Chapter 30
Jaya Algorithm–Assisted Evaluation of Tooth Elements Using Digital Bitewing Radiography Images

Kesavan Suresh Manic
Caledonian College of Engineering, Oman

Imad Saud Al Naimi
Caledonian College of Engineering, Oman

Feras N. Hasoon
Caledonian College of Engineering, Oman

V. Rajinikanth
ⓘD https://orcid.org/0000-0003-3897-4460
St. Joseph's College of Engineering, India

ABSTRACT

A considerable number of heuristic procedures are widely implemented to evaluate biomedical images. This chapter proposes an evaluation procedure for digital bitewing radiography (DBR) images using the Jaya algorithm. The proposed procedure implements an image processing technique by integrating of the multi-thresholding and segmentation procedure to extract the essential tooth elements recorded with DBR. In this paper, 80 dental x-ray images are considered for the evaluation. The performance of the proposed procedure is confirmed using a relative assessment between the extracted section and its corresponding ground-truth. The results of this study confirm that, for most of the DBR cases, the proposed approach offers better values of picture likeliness measures. Hence, this technique can be considered for the automated detection of tooth elements from the DBR obtained from clinics.

INTRODUCTION

Teeth are one of the hardest matters in human body, which play an essential role in the human digestive system. The structure of a tooth is the combination of regions, such as crown, neck and root. The crown is the outermost layer of the tooth which lies on the supporting section called the neck. The neck is the supporting medium surrounded by gum region. Root canal holds the sensitive nerve and blood vessels for an active tooth. The crown is the outermost and visible region of the tooth and it is associated with an outer cover known as the enamel. The major problem in the crown involves in the reasons, such as plaque, erosion of enamel and dentine (Odaira et al., 2011; Weisleder et al., 2009; Jespersen et al., 2014). Tooth decay is one of the chief causes for the damage in outer/interior surface of tooth (Jafarzadeh et al., 2010; Chen and Abbott, 2009; 2011). Tooth decay also commonly known as cavities or caries are the cause of bacterial infection. Bacteria, such as streptococci (mutans & sobrinus) and lactobacilli are the main cause for tooth cavities (Rose and Svec, 2015; Figueiredo et al., 2015; Lin et al., 2012). For these bacteria, food remains or sugar in tooth shell are the principal energy resources. When the bacteria consume sugar and food remains, it will release acid which will affect the outer surface of the tooth wall called enamel. When this process continues, the tooth surface is enclosed with a hard layer called plaque. The bacterial contamination leads to a tiny yellow or black hole on the tooth surface on the tooth called the caries (Wang et al., 2015; 2015a; 2016). If the caries left untreated, it may lead to the trouble, such as pain, sensitivity, infection and tooth loss. To protect the tooth from caries, dental care centers provide various protection methods, like maintaining oral hygiene, avoiding high sugar food, and usage of right amount of fluoride (Son et al., 2018). The dental care procedure also suggest, tooth filling, fitting crown on infected tooth, early stage treatment and root canal treatment (Rad et al., 2013; 2016; 2017). The literature also confirms that, untreated caries will lead to various health problems in human irrespective of their age and gender (Lin et al., 2012; Son et al., 2018). Hence, invasive and non-invasive treatment procedures are implemented by the dentists to treat various dental problems. To plan and implement a suitable treatment procedure, it is necessary to follow a preliminary screening process to identify the cause and the region of tooth infection. The clinical level screening methods involves in; (i) Manual examination of infection by an experienced dentist – this procedure gives the details regarding the type and region of dental infection, (ii) Modern procedures to recognize the severity and intensity of infection – this involves in recording the teeth area using imaging procedure called X-ray (Wang et al., 2015).

Digital Bitewing Radiography (DBR) is a commonly followed imaging procedure to record the entire teeth in order to inspect the various teeth conditions and defects. During this practice, the teeth sections are recorded using the Dental X-ray in a controlled environment under the supervision of a dentist. Later, this DBR is evaluated to identify the infected region using manual, semi-automated and automated procedures to plan for the possible treatment procedures to control or cure the tooth defect by implementing some prescribed treatment procedures. The DBR is extensively considered in dental clinics to record the dental section for the diagnosis and treatment of various dental diseases. It is considered for the examination of teeth orientation, dental infection, early stage dental disease, abnormal teeth growth, and providing the solution for the problems in enamel, dentine, pulp cavity and root canal (Wang et al., 2015).

The proposed work implements a semi-automated practice to evaluate the tooth defects, such as cavities or caries, pulp, Tooth Restoration (TR), and Root Canal Treatment (RCT). In this approach, initially, the image enhancement is implemented to improve the visibility of the DBR picture, a thresholding procedure is implemented with the Tsallis Entropy (TE), and later a segmentation approach based on

21 more pages are available in the full version of this document, which may be purchased using the "Add to Cart" button on the publisher's webpage: www.igi-global.com/chapter/jaya-algorithm-assisted-evaluation-of-tooth-elements-using-digital-bitewing-radiography-images/315066

Related Content

Advancements and Emerging Trends in Deep Learning-Based Transformers for Medical Image Processing
Uzair Aslam Bhatti, Muhammad Aamir, Zia Ur Rehman, Jameel Ahmed Bhutto, Mughair Aslam Bhatti, Ahsan Ahmad Nizamaniand Abdul Haseeb Nizamani (2025). *Deep Learning in Medical Signal and Image Processing (pp. 63-86).*
www.irma-international.org/chapter/advancements-and-emerging-trends-in-deep-learning-based-transformers-for-medical-image-processing/381151

Role of Emerging Technologies in Smart Marketing and Smart Business for Modern Society
Senthil Kumar Arumugam, K. R. Pundareeka Vittala, Smita Manohar Gaikwadand Amit Kumar Tyagi (2024). *Enhancing Medical Imaging with Emerging Technologies (pp. 330-346).*
www.irma-international.org/chapter/role-of-emerging-technologies-in-smart-marketing-and-smart-business-for-modern-society/344677

Image Fusion Techniques for Different Multimodality Medical Images Based on Various Conventional and Hybrid Algorithms for Disease Analysis
Rajalingam B., Priya R., Bhavani R.and Santhoshkumar R. (2023). *Research Anthology on Improving Medical Imaging Techniques for Analysis and Intervention (pp. 268-299).*
www.irma-international.org/chapter/image-fusion-techniques-for-different-multimodality-medical-images-based-on-various-conventional-and-hybrid-algorithms-for-disease-analysis/315050

Digital Image Analysis for Early Diagnosis of Cancer: Identification of Pre-Cancerous State
Durjoy Majumderand Madhumita Das (2023). *Research Anthology on Improving Medical Imaging Techniques for Analysis and Intervention (pp. 1239-1266).*
www.irma-international.org/chapter/digital-image-analysis-for-early-diagnosis-of-cancer/315102

A Study on Segmentation of Leukocyte Image With Shannon's Entropy
N. Sri Madhava Raja, S. Arunmozhi, Hong Lin, Nilanjan Deyand V. Rajinikanth (2023). *Research Anthology on Improving Medical Imaging Techniques for Analysis and Intervention (pp. 1131-1152).*
www.irma-international.org/chapter/a-study-on-segmentation-of-leukocyte-image-with-shannons-entropy/315095