NeckVeins - An Interactive 3D Visualisation of Head Veins

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Abstract. In this paper we present an application for visualizing 3D medical data with possibility of displaying the data in 3D stereoscopic mode. The application consists of several parts designated for: reading the raw medical data, background removal from the data, 3D model creation and visualization of the data with possible adaptations such as subdivisions, different shading etc. It allows user to use 3D mouse as input device for navigation in addition to regular input devices. Design of application is generic and can be easily adapted for presenting different types of content. It allows user to read raw data as obtained from medical imaging machines or post-processed data in form of 3D models. It allows user to use the computational power of modern graphical process units to speed some steps of 3D model calculation process. There are still many possible improvement of the application that are planned for future work.

Keywords: HCI, medical visualization, 3D vizualization, stereo imaging, 3D mouse

1 Introduction

With development of imaging technologies more and more data is available to the physicians as support in medical procedures. 3D imaging allows physicians to get the 3D view inside of human body. Since the beginning in 1991, volumetric CT scanning has resulted in a revolution for diagnostic imaging [1, 2]. With use of different improvements one has possibility to mark only certain tissue type in a body, which shows as specific values in the data. By segmenting the data and only selecting the parts of interest one can obtain the 3D representation of individual parts of human tissue. Such imaging technology can be helpful in minimally invasive endovascular image-guided interventions for treating different cerebrovascular conditions. The data can also be used in combination with 2D x-ray imaging as presented in [3].

2   Application

Idea of the developed application is to create the visualization platform for displaying 3D data from individual patients - in our case the data represents blood vessel in head of the patient, which would be used for search of aneurysms. In first step the developed application allowed the visualization of precomputed patients data where 3D images were already segmented and only model of patient's head vessel was imported and displayed. Later on many extensions of original application were developed where different functionalities were implemented such as support for 3D stereoscopic display of 3D data, 3D mouse integration for more natural interaction with the model of vessels, implementation of segmentation algorithm and creation of 3D model on GPU for faster performance. All extensions are shortly presented in following sections.

Application is developed under open source licence and is hosted in online repository GitHub under name NeckVeins[1]. The application can be downloaded and tested, however the data is not available due to patient confidentiality. We also invite new developers to contribute their share in extending and improving the applications.
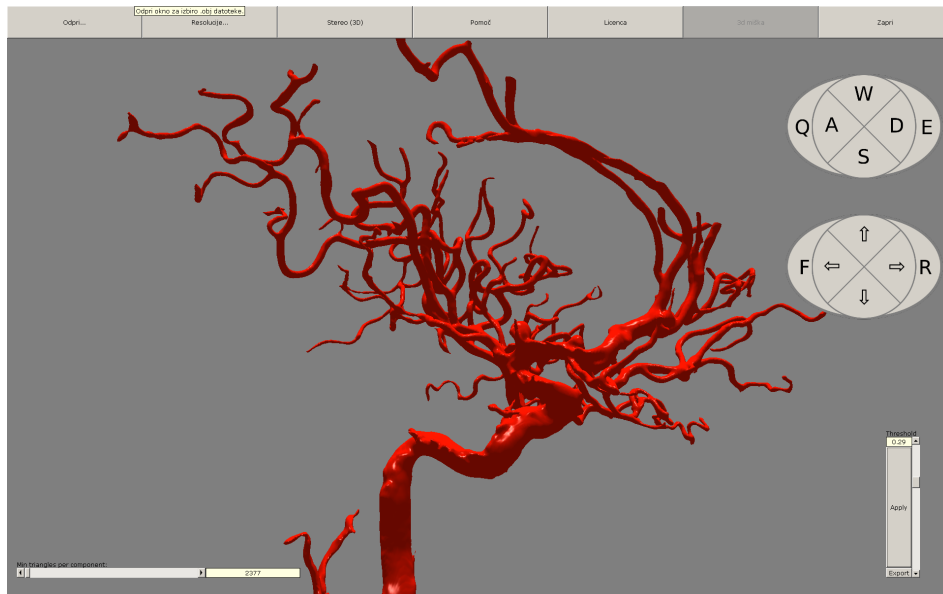

Fig. 1. Image displays the application and its user interface.

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[1] https://github.com/asodja/Neck_Veins

2.1 3D stereo visualization

For more realistic view of blood vessels, we have extended the application with 3D stereoscopic option of displaying the image. For such use one must have special 3D monitor that allows stereoscopic presentation. Since we are aiming for general use with different users we have allowed option of using monitors of different sizes as well as adjustable interpupillary distance. More on basic application and 3D stereo visualization extension can be found in [5].
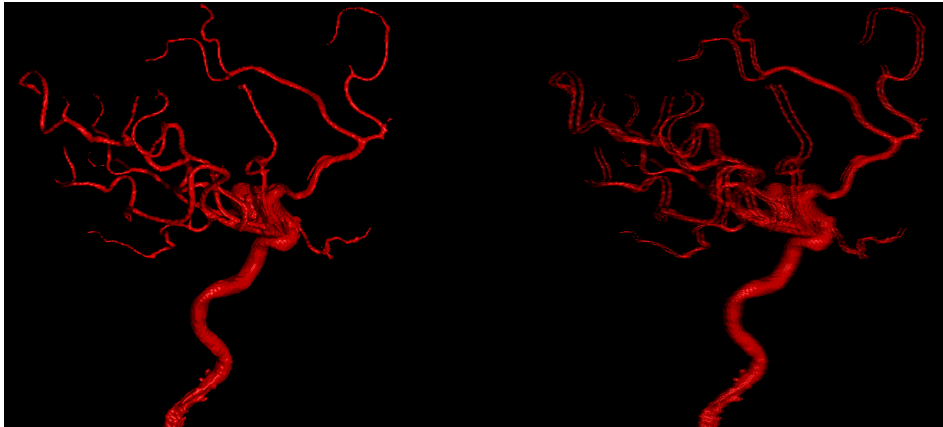

Fig. 2. Images display regular display of blood vessel in head (left) and stereoscopic display (right).

2.2 3D mouse integration

One of the extensions for better user experience was implementation of support for 3D mouse, an input device with 6 degrees of interaction. One can map all the standard translations and rotations on 3D mouse input actions. While at first glance the implementation was straight forward, we had to overcome the gimbal lock problem as well as add support for rotation around local and world coordinate axes and adding sensitivity support.

2.3 GPU computation integration

One of key features was that application should allow reading native raw data that is obtained from the 3D machine. Reading and parsing the data was first step. Next we implemented the segmentation algorithm by applying Gaussian filter and subdividing the data. Next the simple thresholding method was used for distinguish between relevant data and the background. More details on the method can be found in [3].

The implementation was first implemented in Java, but was later re-implemented to run on GPU due to better performance. The speedup was up to 30-times the original implementation. The implementation was done in OpenCL and adapted for use on multiple graphics hardware. This allowed us to implement real-time feedback on parameter changes, which was not possible with regular implementation. More on implementation can be found in [4].

3   Conclusions and Future Work

The target use of presented application is to help physicians with diagnosis of aneurysms and with preparations for surgical procedures. Application is still under development. Physicians are testing the user experience with application and are presenting new ideas of what could be improved or added to current application. Some future ideas include implementation of projecting 2D x-ray images on 3D models obtained by 3D imaging and aligning the images in real time.

4   Acknowledgment

The product is result of several students as part of their work on Bachelor thesis. The software will be further developed with help of new students in the coming years. We would also like to thank the Laboratory of Imaging Technologies from Faculty of Electrical Engineering at University of Ljubljana. Software was developed as part of collaboration with University Medical Centre Ljubljana.

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