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# Innovative methods for Aligning and Comparing Dental Scans

## Alternatives to Global Best-Fit and Landmarks methods

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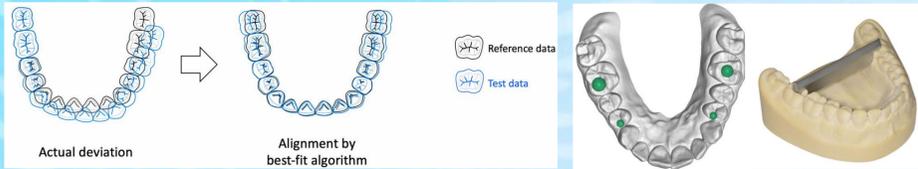
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### 1 INTRODUCTION

Nowadays, STL files are useful for comparing IOS or clinical protocols. Following a bibliographic study of the scientific literature, **two main methods of comparing by superimposing STL files** emerge:

- The use of a **best-fit algorithm** on all the scatterplot <sup>1</sup>
- **Adding physical geometric elements** (landmarks), such as spheres, cylinders and cones, on the dentition <sup>2</sup>



#### BEST-FIT

PROS

- ✓ Easy to implement
- ✓ Visualization

CONS

- ✓ Variable Precision
- ✓ Sensibility
- ✓ Measurement of discrepancies only

#### LANDMARKS

PROS

- ✓ Precision & Trueness
- ✓ Arch distortion, molar distance, etc.

CONS

- ✓ Repeatability
- ✓ In Vivo complexity

### 2 OBJECTIVES

The objective is to find a hybrid post-processing method to integrate virtual reference geometries directly onto scans.

This method aims to obtain the best of both approaches—providing more information than the best fit, but without the constraints of landmarks—through either a combination of localized best fit and geometric landmarks or without explicit landmarks.

### 3 MATERIELS & METHODS

- x12 In vivo scans including a master scan
- Metrology Software : Zeiss Inspect Optical 3D
- Bibliography research
- Tests of different methods on scans
- Analysis of data and statistics obtained

Illustrations	Pros & Cons	Possible Measures
	+ Better calibration in the molar zone - Angular errors	X-axis gap measurement Local trueness and deviation
	+ Reducing cumulative errors - Risk of variations if the selected half is not stable or symmetrical	X-axis gap measurement Angle on the Y axis Standard deviation
	+ Improved aesthetic alignment - Fewer contact points, less precision, can increase sensitivity to scanning errors	X-axis gap measurement Angle on the Y axis Local trueness and deviation
	+ Reduces angular errors - Repeatability	X-axis gap measurement Angle on the X and Z axis

Local alignment (Best-fit)    Chebyshev's plan    Middle plan

### RESULTS

Heatmap	Interpretation	
	Reveals alignment variations and potential occlusion points Visualizes specific deviations and areas requiring adjustment	Highlighting the molar distance of the arch, replacing feasible measures with landmarks
	Quantifies asymmetries between anterior and posterior teeth up to the midline.	Determine which side has more torsion and in which direction, which is not achievable with classical methods.
	Visualizes and analyses incisor alignment, as well as conformity to the ideal contours defined, crucial for dental aesthetics.	Replaces specific landmark placements around incisors, Identify which side exhibits greater arch opening asymmetry.
	The mapping shows how the outer connecting line follows the shape of the dental arch, highlighting variations, twists and imperfections in the overall alignment of the teeth.	Replaces the need for best-fit global by providing angular measurements.

### CONCLUSIONS

Although not as intricate as global best-fit or landmark techniques, these methods offer a practical and robust solution for aligning dental scans.

- I. Easy to implement:** Quick to apply without specialist training or complex equipment.
- II. Greater flexibility:** Adaptable to a variety of clinical situations and dental anatomies.
- III. Repeatability:** Better consistency of results, reducing technical variations.
- IV. Quantity and diversity of measurements:** Quantity and diversity of measurements: Provides a complete overview of deviations and adjustments required, allowing access to measurements or deformations that were not previously measurable

These methods simplify the alignment process while ensuring reliable and detailed results, improving the quality of dental analysis and treatment.

### REFERENCES

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