Università degli Studi di Ferrara
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Bits2Bites

Intra-oral Scans Occlusal Classification

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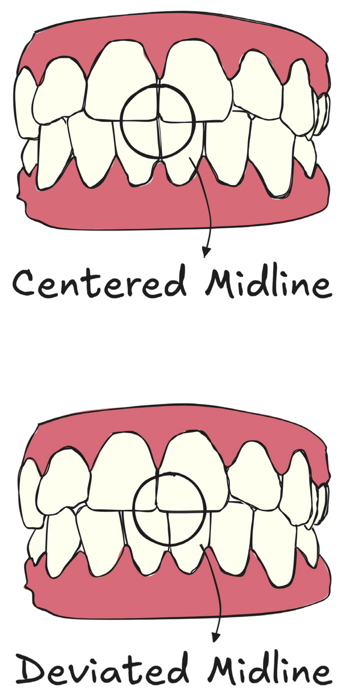
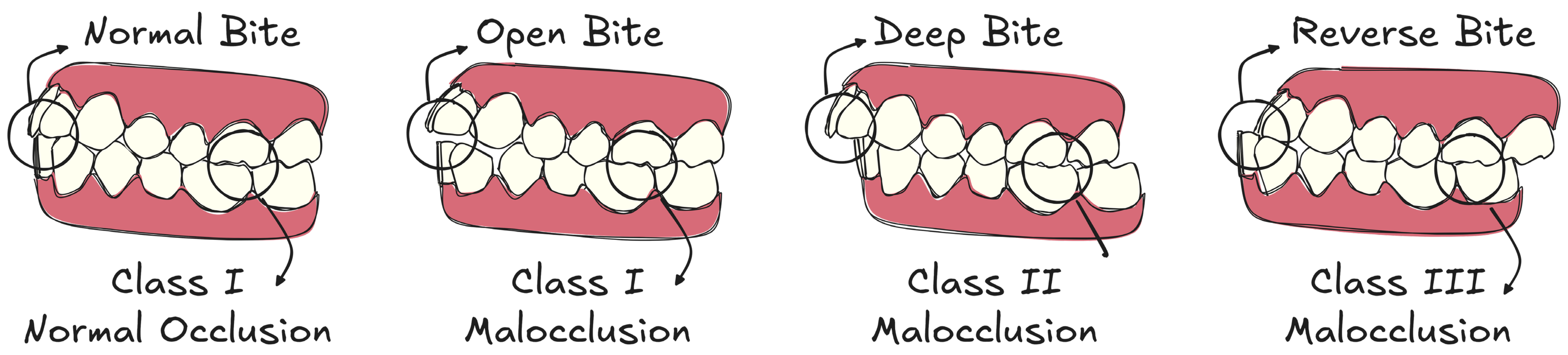
Dataset

1. Introduction and Motivations

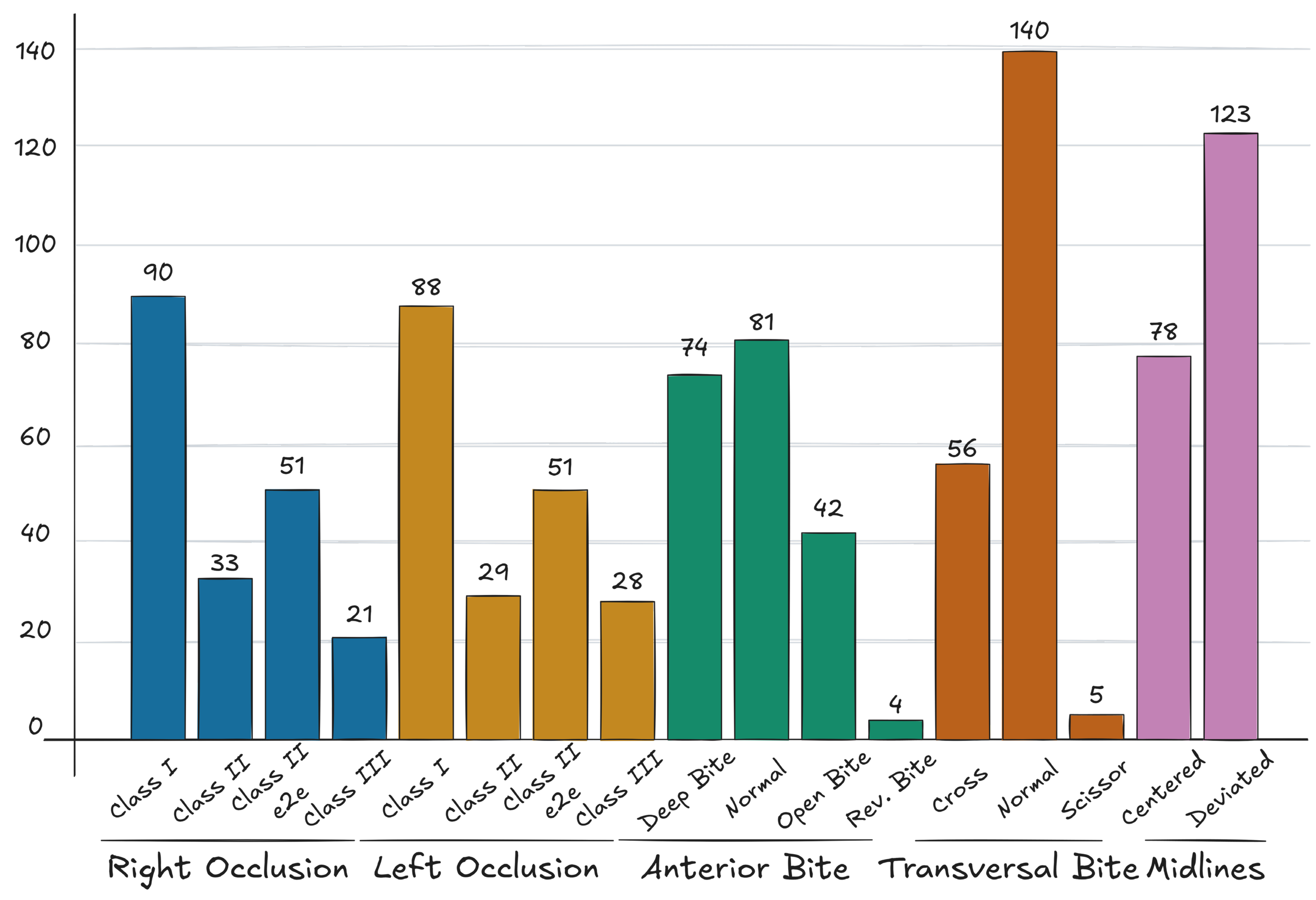
- **Clinical relevance**: Occlusion classification is key for orthodontic diagnosis and treatment planning.
- **Gap**: Existing datasets focus on segmentation or landmarks, but none of them address occlusal classification in 3D intra-oral scans.
- **Goal**: Enable automated and clinically meaningful occlusion analysis directly from IOS data.
- **Impact**: Provides a public resource to foster AI-driven orthodontic tools.





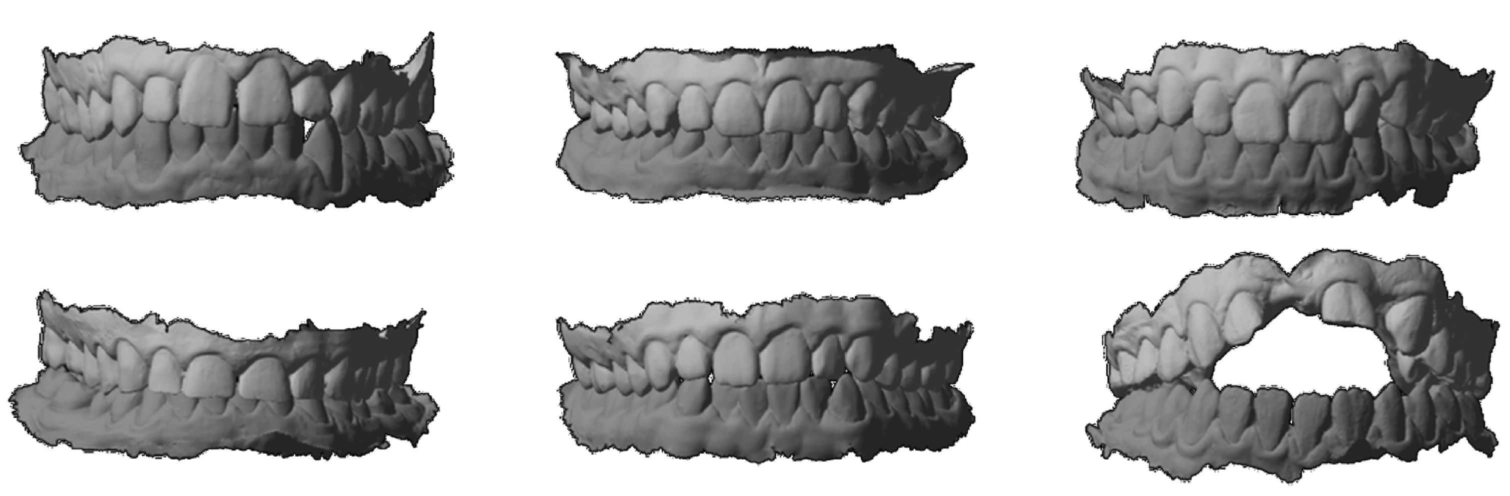
2. Dataset

- **200 paired intra-oral scans** (upper + lower arches) in STL format. Aligned in a standardized coordinate system (RAS).
- Labels across **5 occlusal traits**: Sagittal (left/right), Vertical bite, Transverse bite, and Midline alignment.
- Acquired **with two scanners**: Carestream & 3Shape TRIOS.



3. IOS Samples

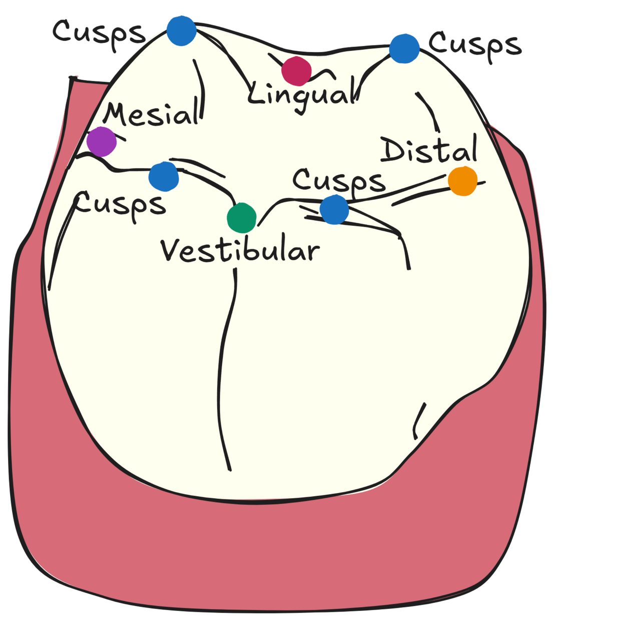
IOS samples randomly chosen from the dataset.



4. Teeth Landmarks

For every intra-oral scan, we predicted different landmarks for each tooth using the winner of **MICCAI2024 3DTeethLand Challenge**.

Both model and weights are available at: *https://github.com/nnistelrooij/3dteethland*



5. Methods

We built our baselines on the **Pointcept framework**, using **PointTransformer V3** and **SPUNet**. To assess the best input type, we compared **mesh vertices only**, predicted **landmarks only**, and **their combination**.

We also contrasted two learning strategies: a shared backbone with five task-specific heads (**multi-task**) versus separate models for each task (**single-task**).

Repository

Evaluation followed a **5-fold cross-validation** scheme, with results reported as mean and standard deviation across folds.

6. Results

Study about **different input features**. All classification metrics are macro-averaged across the five occlusal tasks and reported as mean ± std (%) over the 5 cross-validation folds. Inference time is the average time in seconds to process a single scan.

Input Features	Model	Accuracy	Precision	Recall	F1-Score	Time (s)
Mesh	PointTr.V3	0.69 ± 0.03	0.62 ± 0.02	0.61 ± 0.04	0.60 ± 0.03	0.11
Landmarks		0.70 ± 0.04	0.62 ± 0.04	0.63 ± 0.05	0.61 ± 0.04	0.04
Mesh + Landmarks		**0.71 ± 0.03**	**0.64 ± 0.03**	**0.64 ± 0.02**	**0.63 ± 0.03**	0.11
Mesh	SPUNet	0.64 ± 0.01	0.56 ± 0.03	0.58 ± 0.03	0.56 ± 0.04	0.05
Landmarks		0.60 ± 0.02	0.56 ± 0.06	0.56 ± 0.06	0.58 ± 0.05	**0.02**
Mesh + Landmarks		0.65 ± 0.01	0.59 ± 0.05	0.61 ± 0.04	0.58 ± 0.05	0.05

Multi-Task Learning (MTL) vs. Single-Task Learning (STL). All classification metrics are macro-averaged across the five occlusal tasks and reported as mean ± over the 5 cross-validation folds. Inference time is the average time in seconds to process a scan.

Model	Learning Strategy	Accuracy	Precision	Recall	F1-Score	Time (s)
PointTr.V3	Single-Task (STL)	0.72 ± 0.13	0.66 ± 0.14	0.65 ± 0.14	0.64 ± 0.13	1.10
	Multi-Task (MTL)	0.71 ± 0.03	0.64 ± 0.03	0.64 ± 0.02	0.63 ± 0.03	0.11
SPUNet	Single-Task (STL)	0.67 ± 0.14	0.61 ± 0.13	0.61 ± 0.14	0.60 ± 0.13	0.50
	Multi-Task (MTL)	0.65 ± 0.01	0.59 ± 0.05	0.61 ± 0.04	0.58 ± 0.05	0.05

Per-task F1-score (%) across occlusal classification tasks. Results are macro-averaged over 5-fold cross-validation and reported as mean ± std (%).

Model	Strategy	Right Occl.	Left Occl.	Anter. Bite	Tran. Bite	Midline	Avg.
PointTr.V3	STL	0.71 ± 0.05	0.67 ± 0.07	0.77 ± 0.14	0.59 ± 0.10	0.49 ± 0.06	0.64 ± 0.13
	MTL	0.69 ± 0.05	0.68 ± 0.04	0.74 ± 0.14	0.57 ± 0.12	0.46 ± 0.05	0.63 ± 0.03
SPUNet	STL	0.60 ± 0.02	0.57 ± 0.02	0.78 ± 0.13	0.58 ± 0.14	0.48 ± 0.04	0.62 ± 0.14
	MTL	0.54 ± 0.07	0.59 ± 0.04	0.68 ± 0.15	0.61 ± 0.15	0.51 ± 0.08	0.60 ± 0.13

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