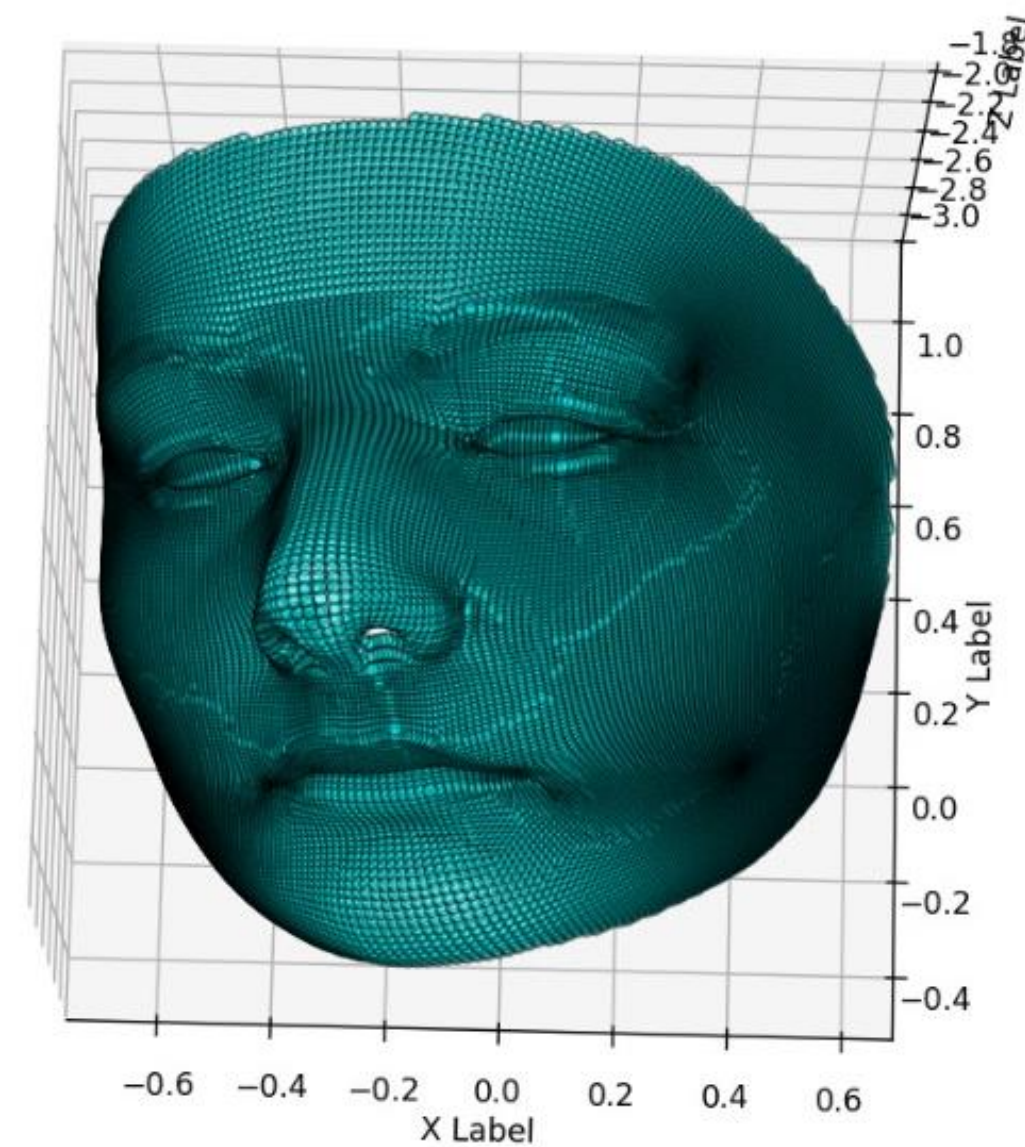


Introduction

Artificial Intelligence (AI) is rapidly transforming various fields of medicine, offering new possibilities for precision, efficiency, and standardization in clinical practice. In plastic surgery, the assessment of facial aesthetics has traditionally relied on manual craniometric measurements that are often subjective and inconsistent. With advancements in AI, it is now possible to analyze facial structures with unprecedented accuracy, leveraging machine learning algorithms to detect landmarks and calculate aesthetic ratios in both two-dimensional and three-dimensional representations. This study explores the use of AI technology to measure facial proportions. By integrating historical artistic representations with modern computational techniques, AI promises to redefine how beauty is understood and quantified in clinical and aesthetic settings.

Methods

A custom-built artificial intelligence (AI) model was developed to automatically identify craniometric landmarks and calculate aesthetic ratios. The model utilized a combination of 2D to 3D face meshing and advanced landmark detection techniques to generate precise representations of facial structures. Model training was performed using large, well-curated datasets consisting of diverse facial images, enabling the AI to learn and generalize craniometric measurements across various demographic profiles. The meshing process involved the conversion of 2D facial photographs into 3D models, allowing for comprehensive spatial analysis of key aesthetic landmarks, such as the nasion (n), glabella (g), pronasale (prn), subnasale (sn), stomion (sto), labiale superius (ls), labiale inferius (li), sublabiale (sl), pogonion (pg), gnathion (gn), and trichion (tr). Advanced algorithms detected these points with high precision, even in varied lighting and pose conditions. Geometric computations were applied to derive aesthetic ratios, including vertical facial thirds, facial width-to-height ratios, and assessments of symmetry and proportionality. To validate the model, values from the model were compared to published values.



Ratio	Landmark	Published Value	AI Model within 5%
Upper profile height / Facial height	tr-prn / tr-gn	62.5 ± 0.1	✓
Lower profile height / Facial height	pm-gn / tr-gn	37.0 ± 1.3	✓
Lower profile height / Upper profile height	pm-gn / tr-prn	59.2 ± 2.1	✓
Upper facial height / Facial height	n-sto / tr-gn	39.3 ± 0.0	✓
Lower facial height / Facial height	sn-gn / tr-gn	32.7 ± 0.1	✓
Lower facial height / Upper facial height	sn-gn / n-sto	83.1 ± 0.2	✓
Forehead height / Facial height	tr-g / tr-gn	31.2 ± 0.2	✓
Nasal height / Facial height	n-sn / tr-gn	29.7 ± 0.1	✓
Mandible height / Facial height	sto-gn / tr-gn	22.9 ± 0.1	✓
Chin height / Facial height	sl-gn / tr-gn	67.3 ± 2.3	✓
Upper lip height / Lower lip height	sn-sto / sto-sl	88.4 ± 1.5	✓
Vermilion of the upper lip height / Upper lip height	ls-sto / sn-sto	31.2 ± 0.3	✓
Vermilion of the lower lip height / Lower lip height	sto-li / sto-sl	56.3 ± 0.5	✓

Results

The AI model successfully identified craniometric landmarks and calculated proportional facial indices with high accuracy. Validation against historical portraits of Simonetta Vespucci demonstrated strong alignment with Renaissance beauty standards as reported in anthropometric analyses. Key facial ratios, including Upper Profile Height / Facial Height 62.5%)and Lower Profile Height / Facial Height 37.0%, were consistent with published values, supporting the model's precision in aesthetic evaluation. These findings indicate that AI-driven facial analysis can reliable model photographs using meshing technology and serve as a valuable tool to study aesthetic ratios.

Conclusion

Artificial Intelligence (AI) has demonstrated remarkable potential in enhancing the precision and standardization of aesthetic evaluations in plastic surgery. By leveraging advanced 2D to 3D face meshing and landmark detection techniques, the AI model accurately identified craniometric landmarks and calculated proportional facial indices. Validation against historical portraits of Simonetta Vespucci by Sandro Botticelli showed strong alignment with published data, supporting the AI's capability to interpret classical renderings quantitatively. This technology paves the way for more objective and reproducible assessments in surgical planning, facial reconstruction, and aesthetic research, offering a modern bridge to historical artistic representations of beauty.

References

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