

Simpleware ScanIP

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Import Formats

- DICOM (version 3.0 and 2D stacks) including:
 - 4D (time-resolved) DICOM with time step selection (in Simpleware ScanIP Medical only)
 - Option to store DICOM tags with imported data
- DICOM encapsulated STL surface models (in Simpleware ScanIP Medical only)
- ACR-NEMA (versions 1 and 2)
- DICONDE
- Interfile
- Analyze
- Meta-image
- Raw image data
- 2D image stacks:
 - BMP
 - GIF
 - JPEG
 - PCX
 - PNG
 - TIFF
 - XPM
- Natively supported pixel types:
 - 8-bit Unsigned Integer
 - 16-bit Unsigned Integer
 - 16-bit Signed Integer
 - 32-bit Floating Point

Export Formats

- Background 3D image:
 - RAW image
 - MetalImage
 - Stack of images (BMP, JPG, PNG, TIF)
 - DICOM
- Background 4D image (in Simpleware ScanIP Medical only):
 - RAW image (all frames/active frame)
 - MetalImage (all frames/active frame)
 - Stack of images (active frame only)
 - DICOM (active frame only)
- Segmented 3D image:
 - RAW image
 - MetalImage
- Segmented 4D image (in Simpleware ScanIP Medical only):
 - Mask RAW (all frames/active frame)
 - Mask MetalImage (all frames/active frame)
- Surface model (triangles):
 - STL
 - IGES
 - 3MF
 - OBJ
 - PLY
 - ACIS (SAT)
 - ANSYS surface

Simpleware ScanIP provides an extensive selection of image visualization, measurement and processing tools for working with 3D image data. Add-on modules are seamlessly combined to expand functionality.

Export Formats cont.

- Surface model (triangles) cont.:
 - ABAQUS surface
 - OPEN INVENTOR
 - POINT CLOUD
 - MATLAB file surface
 - DICOM encapsulated STL (in Simpleware ScanIP Medical only)
- Animations:
 - AVI
 - Ogg Theora
 - H.264/MPEG-4 AVC
 - Windows Media Video (WMV)
 - PNG sequence
 - Transparent PNG sequence
- 2D and 3D screenshot:
 - JPEG
 - PNG
 - Postscript (*.eps)
 - BMP
 - PNM
 - PDF
- Generate virtual X-Ray, with object burn (in Simpleware ScanIP Medical only)
- Export scene – export the current 3D view:
 - 3D PDF
 - 3MF
 - OBJ
 - PLY
 - VRML

General User Interface

- Modern ribbon interface
- Custom ribbon with user-selected tools (My tools)
- Quick find search feature for tools
- User-defined customization: dockable toolboxes, range of 2D/3D view options
- Undo/redo operation support
- Independent part visibility control in 2D and 3D
- Keyboard shortcuts: set user-defined shortcuts to commands or tools to customize and speed up repeated workflows
- Ability to import multiple image sets into the workspace to aid segmentation
- Histogram and profile line utilities assist in finding optimal threshold values

- Automatic logging and timestamp of filters and tools applied since the creation of a project
- Workspace tabs: toggle between the active document, mask statistics, model statistics, centerline statistics, the document log, and the scripting interface
- Integrated dynamic help tool
- Interactive tutorials
- Links to external support resources
- Preferences: a number of different options available for default settings:
 - General: number of undos to save, default startup layout, max permissible CPUs for parallelized operations
 - Slice views: display orientation labels, choose whether to use a dark background, specify model contour and mask voxel outline colors
 - PACS (in Simpleware ScanIP Medical only): two-way PACS communication, configure access (servers, ports, keys etc.)
 - Segmentation: options to adjust behavior of some segmentation tools and set Hounsfield presets for the Threshold tool
 - 3D view: save last camera position before exiting the document, stereo rendering settings, options to further divide higher-order mesh elements (for FE meshes and NURBS patches)
 - Volume rendering: GPU rendering supported, Background volume rendering visibility on startup
 - Folders: options to change locations of temporary files
 - Statistics: default template for Mask, Model and Centerline statistics
 - Number formatting: customize how numbers are formatted within Simpleware ScanIP
 - Annotations: set default styles for annotations
 - Scripting: enable/disable supported scripting languages
 - Licensing: change license location
 - Miscellaneous: reset suppressible dialogs, clear the undo/redo stack, mask name/color creation options

2D User Interface

- 3x 2D views
- Orientation labels
- Scale bars
- DICOM information overlay (in Simpleware ScanIP Medical only)
- Interactive cropping using 2D view
- Window/Level values and control options
- Ability to work on single slice, selection of slices or whole volume
- Slice cursors to identify the position of 2D slices

2D User Interface cont.

- Mask visualization options: solid, translucent, voxel outline
- View 3D model contours from model/3D view, surface objects and volume meshes on 2D slices
- Multi-planar reconstruction through translation and rotation of reslicing axes

3D User Interface

- Background volume rendering: using standard presets or greyscale mapping
- Single mask volume rendering
- Interactive cropping using 3D view
- Clipping box: unconstrained, interactive sectioning of 3D rendering
- Fast 3D preview mode for rapid visualization of segmentation: ability to change preview quality to speed up rendering and reduce memory consumption
- Live 3D: automatic 3D volume rendering refresh of masks
- Mask transparency
- Wireframe mode
- Vertex lines superimposed over surfaces mode
- Lighting and 3D rendering adjustments
- Background adjustments:
 - Single color
 - Two color gradient
 - Skybox
- View surface entities: CFD boundary conditions, node sets, contacts, shells
- View contours of greyscale-based material properties
- Model shading options: None, flat, Gouraud, hardware shader
- Fullscreen mode
- Camera control tool
- Load and save 3D view camera positions
- View slice planes
- Slice intersection position widget
- Show image dimensions on scale axes
- 3D stereoscopic visualization with selected hardware modes available:
 - Crystal eyes
 - Red/blue
 - Interlaced
 - Left
 - Right
 - Dresden
 - Anaglyph
 - Checkerboard

Image Processing Tools

- Data processing:
 - Crop
 - Pad
 - Rescale
 - Shrink wrap
 - Resample using various interpolation techniques: nearest neighbor, linear, majority wins and partial volume effects
 - Flip
 - Shear
 - Align
 - Register datasets: Align background images to other background images or any other dataset type based on sets of landmark points and/or automatic greyscale-based registration
- Basic filters (most commonly used):
 - Smoothing: Recursive Gaussian, Smart mask smoothing, De-stepping
 - Noise filtering: mean filter, median filter
 - Cavity fill
 - Island removal filter
 - Fill gaps tool (using largest contact surface or mask priority)
- Advanced filters (more specialist applications):
 - Binarization
 - Combine backgrounds
 - Connected component
 - Gradient magnitude
 - Lattice factory
 - Local maxima
 - MRI bias field correction (N4)
 - Masking filter
 - Morphological by reconstruction
 - Sigmoid
 - Simplify partial volume
 - Slice propagate
 - Distance maps:
 - Danielsson
 - Signed Maurer
 - CT correction:
 - CT image stabilizer
 - Histogram cylindrical equalization
 - Histogram slice equalization
 - Metal artefact reduction

Image Processing Tools cont.

- Advanced filters (more specialist applications) cont.:
 - Smoothing and noise removal:
 - Bilateral
 - Curvature anisotropic diffusion
 - Curvature flow
 - Discrete Gaussian
 - Gradient anisotropic diffusion
 - Min/max curvature flow
 - Patch-based denoising
 - Level sets:
 - Canny segmentation
 - Fast marching
 - Geodesic active contours
 - Laplacian level set
 - Shape detection
 - Threshold level set
 - Skeletonization:
 - Pruning
 - Thinning
- Morphological filters:
 - Erode
 - Dilate
 - Open
 - Close
 - 3D Wrap
- Segmentation tools:
 - Paint/unpaint
 - Paint with threshold
 - Smart paint
 - Interpolation toolbox – Contains the following options:
 - Slice interpolation: smooth or linear
 - Slice propagation: adapts to image or uses direct copy
 - Confidence connect region growing
 - Background flood fill
 - Mask flood fill
 - Threshold
 - 3D editing tools for application of filters to local regions – option to apply in multiple regions and on camera facing surface only in advanced tool version
 - Mask ungroup tool
 - Automated generation of masks for pre-segmented images
 - Magnetic lasso
 - Multilevel Otsu segmentation
 - Split regions tool, with the ability to mark regions in the 3D view
 - Merge regions tool
 - Direct copy: background to mask or mask to background
 - Watershed segmentation tool
- Boolean operations: applied to/between masks. General and Venn diagram UI options:
 - Union
 - Intersect
 - Subtract
 - Invert
- Local surface correction: local, greyscale-informed correction of mask surface, including the ability to apply on a region of interest only
- Multi-label tools: use mask labels to label different regions within a mask. Use for statistics and visualization:
 - Label disconnected regions
 - Split mask into pores
 - Combine masks to multi-label mask
 - Mask label editor
 - Reports (automatically generate pre-formatted reports of common metrics using a multi-label mask or full model's mesh):
 - Particles report
 - Pores and throats report
- Window/level tool
- Overlap check: display/generate mask to check overlap volume in active masks

Statistical Analysis

- Quick statistics: quickly compute commonly required quantities (volume, surface area, average greyscale, etc.)
- Mask statistics (based on voxel information):
 - Built-in templates: general statistics, contact statistics, material statistics, orientation, pore sizes, surface statistics
 - Ability to generate user-defined templates
 - Variety of statistical information pertaining to:
 - Voxels: count, volume, surface area, etc.
 - Greyscales: mean, standard deviation, minimum, maximum, etc.
 - Surface estimation: area, area fraction, volume, volume fraction, etc.
 - Material properties: mass, mass density, Young's modulus, Poisson's ratio, moment of inertia, etc.
 - Axis-aligned bounding boxes
 - Axis-aligned bounding ellipsoids

Statistical Analysis cont.

- Mask statistics (based on voxel information) cont.:
 - Object-oriented bounding boxes
 - Object-oriented bounding ellipsoids
 - Create a user-defined statistic
- Model statistics (based on polygon information):
 - Ability to generate user-defined templates
 - Built-in templates: general statistics (perimeters, surfaces, volumes and NURBS surfaces), mesh quality (CFD, FE-linear elements and FE-quadratic elements), orientation (perimeters, surfaces, volumes), pore sizes, surface quality (linear, quadratic), volume mesh statistics
 - Variety of statistical information pertaining to:
 - Surface parameters: element count, node count, edge count, etc.
 - Perimeters: length, mean edge length, mean dihedral angle, etc.
 - Surface triangle and quadrilateral primitives: edge-length, in-out ratio, distortion, etc.
 - Tetrahedral, hexahedral, pyramid and prismatic volume element primitives: angular skew, volume skew, shape factor, Jacobian, etc.
 - Axis-aligned bounding boxes
 - Axis-aligned bounding ellipsoids
 - Object-oriented bounding boxes
 - Object-oriented bounding ellipsoids
 - Create a user-defined statistic
- Centerline statistics:
 - Built-in templates: line orientation, lines by network, lines by node, constriction, shape, twist, nodes by network.
 - Ability to generate user-defined templates
 - Variety of statistical information pertaining to:
 - Lines: count, network, length, Euclidean length, curvature, torsion, closed, looped, positions, orientation, connection count, cross-sectional area and perimeter, incircle radius, twist, control points, object-oriented bounding boxes, mean orientation vector, best fit circle, inscribed radius, circumscribed radius, bounding ellipse radius
 - Nodes: name, mask, network, position, line count, connection count.
 - Create a user-defined statistic
 - Probe centerlines to get measurements at specific locations
- Save and import user-defined templates and statistics
- Compute statistics within user-defined regions of interest (ROIs)

Fiber Orientation Analysis

- Allows fiber orientation to be analyzed directly from the image data (without the need for segmentation)
- Option to include a mask representing the fiber region for fiber volume and diameter information
- Specify the fiber diameter and the sampling size to be analyzed for the whole image or a region of interest
- Copy the centerlines generated during the analysis to the centerlines editor for further editing or analysis
- Statistics for analyzed region or region of interest:
 - Analyzed volume, fiber volume, fiber density, principal orientation
 - Eigen analysis (major, medial, minor vectors and value)
 - Orientation tensor
 - Fiber length and cross-section information
- Plot statistics, export as *.png or *.csv:
 - Angle to principal orientation histogram
 - Angle to image axis histogram
 - Orientation tensor components vs image axis
 - Fiber density vs image axis (requires segmentation)
 - Principal orientation hedgehog diagram
 - Length of whole fibers histogram
 - Diameter of all segments histogram (incircle/best fit circle) (requires segmentation)
- Visualize vectors:
 - Orientation vectors, Eigen vectors, Eigen ellipsoids in 3D view
 - Orientation vectors in 2D slices
 - Change color scheme, and glyph density/scale/width
 - Export as *.csv or *.txt files
- Map to mesh:
 - Export (or assign using FE Module) fiber orientation information per mesh cell
 - Average orientation tensor, eigenvector and eigenvalue data calculated for each mesh cell
 - Export volume fraction information per mesh cell (requires segmentation)

Particle Analysis

- Allows particles (either isolated or touching) to be analyzed from a mask or multi-label mask
- There are two types of pore analysis available, "Touching", for particles that are in contact with each other, "Isolated" for particles that are separated from each other.
- Statistics for analyzed region or region of interest:
 - Particle volume (Total, Mean, SD, Min, Max)
 - Particle area (Mean, SD, Min, Max)
 - Particle volume fraction
 - Particle equivalent volume sphere diameter (Mean, SD, Min, Max)
 - Particle bounding box extent (Mean, SD, Min, Max)
 - Particle ellipsoid diameter (Mean, SD, Min, Max)
 - Particle flatness
 - Particle elongation
 - Particle shape factor
 - Particle sphericity
- Plot statistics, export as *.png or *.csv:
 - Volume histogram
 - Area histogram
 - Flatness histogram
 - Elongation histogram
 - Shape factor histogram
 - Sphericity histogram
- Particle visualization:
 - Contact count
 - Voxel count
 - Surface area
 - Boundary contact area
 - Label contact area
 - Volume
 - Max greyscale
 - Mean greyscale
 - Major length
 - Flatness
 - Elongation
 - Shape factor
 - Sphericity
 - Orientation angle to x/y/z axis
 - Orientation to mean
 - Export as *.csv or *.txt files
- Map to mesh:
 - Export (or assign using FE Module) particle volume fraction information per mesh cell

Pore Analysis

- Allows pores (either open or closed) to be analyzed from a mask or multi-label mask
- There are two types of pore analysis available, "Open", for connected pore networks, and "Closed" for pores that are separated from each other
- Statistics for analyzed region or region of interest:
 - Total pores count
 - Total throat count volume
 - Volume fraction
 - Internal pore volume (Mean, SD, Min, Max)
 - Internal pore surface area (Mean, SD, Min, Max)
 - Pore equivalent volume sphere diameter (Mean, SD, Min, Max)
 - Pore Flatness (Mean, SD, Min, Max)
- Statistics for analyzed region or region of interest cont.
 - Pore Elongation (Mean, SD, Min, Max)
 - Pore Shape factor (Mean, SD, Min, Max)
 - Pore Sphericity (Mean, SD, Min, Max)
 - Pore coordination number (Mean, SD, Min, Max)
 - Throat contact count
 - Throat contact area
 - Throat radius (Mean, SD, Min, Max)
 - Throat Flatness (Mean, SD, Min, Max)
 - Throat Elongation (Mean, SD, Min, Max)
 - Throat Eccentricity (Mean, SD, Min, Max)
 - Throat Shape factor (Mean, SD, Min, Max)
- Plot statistics, export as *.png or *.csv:
 - Volume histogram
 - Area histogram
 - Flatness histogram
 - Elongation histogram
 - Shape factor histogram
 - Sphericity histogram
- Particle visualization:
 - Contact count
 - Voxel count
 - Surface area
 - Boundary contact area
 - Label contact area
 - Volume
 - Max greyscale
 - Mean greyscale
 - Major length

Pore Analysis cont.

- Particle visualization cont.:
 - Flatness
 - Elongation
 - Shape factor
 - Sphericity
 - Orientation angle to x/y/z axis
 - Orientation to mean
 - Export as *.csv or *.txt files
- Map to mesh:
 - Export (or assign using FE Module) pore volume fraction information per mesh cell

Surface Mesh Generation

- Topology and volume preserving smoothing
- Triangle smoothing
- Decimation
- Multipart surface creation
- Surface element quality control (for volume meshing in third party software)
- So-called 'sub-pixel accuracy' through the use of partial volume effects data

Surface Mesh Quality Inspection Tool

- Inspect surface triangles or clusters of triangles
- Option to show mesh errors (e.g. surface holes, surface intersections) and warnings
- Show distorted elements above a user-defined threshold
- Display quality metric histograms
- Zoom into the pathological element to inspect it more closely

Measurement Tools

- Create and save points, distances and angles in 2D/3D
- Visualization options to display all at once or selected
- Snap to 3D surface option
- Profile line
- Histogram
- Export as comma-separated values
- Centerline creation toolkit:
 - Centerline creation (general)
 - Centerline creation for fibers
 - Junction editing

- 2D contour measurements:
 - Creation mode
 - Area
 - Total perimeter
 - In-circle diameter
 - Out-circle diameter
 - Trigone-Trigone (TT) distance
 - Septal to Lateral (SL) distance
 - Intercommissural (IC) distance
 - Posterior perimeter
- Wall thickness analysis tool for masks or surface objects, using a raycasting or sphere fitting algorithm
- Shape-based measurement tools:
 - Shape editor: Create, edit, visualize, export and measure shapes
 - Shape fitting: Fit shapes to geometry
 - Shape-to-shape measurements: Obtain measurements between shape objects
- X-ray image import, with alignment and object registration (in Simpleware ScanIP Medical only)

3D Printing Toolkit

- Set of tools for editing, analyzing and visualizing surfaces before sending them to a 3D printer which includes:
 - Preparation tools:
 - Model preview
 - Mask to Surface
 - Emboss text
 - Hollow
 - Cut
 - Create Connectors (inc. manual and automatic options)
 - Pins and Sockets connectors
 - Analysis tool – Greyscale visualization
 - Inspection tools:
 - Color proofing
 - Check printability
 - Export: a variety of file formats including:
 - 3MF
 - STL
 - OBJ
 - PLY
 - 3D PDF
 - VRML

Animations

- Create and export animations in the 3D view
- Built-in-quick animations:
 - Rotations
 - Slice reveals
 - Volume rendering
- User-defined animations cues:
 - Background colors
 - Camera (orbits, follow path and key frame-based),
 - Clipping
 - Opacity
 - 2D slice planes
 - Volume rendering
- Export formats:
 - AVI
 - Ogg Theora
 - H.264/MPEG-4 AVC
 - Windows Media Video (WMV)
 - PNG sequence
- Variety of export sizes: From 480p to 2160p (4K)

4D Frame Toolbox (in Simpleware ScanIP Medical only)

- Active frame slider to manually control frame displayed in the 2D slice views and 3D view
- Cine mode for active slice view and 3D view
- Compare frames – compare two 2D slice views to examine differences
- Options to set the time between frames and delete unwanted frames

Scripting

- The ScanIP Application Programming Interface (API) is an object-oriented programming library that allows access to most of the features of Simpleware ScanIP
- Support for a variety of scripting languages:
 - Python 3
 - C#
 - Python 2 (deprecated)
 - Iron python (deprecated)
 - Visual basic (deprecated)
 - Boo (deprecated)
 - Java (deprecated)
- Macro recording: record, save and play macro
- Convert log entry to script
- Script editor with autocomplete functionality
- Console ScanIP: a GUI-less version of Simpleware ScanIP which can be run with scripted workflows