Nasal Airway Model - Geometry

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Geometry

First open MIMICs and the home screen will appear below.



Next select File -> New Project Wizard

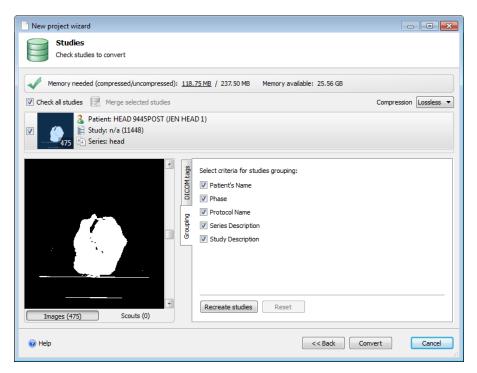
	New project wizard	Ctrl+N
1	Open Project	Ctrl+0
Β	Save Project	Ctrl+S
	Save Project <u>A</u> s	
	<u>C</u> lose Project	Ctrl+W
	Import STL	
	STL <u>L</u> ibrary	
	Import project	
	Organize Images	
	Change Orientation	
	Online Reslice	•
	Reslice Project	
	Crop Project	
	Make Project Anonymous	
112	Run MATLAB Script STL+	

	Project Information	
	Save/Print Screens <u>h</u> ot	Ctrl+H
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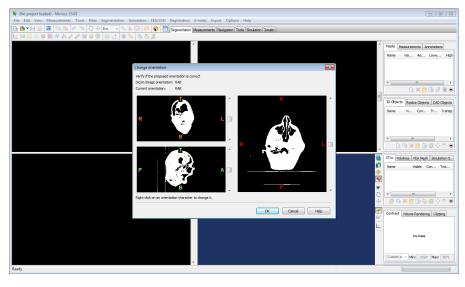
Select the folder containing the DICOM images of the CT scan, MIMICs will detect the order based on the file names of images. Also select the output folder for the project.

New project wizard				- • ×
Images Select the media or fil	es that contain the images to import			
Favorites	File browser			
	C:\Users\bjk97\Desktop\mimics\PA7_Binary			
	File name	Type	Size	
	 Brandon Joseph Kovarovic a.ienv_fea2.014.0_cache Contacts Desktop Lab Software BR 3-22 PA000001 PA000001 PA000001 PA000002 PA000003 PA6_Binary No match PA5_Binary PA9_Binary PA9_Binary 	File folder File folder File folder		-
🙀 Add to favorites	PA10_Binary	File folder		
Target folder: C:\Users\bjk97\D			Force raw import	Show import log
🔞 Help			Next >>	Cancel

Press next and confirm all the settings and order of the images.



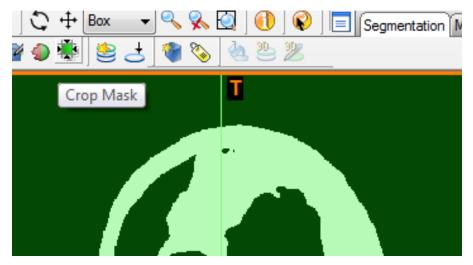
Set all the planes of the images, aligning the posterior, top and right side to the images.

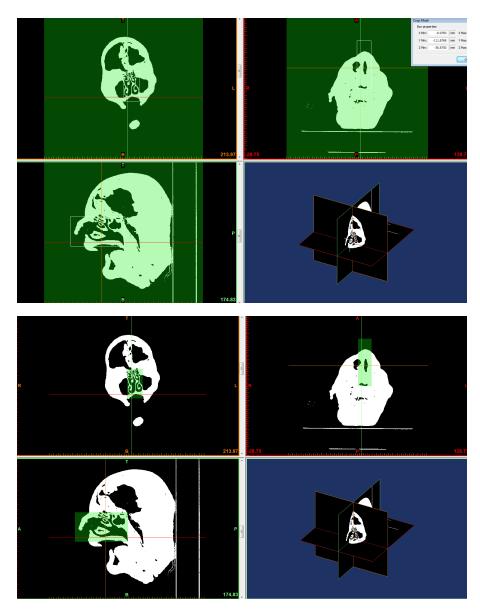


The next step is to start creating the masks of the images that contain the outline of the volumes used in the CFD calculation. Creating the mask is based on first selecting a threshold of pixel values or tissue densities that the primary mask will have. Since the images are now binary, the images have only two pixel values. Press the threshold button to create the first mask. The primary mask should contain both pixel values to include both the air and the tissue, so make sure the min and max values are at the lowest and highest values or that the slider has the entire range.

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Next the mask needs to be cropped with the crop mask button to select only the area around the nasal cavity. Adjust the height, width and length of the rectangular mask in the three viewing planes.





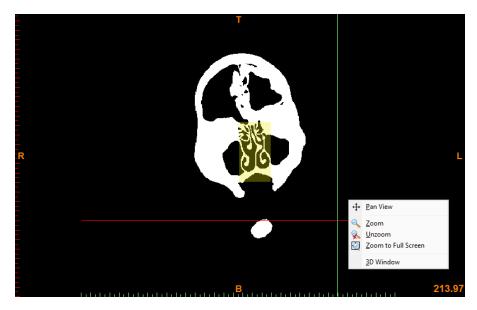
Now on the right side there is the created and cropped mask, by default labeled "Green", right click on this mask and select Duplicate Mask. This will create a copy of the mask in a new color. The purpose of having multiple masks is that you can do boolean operations to the masks, subtracting one or adding one to the other. In this tutorial we will later subtract the secondary mask from the primary to leave a third mask containing only the nasal volume.

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Nan	e Visi As Lowe High					
	New Mask					
	Copy Mask					
×	Delete Mask					
i [Mask Properties					
Ð	Clear Mask					
4	Duplicate Mask					
۲	Calculate 3D					
~	Draw Profile <u>L</u> ine					
Ħ	Thresholding					
88	Region Growing					
20 77	Dynamic Region Growing					
Ð	3D LiveWire					
	Morphology Operations					
ψ	Boolean Operations					
	Cavity Fill					
P	Edit Masks					
Ø	Multiple Slice Edit					
A	Edit Mask in 3D					
٩	Smooth Mask					
*	Crop Mask					
	Calculate Polylines					
ď	Update Polylines					
۵	Label					
da.	Cavity Fill from Polylines					
205	Calculate Polylines from 3D					
	Calculate Mask from object					

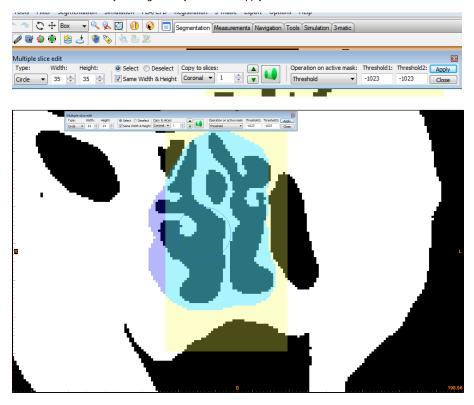
Now deselect the visibility or the 'eye glasses' on the primary mask to have only the secondary yellow mask visible and only edit that mask.

Name	Visi	As	Lowe	High
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Yellow	667 66 7		-1024	-10
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Right click on the black background of the Coronal plane and select Zoom to Full Screen. The Coronal plane will allow us to distinguish the nasal geometry the easiest.



Next select the Multiple Slice Edit button. In the appeared function box, select Coronal under the planes, and Thresholding as the operation. Lower the thresholding values to only include the values of the tissue. The next step is very long and tedious. Middle mouse scroll all the way back to the nasopharynx, and begin highlighting the area of the cavity. Then scroll, image by image selecting the cavity in each slice. There is an Interpolate button that will linearly connect the regions in between distant slices, but this is difficult to do with the complex nasal geometry. Continue all the way to the nostrils and remove any sinus geometry and select apply.



Next with the Boolean Operation button, remove the secondary mask yellow from the primary green mask.



Right clicking on the new mask and selecting Edit Mask in 3-D will allow you to flatten the inlet and outlet geometries by removing additional pixels in at the nostrils and nasopharynx. This also gives you a chance to smooth any geometry and trim any sinus cavities you may have missed.

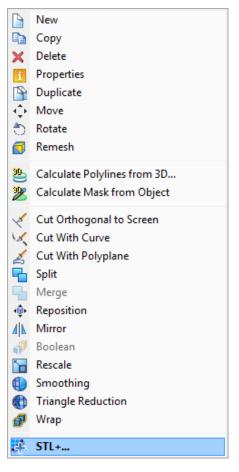
	New Mask
	Copy Mask
×	Delete Mask
i [Mask Properties
Ð	Clear Mask
	Duplicate Mask
۲	Calculate 3D
Ľ	Draw Profile <u>L</u> ine
Ħ	Thresholding
88	Region Growing
**	Dynamic Region Growing
Ð	3D LiveWire
	Morphology Operations
ψ	Boolean Operations
	Cavity Fill
P	Edit Masks
Ø	Multiple Slice Edit
1	Edit Mask in 3D
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8 2 2 2 2	Cavity Fill from Polylines Calculate Polylines from 3D
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8 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	Cavity Fill from Polylines Calculate Polylines from 3D Calculate Mask from object STL+

Next right click on the third mask and select Calculate 3-D, this will make the primary STL geometry. In the options, leave the optimal quality, but select the shell reduction, set at 1. This will create only a single largest volume and make sure there are no floating pixels or random disconnected geometries. Also select the smoothing option, this will help smooth out the pixels give a nice smooth geometry for FLUENT. After the 3-D is created, additional Smoothing can be done and Triangle Reduction so that the exported STL is as small and correct as possible.

	New Mask
	Copy Mask
×	Delete Mask
i [Mask Properties
Ð	Clear Mask
1	Duplicate Mask
۲	Calculate 3D
~	Draw Profile <u>L</u> ine
	Thresholding
8	Region Growing
	Dynamic Region Growing
Ð	3D LiveWire
	Morphology Operations
ψ	Boolean Operations
	Cavity Fill
P	Edit Masks
Ø	Multiple Slice Edit
P	Edit Mask in 3D
٩	Smooth Mask
ŧ.	Crop Mask
	Calculate Polylines
ž	Update Polylines
۵	Label
2	Cavity Fill from Polylines
20	Calculate Polylines from 3D
Z	Calculate Mask from object
4	STL+
-	Export 2D mask area
	Export 3dd
	Export Grayvalues

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Position of first slice:	-157.	5000 mm	Smooth factor:	0.3000
Position of last slice:	138.	7500 mm	Compensate shrin	kage
	Reset		Triangle reduction	
			Reducing mode:	dvanced edge 👻
Matrix reduction			Tolerance;	0.0815 mm
XY resolution: 1	× X C	.6523 mm	Edge angle;	10.0000 °
Z resolution: 1	× X C	.6250 mm	Iterations:	3 🚊
			Working buffer size:	26014 🚔 MB

Right click on the 3D and select STL+ option.



Select the created, smoothed and reduced 3D. Select Add and finally finish. In the directory selected in the very beginning will be the final STL geometry. Save the MIMICs project and close out the program.

STL+ - Mask/3D/3dd file/CAD and nerve/FEA mesh selection	×
Start Mask ^{3D} 3dd CAD FEA	1
Label Reduced_Reduced_S	
Output Directory: Output Format: C:\Users\bjk97\Desktop\mimics\ ASCII STL Files (*.STL) Objects to convert: Objects to convert:	•
Objects to convert Output Filename Reduced_Reduced_SHEAD 9445POST_Reduced_Reduced_Smoothed_Cy	Add <u>R</u> emove
Finish Cancel	Scale factor: 1.0000 Help

Go to Step 3: Mesh

Go to all FLUENT Learning Modules