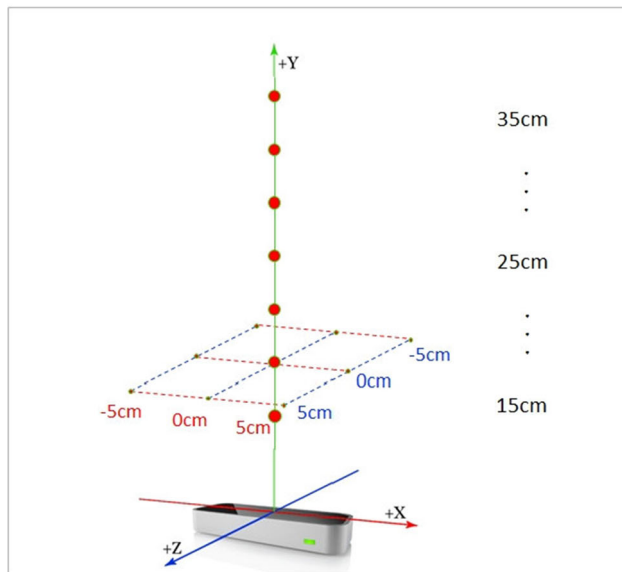


(a)



(b)

Fig. 2 Standard deviation in XZ-plane

The behavior of the sensor resembles to a touchscreen, where the range of action in the Z-Axis (depth) is much shorter than in the X and Y-Axis (width and height).

Conclusions

After evaluating and comparing the outcomes of the tests, it can be concluded that the characteristics and properties of the LEAP are suitable and reliable to be implemented in medical environments. Moreover, the analysis of the influence of a plastic coating on the sensor returned positive results. The functionality of the controller is not affected in a greater manner with the use of the plastic film. The coating protects the OR from any contaminants brought by the sensor, and increases its service life.

Taking under consideration the obtained results, and to exploit the whole potential of the sensor, it is recommendable to limit the area of usage to heights not >25 cm above the sensor. Likewise, is suggested the addition of the hands image moving in the area of action in future implementations,

potentially enhancing the accuracy of the device. This way the user can look if his hand is in the right position to make the desired gesture.

As future work it's recommended to perform tests with different types of lightning.

References

- [1] A. Bigdelou, L. A. Schwarz, N. Navab. An Adaptive Solution for Intra-Operative Gesture-based Human-Machine Interaction. 2012.
- [2] Weichert, F.; Bachmann D. Analysis of the Accuracy and Robustness of the Leap Motion Controller. Sensors 2013.
- [3] J. Wachs, H. Stern, Y. Edan, M. Gillam, C. Feied, M. Smith, J. Handler. Real-Time Hand Gesture Interface for Browsing Medical Images. 2007.

Usability evaluation of a mobile application for medical image viewing and planning in liver surgery

D. Baumann¹, T. Winklehner¹, P. Tinguely², S. Weber¹

¹University of Bern, ARTORG Center for Biomedical Engineering Research, Bern, Switzerland;

²Department Visceral Surgery and Medicine, University Hospital Inselspital Bern, Bern, Switzerland

Keywords Mobile computing device · Liver surgery · Image viewing · Surgical planning

Purpose

Medical image viewing and tasks based on it, such as surgical planning, are often restricted to be performed on dedicated workstations. This is due to the fact that specialized software and data access capabilities for such purposes have to be used.

Nowadays, rapid development in the field of mobile computing allows data access outside this limited environment. Mobile computing devices have sufficient computational power, screen resolution, and an intuitive user interface to create a new and efficient way of presenting medical data. In addition, most doctors are now accustomed to mobile computing devices, which makes it possible for them to use medical application tools on their tablets.

Therefore, the aim of this work is to investigate the usability of mobile devices for medical image data viewing and surgical planning tasks based thereon.

Methods

The usability of mobile devices for viewing medical images was evaluated using an existing application (Liver Viewer 3D, MeVis Medical Solutions, Bremen, Germany), which allows interactive viewing of anatomical models of the liver and its vascular structure on an iPad. This already existing application was extended with a module for viewing of DICOM data. In addition, a module for resection and ablation planning for open liver surgery was enclosed to evaluate surgical planning tasks.

Consequently, the evaluated application is arranged in three modules, which are the previously existing 3D viewer, a DICOM viewer and a planning module. The 3D viewer module allows the user to interactively view 3D anatomical models of the liver and its vascular structure by rotating the models, zoom in and out on them and turn on and off different structures.

The additionally developed DICOM viewer module enables the viewing of 2D medical images and segmentation masks used for generation of the 3D models. Brightness and contrast of the displayed image can be adjusted through a single finger swipe. Technically this is realized through window leveling, which is computed on the GPU to allow for fast setting of the parameters via touch gestures. An additional button, which also can be evoked through a touch gesture, allows the user to choose among different predefined window level settings.

In the planning module, the user can choose between resection and ablation planning. For ablation planning a simple touch guided procedure is used to select a tumor, display an ablation tool and its respective ablation

volume and adjust the tool rotation. For resection planning, a virtual cut has to be drawn on the surface of the liver, according to which a plane indicating the resection surface is generated. The user is able to further adjust the deformation of the plane to include or remove virtual tissue. Finally the resected volume can be computed and visualized (Figs. 1, 2).

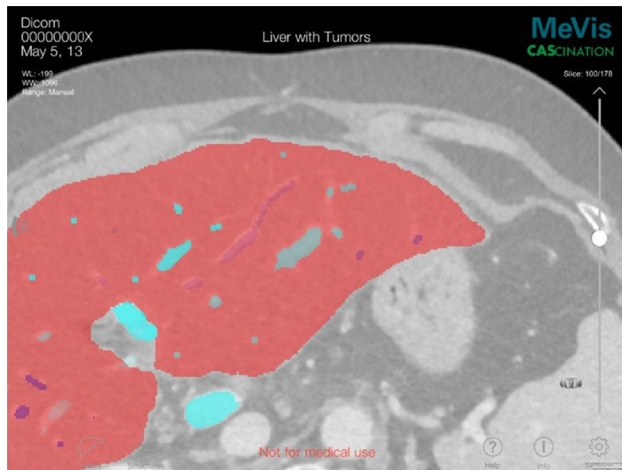


Fig. 1 DICOM image with segmentation masks in the DICOM viewer module

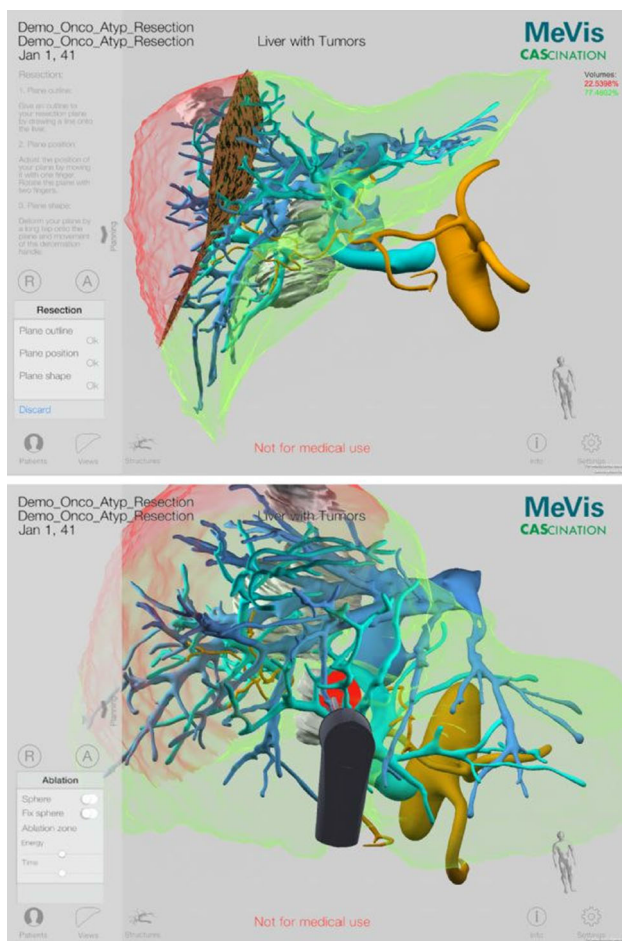


Fig. 2 *Top* Resection proposal planned and computed on the mobile device. *Bottom* Ablation planning in the planning module

The entire application was developed using the cross-platform game-engine Unity and inbound C# scripts. Three-dimensional anatomical models and the representative two-dimensional images were generated by MeVis Medical Solutions (Bremen).

The usability study was conducted with 11 test users, including three medical doctors performing or planning liver surgeries.

Results

The DICOM viewer module was first evaluated. A SUS (system usability scale) score [1] of 86.6 points (t-confidence interval of 5.22) or a transformed usability ranking (TUR) of 98 % compared to a total of 500 usability studies was reached [2]. The SUS score measured with medical doctors (mean SUS = 79.2, 95 % t-confidence interval 25.1, TUR = 86 %, 3 testers) was significantly lower compared to other testers (mean SUS = 89.4, 95 % t-confidence interval 4.1, TUR = 99 %, 8 testers).

Evaluation of the module for surgical planning showed sufficient computational capacity of mobile devices for the tested tasks. Testing of the ease of use showed no need for further instructions to guide the planning tools, indicating that the module is intuitive to use for the users.

Conclusions

By evaluating an available image viewing application with extended DICOM display functionality and surgical planning functions developed in this work, we show that mobile computing devices have good usability for viewing medical image data and performing surgical planning tasks based on their computational power, display resolution and user interface. Their portability, accessibility to data and user interaction modes create a new way of medical data visualization and task processing, which shows a great potential for large scale clinical impact.

Future work will focus on more tests with clinicians as well as a quantitative validation of the surgical planning module.

References

- [1] J. Brooke. SUS - A quick and dirty usability scale. Usability evaluation in industry, 1996.
- [2] J. Sauro and J. R. Lewis. Quantifying the user experience - Practical statistics for user research. Morgan Kaufmann, 2012.

Wireless surgical navigation system with high-resolution images by non-rigid registration of pre- and intra-operative MR images in neurosurgery

H. Shibata¹, I. Sato¹, Y. Fujino¹, T. Suzuki², Y. Muragaki², K. Masamune²

¹Future University Hakodate, Hakodate, Japan; ²Tokyo Women's Medical University, Tokyo, Japan

Keywords Surgical navigation system · Non rigid registration · Wi-Fi · Multimodality

Purpose

Introduction of the intelligent operating room, which includes an open MRI instrument for use during neurosurgical procedures, has allowed for the confirmation of residual tumors and has facilitated surgical navigation using intra-operative MR images corresponding to brain shifts. However, despite introduction of this technology, the 5-year survival rate for patients with high-grade tumors remains insufficient. Thus, operation support with high-resolution images and an easily available support system are expected to improve to complete resection rate of malignant tumors. For operation support with high-resolution images, the use of a surgical navigation system with pre-operative images corresponding to the brain shift may be useful for achieving non-rigid body registration of the pre- and intra-operative images [1]. In addition, as an easily applicable robust system, we have suggested the use of a multi-wireless surgical navigation system [2].