A Range Image Processing Approach for Orthodontic Diagnosis

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Abstract

This paper presents the latest developments in the design of a computer vision-based system for automatic diagnosis in orthodontics. The need for an automatic diagnosis system in orthodontics is first discussed. The principal components of the system are then introduced and the strategy for the acquisition of range information on the shape of the mandibular and maxillary arches is presented. This is followed by a description of the range acquisition approach used to acquire registered 2D and 3D images of the arches. Since the acquisition has been described in detail elsewhere, this paper focuses on the algorithm for the removal of interreflection to improve the accuracy in range. The algorithms for processing the image data leading to the measurement of a set of orthodontic parameters are described and experimental results are presented showing the performance of the system on a large set of data.

1. The need for an automatic diagnosis system for orthodontics

The purpose of orthodontics is to evaluate the quality of occlusion between the teeth of the mandibular arch and those on the maxillary arch. Once the quality of the occlusion has been evaluated, an orthodontist or even an expert system can decide whether the patient needs dental work or not. Considering the cost of dental care, there is an urgent need for an automatic diagnosis system for conducting epidemiological studies or for screening health insurance beneficiaries.

Several approaches have been proposed to estimate the quality of occlusion [1]. Among these approaches, the measurement of a set of 10 orthodontic parameters has proven to be both practical and efficient [2]. Each parameter describes the relation between specific points located on the teeth. For instance, the cusps on the molars and the premolars, the apex on the canine, and the cutting edge of the incisors are among the points or set of points of interest (see Figure 1). The set of parameters is fed to an expert system for diagnosis. The expert system has been trained by highly qualified orthodontists using a large number of samples.

The orthodontic parameters are currently being measured manually by the orthodontist on plaster models of a patient's mouth. This procedure is slow and often brings discomfort to the patient. Furthermore, the models must be altered manually to improve the cast. When the cast is ready for each arch, the orthodontist has to measure the parameters with a caliper by slightly altering the occlusion between the casts of the arches by opening the model (see Figure 2). This perturbation leads to significant estimation errors of the parameter values. A non-contact approach is called for and computer vision is particularly adapted to this application.

Figure 1 View of the right hand side of a mandibular arch showing points of interest for orthodontic diagnosis.

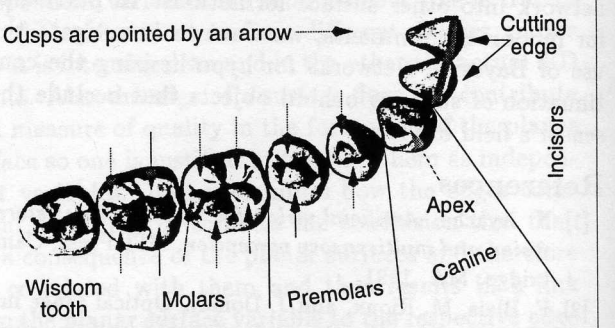

Figure 2 Manual measurement of orthodontic parameters on a plaster cast of the maxillary and mandibular arches.