

Coordinate-Aware Point Cloud Registration for Crown-to-Root Alignment in CBCT and Intraoral Scans

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Consistent augmentation improves semi-supervised registration.

–6.04 mm translation • –1.04° rotation versus no augmentation
Fixed-holdout comparison; supervised fine-tuning remains strongest.



Scan for code & checkpoints

One rigid transform connects crowns to roots.

Intraoral scans (IOS) capture crowns; cone-beam CT (CBCT) adds roots and bone. Different coverage, point density, and coordinate conventions make alignment difficult.

30

labeled training cases

300

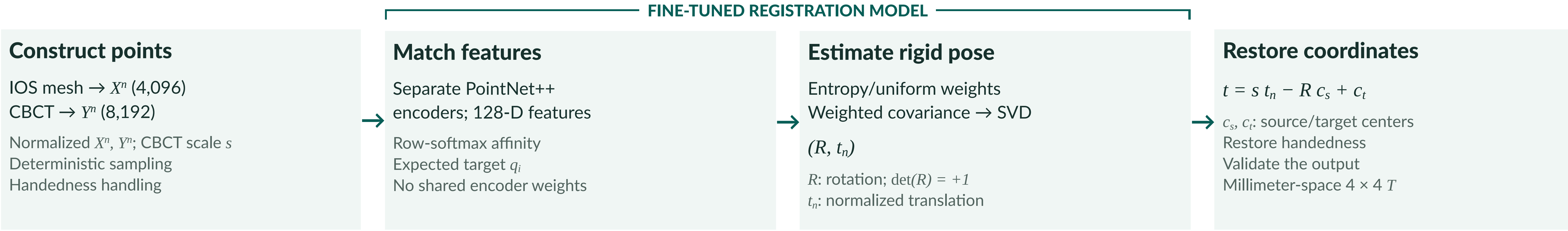
unlabeled training cases

50

hidden-label validation cases

01 A coordinate-aware, pretrained registration pipeline

Independent upper/lower models start from the public STSR 2025 PointNet++–SVD checkpoints [1–3]. The solid left-to-right path is used at inference; the lower band describes training only.



02 What contributes on the fixed holdout?

24 training + 6 held-out cases per jaw • 12 evaluated case-jaw pairs • lower is better

Configuration	Translation (mm) ↓	Rotation (°) ↓
Public pretrained	170.982	49.261
Supervised fine-tuning	105.023	17.853
Semi-supervised, no augmentation	143.978	25.905
Complete semi-supervised	137.941	24.870
Complete, uniform SVD	136.795	24.530

Diagnostic insight. Augmentation closes part of the pseudo-label gap. Entropy weighting remains near uniform; better confidence calibration is a priority.
Single seed; the same holdout selects checkpoints and reports results.

Official online evaluation

Separate from the local ablation.

107.9250 mm
mean translation error

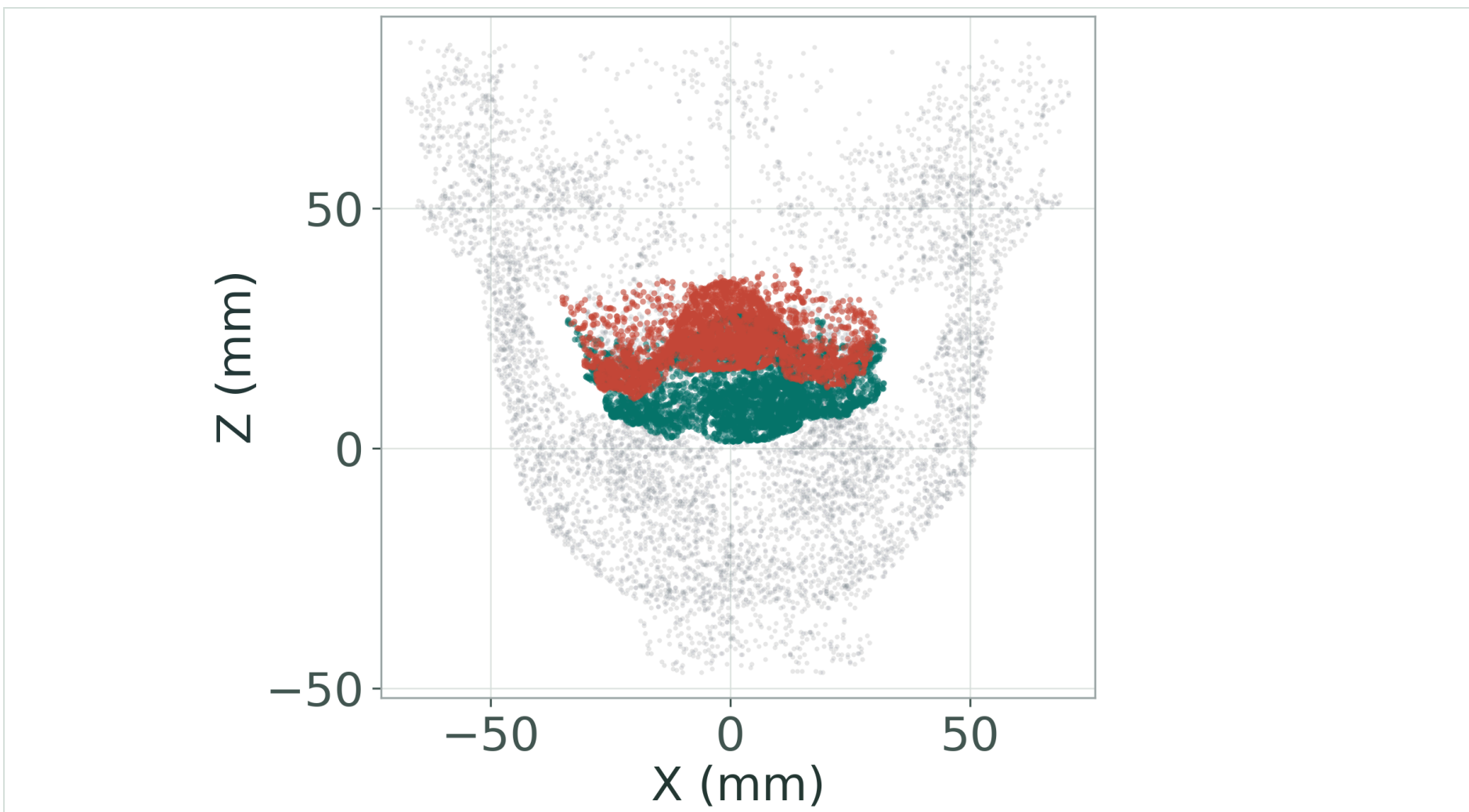
25.1658 °
mean rotation error

3.526 s/case • 691 MiB

Local end-to-end inference on RTX 4090.
50 cases in 176.297 s; sampled GPU peak.
82,433 parameters per jaw.

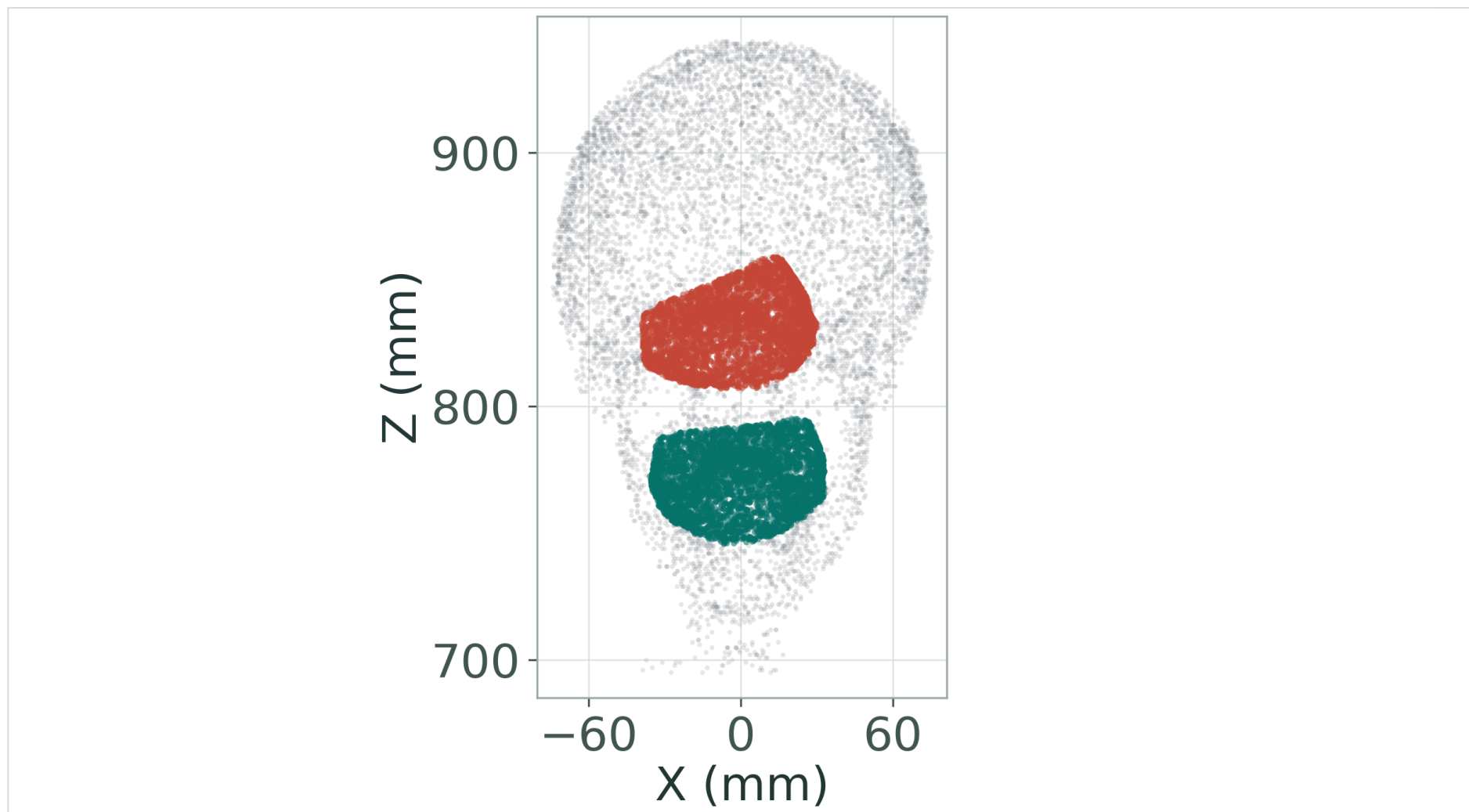
03 Why coordinate origins matter

Case 269 • relatively lower error



40.703 mm / 20.117°
IOS center norm: 58.7 mm

Case 003 • challenging alignment



306.692 mm / 25.237°
IOS center norm: 804.5 mm

A distant source center amplifies rotation error.

For predicted rotation $\hat{R}$ and reference R , translation restoration introduces

$$-(\hat{R} - R) c_s.$$

Case 003: **306.7 mm** matrix translation error, but **83.9 mm** mean vertex displacement.

Upper-jaw supervised holdout examples, not online predictions.
Relative error levels are not clinical categories.

Selected references & reproducibility

- [1] Qi et al. PointNet++: Deep Hierarchical Feature Learning on Point Sets. NeurIPS, 2017.
[2] Arun et al. Least-Squares Fitting of Two 3-D Point Sets. IEEE TPAMI, 1987.
[3] STSR 2025 Task 2 public baseline. STSR-Challenge, commit bb10b433bf13.
Released lower_jaw_registration_v1 / upper_jaw_registration_v1 best_model.pth.
Challenge: codabench.org/competitions/16042/ • Code: github.com/I2B2CU/pointcloud-registration

Next: geometry-aware pseudo-labels and explicit coordinate metadata.

Developed and evaluated in the ODIN 2026 challenge cluster. We thank the organizers and data providers.

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