

Dental Implant Planning in EasyVision

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Introduction

This work is part of the EC funded PISA project which aims at the development of tools for design and manufacturing of Personalized Implants and Surgical Aids. Sub-optimal implant positioning is a major reason for implant failure and (too) early revision. Although planning is possible to various extends on currently available systems, there is in general no means to transfer the planning to the patient. The PISA project covers the transfer to the patient as well as the planning. Within this project, PMS focused on dental implant planning and design of appropriate drill guides to transfer the planning to the patient. A prototype application was developed on our EasyVision clinical workstation, which includes the following steps:

Segmentation

Various semi-automatic tools are available to obtain a desired segmentation result including thresholding, region growing and watershed separation. If required, the result of these semi-automatic tools can be manually edited and refined in a user friendly and interactive way. Editing can be performed in 2D as well as in 3D.

Curved Path Definition

The first step is to define a suitable cross-sectional plane through the dataset, such that the relevant part of the mandible or maxilla is clearly visible (see figure 1). This base plane can have any orientation with respect to the original slices. Next, a smooth polybezier path, which passes approximately through the center of the bone, is created by a few mouse clicks. This results in the generation of a panoramic view on a curved plane through the created path and perpendicular to the selected base plane, as well as a number of cross-sections perpendicular to this base plane and also locally perpendicular to the curved panoramic plane.

Nerve Canal Modeling and Implant Positioning

If required, the lower alveolar nerve canal in the mandibula can be modeled and visualized, which is helpful to keep implants at a save distance from this nerve canal. Implants can be selected from a list of available models, for instance provided by a preferred supplier. An implant model is placed in initial position by a single mouse

click and can be manipulated to optimize the position. The various images give direct feedback to the user by showing cross-sections of CT data and implants, as well as 3D renderings of anatomy with implants (figure 1).

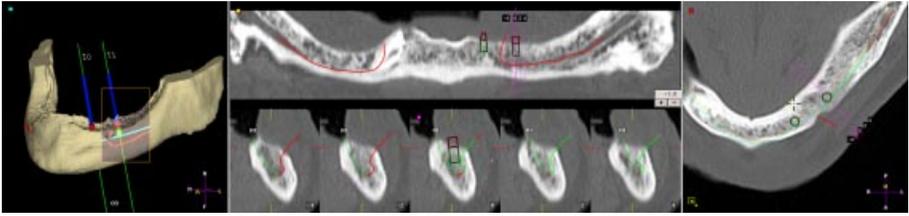


Fig. 1. The UI shows all relevant information: cross-sections of the implant models are shown together with Hounsfield values, 3D renderings and modeled mandibular nerve.

Drill Guide Generation and Interface to Manufacturer

When the implants are positioned optimally with respect to the anatomy and to each other, a drill guide can be generated (figure 2). This is an automatic procedure, which generates a complete CAD compatible description of a suitable drill guide shape, based on the planned positions and sizes of implants and an area of contact between bone and drill guide. The drill guide shape can be exported in STL format to any manufacturer.

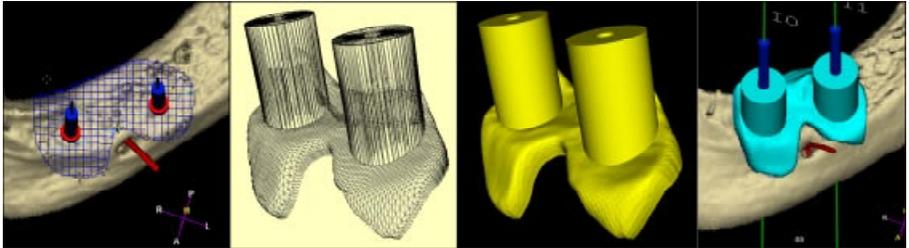


Fig. 2. From left to right: User-modifiable contact area, triangulated surface of automatically generated drill guide shape, same but shaded display, simulation of drill guide shape fitted on mandibula for inspection before manufacturing.

Conclusion

We have developed a prototype application for planning of dental implant placement, which can serve as a basis for surgical planning in a more general sense. The software was fully integrated in the EasyVision clinical workstation environment. Many of the tools, which were developed as part of this work, can be applied in a broader context within future EasyVision products. Examples of these are the functionality to visualize and manipulate triangulated surfaces in combination with voxel-based data, and the functionality for data exchange with CAD/CAM based environments.