

Learning-based Landmarks Detection for Osteoporosis Analysis

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ABSTRACT

Osteoporosis is the common cause for a broken bone among senior citizens. Early diagnosis of osteoporosis requires routine examination which may be costly for patients. A potential low cost diagnosis is to identify a senior citizen at high risk of osteoporosis by pre-screening during routine dental examination. Therefore, osteoporosis analysis using dental radiographs serves as a key step in routine dental examination. The aim of this study is to localize landmarks in dental radiographs which are helpful to assess the evidence of osteoporosis. We collect eight landmarks which are critical in osteoporosis analysis. Our goal is to localize these landmarks automatically for a given dental radiographic image. To address the challenges such as large variations of appearances in subjects, in this paper, we formulate the task into a multi-class classification problem. A hybrid feature pool is used to represent the landmarks. For the discriminative classification problem, we use a random forest to fuse the hybrid feature representation. In the experiments, we also evaluate the performances of individual feature component and the hybrid fused feature. Our proposed method achieves an average detection error of 2.9 mm.

Keywords: Landmark detection, Random forest, Hybrid features

1. INTRODUCTION

Osteoporosis is the common cause for a broken bone among senior citizens. Patients may suffer pain from bone fractures such as spine or dental osteoporosis fractures. Early diagnosis of osteoporosis requires routine examination which may be costly for patients. A potential low cost diagnosis is to identify a senior citizen at high risk of osteoporosis by pre-screening during routine dental examination. Therefore, osteoporosis analysis using dental radiography serves as a key step in routine dental examination. Further analysis of dental radiographs would provide additional information. For example, bone mineral density (BMD) analysis is one of the most important means for osteoporosis fractures estimation.¹ Texture analysis of region of interest (ROI) in dental screening image is a way for osteoporosis analysis, as many studies have shown that 2D texture analysis can indirectly evaluate 3D microarchitecture.^{2,3}

Recent studies include trabecular texture analysis in multi-ROI in dental cone beam computed tomography (CBCT) data.⁴ ROI in dental screening image can be used for osteoporosis analysis. The aim of this study is to localize landmarks in dental radiographic images which are helpful to assess the risk of osteoporosis. We collect eight landmarks which are useful to conduct osteoporosis analysis. Specifically, these landmarks provide six regions (ROIs) for further image-based osteoporosis analysis. Fig. 1 shows an example of eight landmarks on an X-ray image (Detail explanation is given in Sec. 1.).

Our goal, in this paper, is to automatically localize these landmarks on a given dental radiographic image. Basically, we treat landmarks detection as a multi-class classification problem. There are two key ingredients in our framework: 1) a hybrid feature which brings diverse types of discriminative information in a dental