StraboMicro2 Improvements Over Legacy Java App

Document Created: 2026-01-13 **Last Updated**: 2026-03-09

This document catalogs all improvements, new features, and enhancements in StraboMicro2 compared to the legacy JavaFX StraboMicro application.

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Major New Features

These features are entirely new to StraboMicro2 and did not exist in the legacy app.

1. Version History System

Full project versioning with snapshots and restore capability.

- **Snapshots**: Every save creates a version snapshot
- **Named checkpoints**: Create named versions that persist through auto-pruning
- **Diff preview**: Visual comparison showing added/removed/modified entities
- **Restore**: Restore any previous version with automatic backup of current state
- **Auto-pruning**: Maintains max 200 versions, 30 days retention, minimum 10 kept
- **Storage stats**: View version history storage usage

Access: File > View Version History...

2. Autosave System

Automatic saving prevents data loss.

- **5-minute timer**: Saves automatically after 5 minutes of inactivity
- **Close protection**: Auto-saves on app close if unsaved changes exist
- **Version integration**: Creates version snapshot on each autosave

3. High-Resolution Overlay System (LOD)

Dynamic Level-of-Detail rendering ensures overlays are always sharp.

- **Dynamic resolution**: Overlays render at appropriate resolution based on zoom level
- **Three LOD modes**:
  - THUMBNAIL: < 10% screen coverage or zoomed out
  - DOWNSAMPLED: 10-40% coverage, moderate zoom
  - TILED: > 40% coverage or high zoom (full resolution)
- **Viewport culling**: Only loads tiles for visible areas
- **Memory management**: LRU eviction prevents memory overflow

Result: No more pixelated overlays when zoomed in!

4. Recent Projects Menu

Quick access to previously opened projects. Can now have multiple projects open at a time.

- **Quick switching**: File > Recent Projects submenu
- **Last 10 projects**: Shows most recently opened projects
- **Relative dates**: Displays "Today", "Yesterday", "Nov 25", etc.
- **Current indicator**: Checkmark next to currently open project
- **Auto-rebuild**: Index rebuilds on app startup by scanning project folders
- **Unsaved changes**: Prompts to save before switching

5. Recursive Spots

View spots from child micrographs on the parent view. Currently only traverses to first child, but grandchild and beyond may be possible with extra development work.

- **Transformed display**: Child spots render with correct position, scale, and rotation
- **Full interactivity**: Click to select, right-click for context menu
- **Toggle control**: View > Show Recursive Spots

Use case: See all analytical spots from high-mag images while viewing the reference micrograph.

6. SVG Export with Vector Spots

Export micrographs as editable vector graphics.

- **Vector spots**: All spots export as editable SVG paths
- **Editable labels**: Text labels are editable in vector software
- **Raster base**: Base image embedded as JPEG
- **Software compatible**: Works with Adobe Illustrator, Inkscape, Affinity Designer

Access: Download dropdown > "Download as SVG (Vector)" **Or**: File > Export all Images > "SVG (Vector)"

7. Real-World Spot Measurements

Automatic calculation of physical dimensions.

- **Line spots**: Shows total length (sum of all segments)
- **Polygon spots**: Shows area (shoelace formula) and perimeter
- **Smart units**: Auto-selects µm, mm, or cm based on magnitude
- **Calibration required**: Only displays when micrograph has scale set
- **Precision**: 3 decimal places
- Measurements appear in "Spot Metadata" section of metadata bar.

8. Overlay Drill-Down Navigation

Click-to-navigate through overlay hierarchy. Feature requested by Julie.

- **Direct navigation**: Click any overlay micrograph to jump to it
- **Back button**: Navigate back through history
- **Unlimited depth**: A → B → C → back to B → back to A
- **Visual feedback**: Cursor changes to pointer on hover
- **Sidebar integration**: Navigation stack clears when selecting from sidebar

9. Sentry Error Tracking

Automatic crash reporting for production builds.

- **Automatic reporting**: Crashes sent to Sentry dashboard
- **Production only**: Disabled in development mode
- **Privacy**: User paths scrubbed before sending
- **Release tracking**: Errors tagged with app version

10. Bulk Associated Files Import

Import multiple associated files at once.

- **Multi-select**: Cmd/Ctrl+click for multiple files
- **Preview**: Selected files shown as removable chips
- **Shared metadata**: File type and notes applied to all
- **Progress tracking**: Visual feedback during import

11. Clickable Associated Files

Quick access to associated files.

- **Click to open**: File names open with user's system default app
- **Visual indicator**: Small external link icon (↗)
- **Works everywhere**: Both in edit dialog and accordion summary

12. Project Stats Footer

Running totals in the sidebar.

- **Always visible**: Pinned to bottom of left sidebar
- **Live updates**: Changes as content is added/removed
- **Content**: "Total Samples: x · Total Micrographs: x"

13. File Association (.smz)

Double-click .smz files to open them.

- **macOS**: Registered via Info.plist
- **Windows**: Registered via NSIS installer
- **Single instance**: Second instance passes file to first
- **Works when running**: Opens file in already-running app

14. GitHub Actions CI/CD

Automated build and release pipeline.

- **Multi-platform**: Builds for macOS (Intel + Apple Silicon) and Windows
- **Automated releases**: Creates releases on git tag
- **Code signing**: Configured for notarization (when certificates available)

15. Automatic Updates

Automatic updates based on GitHub uploads.

- **Instant Availability**: Updates available automatically once built by GitHub
- **Instant Notification**: Updates are checked for with every app launch and every 30 minutes while running
- **No Manual Install**: Updates are downloaded in background and implemented next app launch

16. Point Count System

Systematic point counting for modal analysis and petrographic studies.

- **Grid generation**: Customizable grid overlay with adjustable spacing
- **Keyboard navigation**: Arrow keys to move between grid points
- **Quick mineral shortcuts**: Configurable letter keys (A-Z) for rapid mineral assignment
- **Statistics panel**: Live counts and percentages by mineral
- **Session management**: Save and resume point count sessions
- **Export**: Export results as CSV

Access: Tools > Point Count...

17. Grain Detection (OpenCV)

Automated grain boundary detection using classical computer vision.

- **Edge detection**: Canny edge detection for boundary identification
- **Watershed segmentation**: Marker-based watershed algorithm for grain separation
- **Preview mode**: See detected grains before committing
- **Adjustable parameters**: Sensitivity, minimum grain size, edge threshold
- **Batch creation**: Creates polygon spots for all detected grains

Access: Tools > Grain Detection > OpenCV Detection...

18. FastSAM AI Grain Detection

AI-powered grain detection using the FastSAM (Fast Segment Anything Model) neural network.

- **GrainSight algorithm**: Specialized contour extraction optimized for thin sections
- **Automatic model download**: Downloads ONNX model from HuggingFace on first use
- **High accuracy**: Better boundary detection than classical methods, especially for complex textures
- **Cross-platform**: Works on macOS, Windows, and Linux
- **WASM inference**: Runs entirely in-browser via WebAssembly for maximum compatibility

Access: Tools > Grain Detection > AI Detection (FastSAM)...

19. Quick Edit Mode

Keyboard-driven interface for rapidly reviewing and classifying spots after grain detection.

- **Keyboard navigation**: Arrow keys to move between spots
- **Quick mineral assignment**: Letter keys (A-Z) for instant classification (shared shortcuts with Point Count)
- **Visual states**: Unreviewed (black outline), selected (red), classified (green)
- **Filled rendering**: Spots display with standard fill, color, and opacity
- **Statistics panel**: Track progress with reviewed/remaining counts
- **Auto-advance**: Automatically moves to next spot after classification
- **Lasso selection**: Batch classify similar grains with Shift+drag

Access: Edit > Quick Edit Spots... (Cmd+Shift+Q)

20. Batch Edit & Multi-Select

Select and edit multiple spots simultaneously.

- **Lasso selection**: Shift+drag to select multiple spots
- **Cmd/Ctrl+Click**: Add/remove spots from selection
- **Batch property editing**: Change color, mineral, tags for all selected spots
- **Batch delete**: Delete multiple spots at once
- **Visual feedback**: Selected spots highlighted with distinct styling

Access: Use Shift+drag on canvas, or Cmd/Ctrl+click spots

21. Merge & Split Tools

Combine or divide polygon spots for grain boundary refinement.

- **Merge spots**: Combine multiple adjacent polygons into one (M key)
- **Split spot**: Draw a line to divide a polygon into two parts (/ key)
- **Undo support**: Full undo/redo for merge and split operations
- **Provenance tracking**: Merged/split spots track their origin

Access: Select spots, then use M to merge or / to split

22. Grain Size Analysis

Quantitative morphometric analysis of polygon spots with statistical visualization.

- **Per-grain metrics**: Area, perimeter, equivalent diameter, aspect ratio, orientation, circularity
- **Population statistics**: Mean, median, std dev, skewness, sorting coefficient
- **Rock type schemes**: Wentworth (sedimentary), igneous, and metamorphic classification scales
- **Size histogram**: Distribution chart with classification overlay
- **Rose diagram**: Grain orientation distribution (0-180°)
- **Mineral grouping**: Statistics broken down by classified mineral
- **Scope options**: Analyze current micrograph or all micrographs
- **CSV export**: Export all metrics for external analysis
- **PDF reports**: Generate formatted reports with charts and statistics

Access: Tools > Grain Size Analysis... (Cmd+Shift+G)

23. Image Comparator

Full-screen multi-canvas view for comparing micrographs side-by-side.

- **Grid layout**: View multiple micrographs in a grid arrangement
- **Independent pan/zoom**: Each canvas has independent navigation
- **Sync option**: Optionally synchronize pan/zoom across all canvases
- **Overlay support**: Shows associated micrographs with outlines
- **Affine overlay support**: Works with 3-point registered overlays
- **Theme-aware**: Background adapts to light/dark theme

Access: Help > Image Comparator...

24. Affine Transform Placement (3-Point Registration)

Precise overlay alignment using three-point correspondence.

- **3-point registration**: Click three points on parent, then three corresponding points on child
- **Affine transform**: Supports translation, rotation, scale, and shear
- **Live preview**: See the transformed overlay before applying
- **Persistent**: Transform data saved with project and regenerated on import
- **Export support**: Affine overlays included in composite images and PDFs

Access: New Micrograph wizard > "3-Point Registration" placement option

25. Splash Screen

Professional startup experience with branding.

- **App logo**: Displays StraboMicro logo during startup
- **Version display**: Shows current app version
- **Loading indicator**: Visual feedback during initialization

26. Properties Panel Tabs

Organized metadata viewing with tabbed interface.

- **Micrograph/Spot tab**: Shows details for selected micrograph or spot
- **Sketches tab**: Sketch layer management (appears when micrograph selected)
- **Project tab**: Quick access to project-level metadata
- **Tab persistence**: Remembers last selected tab

27. Wizard Thumbnail Preview

Visual confirmation during micrograph import.

- **Thumbnail display**: Shows preview of selected image in wizard header
- **Immediate feedback**: Confirms correct image selection before proceeding

28. Ruler/Measurement Tool

On-canvas distance measurement.

- **Click and drag**: Draw measurement line on canvas
- **Real-world units**: Displays distance in µm, mm, or cm (when scale is set)
- **Crosshair cursor**: Clear visual indication when tool is active
- **Non-persistent**: Measurement clears after use (for quick checks)

Access: Drawing toolbar ruler icon, or Tools > Measure (M key)

29. Micrograph Opacity Slider

Fine-grained opacity control for overlay micrographs.

- **Slider control**: Adjust opacity from 0-100%
- **Quick access**: Popover appears from opacity button

- **Live preview**: See changes in real-time
- **Per-micrograph**: Each overlay can have different opacity

Access: Click opacity icon in micrograph context menu or properties panel

30. Linux Support

Full support for Linux distributions.

- **AppImage format**: Single-file distribution for easy installation
- **Sandbox compatibility**: Works with Electron sandbox restrictions
- **Tested distros**: Ubuntu, Fedora, and derivatives

31. Sketch Overlay System

Complete freehand drawing and annotation system layered on top of micrographs.

- **Pen tool**: Thin freehand strokes with configurable color and width (1-50px)
- **Marker tool**: Semi-transparent highlighter strokes (3x width, 40% opacity)
- **Eraser tool**: Click or drag-to-erase strokes and text items with visual hover feedback
- **Text tool**: Place text annotations with configurable font size (8-72px)
- **Multi-layer system**: Create unlimited sketch layers per micrograph with independent visibility
- **Layer management**: Rename, reorder, show/hide, and delete layers via dedicated Sketches tab
- **Color picker**: Full hex color picker for stroke and text color
- **Undo/redo**: All sketch operations (stroke, text, layer changes) fully undoable
- **Export**: Export micrograph with selected sketch layers as PNG or JPEG at 1x-4x resolution

Access: Drawing toolbar > Sketch Mode button, or press S. Export via File > Export Micrograph with Sketches...

Result: Annotate micrographs with freehand drawings without affecting the underlying image data!

32. XPL/PPL Synchronized Viewing

Toggle between cross-polarized (XPL) and plane-polarized (PPL) views of the same thin section with synchronized navigation.

- **Sibling pairing**: Link complementary PPL and XPL micrographs (must share same aspect ratio)
- **One-click toggle**: Instantly switch between PPL and XPL views
- **Synchronized pan/zoom**: View position preserved when toggling between siblings
- **Shared spots**: Annotations are shared between paired micrographs
- **Add sibling**: Create a new paired image directly from an existing micrograph (inherits position/scale)
- **Link existing**: Pair two existing micrographs with matching dimensions

Access: Press X to toggle, or click the swap icon in the viewer toolbar

Result: Seamlessly compare polarized light views without losing your place!

33. Mineral Color Tool

View spots colored by their mineral classification instead of individual spot colors.

- **Two view modes**: Toggle between "View by Spot Color" and "View by Mineral Color" via View menu
- **Global colors**: App-wide mineral-to-color mappings applied to all projects
- **Project overrides**: Per-project color overrides that take precedence over global settings
- **Color configuration**: Full color picker for each mineral with add/remove capability
- **Default palette**: Built-in color defaults for common minerals
- **Case-insensitive**: Mineral name matching works regardless of capitalization

Access: View > View Spots by Mineral Color. Configure via Spot > Configure Mineral Colors...

Result: Instantly visualize mineral distribution across your micrograph!

34. Quick Spot Presets

Reusable metadata templates for rapidly applying properties to spots.

- **Template system**: Save spot color, label, opacity, and all geological feature data as a named preset
- **Key bindings**: Bind presets to number keys 1-9 for instant application in Quick Edit mode
- **Two scopes**: Global presets (app-wide) and project-specific presets
- **Drag-to-reorder**: Rearrange presets via drag and drop
- **Preset summary**: Each preset displays a summary of included data types
- **Duplicate & edit**: Clone existing presets and modify for variations

Access: Spot > Quick Spot Presets... (Cmd+Shift+P)

Result: Apply complex geological classifications to spots with a single keypress!

35. Startup Messages

In-app announcements from the StraboSpot team.

- **Server-fetched**: Messages loaded from StraboSpot backend on app launch
- **Markdown rendering**: Rich text formatting with clickable links
- **Dismissible**: "Don't show this again" checkbox to hide individual messages
- **External links**: Links open in the user's default browser

36. Batch Import File Validation

Pre-validation of image files during import to catch problems before they cause errors.

- **Magic-byte detection**: Reads first 8 bytes of each file to verify actual image format (PNG, JPEG, TIFF, BigTIFF, BMP)
- **Cloud storage detection**: Identifies files that appear present but haven't been downloaded from cloud storage (Dropbox, iCloud, OneDrive)
- **Warning indicators**: Invalid files show warning icons with descriptive messages
- **Graceful handling**: Only valid files proceed to import; invalid files can be fixed and re-selected

Result: No more cryptic "unsupported image format" errors from cloud-synced files!

Significant Improvements

These features existed in the legacy app but have been substantially improved.

Image Handling

Feature	Legacy App	StraboMicro2
Maximum zoom level	5x	20x
Overlay rendering	Fixed resolution, pixelated at zoom	Dynamic LOD, sharp at any zoom
Tile caching	None	Disk-based cache with LRU eviction
Loading feedback	None	Progressive tile loading with visual indicators
Image formats	Limited Java ImageIO	TIFF, JPEG, PNG, BMP via Sharp library
Large image support	Memory issues	Streaming with libvips, handles 100MB+ files

User Experience

Feature	Legacy App	StraboMicro2
Theme support	Light only	Dark/Light/System with smooth transitions
Panel layout	Fixed sizes	Resizable, collapsible with drag handles
Window state	Not saved	Position, size, maximized state persisted
Session state	Lost on restart	Full session persistence to file
Sidebar expansion	Resets on restart	Expansion state persists
Undo/Redo	Limited	Comprehensive with Cmd+Z / Cmd+Shift+Z
Toolbar position	Fixed	Dockable toolbars with 4-edge cycling (right/bottom/left/top), persisted
View preferences	Reset on restart	All View menu toggles synced and persisted across sessions

Export Capabilities

Feature	Legacy App	StraboMicro2
PDF export	Basic layout	React-PDF with Table of Contents, internal links, all metadata fields
Image export	Low Resolution Only / Poorly Annotated	Composite with overlays + spots + labels, or SVG vector
Sketch export	Not available	Export with selectable sketch layers, PNG/JPEG, 1x-4x resolution

Feature	Legacy App	StraboMicro2
README in archive	None	Auto-generated README.txt with project summary

Batch Operations

Feature	Legacy App	StraboMicro2
Batch associated files	Not available	**Multi-select with shared metadata**
Batch import validation	None	**Magic-byte pre-validation with cloud storage detection**

Data Organization

Feature	Legacy App	StraboMicro2
Reorder items	Limited to Up/Down Arrow	**Drag & drop for datasets, samples, micrographs**
Keyboard reorder	Not available	**Ctrl/Cmd + Up/Down arrows**

Canvas & Drawing Tools

Feature	Legacy App	StraboMicro2
Spot labels	Basic rendering	**Three label modes: Original name, Mineralogy abbreviation, or None**
Edit polygon geometry	Limited	**Advanced midpoint handle mode, move entire feature**
Drawing tool shortcuts	Not available	**Keyboard shortcuts: P (point), L (line), G (polygon), M (measure)**
Freehand annotation	Not available	**Full sketch overlay system with pen, marker, eraser, and text tools**

Metadata & Analysis

Feature	Legacy App	StraboMicro2
Grain size data	Not visible in panel	**Grain size metrics displayed in Properties Panel spot view**
Point count data	Not visible in panel	**Point count summaries displayed in Properties Panel spot view**
Instrument requests	Manual process	**Mailto link in metadata panel to request new instruments**

Parity Features

These features exist in both apps with similar core functionality:

Project Management

- New project creation with metadata
- Save project / Save as
- Open local .smz files
- Open remote projects from server
- Open shared projects via code
- Upload project to server
- Edit project metadata

Hierarchy

- Dataset creation and management
- Sample creation and management
- Micrograph creation and management
- Project → Dataset → Sample → Micrograph → Spot structure

Spots & Annotations

- Point spot creation
- Line spot creation
- Polygon spot creation
- 78 geological data types
- Spot color and label customization
- Copy data from existing spots

Instrument Support

- Optical Microscope
- SEM (Secondary Electron, Backscattered Electron)
- TEM
- EBSD
- Cathodoluminescence
- Instrument database lookup

Scale & Orientation

- Scale bar tracing
- Micrograph orientation (trend/plunge)
- Flip horizontal

Integration

- StraboSpot field data linking
- Sample import from StraboSpot
- Mineral database (204KB SQLite)
- Lithology database (20KB SQLite)

Micrograph Features

- Opacity control for overlays
- Visibility toggle for associated micrographs

Summary

StraboMicro2 represents a significant advancement over the legacy JavaFX application:

- **36+ entirely new features** not present in the legacy app
- **30+ significant improvements** to existing functionality
- **Modern tech stack** enabling faster development and better UX
- **Complete spot generation workflow**: Point Count → Grain Detection → Quick Edit → Grain Analysis
- **AI-powered analysis**: FastSAM neural network for grain detection
- **Full annotation system**: Sketch overlays with multi-layer drawing tools
- **Cross-platform** with native-quality experience on macOS, Linux and Windows

The most impactful improvements for users are:

1. **Version History** - Never lose work again
2. **High-Resolution Overlays** - Sharp images at any zoom level
3. **Sketch Overlays** - Freehand drawing directly on micrographs
4. **XPL/PPL Toggle** - Seamless polarized light comparison
5. **Recent Projects** - Quick access to your work
6. **Dark Theme** - Reduced eye strain