgeons have at least one hand or the feet available as an input method if not already used for input in form of buttons on the floor. Previous research on interaction methods in the OR confirms this observation . As hand and feet are available for interacting with the system, we developed two approaches: a single hand-based interaction method and a foot-based interaction method.

For hand-based interaction different gesture sets have been developed for intra-operative use. Whereas some use pointing gestures, others use hand gestures [22] [10], which involve the different finger positions and yet others incorporate more space-consuming gestures that involve lower arm movement . They all support a variety of image manipulation functions and require a sophisticated hand recognition.

Glebys Gonzalez,Lingsong Zhang,Naveen Madaoana,"agreement Study Using Gesture Description Analysis".

It allows surgeons to control medical systems in a touchless manner while maintaining total asepsis.

They are not only intuitive to the user but also there is a cultural aspect to them, such as in emblems . Additionally, they can be used as a safe and aseptic alternative to traditional interfaces in the particular case of medical environments.

The SAR is defined as a mean of the Jaccard similarity applied to all possible pairwise combinations of binary vectors corresponding to gestures in P r . The overall SAR is defined as a mean of SAR of individual commands. The mathematical representation of SAR relates to (AR) in terms of considering all possible pairwise combinations.

Tian Zhou,Maria Eugenia Cabrera,Juan Wachs,"A Comparative Study for Touchless Telerobotic Surgery".

A different approach to convey force is through ultrasound generated waves directly onto the users' bare hands . These touchless feedback methods allow the use of new interfaces based on natural free gestures, widely used in other human-robot interaction applications currently . The main benefits of commodity sensors like Kinect, Leap Motion or the MYO arm band, are lower costs than many haptic devices and their increasing popularity in gaming consoles.

Hartmann and Schlaefer used the Kinect sensor for automating the OR lighting . In Wachs et al. hand gestures were adopted for browsing radiological images . Mouth gestures were also tested as a way to control the da Vinci Robot .

Fernando Alvarez-Lopez,Marcelo maina,Francesc Saigí-Rubió, Use of commercial off-the-shelf devices for detection of manual gestures in surgery.

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Using commercial devices to detect manual gestures in surgery is a very topical issue given the need to manipulate medical images and for real-time 3D reconstructions during procedures without breaking asepsis and antisepsis protocols. Early studies published on this possibility used COTS systems with webcams, CMOS-sensor cameras and commercial digital cameras . These pioneering studies showed that contactless interaction with images and medical information in environments such as operating rooms was possible using low-cost devices.

Rolf Wipfli, Victor Dubois-FerriereSylvain Budry, Christian Lovis,"Gesture-Controlled Image Management for Operating Room: A Randomized Crossover Study to Compare Interaction Using Gestures, Mouse, and Third Person Relaying".

Studies showed the feasibility of such systems . Wachs et al. conducted an in vivo experiment for a biopsy planning task. The methods for evaluation included contextual interviews, individual interviews, and subjective satisfaction questionnaires.

Even if the experiment had been constructed in order to measure a learning effect, it failed to do so. The study supports previous studies that showed that pre-defined gestures with Kinect1 can be learned easily and that reliability of gesture-control systems is good . However, in a next study difficulty of scenarios should be increased.

Amin Khorsandi, Nader Karimi,S.M.Reza Soroushmehr,Kayvan Najarian"Radon Transform Inspired Method for Hand Gesture Recognition".

Voice commands are another type of touchless interaction, but due to existence of noise in surgery room, it is difficult to implement a voice recognition system. Another problem in voice commands is that these commands are discrete . The number of gestures to communicate with medical devices are limited and the response time is very important .

Another problem in voice commands is that these commands are discrete . The number of gestures to communicate with medical devices are limited and the response time is very important .Another application of hand gesture is discussed which is related to hospital patients or handicap people.

Hooman Esfandiari ,Pascal Troxler,Sandro Hodel,Philipp Fürnstahl.”Introducing a brain-computer interface to facilitate intraoperative medical imaging control – a feasibility study”.

One of the earliest examples of the vision-based gesture recognition technologies was presented in, where the authors developed a noncontact mouse for intraoperative use by detecting the surgeon's gestures based on a stereo camera setup. This was followed by several other publications that utilized image-based gesture recognition for medical image manipulation . More recently, conceptually similar approaches haven been introduced that provide the possibility of remote, touch-less interaction with medical imagery based on gesture recognition using depth (i.e., RGB-D) sensors. Performing such gestures requires certain movements of either one or both hands, rendering such technologies limited for interventions where both of the surgeons' hands are occupied.

Comparing this accuracy rate to the prior-art, to our knowledge most of the existing research on advanced image manipulation interfaces only report qualitative metrics or time of task completion and lack quantitative analyses on spatial image control accuracy. However, compared to a study that implemented the closest counterpart to our 3D spatial accuracy metric and despite the substantial differences in implementation of the metric and tasks, we found that our image control accuracy was better than the 3D target accuracy reported in that study (on average from 32.0 mm to 90.3 mm) despite the fact that our interface did not rely on any gesture recognition algorithms.

Annop Gobhiran,Daorutchada ,Wongjunda,Kraiyot Kiatsoontorn, Theekapun Charoenpong.”Hand Movement-Controlled Image Viewer in an Operating Room by Using Hand Movement Pattern Code”.

In practice, to keep surgeons' hands sterilized, the surgeons will communicate with nurses or assistants to control the keyboard and computer mouse. To convey information between the surgeons and assistants by speaking dialogue is inaccurate, inconvenient, and ineffective . Therefore, a new system is necessary to serve surgeons to control images directly on the computer and also avoid contamination in the operating room.

In this section, a pattern code is considered. Many hand gesture analysis techniques are used to interface with a computer. One limitation of existing hand gesture method is that some existing commands need two hand gestures.

André Mewes,”Projector-based Augmented Reality and Touchless Interaction to Support MRI-Guided Interventions”.

These are either single RGB-cameras or range cameras, such as stereo, time-of-flight, or structured-light cameras. With an RGB camera, Wachs et al. detected hand gestures and postures by segmenting the hand in the image based on its colour from the background. The difference between two consecutive frames is computed and serves as a motion cue that can then be interpreted as a gesture.

While these are mostly operated without hands, the interventional control of medical image viewers is mainly focused on hand gestures in order to accurately convey the intended actions to the software. Wachs et al. presented a 5.1 G -C I R S camera-based hand gesture control for the exploration of medical images. Though, this system offers only a small set of gestures and lacks accuracy and robustness.

Ivica Klapan,”Utilization Of 3d Medical Imaging and Touch-Free Navigation in Endoscopic Surgery: Does our Current Technologic Advancement Represent the Future Innovative Contactless Noninvasive Surgery in Rhinology? What is Next?”

If in today's real world, without touching the screen during "in the air" contactless navigation surgery , if we enable "virtual listening and sensing" of 3D spatial data in the world of virtual diagnostics and surgery , which does not exist in reality , we will form a reaction of a human being (a surgeon) who thinks differently , has impulses and certain tendencies, -as a result, we define a completely new creative sense of understanding space and self-awareness. Of course, we are still not yet at the level of the brain-computer interface, but we are certainly able to use technology that can make invisible, visible to doctors/surgeons, i.e., to experience and understand what we cannot realistically see4, or what does not really exist.

Ahmed EzzatAlexandros Kogkas,Josephine Holt,George P Mylonas,"An eye-tracking based robotic scrub nurse: proof of concept".

The surgeon is able to access imaging using their hand gesture intra-operatively. Hand gesture is captured through a 2D Canon VC-C4 camera mounted on top of a flat screen monitor, in so designating predetermined hand gestures respective functions such as replacing or magnifying the image . In laparoscopic surgery using an ARD, such as the da Vinci® surgical robot, gives the surgeon seven degrees of freedom (DoF) compared to conventional four DoF; this represents the same range of a human wrist in open surgery.

Hairong Jiang,,,Bradley S Duerstock,Juan Wachs."Variability Analysis on Gestures for People With Quadriplegia".

Gesture-based interfaces have become an effective control modality within the human computer interaction realm to assist individuals with mobility impairments in accessing technologies for daily living to entertainment. Recent studies have shown that gesture-based interfaces in tandem with gaming consoles are being used to complement physical therapies at rehabilitation hospitals and in their homes. Because the motor movements of individuals with physical impairments are different from persons without disabilities, the gesture sets required to operate those interfaces must be customized. This limits significantly the number and quality of available software environments for users with motor impairments. Previous work presented an analytic approach to convert an existing gesture-based interface designed for individuals without disabilities to be usable by people with motor disabilities. The objective of this paper is to include gesture variability analysis into the existing framework using robotics as an additional validation framework. Based on this, a physical metric (referred as work) was empirically obtained to compare the physical effort of each gesture. An integration method was presented to determine the accessible gesture set based on stability and empirical robot execution. For all the gesture types, the accessible gestures were found to lie within 34% of the optimality of stability and work. Lastly, the gesture set determined by the proposed methodology was practically evaluated by target users in experiments while solving a spatial navigational problem.

Miroslav Bachinski.”Biomechanical models for human-computer interaction”.

Development of IMU-, camera-and depth-based motion tracking and gesture recognition technology allowed human-computer interaction to be shifted beyond the desktop and touch into mid-air. A large number of recent works propose mid-air interfaces, which bring benefits to users where touching a computer is not acceptable (medical setting, surgery), regular 2-D touch interaction is not comfortable (large display environments, 3D interaction, remote interaction, smartwatch interaction), touch interaction is not hygienic due to too many users (outdoor interactive public displays), specific movements are desired (rehabilitation, exergaming), the movements provide a more natural communication channel (human-robot interaction), or mid-air interactions better map to physical world movements and could be more fun (sports games for Microsoft Kinect, PlayStation Move, Nintendo Wii). Unfortunately, most current papers propose an interface or interaction technique without proper evaluation and possibility to put them into context with other works with respect to ergonomics and performance.

Yuanyuan FengUchenna, A. Uchidiuno, Hamid Reza Zahiri, Helena M Mentis.”Comparison of Kinect and Leap Motion for Intraoperative Image Interaction.”

Often, stay sterile, surgeons rely on a third party (eg a nurse) to manipulate these images under their guidance leading to errors and delays. 1 With the rising use of imaging systems in the OR and a need for surgeons to maintain direct control over image manipulation, a number of studies have proposed the use of touchless interaction devices (ie voice and/or gesture) as a replacement for intraoperatively manipulating medical images with a mouse, stylus, or touchscreen, which cannot be guaranteed to be sterile. These studies have further shown that touchless devices provide a benefit to surgeons in being able to access and gain knowledge from medical images during the course of a surgery. Touchless interaction devices have been shown to enable surgeons to be more autonomous in carrying out various image interaction tasks required during surgery, and this has led to further use of the images intraoperatively to support decision-making or instruction.

Rahul Taneja, Naveen Madapana, Glebys Gonzalez,Juan Wachs.”Preference Elicitation: Obtaining Gestural Guidelines for PACS in Neurosurgery”.

Accessing medical records is an integral part of neurosurgical procedures in the Operating Room (OR). Gestural interfaces can help reduce the risks for infections by allowing the surgical staff to browse Picture Archiving and Communication Systems (PACS) without touch. The main objectives of this work are to: a) Elicit gestures from neurosurgeons to analyze their preferences, b) Develop heuristics for gestural interfaces, and c) Produce a lexicon that maximizes surgeons' preferences. Materials and methods: A gesture elicitation study was conducted with nine neurosurgeons. Initially, subjects were asked to outline the gestures on a drawing board for each of the PACS commands. Next, the subjects performed one of three imaging tasks using gestures instead of the keyboard and mouse. Each gesture was annotated with respect to the presence/absence of gesture descriptors. Next, K-nearest neighbor approach was used to obtain the final lexicon that complies with the preferred/popular descriptors. Results: The elicitation study resulted in nine gesture lexicons, each comprised of 28 gestures. A paired t-test between the popularity of the overall gesture and the top three descriptors showed that the latter is significantly higher than the former (89.5%-59.7% vs 19.4%, $p < 0.001$), meaning more than half of the subjects agreed on these descriptors. Next, the gesture heuristics were generated for each command using the popular descriptors. Lastly, we developed a lexicon that complies with surgeons' preferences. Conclusions: Neurosurgeons do agree on fundamental characteristics of gestures to perform image manipulation tasks. The proposed heuristics could potentially guide the development of future gesture-based interaction of PACS for the OR.

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