Human body modelling

Subject: Numerical modelling in medical therapy and diagnostics
Author: Ing. Ondřej Fišer, Ph.D., Ing. Tomáš Dřížďal, Ph.D
Experiment supervisor: Ing. Ondřej Fišer, Ph.D.

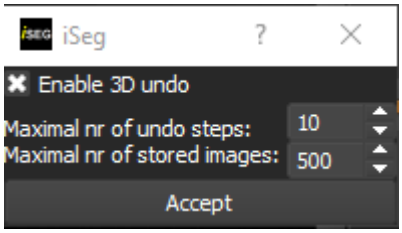
Required equipment:
Powerful computer station in the laboratory of analysis, processing and modeling of clinical and experimental signals B-124.

Introduction:

Numerical simulations are becoming more and more important in treatment planning. Medical applications of electromagnetic fields are new options for diagnostics and therapy. In that kind of medical applications, the numerical simulations are providing information about the correctness of the system setting to ensure the therapy safety and the best outcome. During last years the computing power of computers rapidly increase. This enables to use more accurate numerical phantoms with high anatomical precession. To obtain good results which are corresponding with the reality it is necessary to have good information about the dielectric and thermal properties of each tissue.

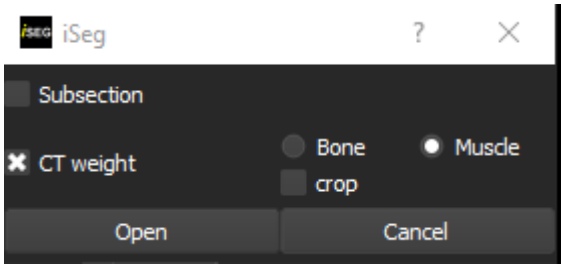
Instructions:

1) Open folder where are data intended for this exercise. Unzip files with the name *„iSeg_v1.1.zip“*, *„DHT_TissueList.zip“* a *„8004.zip“*...
2) Run the program ISeg. Open project with name *„DHT_TissueList.prj“.*
3) In *File* choose *Set Tissue list* as *Default*, close *ISeg* without any data savings. Run again the *ISeq*. We can get the same names and colors of different tissues as in this tutorial.
4) In the tab *Edit choose Configure Undo*…. Click on the *Enable 3D undo* and set the value of parameter *Maximal nr os stored* images to the value 500.

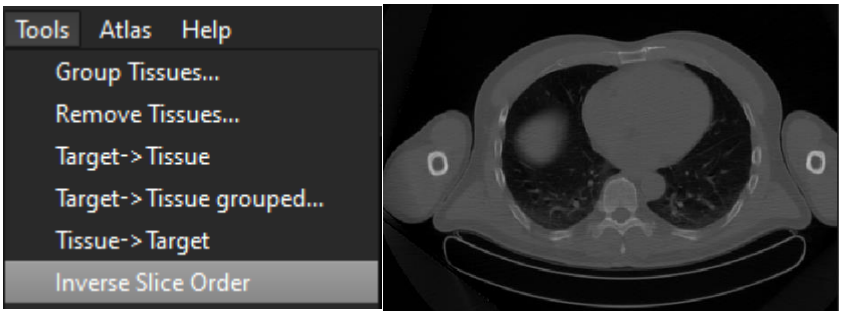


5) In *File* choose *Open dcm* and mark all dcm files from 8004.zip.
6) Unclick *Subsection*. Click on *CT weight*, set *Muscle*. By choosing the muscle tissue, the threshold for segmentation will be set right to this tissue (value 10).

EVROPSKÁ UNIE
Evropské strukturální a investiční fondy
Operační program Výzkum, vývoj a vzdělávání
MINISTERSTVO ŠKOLSTVÍ, MLÁDEŽE A TĚLOVÝCHOVY

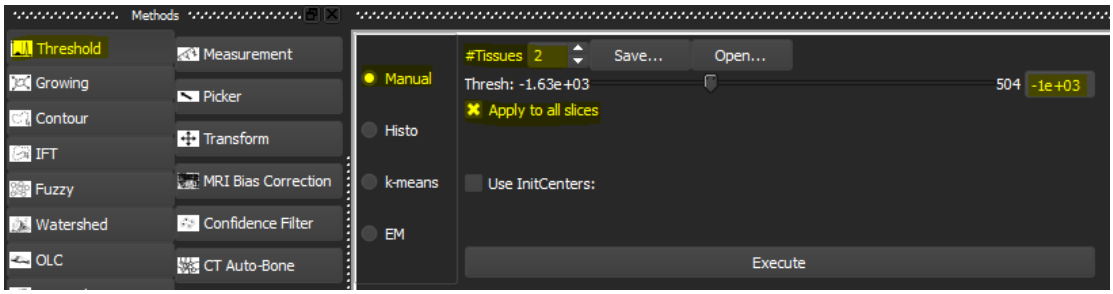


7) Choose *Tools/Inverse Slice Order* that you will see the cross section through patient's chest.

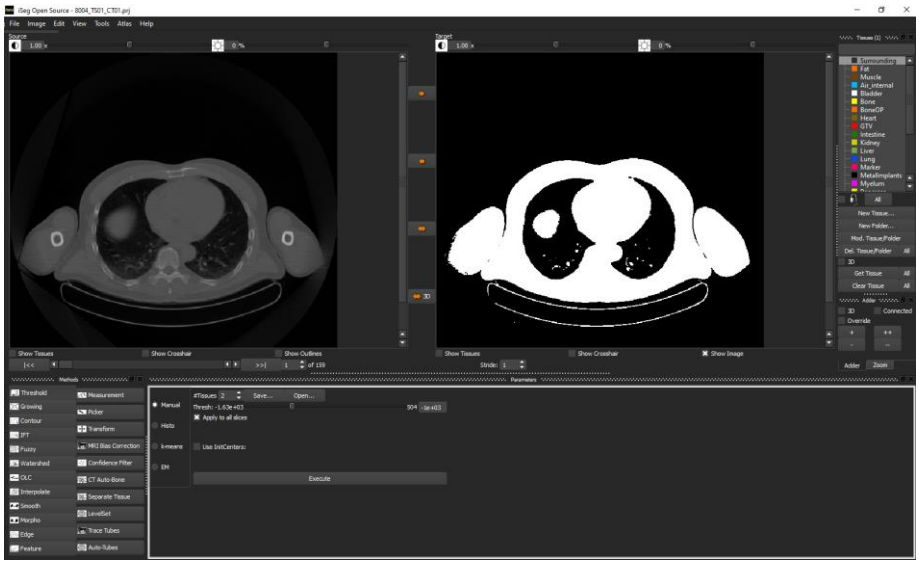


8) Save the project.

9) In the *Panel* click on *Methods*. Choose *Threshold* and then *Manual*. For two tissues *(„#Tissues" equal to „2").* Set the Thresh to -1000. Click on *Apply* to all slices and click on *Execute*.

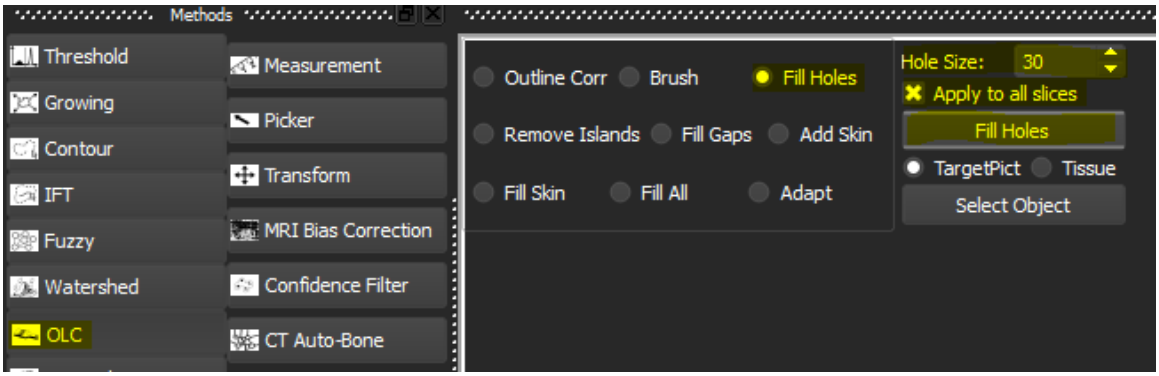


10) After performing the operation, you should see a similar black-and-white image below on your PC in "*Targets*", in which the area with a lower image intensity value than the selected "*Threshold*" -1000 is displayed in black and the area with a higher signal value in white.

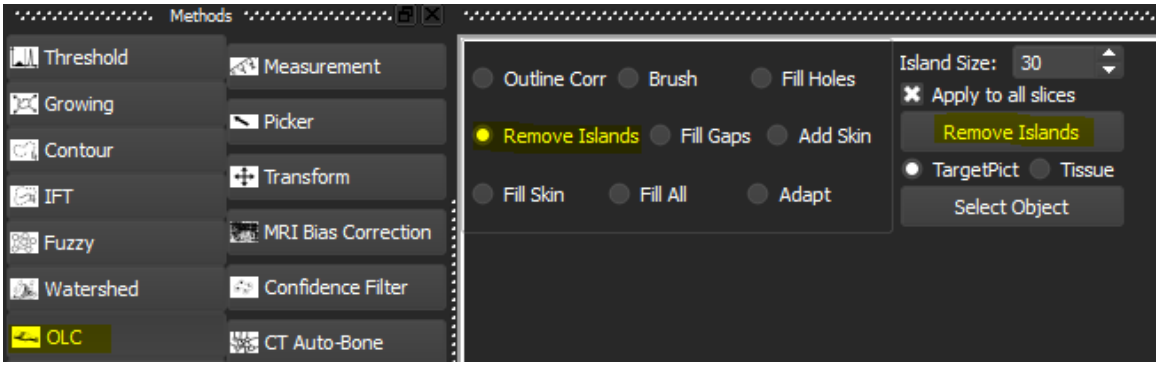


11) In the tab *Methods* choose OLC and then check *TargetPict*, click on *Select Object* in the window *Target*.

12) In *OLC* choose *Fill Holes*, choose *Hole Size* and set 30. Click on *Apply* to all slices and then click on *Fill Holes*. This fill all black places inside the white surface, which are smaller than 30 pixels.



13) Then select "*Remove Islands*" in "*OLC*" and press the "*Remove Islands*" button. This will remove white areas smaller than 30 pixels. We perform both of these operations with respect to the neglect of smaller structures due to faster generation of the resulting 3D models in the Sim4Life electromagnetic field simulator, and also due to the smaller size of the generated Sim4Life files. The value of 30 pixels was chosen subjectively depending on experience and can be modified to any value, or these two steps can be skipped.



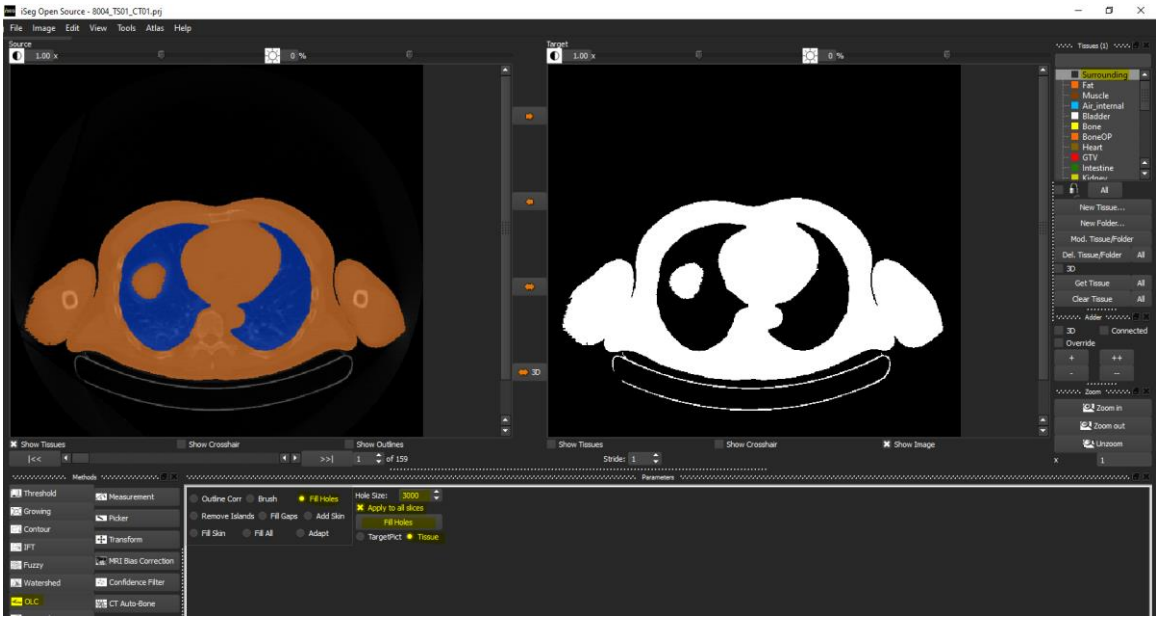
14) In the "*Tissues*" toolbar, click on "*Fat*" and in the "*Adder*" toolbar then check the boxes "3D", "*Connected*", click on the "+" sign and then in the "*Target*" window somewhere inside the patient's body.

15) In the "*Adder*" toolbar, select "3D" to assign fat in 3D, the checked box "*Connected*" will ensure the assignment of only white areas that have contact with the place we clicked on in the "*Target*" window. In combination with "*3D*", this check is performed on all active images - it is therefore possible that, for example, when marking the area of the left foot, the right will also be marked over the pelvic area. Without "*Connected*" checked, all white pixels in the 3D fat would be assigned. "*Override*" is used when overwriting an already assigned image area, such as in point 16 of this manual. The "+" button is active for one assignment (click) while "++" allows multiple assignments - be careful to turn it off by clicking on "++". If it is active, an unintentional

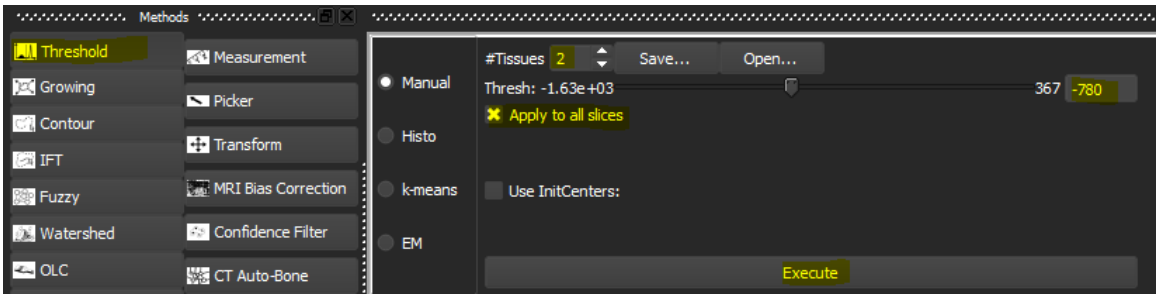
assignment may occur in a step, such as during manual corrections or in the selection made in point 11 of this manual.

16) After displaying the "*Show Tissues*" in the "*Source*" window, you should receive a similar image.

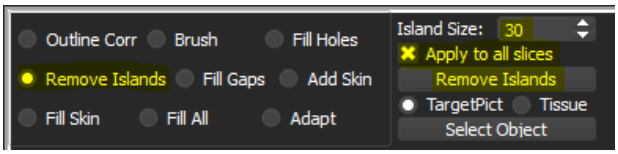
17) In "*Tissues*" select "*Lung*", in "*Adder"* leave the settings from the previous step and press "++" and click on the left and right lungs separately.
18) Next, in "*Tissues*", select "*Surrounding*" and click on the black background around the patient, deactivate the assignment by clicking "++" again.
19) In "*OLC*" select "*Fill Holes*", select *"Hole Size*" equal to "3000", check "*Apply to all slices*", check "*Tissue*", check that "*Tissues (1)*" is still selected in the toolbar "*Surrounding*" and press the "*Fill Holes*" button. This removed all areas of already assigned tissue within the "*Surrounding*" with an area of less than 3000 pixels, such as the table below the patient.



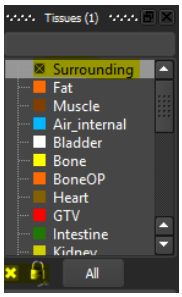
20) In the "*Tissues (1)*" toolbar, select "*Air_internal*", in "*Adder*" check only "*3D*", click on "+" and on some image, for example 22, click on the black area inside the patient. This will assign air ("*Air_internal*") to all remaining black pixels that have not been marked as "*Surrounding*". Each pixel should be assigned to a tissue, which is important when reconstructing a model in Sim4Life, where unassigned pixels would be filled with, for example, deionized water in hyperthermic regional treatment planning.
21) In the "*Methods*" toolbar, select "*Threshold*" and then "*Manual*". For two tissues ("#Tissues" equal to "2"), set "Thresh:" equal to "-780", check "*Apply to all slices*" and press *"Execute*"



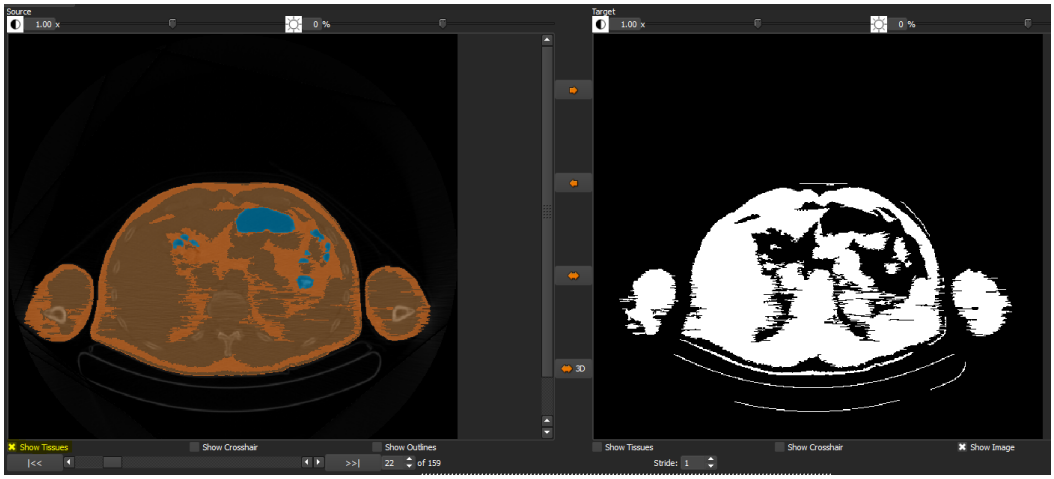
22) In the "*Methods*" toolbar, select "*OLC*" and then select "*Fill Holes*", "*Hole Size*" equal to "30", check "*Apply to all slices*" and press the "*Fill Holes*" button. Then select "*Remove Islands*" in "*OLC*" and press the "*Remove Islands*" button.



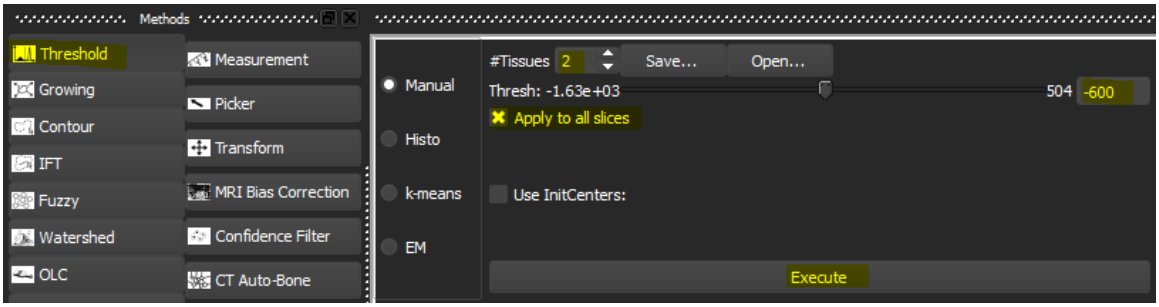
23) In the "*Tissues (1)*" toolbar, select "*Surrounding*" and lock this tissue by checking the lock symbol below the tissue list. After the operation, a cross is displayed over "*Surrounding*".



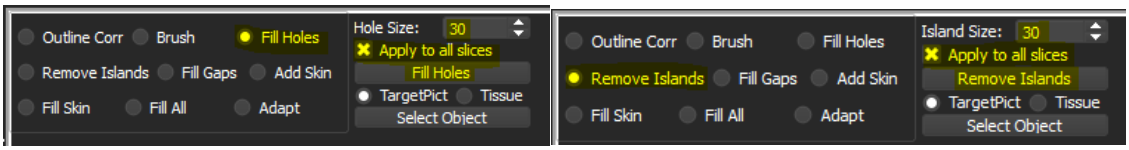
24) In the "*Tissues (1)*" toolbar, select "*Muscle*" and then in "Adder" check "3D", "Override", click on "+" and then in the "*Target*" window on any muscle tissue.
25) After displaying the "*Show Tissues*" in the "*Source*" window, you should receive a similar image. Locking "*Surrounding*" did not assign the pad as a muscle.



26) In the "*Methods*" toolbar, select "*Threshold*" and then "*Manual*". For two tissues ("#Tissues" equal to "2"), set "*Thresh*:" equal to "-600", check "*Apply to all slices*" and press "*Execute*"

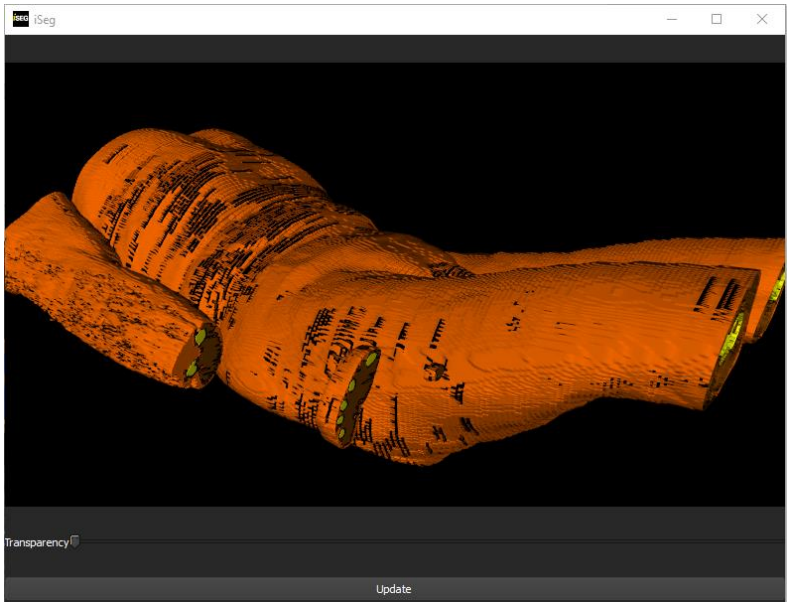


27) In the "*Methods*" toolbar, select "*OLC*" and then select "*Fill Holes*", select "*Hole Size*" equal to "30", check "*Apply to all slices*" and press the *"Fill Holes*" button. Then select "*Remove Islands*" in "*OLC*" and press the "*Remove Islands*" button. This step is the same as step 22 and is always recommended after applying the "*Threshold*".



28) In the "*Tissues (1)*" toolbar, select "*Bone*", then in "*Adder*" check "*3D*", *"Override*", click on "+", and then in the "*Target*" window on any area of bones.

29) The temporary result of segmentation in 3D can be displayed in the "*Image*" menu and then by selecting "*Tissue surface view*". Opening a new window may take a while depending on the performance of your PC.



Final anatomic torso of the patient.

References

1. P. Hasgall, E. Neufeld, M. Gosselin, A. Klingenböck, and N. Kuster. (2011) IT'IS database for thermal and electromagnetic parameters of biological tissues. [Online]. Available: www.itis.ethz.ch/database.