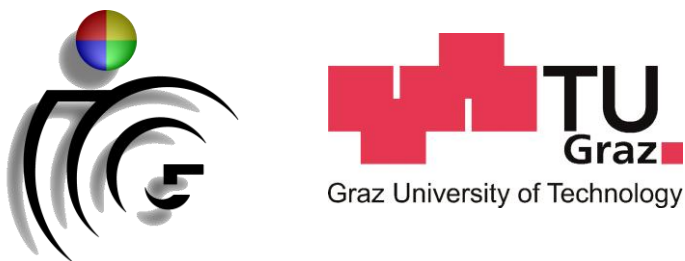


# A Client/Server based Online Environment for the Calculation of Medical Segmentation Scores



Maximilian Weber <sup>a,b</sup>, Daniel Wild <sup>a,b</sup>, Jürgen Wallner <sup>b,c</sup>, Jan Egger <sup>a,b,c</sup>



<sup>a</sup> Institute for Computer Graphics and Vision, TU Graz, Inffeldgasse 16, 8010 Graz, Austria

<sup>b</sup> Computer Algorithms for Medicine Laboratory, Graz, Austria

<sup>c</sup> Dept. of Oral and Maxillofacial Surgery, Med Uni Graz, Auenbruggerplatz 5/1, 8036 Graz, Austria



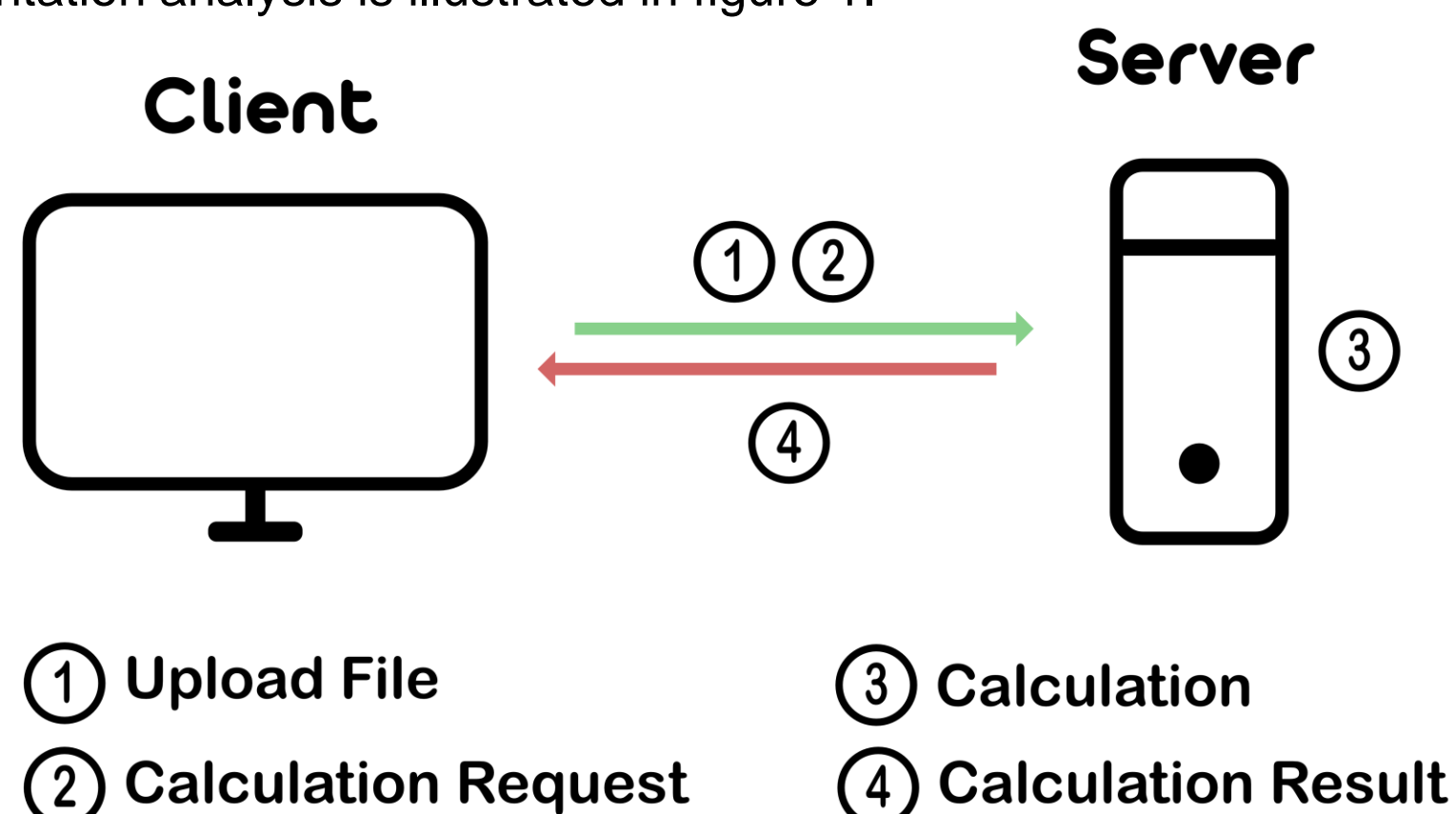
## Introduction

Medical image processing covers a wide range of applications [1]. An important part of these applications is medical image segmentation [2]-[4]. Medical image segmentation algorithms are needed to evaluate and compare segmentations. These algorithms are used and proven for years in all different fields of image processing.

Although image segmentation has grown rapidly in medicine a major part of the tools and applications stayed the same for years. Especially in terms of availability, cross-platform support and usability there is major room for improvements. This contribution aims to remedy the mentioned problems by the development of a cross-platform web-tool for manual image segmentation and calculation of segmentation scores.

## Methods

The decision was made to develop a web tool to ensure multi-platform usage. Since the calculation of the segmentation scores cannot be done client-sided, the development splits into a client and a server part. A concept of how the communication between client and server looks like when performing an image segmentation analysis is illustrated in figure 1.



**Figure 1** – Client-Server communication implementation. The client can send requests to the server via the web-interface.

The client part of the tool is a simple web-interface. It is a part of the research tool ‘Studierfenster’ (<http://studierfenster.at>). One should have the possibility to calculate the Hausdorff Distance (HD) [5] and Dice Similarity Coefficient (DSC) [6] values out of two medical image volumes directly on the webpage. For the volume files only the file-format NRRD is accepted because of the benefit, that the medical image does not contain personal data of the patients in the file meta-data.

As Server environment the Python framework Flask (<http://flask.pocoo.org/>) is used. The communication is handled via AJAX requests. For the HD and DSC calculation, the Insight Segmentation and Registration Toolkit (ITK) (<https://itk.org/>) and SimpleITK (<https://simpleitk.org/>) are used.



## Acknowledgements

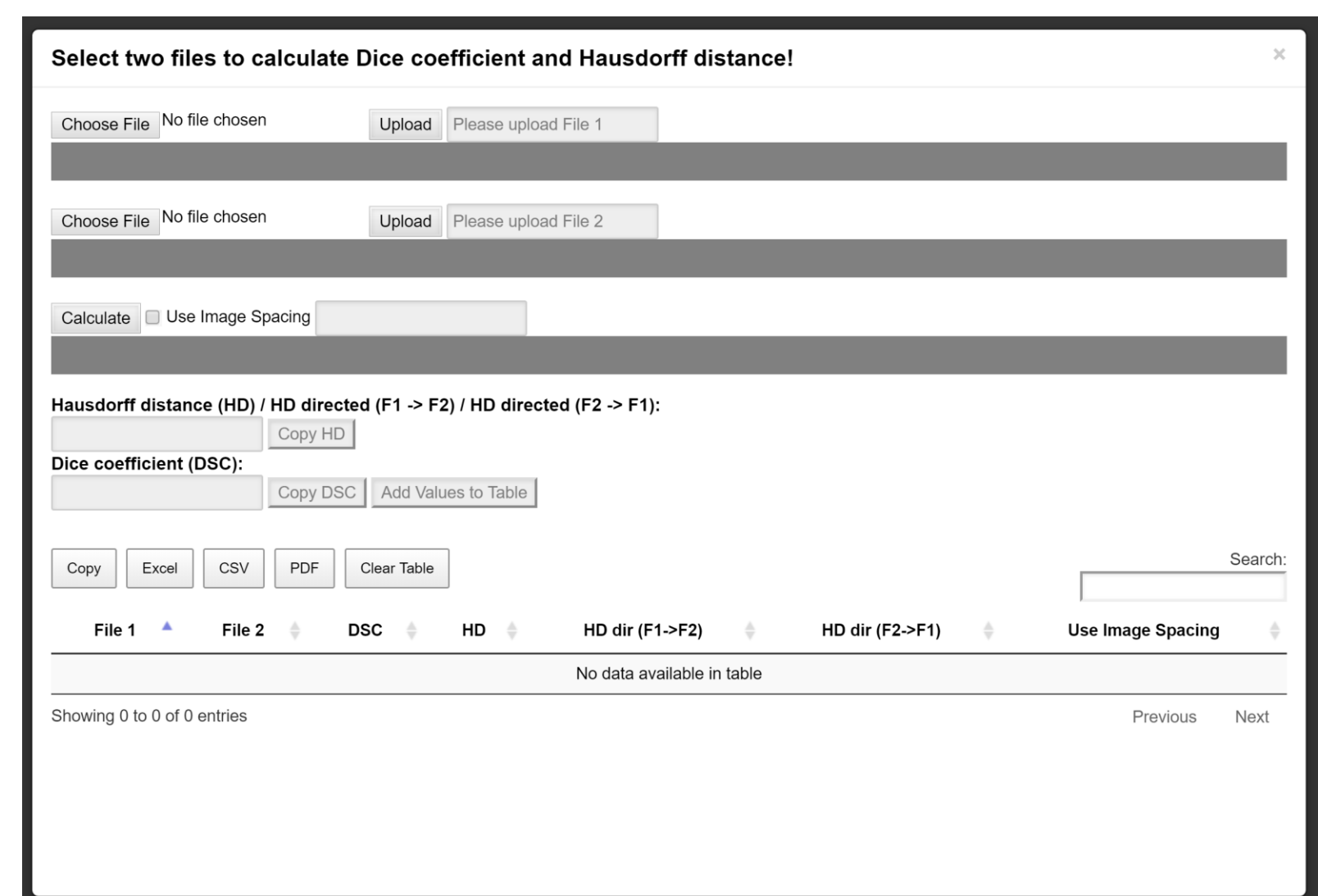
The work received funding from the Austrian Science Fund (FWF) KLI 678-B31: “enFaced: Virtual and Augmented Reality Training and Navigation Module for 3D-Printed Facial Defect Reconstructions” (Principal Investigators: Drs. Jan Egger & Jürgen Wallner), the TU Graz Lead Project (Mechanics, Modeling and Simulation of Aortic Dissection), CAMed (COMET K-Project 871132), which is funded by the Austrian Federal Ministry of Transport, Innovation and Technology (BMVIT) and the Austrian Federal Ministry for Digital and Economic Affairs (BMDW) and the Styrian Business Promotion Agency (SFG), and the Summer Bachelor Program from the Institute of Computer Graphics and Vision of the TU Graz.

## References

- G. Dougherty, “Medical Image Processing: Techniques and Applications (Biological and Medical Physics, Biomedical Engineering),” 2011th Edition, ISBN-13: 978-1441997692, 2011.
- T. Kapur, et al. “Registration and Segmentation for Image Guided Therapy,” Ferenc A. Jolesz (Ed.), Springer, pp. 79-91, ISBN: 978-1-4614-7656-6 (Print) 978-1-4614-7657-3 (Online), 2014.
- J. Egger, et al. “Interactive volumetry of liver ablation zones,” Sci. Rep. 5, 15373, 2015.
- K. Greiner, et al., “Segmentation of Aortic Aneurysms in CTA Images,” Proceedings of Bildverarbeitung für die Medizin (BVM), Berlin, Germany, Springer Press, pp. 51-55, 2008.
- F. Hausdorff, “Grundzüge der Mengenlehre,” Veit & Comp., Leipzig 1914 (rep. in Srishti D. Chatterji et al. (Hrsg.), Gesammelte Werke, Band II, Springer, Berlin, ISBN 3-540-42224-2, 2002.
- M. P. Sampat, et al. “Measuring intra- and inter-observer agreement in identifying and localizing structures in medical images,” IEEE Inter Conf Image Processing, 4 pages, 2006.
- Studierfenster, YouTube Channel, <https://www.youtube.com/channel/UCSe-q1nicDVwC550dngQT2w>
- J. Wallner and J. Egger, “Mandibular CT Dataset Collection,” Figshare, 2018. [https://figshare.com/articles/Mandibular\\_CT\\_Dataset\\_Collection/6167726](https://figshare.com/articles/Mandibular_CT_Dataset_Collection/6167726)
- T. S. Yoo, et al. “Engineering and algorithm design for an image processing Api: a technical report on ITK—the Insight Toolkit,” Stud Health Technol Inform. 85: 586-92, 2002.
- E. L. Spangler, et al. “Evaluation of internal carotid artery segmentation by InsightSNAP,” Proceedings of SPIE. 6512 (5): 65123F, 2007.

## Results

Figure 2 presents the implemented client of the tool. The following functionalities were implemented for the calculation analysis: an uploading interface with the possibility to upload two files at a time, a calculation output, the possibility of a tabular view of different results, search functionality through the different calculations in the tables, different export possibilities for the tables and the automatic deletion of the uploaded files after the calculation.



**Figure 2** – Client implementation of the tool. Two NRRD files can be uploaded via the file upload forms. The results of the calculation are displayed in the corresponding HD and DSC fields and can be added to an overview table.

When the calculation is finished the results can be added to a table. The table can be filtered and can then be exported into an Excel, PDF or CSV file. Tutorial videos of the tool can be found at [7].

To get information about the calculation accuracy of the developed tool, results of the HD and DSC calculation of this tool were compared to the results of the HD and DSC calculation of a widely used medical imaging tool (MeVisLab). The data used for the comparison are mandibular Computed Tomography (CT) files which can be found at [8]. The dataset contains CT scans from ten anonymized patients. From these datasets the mandible has been segmented by two specialists. The developed tool delivers the exact same metric results as widely used desktop applications. This is a basic requirement and necessary for a practical application.

## Conclusions

Taking all the results into account, the targeted goal of this contribution was reached. A platform independent tool for the calculation of segmentation scores has been developed and evaluated. For basic tasks and training the tool is already ready for usage and can be accessed worldwide via a standard web browser from a desktop PC, smartphone or tablet. There are several areas of future work, for example, providing more ITK and VTK functionalities within our tool to the end user [9]. This could be advanced segmentation and registration algorithms that are already implemented within these libraries, like ITK-SNAP [10]. Furthermore, incorporating other research groups and collaborators to add more functionalities to Studierfenster, thus providing their research findings to a broader audience.