Conversion of 2D medical scan data into 3D printed models

Eva Hnatkova, Petr Kratky and Zdenek Dvorak

***Abstract* -** This work deals with the possibility of using 2D medical image data acquired from computed tomography (CT) and magnetic resonance imaging (MRI) for 3D desing and modeling of implants and other medical applications. In this project the latest medical data processing software Mimics from Materialise was used to generate the 3D models of spinae vertebrae which was converted with CAD software into standard triangulated (STL) files. These highly accurate 3D models of anatomical structures in STL format served to create realistic tissue models using rapid prototyping technology.

***Keywords* -** computed tomography, magnetic resonance, 2D image data, 3D models, medical implants, rapid prototyping.

I. INTRODUCTION

PRODUCTION of anatomical part via rapid prototyping is a modern medical trend. This technology allows the printing of customised implants or the preoperative planning models from medical 2D scans [1-2]. In the past, the production of medical models of individual patient was very difficult, because of the complex geometry of the anatomical parts. Prior to rapid prototyping, medical implants were manufactured using pressing, forging, machining and casting processes. But these processes were expensive and also time-consuming. [3]

Nowadays, there exist special biomedical softwares, for example Mimics developed by Materialise, which can process 2D medical images, coming from computed tomography (CT), magnetic resonance imaging (MRI) or ultrasound, into 3D high accurate models of pacient anatomy. Figure 1 shows the medical image segmentation in Mimics software. [4-5]

II. EXPERIMENTAL PART

A. Medical input data

In this project, the real 2D medical images were used as the input data. This data was acquired from a tomograph at Tomas

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Bata regional hospital in Zlín. CT takes pictures of the body in particular slices and provides information on tissues in various locations. The examination outputs are 2D slices saved in stadardized format DICOM. These data could only be displayed as 2D or 3D preview in hospital software (Fig. 2). The previews are not available to any changes and for future work the data have to be adjusted in other software.
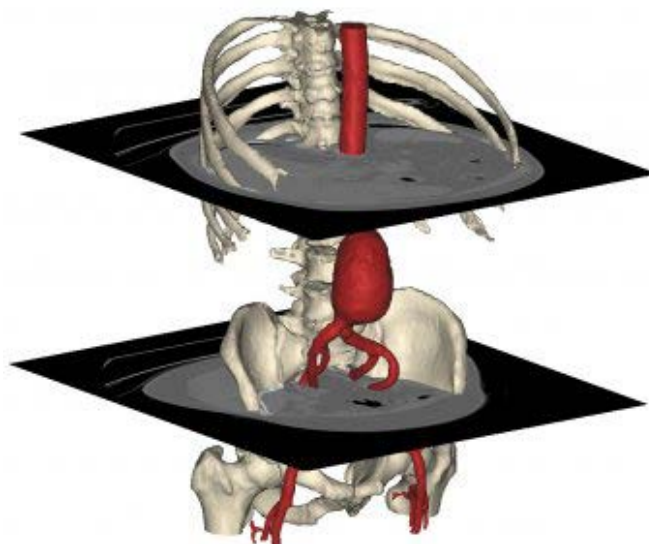

Fig. 1 Medical image segmentation (software Mimics) [6]

B. Preparation of 2D data

Firstly, the 2D image data from the CT had been prepared in Mimics software. The preparation included an upload of DICOM files and selection of analyzed tissue, which would be transferred to 3D model. In this moment, it was possible to get information about patient tissues from the neck to the pelvic. It was required to define the tissue location in any slice, then Mimics software could choose automatically the same tissue type in particular slices and created preview of 3D model.

The created 3D preview gives us information about approximate shape of all vertebrae (Fig. 3), but there are locations with lower density (displayed in dark colour) in particular slices because the vertebrae tissue density is not uniform. These tissues were not included in the selection; therefore, it was necessary to add them to the selection in particular slices. The rest of the directions was calculated. To demonstrate the preparation process, 2 vertebraes were chosen (Fig.4). The rest of the selection was removed away.
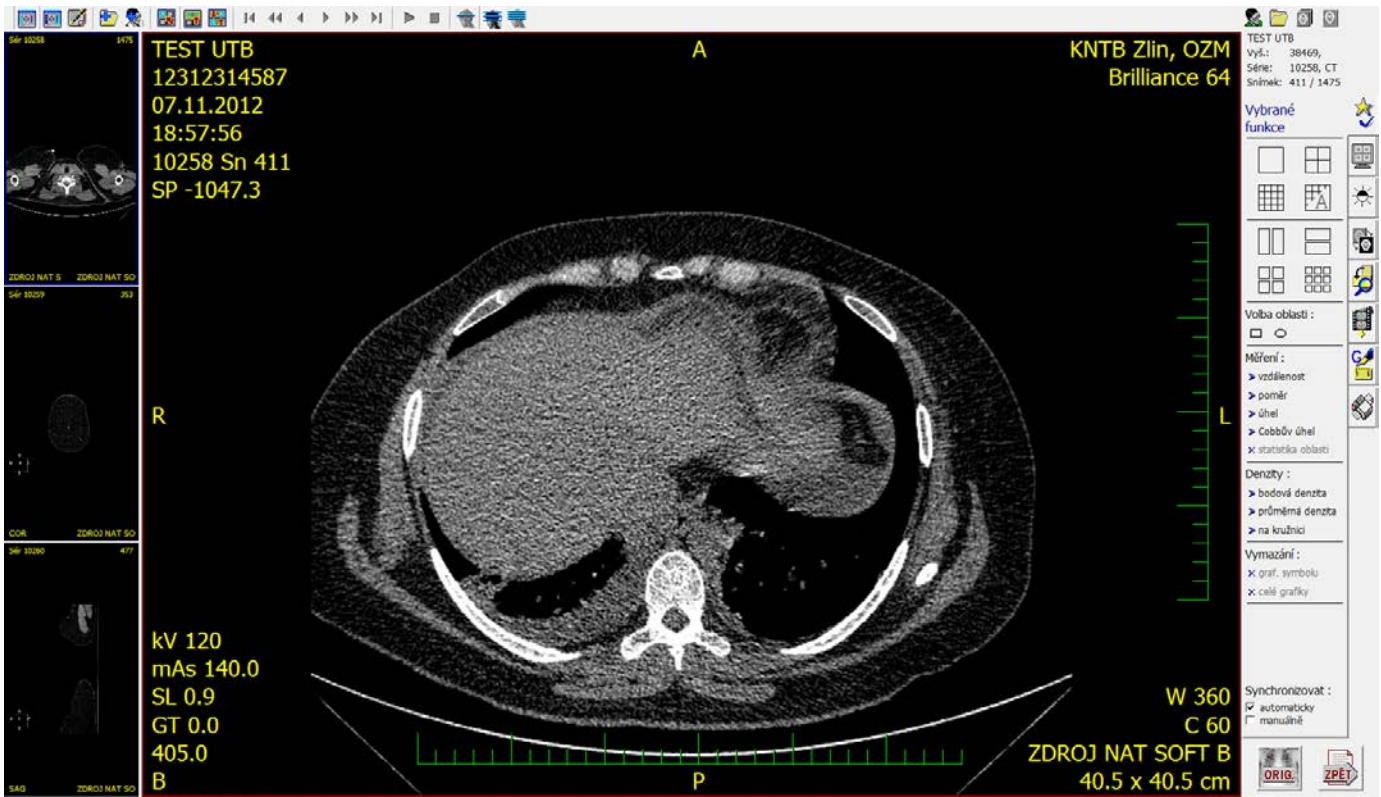
Fig. 2 Two dimensional scan slide after examination (in the hospital software)
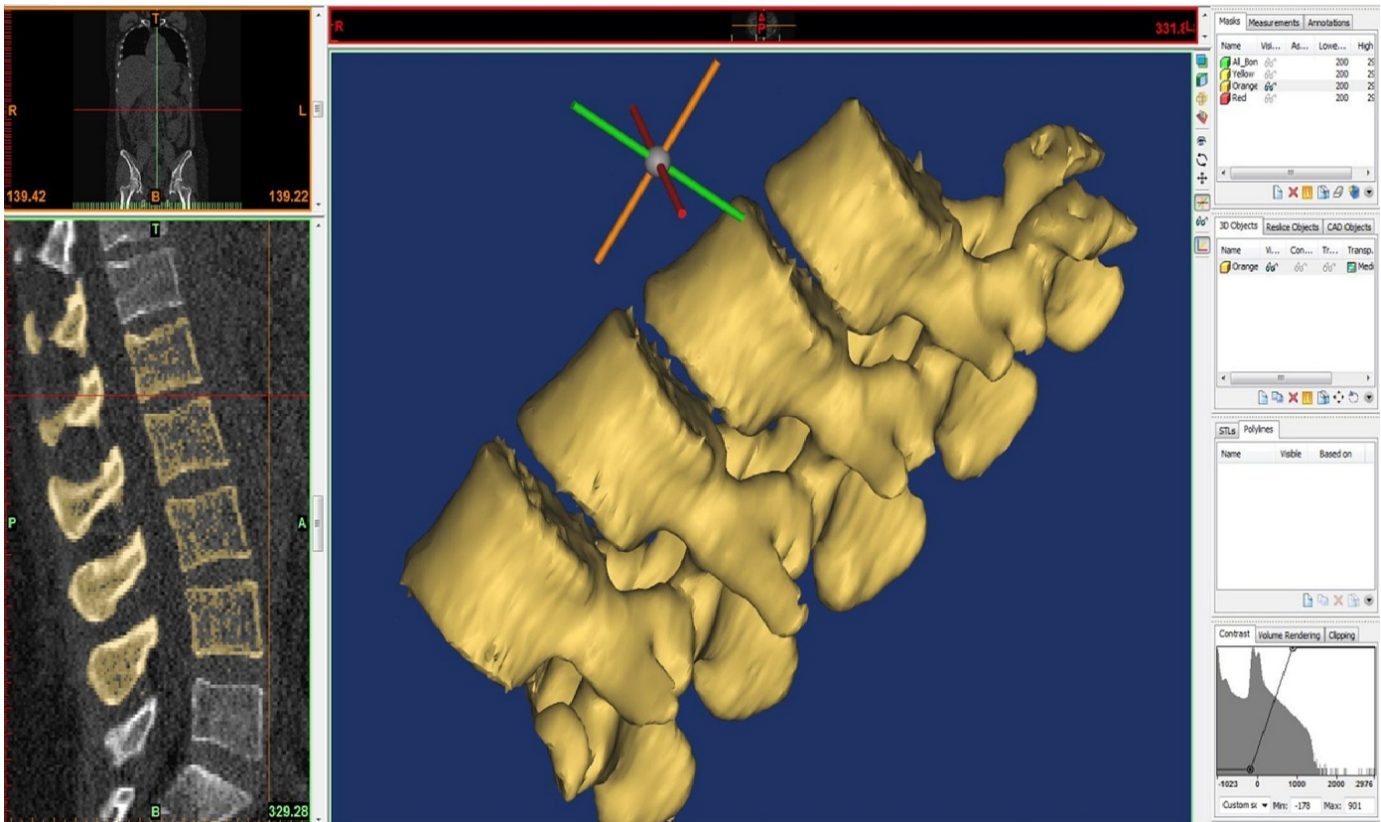

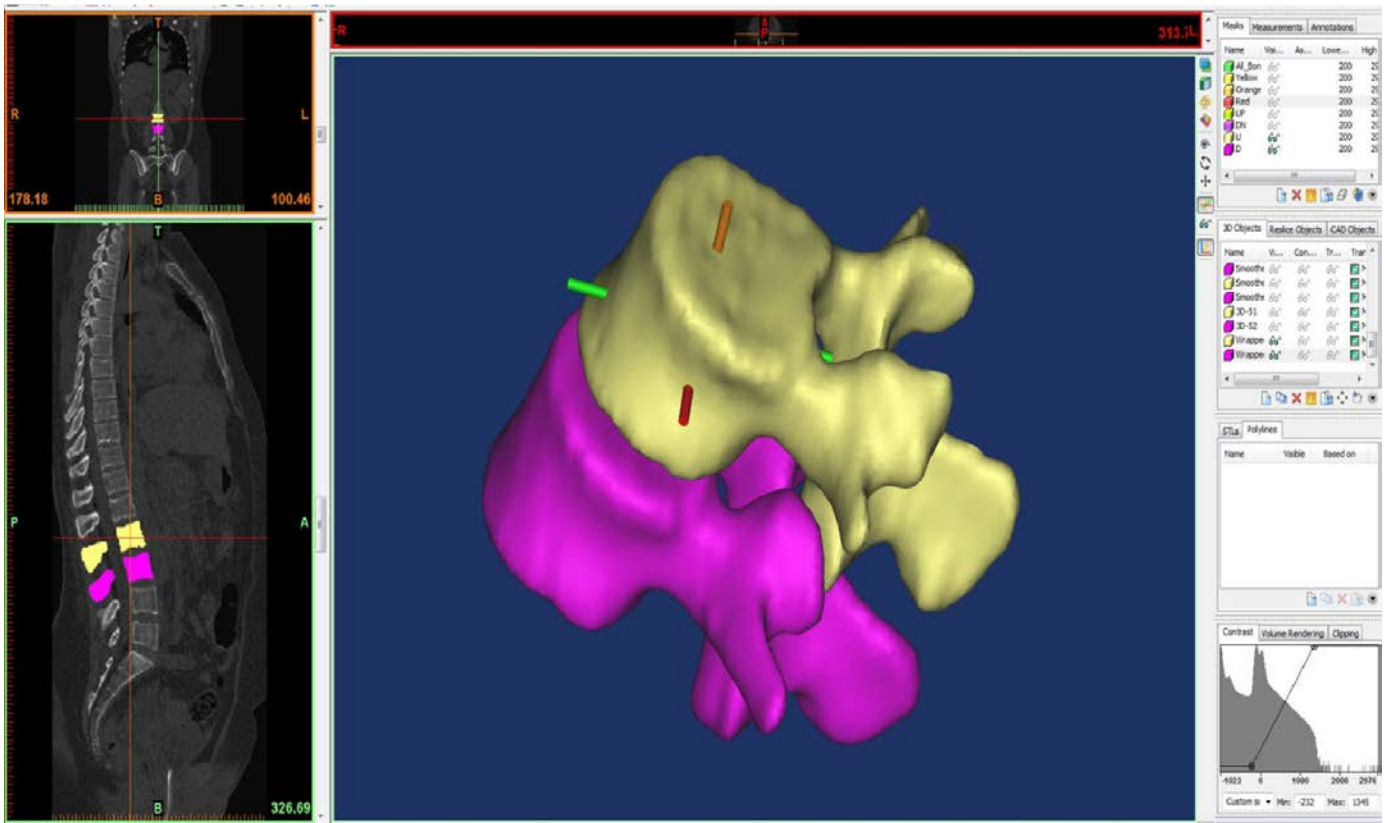Fig. 3 Three dimensional preview with approximate shape of all vertebrae

Fig. 4 The correction of chosen vertebrae tissues

C. *Processing of 3D models*

After corrections of 2D image data in Mimics software, it was possible to generate 3D models to stadard STL format. This file format can be processed by any CAD software. In this project, the CAD software from Dassault Systèms (Catia V5R18) was used (Fig. 5). To continue with printing by Rapid Prototyping it was necessary to move models into zero axis of the system. Other modifications like usual CAD modifications were also possible to use. The process ended by exporting final models to STL format for 3D printing.

III. PRINTING OF MODELS VIA RAPID PROTOTYPING

The STL files were postprocessed and printed with a 3D printer (Objet Eden 250), which use the PolyJet method (Fig. 6) based on the jetting photo-sensitive polymer.

In our case, we used "like ABS" material, because the created models have only demonstrative character; there were not any requirements on selected material. The photopolymer was applied from the print head with 96 jets and created the ultra thin layer onto the build tray.

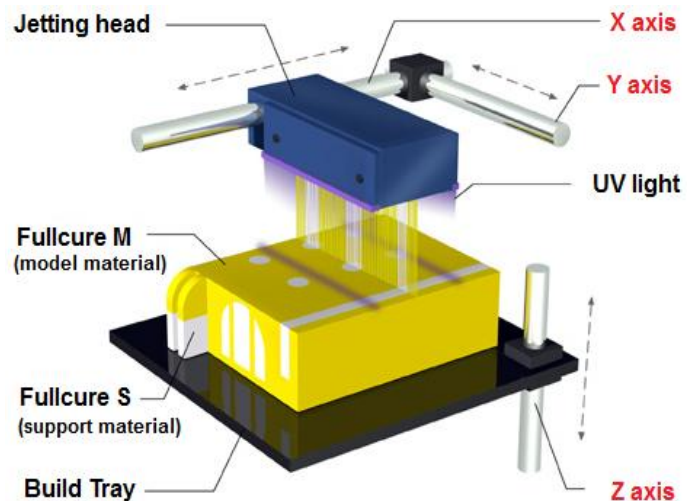Fig. 5 Principle of polyJet method

Fig. 6 Principle of polyJet method [7]

Immediately after the building of a layer, the photopolymer was cured by UV lights. The thickness of the layer is 0.016 mm so the final model has a smooth surface with accuracy ranging from 0.05 to 0.1 mm. The support material was based on the gel and it was easy to remove it from the part. Figure 7 shows the real models of spinae vertebrae with support material.

Fig. 7 The 3D models of spinae vertebrae with support material

IV. RESULTS

After removing of support material, we obtained 3D models with two different types of surfaces, one of them is shown in Fig. 7.

Fig. 8 The 3D models of spinae vertebrae with matt surface

V. CONCLUSION

The goal of this project was the modeling and printing of the real 3D anatomical models from the original 2D data. With the advance medical software such as Mimics from Materialise, it is possible to construct three dimensional 3D models of anatomical structures of the human body and by rapid prototyping technology to print them into real parts. In the future, the medical implant technology can continue to improve if we use the biomaterial in 3D printers.

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