HEALTH

1 | TOUCHLESS MEDICAL IMAGES INTERACTION IN SURGERY

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Surgeons are very interested in the new human-machine interface solutions recently marketed. They are particularly attracted by the potential applications using augmented reality systems and depth sensors **[1]**. However, these interfaces, initially designed for games, are not directly usable in the operating rooms. The problem may be on the hardware side. For example, it is difficult to imagine a surgeon wearing Microsoft HoloLens during an entire surgical operation, because this device hides part of the view and because it is too uncomfortable to wear for several hours. The software side can also create difficulties because these devices are usually provided with their own Software Development Kit (SDK), but these SDKs are rarely multiplatform and open source. Finally, there may be incompatibilities with the aseptic rules. Surgeons and engineers therefore need to work together to design solutions.

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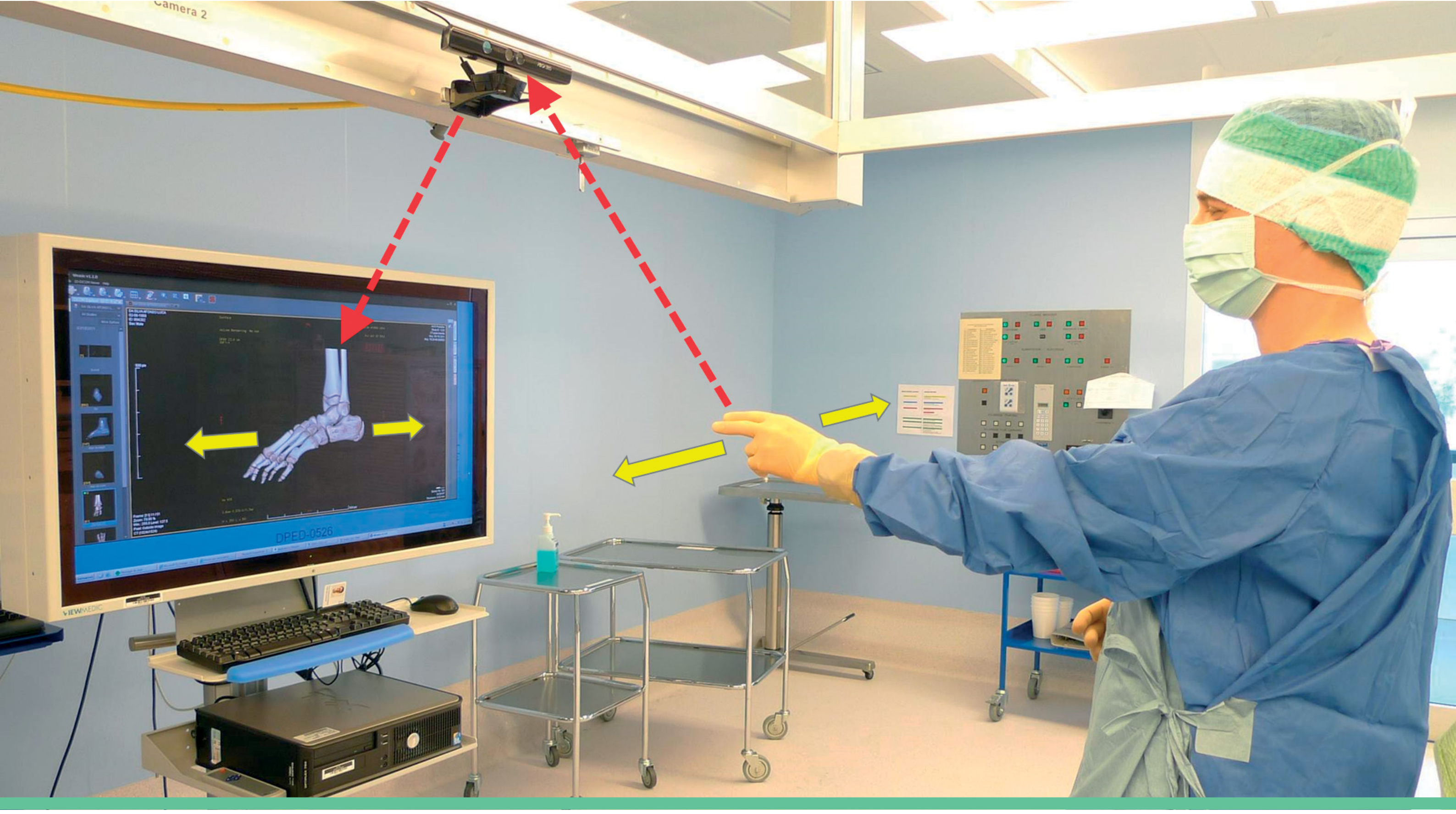
In this paper, we present the on-going work carried out by Hepia engineers and HUG surgeons to solve an issue related to the manipulation of radiological images. Currently, each time the surgeon needs to change the displayed images of his patient during a surgery, he must touch a computer keyboard or a mouse. Then, before proceeding the surgical operation, the surgeon must perform a sterilization procedure (wash the hands and pull new gloves on) increasing the surgery time and contamination risks for the patient. An alternative solution consists in dictating the manipulations to an assistant, but it is not practical either. In **[2]**, HUG surgeons showed, with a first prototype developed by Hepia engineers, that using a touchless user interface based on a depth sensor is a good solution. The whole team has therefore continued developing this prototype named KiOP (contraction for Kinect Operating room).

For the development of this touchless interface, the constraints imposed by its integration in surgery are the following. Due to the ambient noise and for sterility reasons, the viewer should be controlled by gestures without markers. Because surgery can take hours, the gestures must be as effortless as possible. To reduce the surgeon learning time, the user interface should be particularly intuitive. Finally, to ensure the system usability and real interest, gesture recognition must be excellent. Indeed, errors in detecting gestures in a video game are annoying but acceptable, whereas in the operating room, the surgeons have no time to deal with bad gesture recognition.



Regarding the depth sensor, we chose to develop our gesture-based interaction system with the Microsoft Kinect sensor 2.0, as its wide field of view allows to track the surgeon inside the sterility area from an outside point of view. Moreover, the Kinect 2, based on time of flight technology (ToF), shows better performance in the high-brightness operating room environment and higher resolution depth data than camera based on structured light technology (e.g. Kinect 1.0) **[3]**.

The most challenging part of this project is about the surgeon hand tracking robustness. When we detect a problematic situation, we increase the robustness of our software either with image processing algorithms or by adding feedback information to the user.

In conclusion, the new human-machine interface coming from games can have very useful applications in the surgery field. In this paper, we presented a work regarding tool development to assist surgeons in their work with a Kinect 2 sensor. In future work, we would like to use such human-machine device in surgeon training application. In **[4]**, K. Kahol and M. Smith showed that game devices can contribute to develop surgeon dexterity in a playful way. In **[5]**, D. Chevallier presented the current need to develop serious games dedicated to surgeon, particularly to learn and practice technical gestures.

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