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Plantar pressure-based gestures for medical image manipulation

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Motivation and Goal

Due to the need of maintaining sterility, computer interaction during image-guided surgical procedures is heavily constrained. Often both hands of the leading surgeon are occupied and therefore interaction tasks are allocated to surgical assistants. This demands clear instructions from the leading surgeon and requires more time [1]. Several publications propose touch-less interaction using foot gestures [2]. Plantar pressure has been used to perform foot gestures in a subtle way and to identify different users and surfaces while walking [3,4]. In Hatscher et al. 2017 a prototype shoe with a mounted distance sensor and a gyroscope has been built. An image viewer is manipulated using solely heel rotation and ball lifting/tapping. Based on a similar approach, we use a pressure-sensitive insole to manipulate an image viewer. The interaction is focused on scrolling up and down. The purpose of this project was to estimate how suitable and user-friendly different foot gestures are in practice.

Methods

Tasks

- Selection of an 2D slice in an image viewer
- De-/activation of the system

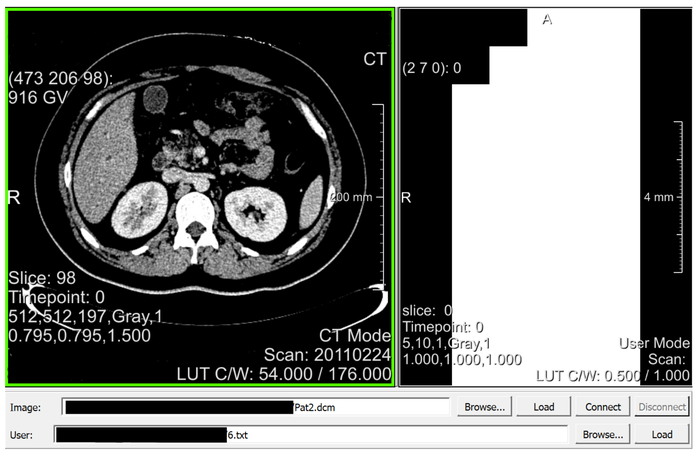
Interactions:

1. Activating the viewer: pressure on the big toe, while lifting the heel completely
2. Deactivating the viewer: pressure on, while lifting the ball of the foot completely
3. Increasing the slice number: shifting weight to the ball of the foot
4. Decreasing the slice number: shifting weight to the back of the foot

In order to recognize the gestures, an insole with 50 sensors is used. Those sensors are grouped into 4 distinct areas.

Pressure areas and mapping of the four gestures
From left to right: defined four sensor areas, activation, deactivation, increase, decrease

Depending on the size, weight and personal variety of applying pressure, different output data has to be interpreted and integrated into the system. In order to achieve this, a calibration step has been integrated. During calibration the user is instructed to perform each foot gesture for three seconds.

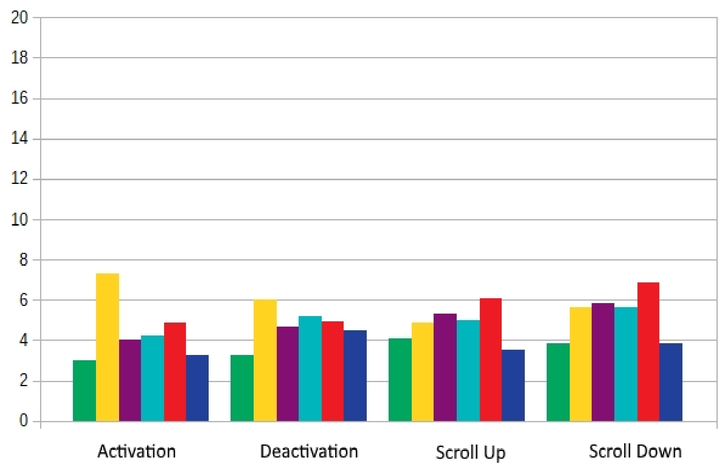


Graphical Interface: On the left side the medical imaga data is presented. The green border indicates successful activation. On the right side the black tiles in the upper left symbolize pressure applied by the big toe

Insole „PlantaPress“ by Thorsis Technologies GmbH

Results

- NASA-TLX evaluation of 14 student participants performing 8 tasks
- Participants first had to activate the system, scroll down, scroll up and decativate the system.
- Afterwards they had to activate the system, scroll up to a specific slice, scroll down to another specified slice and deactivate



Mean results for NASA-TLX questionnaire for the dimensions Mental Demand (MD), Physical Demand (PD), Temporal Demand (TD), Performance (P), Effort (E) and Frustration (F).
0 = low/god,
20 = high/poor

Conclusion

Overall, the usage of plantar pressure-based gestures have potential for manipulating medical images in a surgical set up. The physical demand is relatively low and intuitive for scrolling up and down. However, the experiment has also shown the need for a better calibration and the need for different activation/deactivation schemes. The deactivation gesture and the scroll down gesture share some of the same sensor activity, which lead to multiple unintentional slice number changes right before the deactivation. Therefore, deactivation and activation should be triggered with different modalities.

References

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