AUTOMATIC DETECTION OF OCCLUSAL CARIES BASED ON PHOTOGRAPHIC COLOR IMAGE PROCESSING

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Introduction

Diagnosis of occlusal caries (OC) in clinical setting is a difficult process, because of the complicated morphology of pits and fissures of the occlusal surfaces. Diagnosis consists of two basic steps (a) the detection of the carious lesion and (b) the assessment of the depth and the activity of the lesion based on the optical characteristics of the lesion. A common approach for the detection of OC is visual inspection. However, this method is not consistent, since it is based on several subjective parameters among which the experience of the clinician is of paramount importance. The variance of the assessments between clinicians leads to different approaches for the management of carious lesion. This work aims at developing an automated method for the detection of OC using photographic color digital images.

Methods

The proposed method consists of four stages: (a) preprocessing of the color image, (b) detection of decalcified stained (DS) areas, (c) detection of OC areas, and (d) fusion of the results of the two previous steps. In the preprocessing stage the color image is converted to gray scale by eliminating the hue and saturation information while retaining the luminance [Gonzalez, 2009]. The contrast of the produced image is adjusted using the sigmoid function [Saruchi, 2012]. The detection process for the two different areas of interest runs in parallel. It includes the following procedures: (1) *segmentation of areas of interest:* the segmentation of the DS areas is based on the *k*-means algorithm while the segmentation of the OC is based on morphological operations, (2) *feature extraction:* features, expressing the area, the shape and the position of the objects detected in the previous step, are extracted, and (3) *object elimination:* the extracted features are combined and rules, expressing medical knowledge, are applied to eliminate areas that correspond to false positives. In order the results to be fused, the detected objects that correspond to regions of interest are projected on the same image. The distance between the centroids of the DS areas with each one of the centroids of the OC regions is computed. The decalcification regions of distance greater than 320 pixels are eliminated in order only the decalcification objects that are close or surround OC objects to be retained.

Results

The method was evaluated using a set of 89 areas of interest which were manually annotated by the clinician. The obtained sensitivity and precision is 85.4 and 83.5%, respectively. The non detected regions correspond mainly to pit and fissures of the tooth that, according to the assessment of the clinician, are either sound or in an early stage of caries. Regions not correctly identified are mainly regions of the tooth where the flash of the camera is reflected.

Discussion

An automatic unsupervised method for the detection of OC on extracted teeth is proposed. It is differentiated from those reported in the literature [Kamburoglu, 2009] since it does not require the subjective interpretation of the clinician and does not need the patient to be subjected to imaging examination. The performance of the method will be furthered improved by eliminating the false positives.

References

Gonzalez *et al*, Digital Image Processing Using Matlab, Gatesmark Publishing, 2009.

Kamburoglu *et al*, Dentomaxillofacial Radiology, 39:17–22, 2009.

Saruchi, International Journal of Computer Applications, 55:45-49, 2012.