

Rhino3DMedical Commands and Components

Version 1.0.8.1

Rhino Main Commands in workflow order

RMOpenImage

- Open a new image in any supported format
- The currently supported formats are
 - MetalImage (*.mhd / *.mha)
 - NIFTI (*.nii / *.nii.gz)
 - NRRD (*.nrrd)
 - TIFF (*.tif / *.tiff)
 - DICOM (single image, single series, multiple series)
- To read a DICOM, select any file from the series
- When reading DICOM series, a *DICOM Manager* window shows its related metadata. If there is more than one series in the file directory, it lets you select a particular one

RMImageAnalysis

- Open the *Image Analysis* window
- Functionalities of this window:
 - In *Image Navigation*, explore the image in the sagittal, coronal or axial plane with the sliders, or type the slice number
 - Check or uncheck *Show* to show or hide the corresponding image slice in Perspective view
 - Check or uncheck *Superimpose 3D surfaces* to show or hide the intersection of any surface mesh that is visible with the image slices. The color of this intersection corresponds to the surface layer material color
 - In *Set Contrast And Brightness*:
 - In *Contrast*, adjust the contrast with the slider
 - In *Brightness*, adjust the brightness with the slider
 - Change overall color among four possibilities
 - In *Set Threshold*, set lower and upper thresholds. Every image voxel within this range will be painted
 - Check or uncheck *Show Threshold* to see the image area lying within the threshold
 - Click the color button next to *Show Threshold* to change the threshold color
 - Click *Surface Preview* to display a window showing the extracted surface according to the selected threshold.
 - Set the lower threshold with the slider (the upper threshold is automatically set to the maximum of the image)

- Check or uncheck *Check Connectivity* to see or hide in color code the different connected components of the surface
- Click *Create Surface* to add the resulting surface to Rhino scene, *Reset Camera* to reset the auxiliary window camera, and *Close* to close the window.
- Hold right mouse click to rotate the surface, mouse wheel to zoom the view, and Shift right mouse click to translate the view.
- The extracted surface will correspond to the selected threshold range, and it takes into account the effect, if any, of the Manual Mask Bounding Box

RMSegmentation

- Open the *Segmentation* window
- Available segmentations:
 - *Threshold-based Segmentation*
 - It takes the threshold range defined in the *Image Analysis* window
 - Click *Surface from Threshold* to extract the surface containing the current threshold range
 - Check *Close Surface* to extract a closed surface
 - Check *Extract Largest Region* to retrieve the biggest connected component within the surface containing the current threshold range
 - *Region Growing Segmentation*
 - It takes the threshold range defined in the *Image Analysis* window and a seed point within the image from which a surface will grow collecting as much segmented area as possible
 - Click *Pick Seed Point* to select a seed point over the image
 - Click *Surface from Region Growing* to extract the surface growing from the seed point and current threshold defined in *Image Analysis*
 - Check *Close Surface* to extract a closed surface
 - Check *On Mask* to perform region growing over the mask defined in *Manual Segmentation* instead of the current threshold defined in *Image Analysis*
 - *Manual Segmentation*
 - It takes a manually segmented area defined by the user. We define this area as a manual segmentation mask, manual mask or mask
 - Click *Mask from Threshold* to create a mask from the current threshold defined in the *Image Analysis* window
 - Click *Mask from Object* to create a mask from the enclosed volume of a Rhino object (a surface brep, mesh or closed curve)
 - Click *Import Mask from File* to import a mask from a file (most convenient format is TIFF)
 - Click *Create* under *Bounding Box* to define a 3D box that will restrict the current mask to its boundaries

- Click *Paint / Erase* under *Mask* to open a window that will let you manually add or remove area to the current mask. Note that while the *Paint / Erase* window is open the image can be navigated through in *Image Analysis*
- Click *Invert* to invert the current mask, *Delete on slice* to remove all the mask present in an image slice, and *Delete all* to remove the whole current mask
- Check or uncheck *Show Mask* to see the mask
- Click the color button next to *Show Mask* to change the mask color
- Click *Check connectivity* to see, within the current mask, the parts of it that are isolated with different colors
- Click *Export Mask* to export the current manual mask to a file in TIFF format
- Click *Export Masked Image* to export an image that is the superposition of the current active image with the current active mask. Format can be any among DICOM, MHD, TIFF, NII, NRRD. Follow the instructions in the command line
- Click *Surface from Mask* to extract the surface containing the current mask
 - Check *Close Surface* to extract a closed surface

RMImageFilters

- Open the *Image Filters* window
- A range of filters is available at the top drop-down menu. Once a filter is selected, check *Preview* to see its effect over the active image. Click *Apply* to make this effect permanent or *Cancel* to cancel it.
- Available filters:
 - *Closing*
 - It removes small light areas
 - *Dilation*
 - It increases light areas
 - *Erosion*
 - It increases dark areas
 - *Flip*
 - It flips images axis in X, Y or Z direction
 - *Gradient Magnitude*
 - It detects edges in the image
 - *Median*
 - It reduces noise by taking the median over a window
 - *Opening*
 - It removes small dark areas
 - *Ridge Detector*
 - It detects ridges in the image
 - *Smoothing*
 - It reduces noise by averaging over a window
 - *Voxel Spacing*
 - It rescales the spacing of the image unit voxel in X, Y or Z
- The radius parameter of some filters can be changed

RMMeshRepair

- Open the *Mesh Repair* window
- A set of buttons lets the user correct or fix some deficiencies that may arise in surface meshes
- Available tools:
 - *Extract Largest Region*
 - It extracts the largest connected mesh
 - *Fill Mesh Holes*
 - It attempts to fill all openings and produce a closed mesh
 - *Smoothen Mesh*
 - It reduces jagged parts in the mesh
 - *Remesh*
 - It reduces the number of triangles by a set percentage

Rhino Auxiliary Commands in alphabetic order

RMCreateBoundingBoxMaskFromBox

- Create bounding box to constrain manual mask from a 3D box

RMCreateBoundingBoxMaskFromRectangle

- Create bounding box to constrain manual mask from a 2D rectangle (the rectangle height will take the full height of the image)

RMDeleteActiveImage

- Delete the active image. Note that corresponding layers will be kept

RMExportImage

- Export current image to a specific format

RMExportManualMaskToTIFF

- Export current manual mask to TIFF format

RMExportMaskedImage

- Export superposition of current image with current manual mask to a specific format

RMExtractLargestRegion

- Given a mesh, extract the single largest connected surface

RMFillMeshHoles

- Given a mesh, try to fill the holes automatically and create a closed mesh

RMGetRegionGrowingSeedPoint

- Select the seed point for the region growing segmentation

RMGetRegionGrowingSeedPointAndSurface

- Select the seed point for the region growing segmentation and directly extract its region-growing surface according to the current threshold range

RMIImageInfo

- Display information related to the active image

RMImportManualMask

- Import manual mask from image file

RMinvertManualMask

- Invert current manual mask

RMLicense

- Check the status of your license, deactivate the current or activate a new one

RMMaskFromObject

- Add/Subtract/Intersect a Rhino object (surface brep, mesh or closed curve) with respect to current manual segmentation mask

RMMoveToImageReference

- Select a Rhino object and translate it by a vector going to the coordinate origin to the current image center or origin (choose the option in Rhino command line)

RMPaintErase

- Open a window with brush tools to create an area over the image that will be added or removed to the current mask upon clicking *Apply Selection* or *Apply and Close*. These include:
 - *Brush* button to manually draw over the image
 - *Delete on slice* button to remove drawn area from one slice, *Delete all* to remove the whole area
 - Possibility to change brush behavior into removal by holding *Shift* key in the keyboard
 - Possibility to change the brush size by holding *Alt* key in the keyboard
 - A field to change the brush size
 - A field to change the brush shape (between *Circle* and *Square*)
 - *Fill Between Slices* button to automatically add area between manually painted slices
 - A checkbox *Show Area* to show or hide the drawn area, and a color button to change its color
 - *Apply Selection* button to add or remove the drawn area to the mask, depending on whether the radio button at right is set to *Add to Mask* or to *Remove from Mask*.

RMRefocusImage

- Center the views in Rhino on the current image

RMRemesh

- Given a mesh, reduce the number of faces by a given percentage

RMRResetImagePath

- Reset the image path of a saved .3dm file.

RMSSetSlicesToPosition

- Center all slices onto a selected 3D point over the image

RMSmoothenMesh

- Given a mesh, apply the Laplacian mesh smoothing filter to reduce sharp edges

RMSurfaceFromMask

- Create a surface from the manual segmentation mask

RMSurfaceFromRegionGrowing

- Create a surface according to the current thresholds and a selected seed point

RMSurfaceFromThreshold

- Create a surface according to the current threshold range

RMSurfacePreview

- Display a display a window showing the extracted surface according to the selected threshold.:
 - Set the lower threshold with the slider (the upper threshold is automatically set to the maximum of the image)
 - Check or uncheck *Check Connectivity* to see or hide in color code the different connected components of the surface
 - Click *Create Surface* to add the resulting surface to Rhino scene, *Reset Camera* to reset the auxiliary window camera, and *Close* to close the window.
 - Hold right mouse click to rotate the surface, mouse wheel to zoom the view, and Shift right mouse click to translate the view.
 - The extracted surface will correspond to the selected threshold range, and it takes into account the effect, if any, of the Manual Mask Bounding Box

RMSwitchLinearInterpolation

- Switch image pixel representation between nearest neighbors and linear interpolation (by default it is nearest neighbors)

Clinical interface related Commands in alphabetic order

R3DMedical Clinical appears upon installation as a desktop shortcut. Run it to launch Rhino with a specialized interface suited for the following commands. Note that these commands can also be called from normal Rhino at any moment and with an equivalent workflow

RMClinical

- Launch the clinical interface. This interface is a dock bar that lets the user open an image, navigate through it and perform image analysis, segmentation, region of interest, preview, information, orbit enhancement, mirroring and 3D print export tasks. When opening R3DMedical this command is automatically called

RMExportToSTL

- Select a surface mesh that will be exported to STL (Stereolithography) format. Follow the instructions in the command prompt or the interface

RMJointSeparation

- Create a half sphere that will cut the current manual mask after the user moves it with the gumball and presses *Enter*. The mask will then change to *Check connectivity* mode to see if it has been split into different parts. A window appears to let the user choose to repeat the whole operation from the beginning (*Resegment*), accept it as it is (*Accept segmentation*) or cancel the whole process (*Cancel*)

RMOrbit

- Launch the orbit enhancer module. Follow the instructions displayed in the command prompt or the interface

Grasshopper Components

Analysis

Extract Slice

- Get a single slice
 - The slice is returned as a mesh with vertex colors
- **IN** Image (I) [**custom object** no default]
- **IN** Plane (P) [**integer** default=0]
 - 0 = XY, 1 = XZ, 2 = YZ
- **IN** Number (N) [**number** default=0]
 - slice number to be displayed
 - clamped to the extents if it exceeds them
- **OUT** Slice (S) [**mesh**]
 - The resulting mesh with vertex colors

Get Bounding Box

- Get the bounding box of an image
- **IN** Image (I) [**custom object** no default]
- **OUT** BBox (B) [**box**]

Get Extents

- Get the extents of an image in the X, Y and Z direction
 - The extents are the valid indices in any direction, useful for the **ExtractSlice** component
- **IN** Image (I) [**custom object** no default]
- **OUT** XExtents (X) [**interval**]
- **OUT** YExtents (Y) [**interval**]
- **OUT** ZExtents (Z) [**interval**]
 - The size in the X, Y, and Z dimension

Get Range

- Get the intensity range of an image
- **IN** Image (I) [**custom object** no default]
- **OUT** Range (R) [**interval**]

Image Filters

Close

- Applies closing operation to a 3D volume
 - Removes small holes (dark areas) from the image
 - Equivalent to dilation followed by erosion
- **IN** Image (I) [**custom object** no default]
- **IN** Size (S) [**integer** default=5]
 - Size of the dilation and erosion kernel
- **OUT** Image (I) [**custom object**]

Dilate

- Applies dilation operation to a 3D volume
 - Enhances objects (bright areas)
- **IN** Image (I) [**custom object** no default]
- **IN** Size (S) [**integer** default=5]
 - Size of the dilation kernel
- **OUT** Image (I) [**custom object**]

Erode

- Applies erosion operation to a 3D volume
 - Enhances holes (dark areas)
- **IN** Image (I) [**custom object** no default]
- **IN** Size (S) [**integer** default=5]
 - Size of the erosion kernel
- **OUT** Image (I) [**custom object**]

Gradient

- Computes the magnitude of the gradient of the image
- **IN** Image (I) [**custom object** no default]
- **OUT** Image (I) [**custom object**]

Median

- Compute the local median for each pixel
 - Useful for noise removal
- **IN** Image (I) [**custom object** no default]
- **IN** Size (S) [**integer** default=5]
 - Size of the median kernel
- **OUT** Image (I) [**custom object**]

ModifyOriginSpacingFlipping

- Modify Origin Spacing Flipping

- **IN** Image (I) [**custom object** no default]
- **IN** Origin Point (Orig) [**3D Point** default=Unset]
 - Point that will be the new origin
- **IN** Spacing X (SpacX) [**number** default=0]
 - Voxel spacing X coordinate
- **IN** Spacing Y (SpacY) [**number** default=0]
 - Voxel spacing Y coordinate
- **IN** Spacing Z (SpacZ) [**number** default=0]
 - Voxel spacing Z coordinate
- **IN** Flipping X (FlipX) [**boolean** default=false]
 - Flip image along X axis
- **IN** Flipping Y (FlipY) [**boolean** default=false]
 - Flip image along Y axis
- **IN** Flipping Z (FlipZ) [**boolean** default=false]
 - Flip image along Z axis
- **OUT** Image (I) [**custom object**]

Open

- Applies opening operation to a 3D volume
 - Removes small objects (bright areas) from the image
 - Equivalent to erosion followed by dilation
- **IN** Image (I) [**custom object** no default]
- **IN** Size (S) [**integer** default=5]
 - Size of the dilation and erosion kernel
- **OUT** Image (I) [**custom object**]

Smooth

- Applies gaussian smoothing to a 3D volume
- **IN** Image (I) [**custom object** no default]
- **IN** Size (S) [**number** default=3.0]
 - Size of the gaussian blur kernel
- **OUT** Image (I) [**custom object**]

Image Operations

Invert Mask

- Invert the input mask: 1 goes to 0 and 0 goes to 1
- **IN** Mask (M) [**custom object** no default]
- **OUT** Mask (M) [**custom object**]

Masked Image

- Create an image from the superposition of an image and a mask
- **IN** Image (I) [**custom object** no default]
- **IN** Mask (M) [**custom object** no default]
- **OUT** Image (I) [**custom object**]

Masked Image from Threshold

- Create an image from the superposition of an image and a threshold
- **IN** Image (I) [**custom object** no default]
- **IN** Threshold (T) [**number list** no default]
 - Thresholds for image extraction
- **OUT** Image (I) [**custom object**]

Mask from Mesh

- Extract a binary mask from an image and a closed mesh
- **IN** Image (I) [**custom object** no default]

- **IN** Mesh (M) [**mesh** no default]
 - Input mesh, closed
- **OUT** Mask (M) [**custom object**]

Mask from Threshold

- Extract a binary mask from an image and a threshold
- **IN** Image (I) [**custom object** no default]
- **IN** Threshold (T) [**number list** no default]
 - Thresholds for mask extraction
- **OUT** Mask (M) [**custom object**]

Mask Operation

- Perform mask operation of addition, subtraction or intersection
- **IN** Mask 1 (M1) [**custom object** no default]
- **IN** Mask 2 (M2) [**custom object** no default]
- **IN** Operation (O) [**integer** default=0]
 - 0 = Add, 1 = Subtract, 2 = Intersect
- **OUT** Mask (M) [**custom object**]

White Mask

- Create a white mask with the image extents and dimensions
- **IN** Image (I) [**custom object** no default]
- **IN** Value (V) [**boolean** default=true]
 - Value of the output mask
- **OUT** Mask (M) [**custom object**]

IO

Read File

- Read a MetaImage, NIFTI, DICOM, NRRD, TIFF file
 - To read a DICOM series, input the path of any file in the series
- **IN** Path (P) [**text** no default]
 - The path to the file
- **OUT** Image (I) [**custom object**]
 - The 3D image object

Write Image

- Write Image
- **IN** Path (P) [**text** no default]
 - Path of a folder (for DICOM) or a file (for non-DICOM) with format .mhd/.mha/.tiff/.nii/.nrrd

- **IN** Initial DICOM Path (DICOMP) [**text** default=empty]
 - Path of the initial image to take DICOM header info from

Mesh Extraction



Surface from Region Growing

- Create the surfaces from a given 2 thresholds and a point
- **IN** Image (I) [**custom object** no default]
- **IN** LowerThreshold (LT) [**number** default=0]
- **IN** UpperThreshold (UT) [**number** default=1000]
 - Lower and upper threshold may also be flipped, which one has the smaller value is not important
- **IN** Point (P) [**3D Point** default=0,0,0]
 - The point from which to grow the region
- **IN** Close (C) [**boolean** default=false]
 - Whether to return a closed mesh
- **IN** Smooth (S) [**boolean** default=true]
 - Whether to produce a smooth output
 - If this is set to false, the result may have jagged bumps in it
- **OUT** Mesh (M) [**mesh**]



Surface from Threshold

- Create a surface from a given list of thresholds
- **IN** Image (I) [**custom object** no default]
 - The 3D image object
- **IN** Threshold (T) [**number list** no default]
 - Thresholds for extracting the mesh
 - If there are 2 thresholds a single closed surface can be created
- **IN** Close (C) [**boolean** default=false]
 - Whether to return a closed mesh or a surface
- **IN** Smooth (S) [**boolean** default=true]
 - Whether to produce a smooth output
 - If this is set to false, the result may have jagged bumps in it
- **OUT** Mesh (M) [**mesh**]

Mesh Filters



MeshFilter Fill Holes

- Creates a closed mesh by filling any openings in a mesh
 - If the input mesh is closed this component doesn't modify it
- **IN** Mesh (M) [**mesh** no default]
 - Input mesh, open or closed
- **OUT** Mesh (M) [**mesh**]
 - Closed output mesh

Other

License

- Validate / disable / modify the installed license
- **IN** ShowWindow (S) [**boolean** default=false]
 - If true display the wizard for modifying the state of your license or activating another
- **OUT** IsValid (I) [**boolean**]
 - Whether license is valid

Download

Direct

<http://download.mirrakoi.com/download?file=Rhino3DMedicalInstaller.exe>

Website

<https://rhino3dmedical.mirrakoi.com/>

Update

If you installed a previous version of Rhino3DMedical it should update automatically.