Medical Core · Clinical Workflow Integration

Maxillofacial Digital Occlusion Workflow

Redesigned separate landmarking, occlusion, and evaluation tools into a user-friendly end-to-end workflow that researchers can operate in one application.

Period 2026.03 - present | Evidence state Ongoing · Researcher Validation | Portfolio tier Medical Core

Connected eight-model preparation, dental and maxillofacial landmarks, anatomical frames, automatic occlusion, 6-DOF adjustment, contact analysis, RMSE/Gap/FRE evaluation, and export in one Custom App.

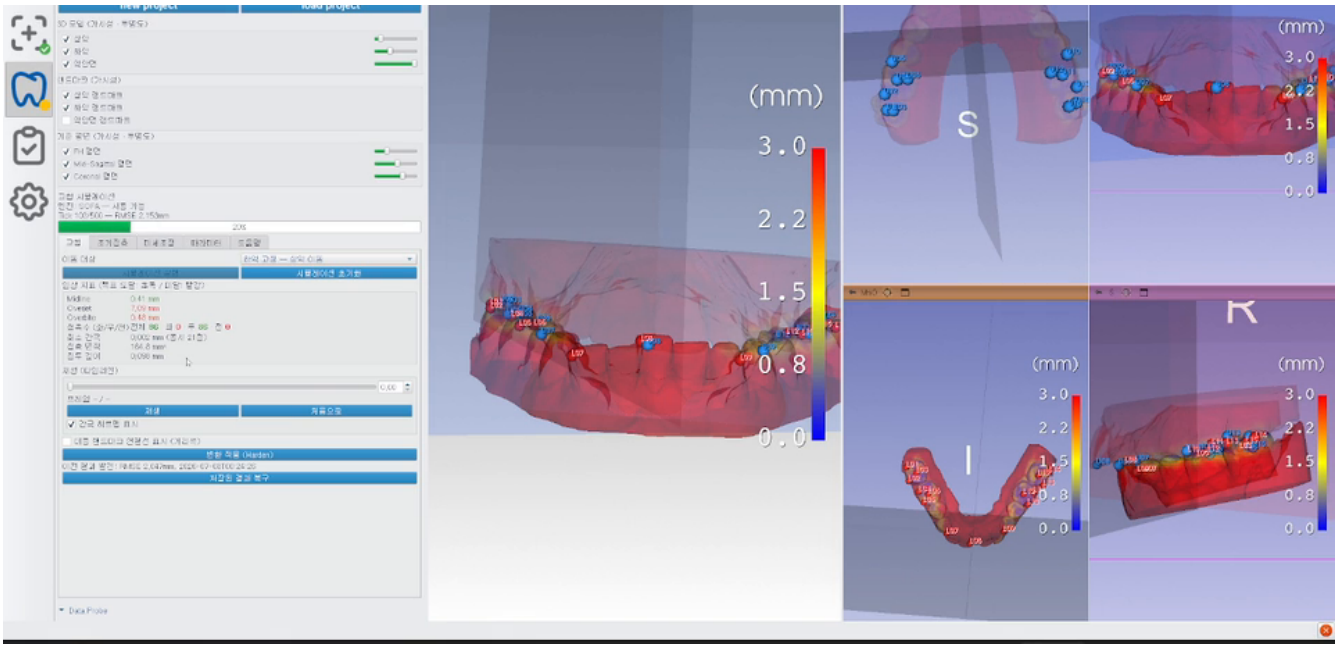


Figure 1. Development-build demonstration of landmarking, multi-view occlusion, and evaluation using synthetic test data.

Problem and system boundary

The earlier flow separated landmarking into another application, made reference comparison and view navigation awkward, lacked multi-view occlusion, fragmented save/load, omitted maxillofacial landmarks, and had no sufficiently integrated result screen.

Owned decisions and implementation

My role

Technical Lead · Primary Developer

As technical lead and primary developer, designed the complete Custom App architecture across the C++/Qt shell, Python modules, and shared library, and led the end-to-end UI/UX, algorithm and engine integration, evaluation/export, CMake/SuperBuild, testing, and packaging.

A seven-stage workflow in one application

Project state remains connected from data preparation through evaluation and export.

- Prepare eight 3D models
- Enter and visualize 30 dental landmarks (15 upper and 15 lower) plus 30 maxillofacial landmarks
- Construct anatomical frames from the landmarks
- Run automatic occlusion, 6-DOF fine adjustment, and pivot rotation
- Visualize contact state and distance
- Evaluate RMSE, Gap, and FRE
- Save the project and export results

Designed for direct researcher use

The priority was not feature count, but helping researchers repeat the workflow without interruption and compare its results.

- A reference image beside the zoomable landmark-entry view
- Multiple simultaneous views of the occlusal state
- A unified and simplified project save/load flow
- A playback bar for reviewing the occlusion process
- Pivot rotation handles for fine adjustment
- Model-opacity and landmark-visibility controls

Custom App architecture and ownership

The 3D Slicer Custom App is structured around a C++/Qt shell, Python workflow modules, and shared state and libraries. Collaborative algorithms and engines are not reassigned as individual implementations; the individually owned integration into state flow, UI, visualization, and evaluation remains explicit.

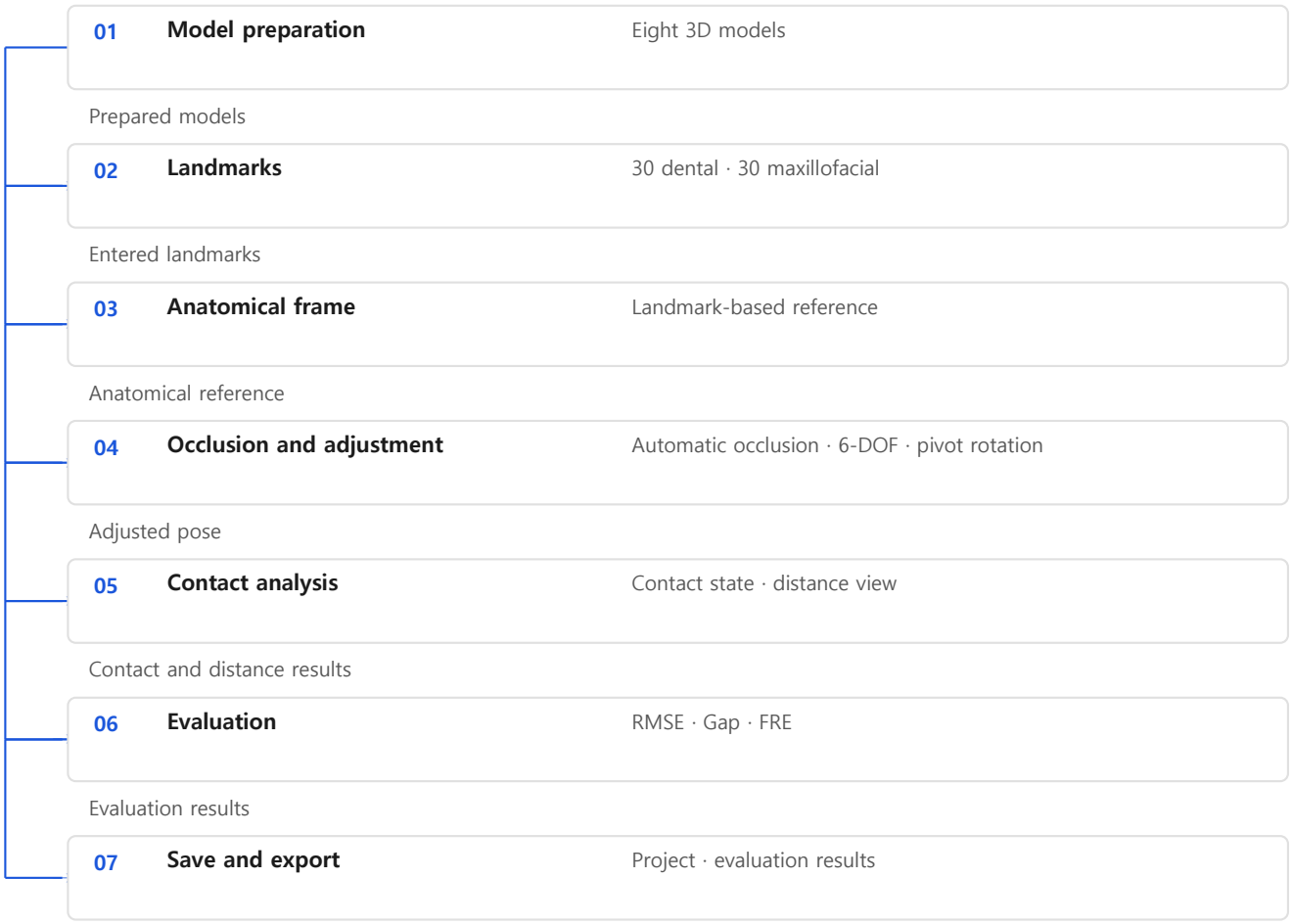
Current validation state and limitations

Functional operation and clinical applicability remain separate claims.

- Implemented: eight-model preparation, dental and maxillofacial landmarks, anatomical frames, automatic occlusion, 6-DOF and contact analysis, evaluation, and export
- Under review: researchers directly use development and demonstration builds to review workflow usability and occlusion output
- Not claimed: hospital installation, use in real surgery, medical-device status, clinical efficacy, accuracy or safety, or performance interpretation of displayed example values

Data preparation through evaluation

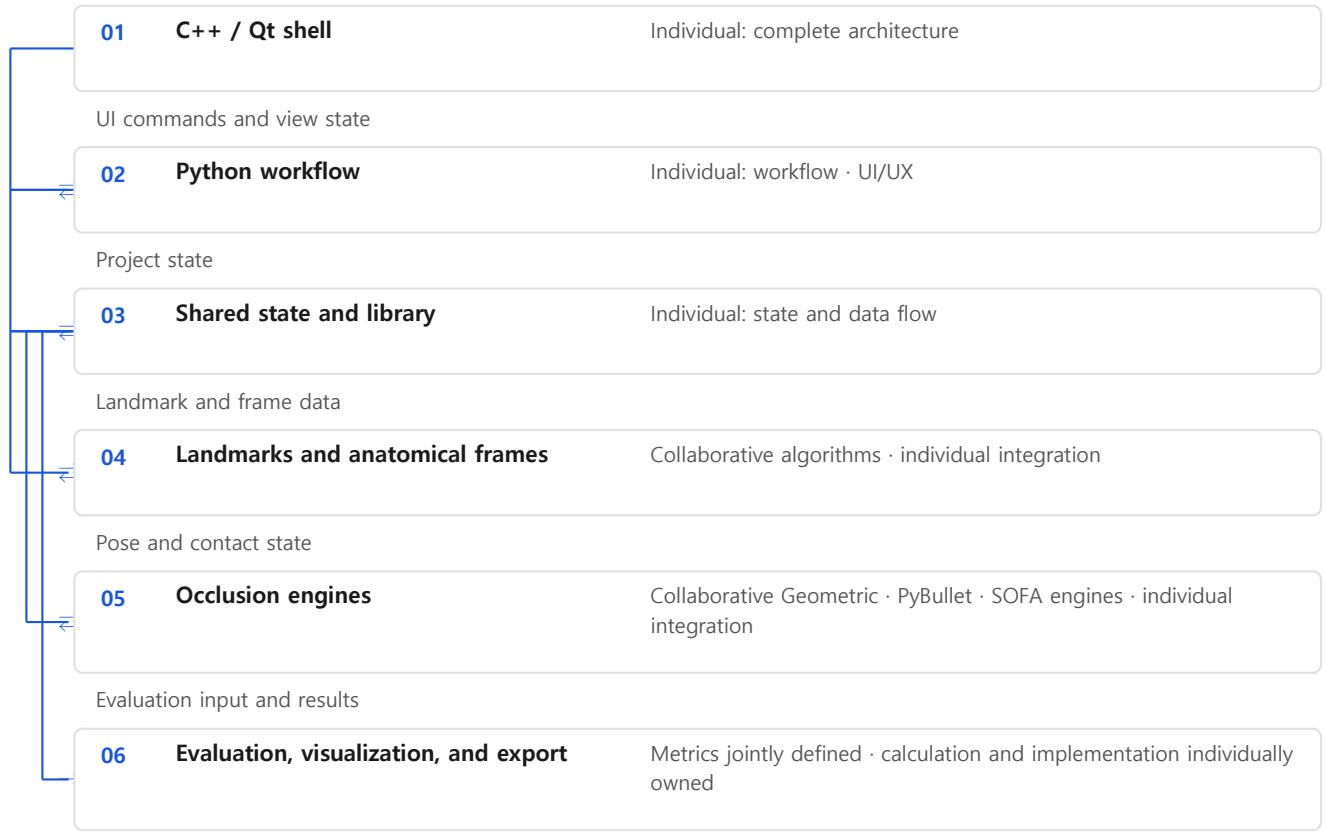
The seven-stage digital-occlusion workflow implemented in the current build.



Implemented scope · Under researcher validation

Custom App integration structure

Architecture separating collaborative algorithms and engines from individually owned architecture and integration.



Individual ownership separated from team results

Explanatory system relationship diagram; it is not photographic or experimental evidence.

Verification and evidence ledger

A working development build demonstrates landmarking, multi-view occlusion, contact visualization, RMSE/Gap/FRE evaluation, and export, with direct researcher use and feedback.

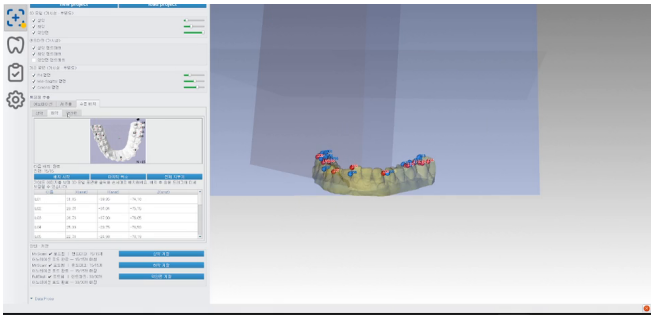


Figure 2. Researchers enter landmarks while viewing a reference image beside a zoomable 3D view. The screen uses synthetic test data.

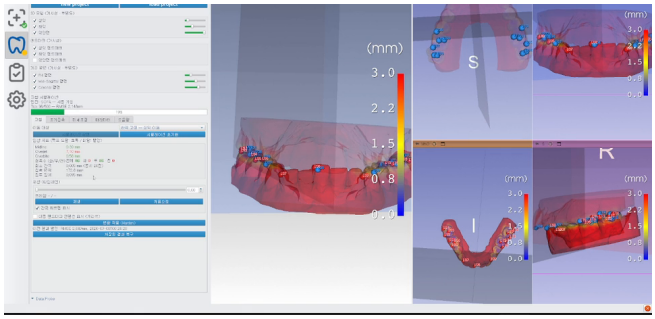


Figure 3. The occlusion workspace compares the occlusal state and contact-distance map across several views. The screen uses synthetic test data.

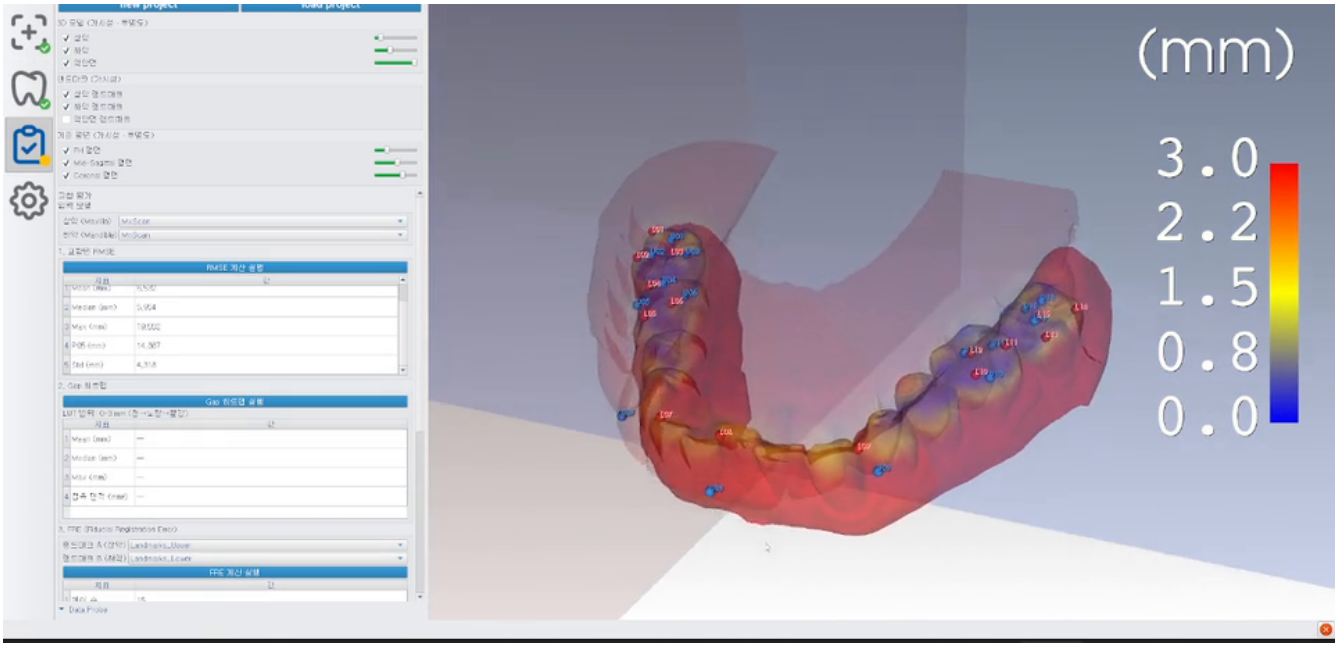


Figure 4. The evaluation screen combines RMSE, Gap, and FRE calculation with result export. Displayed values illustrate the UI, not performance outcomes.

Role, team result, and limits

Team result

Samsung Medical Center researchers jointly define the clinical workflow, landmarks, and evaluation metrics and directly review development builds. The DIGITRACK team supports the landmark algorithms and occlusion-engine implementation and research.

Limitations

The software is under researcher validation as a development and demonstration build. This case does not claim hospital installation, use in real surgery, medical-device status, or clinical efficacy, accuracy, or safety; displayed values are not performance outcomes.

Collaboration boundary

The long-term Samsung Medical Center and DIGITRACK R&D direction expands from digital occlusion toward normal-occlusion-based mandibular motion and complete oral and maxillofacial surgical planning.

Implementation technologies

3D Slicer · C++ · Qt · Python · VTK · PyBullet · SOFA

Primary capability

Medical Navigation & Visualization · 3D Geometry & Registration

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Registered public evidence

No external public link is currently registered.

What to bring

Share the problem, data or sensors, target validation, and schedule. We can define coordinate and evidence boundaries together.

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