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Evaluation of Craniofacial Reconstruction using Geodesic Network

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Abstract

The goal of craniofacial reconstruction is to infer from a person's skull the shape of their face. It is frequently used in forensic medicine, archaeology, cosmetic surgery, and other ýelds. However, the assessment of craniofacial reconstruction receives minimal attention. The geodesic network-based reconstruction of the craniofacial faces is evaluated both globally and locally using an objective method proposed in this paper. First o , the geodesic networks of the original face and the reconstructed craniofacial face are created using geodesics and geodesics, respectively, whose intersections constitute network vertices. Then, the weighted average of the shape index values in a neighbourhood is deýned as the feature of each network vertex, and the absolute value of the correlation coe cient of the features of all related geodesic network vertices between two models is considered as the holistic similarity. Additionally, the local similarity is calculated for each of the six subareas of each model's geodesic network, which are the forehead, eyes, nose, mouth, cheeks, and chin. The subjective judgement received from 35 people in ýve groups is broadly similar with the evaluation made by our method, according to experiments using 100 pairs of reconstructed craniofacial faces and their corresponding original faces.

Keywords: Craniofacial reconstruction; CT scans; Neurodevelopment; Image augmentation

Introduction

Craniofacial reconstruction uses the connection between so tissues and the underlying bone structure to predict an individual's face appearance from their skull. Numerous elds, including forensic medicine, archaeology, medical cosmetic surgery, and public safety, use it extensively. e research on computer-aided craniofacial reconstruction has drawn a lot of attention as a result of the advancement of 3D digitalization technology. e improvement of craniofacial reconstruction techniques greatly bene ts from the evaluation of the procedure. However, the majority of studies on craniofacial reconstruction concentrate on the rebuilding process alone, giving little thought to how the results of the reconstruction are evaluated [1].

One of the most intricate geometrical structures in the natural world is the craniofacial face. e evaluation of the outcomes of the craniofacial reconstruction remains a di cult problem. ree di erent types of craniofacial reconstruction evaluation techniques are currently in use: subjective qualitative evaluation, objective quantitative evaluation, and combination methods of subjective and objective evaluation. By developing various evaluation procedures, subjective evaluation methods evaluate the outcomes of craniofacial reconstruction subjectively. Although the subjective evaluation approach is in line with human cognitive theory, the evaluation procedure is labour-intensive and time-consuming, and human subjective factors a ect how accurate the evaluation results are [2].

A preliminary study on assessing the outcomes of craniofacial reconstruction using an objective manner was conducted by certain academics. By calculating the number of relative angles in various intervals, they were able to de ne the probability density function of the relative angle-context distribution. By measuring the bending of a reference hemisphere to a craniofacial model, the RACD algorithm was expanded to bending-relative angle-context distribution (BRACD) to address the calculation instability and high time complexity of RACD. Examined the relationship between the shape of the skulls and the faces, and then used the distance between matching spots on the rebuilt craniofacial face and the original face to calculate the craniofacial reconstruction error [3].

Many academics merged their subjective and objective assessments. As an illustration, VaneZis asked 20 assessors to select the top three matches among 10 rebuilt craniofacial faces of a single skull and the original face. ey also used mathematical shape analysis assessment and Procrustes Analysis to compute the correlation between the subjective and objective evaluation outcomes. Despite the fact that the ndings are not statistically signi cant, they do show that the objective technique does appear to capture some perceptual similarity in human observers. ey carried out a subjective investigation in which a group of people (12 people on 180 3D faces) judged the similarity of pairs of faces (a total of 5490 pairs of similarity scores). ey retrieved Gabor features from 3D faces' texture photos and automatically detected feature spots on the range in terms of objectivity. Finally, they showed how strongly these traits connected with people's ability to judge similarity [4].

In this research, we provide a brand-new geodesic network-based global and local evaluation method for craniofacial reconstruction. e feature of one vertex is de ned as the weighted average of the shape index value in a neighbourhood. e degree of similarity between two models is determined by the absolute value of the correlation coe cient of each characteristic of all associated geodesic network vertices. It provides direction for improving the techniques used in craniofacial reconstruction and lays the groundwork for qualitative and quantitative examination of the results [5].

Materials and Methods

e Institutional Review Board (IRB) of Beijing Normal University's Image Center for Brain Research's National Key

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