

Feature Curves Based Cephalometric Superimposition

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Abstract

The analysis of the spatial changes of the craniofacial structures for orthodontic treatment or surgery always relies on the superimposition of cephalometric tracings taken at different times. The errors in the manual measurement of superimposition may be arisen from the bad cephalogram quality, the facial growth, and the orthodontist's experience. In this paper, the computerized superimposition is developed for alleviating the problems mentioned above. This procedure contains three parts: 1. To digitize and calibrate the cephalogram through the CCD camera; 2. To extract the feature curves for the cranial base using the best oriental edge detector and Hough transform, and for the mandible using the Laplacian of Gaussian and grouping; and 3. To automate the superimposition based on the clinically available procedure and finally to display the associated results. The complete procedure typically takes 5 to 6 minutes of computation. The precision for the cranial base superimposition is about 0.312cm, and the mandible about 0.605cm. The difference between the superimpositions of the proposed system and the manual measurement is about 0.95cm in the cranial base, 0.98cm in the maxillary, and 1.26cm in the mandible.

Keywords: Feature curve matching, Cephalometric superimposition, Landmark, Image processing

Introduction

Cephalogram usually plays the key role in cephalometric diagnosis and superimposition. In general, orthodontists manually locate the landmarks and trace their associated feature curves and lines on the tracing paper (Fig. 1(b)) attached on the cephalogram (Fig. 1(a)). Landmarks on the cephalogram are defined according to the anatomical features [26] for clinical reference. The associated data for the cephalometric analysis is then measured and computed. This manual procedure is very tedious and time-consuming. Moreover, the accuracy of measurements is heavily dependent on the factors such as the film quality and orthodontist's experience.

Spatial changes of craniofacial structures are the basic information for the orthodontic treatment and surgery. They are measured by superimposition of cephalometric tracings taken at pre- and post-treatment, or pre- and post-surgery. It usually takes about 5 to 10 minutes to plot a tracing paper, and 20 to 30 minutes for superimposition in cephalometrics. From the cephalometric analysis, the orthodontists can understand the general view of growth changes and the effect of treatment. Superimposition is a procedure to match two cephalograms with the same features, relative landmarks, or anatomical

structures. Some difficulties may be encountered in the cephalometric superimposition, especially for the growing young patients. In the growing skulls, the various bones may move apart from each other at different rates. The landmarks adjacent to the growth locations will then move farther from the growth sites. Therefore, same feature curves and anatomical structures may not be easily found and matched. The parts for cephalometric superimposition are generally divided into three areas as follows.

Cranial base superimposition

To evaluate facial changes, the anatomic structures for registration must be relatively stable over the time of orthodontic treatment or surgery. The cranial base region grows rapidly in early postnatal life and reaches 90% of its final size by 4 to 5 years of age [1]. So the cranial area is considered as a satisfactory reference for the cephalometric registration. For examples, there are two methods of superimposition on the cranial base [2]. One is the superimposition on the best fit of the anterior cranial base anatomy as shown in Fig. 2(a), and the other is superimposition on Sella-nasion(SN).

Maxillary base superimposition

Maxillary superimposition is done along the palatal plane from ANS to PNS registered at ANS [3]. It may also superimpose on the palatal plane but register at the pterygomandibular fissure. The method of the best fit on the

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Stuart C. White, Michael J. Pharoah



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Orthodontics: Diagnosis and Management of Malocclusion and Dentofacial Deformities, E-Book Om Prakash Kharbanda, 2019-11-14 The second edition is expanded and rejuvenated with a greater focus on PG students orthodontic educators UG students and practitioners The book covers entire panorama of science and clinical practice of orthodontics from basics to clinical presented in 58 chapters organised in 15 sections The information is provided in depth literature supported complimented with real life scenarios and case reports A special effort has been made to include structured information on subjects of relevance which are much talked about but found only in journals Contains a balanced blend of texts graphics boxes and clinical case reports encountered in clinical practice A comprehensive coverage of cephalometric radiology ethnic norms and advances in three dimensional imaging A detailed step by step approach to orthodontic treatment with contemporary fixed appliances from diagnosis to finishing Provides an up to date information on topics of day to day relevance such as epidemiology of malocclusion and orthodontic indices psychological aspects of orthodontics debonding care and maintenance of occlusion after orthodontic treatment Presents updated information on temporary anchorage devices TAD impacted and transposed teeth inter disciplinary treatment management of cleft lip and palate and orthognathic surgery Emerging fields such as surgically facilitated rapid tooth movement distraction osteogenesis and obstructive sleep apnoea OSA are included with up to date clinically relevant information Includes Companion Website containing procedural videos Historical aspects of orthodontics and Development of teeth dentition and occlusion A whole new section on emerging 3D Digital technologies and their application Orthodontic instruments armamentarium and operator design Comprehensive chapters on Tweed philosophy contemporary pre adjusted appliance and self ligation system Evidence based Orthodontics Autotransplantation of teeth A section on the asymmetry of occlusion and face Additional Features Complimentary access to full e book Eight online chapters Twelve videos Exhaustive list of references

Skeletal Anchorage in Orthodontic Treatment of Class II Malocclusion E-Book Moschos A. Papadopoulos, 2014-09-29 The book offers a comprehensive and critical review which presents not only the principles and techniques involved in the use of skeletal anchorage techniques and devices such as orthodontic implants miniscrew implants and mini plates but also the scientific evidence available regarding the use of these contemporary applications and their clinical efficacy Provides an introduction to the conventional and noncompliance treatment of Class II malocclusion Provides an introduction to the use of skeletal anchorage reinforcement approaches in orthodontics Outlines the clinical considerations required for the use of skeletal anchorage devices in orthodontics Explains the insertion and removal procedures of orthodontic implants miniscrew implants and mini plates Discusses the use of orthodontic implants for the treatment of Class II malocclusion Explains the use of mini plates and zygomatic anchorage for the treatment of Class II malocclusion Discusses the use of mini screw implants for the treatment of Class II malocclusion Explains the use of skeletal anchorage reinforcement of the noncompliance devices used for the

treatment of Class II malocclusion Explores the efficiency of skeletal anchorage and its risk management **Fundamentals of Craniofacial Growth** Andrew D. Dixon, David A.N. Hoyte, Olli Ronning, 2017-12-14 This book brings together in one volume selected important topics in craniofacial growth Topics include principles of skeletal growth osteogenesis and its control formation of the cranial base and craniofacial joints prenatal development of the facial skeleton growth of the mandible nasomaxillary complex orbit cranial base ear capsule and cranial vault bone remodeling muscles soft tissues and blood vessels Fundamentals of Craniofacial Growth contains detailed illustrations and extensive reference lists Independently authored chapters provide comprehensive reviews encompassing both contemporary and historical perspectives In addition to medicine and dentistry contributors provide expertise from such diverse backgrounds as anatomy biology biomathematics embryology orthodontics physical anthropology and plastic and reconstructive surgery Oral Radiology - E-Book Stuart C. White, Michael J. Pharoah, 2014-05-01 With more than 1 000 high quality radiographs and illustrations this bestselling book visually demonstrates the basic principles of oral and maxillofacial radiology as well as effective clinical application You ll be able to diagnose and treat patients effectively with the coverage of imaging techniques including specialized techniques such as MRI and CT and the comprehensive discussion of the radiographic interpretation of pathology The book also covers radiation physics radiation biology and radiation safety and protection helping you provide state of the art care A consistent format makes it easy to follow and comprehend clinical material on each pathologic condition including a definition synonyms clinical features radiographic features differential diagnosis and management treatment Updated photos show new equipment and radiographs in the areas of intraoral radiographs normal radiographic anatomy panoramic imaging and advanced imaging Updated Digital Imaging chapter expands coverage of PSP plates and its use in cephalometric and panoramic imaging examining the larger latitudes of photostimulable phosphor receptors and their linear response to the five orders of magnitude of x ray exposure Updated Guidelines for Prescribing Dental Radiographs chapter includes the latest ADA guidelines and also discusses the European Guidelines Updated information on radiographic manifestations of diseases in the orofacial region includes the latest data on etiology and diagnosis with an emphasis on advanced imaging Expert contributors include many authors with worldwide reputations Cone Beam Computed Tomography chapter covers machines the imaging process and typical clinical applications of cone beam imaging with examples of examinations made from scans Evolve website adds more coverage of cases with more examples of specific issues *Oral Radiology* Stuart C. White, DDS, PhD, Michael J. Pharoah, DDS, 2013-12-12 With more than 1 000 high quality radiographs and illustrations Oral Radiology Principles and Interpretation 7th Edition visually demonstrates the basic principles of oral and maxillofacial radiology along with their clinical application First you ll gain a solid foundation in radiation physics radiation biology and radiation safety and protection Then you ll learn intraoral and extraoral imaging techniques including specialized techniques such as MRI and CT The second half of the book focuses on how to recognize the radiographic features of pathologic conditions and

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Advances in Orthodontics ,1970 Dento Maxillo Facial Radiology ,1995 *Handbook of Cephalometric Superimposition* Herman S. Duterloo, Pierre-Georges Planché, 2011 History and origin of the structural method Validity and reliability method error Interpreting growth and growth patterns Interpreting image variation Interpreting growth and treatment changes in superimpositions Describing growth and treatment changes Producing manual structural superimpositions Producing computerized structural superimpositions Comparison of Hand Traced and Computer Based Cephalometric Superimpositions Edward Louis Grubaugh, 2007 Abstract Orthodontic practitioners are acquiring digital records and analyzing cephalometric radiographs with imaging software However few studies have compared hand traced cephalometric superimpositions with those produced by current computer programs The specific aim of this study was to quantitatively compare hand traced and digital computer based superimpositions Sixty four high quality initial T1 and final T2 cephalometric film radiographs were selected from an orthodontic archival database after Institutional Review Board approval Cephalometric landmarks were identified Cranial base and regional maxillary and mandibular superimpositions were completed independently for each pair of radiographs by the two methods Digital superimpositions were created using the free form feature in Dolphin Imaging 10 Dolphin Imaging and Management Solutions Chatsworth CA Twenty sets of hand and digital superimpositions were repeated one week apart

to examine for intraoperator error Both hand and digital superimpositions were imported into the GetData GetData Graph Digitizer S Fedorov digitizing program to obtain the x y coordinates of each landmark Linear distance between multiple paired hand and digital T2 cephalometric landmark locations e g A point were measured After accounting for intraoperator error a T2 landmark distance of zero would suggest that there was no difference between the hand and digital method To account for skewed distributions the mean and median linear distances and 95% confidence intervals between the T2 cephalometric landmark locations were calculated A Friedman test was applied to examine for error between repeated hand superimpositions error between repeated digital superimpositions and the T2 landmark distances between the hand and digital methods The upper 95% confidence limit for the median of the linear distances was 1 mm for all landmarks except maxillary incisor tip 1 02 mm The error calculations indicated no statistically significant differences $p > 0.05$ for the reliability of each method and more importantly between superimposition methods There was no difference between cranial base and regional superimpositions created by the traditional hand tracing method when compared to digital superimpositions This study validates the use of digital superimpositions produced by Dolphin Imaging version 10

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