行政院國家科學委員會專題研究計畫　期中進度報告

應用數學形態分析法於數位放射線影像以輔助診斷顎骨病變(1/2)

計畫類別：個別型計畫
計畫編號：NSC91-2314-B-002-157-
執行期間：91 年 08 月 01 日至 92 年 07 月 31 日
執行單位：國立臺灣大學醫學院臨床牙醫研究所

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報告類型：精簡報告
報告附件：出席國際會議研究心得報告及發表論文
處理方式：本計畫可公開查詢

中　華　民　國 92 年 5 月 21 日

行政院國家科學委員會專題研究計畫成果期中報告

應用數學形態分析法於數位放射線影像以輔助診斷顎骨病變

Computer-assisted diagnosis of jaw bone diseases with mathematical morphology on digital dental radiographs

計畫編號：NSC 91-22314-B-002-157

執行期限：91 年 8 月 1 日至 92 年 7 月 30 日

主持人：陳思光

國立台灣大學臨床牙醫學研究所

一、中文摘要

簡介:

數學型態分析法是一種萃取特定結構圖紋的型態分析法，而顎骨的骨小樑結構圖紋會因某些病變侵襲而改變，因此理論上應用數學型態分析法萃取骨小樑結構圖紋輔助診斷顎骨病變是可能的，但目前此類應用僅有極初步之研究報告。此研究擬將此應用作一有系統之研究，期能評估現有技術，作出最適切之改良，以開發出臨床上實用之數學型態分析法以輔助診斷顎骨病變。

研究目的:

1: 建立適用於數學型態分析法的口腔顎面數位放射線影像擷取流程.

2: 比較投射之口腔顎面數位放射線影像取得之結構圖紋與高解像度電腦斷層影像取得之三維結構

3: 開發口腔顎面數位放射線影像之數學型態分析法

4: 評估使用不同結構元素之數學型態分析法

5: 評估使用不同分析方程式之數學型態分析法

6: 比較正常顎骨的骨小樑與受力顎骨的骨小樑的結構圖紋

7: 比較正常顎骨的骨小樑與根尖周囊腫顎骨的骨小樑的結構圖紋

8: 數學型態分析法中不同結構元素與不同分析方程式之最佳化

9: 應用數學形態分析法於數位放射線影像以輔助診斷顎骨病變之自動化

方法:

1: 比較以不同方式及解像度擷取之口腔顎面數位放射線影像

2: 比較投射之口腔顎面數位放射線影像取得之結構圖紋在質與量方面與高解像度電腦斷層影像取得之三維結構知不同

3: 結合蝕刻與封閉處理之數學型態分析法

4: 採用線性與環型結構元素
5: 結合蝕刻、擴張、開放與封閉處理之數學型態分析法
6: 應用開發出之技術比較正常顎骨的骨小樑與受力顎骨的骨小樑的結構圖紋
7: 應用開發出之技術比較正常顎骨的骨小樑與根尖周囊腫顎骨的骨小樑的結構圖紋
8: 結合不同結構元素與分析方程式之數學型態分析法
9: 將應用數學形態分析法於數位放射線影像以輔助診斷顎骨病變之方法與口腔顎面數位放射線影像存取與傳輸系統結合

此計畫將開發出應用數學形態分析法於數位放射線影像以輔助診斷顎骨病變

關鍵詞　數學型態分析法　電腦輔助診斷系統　口腔顎面數位放射線影像存取與傳輸系統

Abstract

Introduction:

Mathematical morphology is a morphological operation that can extract a specific pattern on a digital image. The trabecular pattern of maxilla and mandible changes in some diseases. It is possible to facilitate diagnosis of oral diseases on radiographs with a computer running mathematical morphology.

Objectives:
1: Set up digital image acquisition protocol.
2: Comparison of 2D projection data with 3D object acquired by micro CT
3: Develop morphological filtering techniques for CAD in oral radiology
4: Evaluate structuring element of different shape and threshold level
5: Evaluate different Mathematical Morphology Equations
6: Difference between normal trabecular pattern and stress bearing bone
7: Difference between normal trabecular pattern and apical periodontal cyst
8: Optimization of structuring element and mathematical morphology equations
9: Automation of mathematical morphology operations on detomaxillofacial images

Method:
1: Compare digital image from various modalities and with different resolution., including CR image acquisition
2: Comparisom of quality and quantity of bone captured on projectional and

micro CT images.
3: Combination of erosion and closing operations
4: Linear and circular structuring elements
5: Combination of erosion, dilation, closing and opening operations
6: Application of developed operations on digital radiologic images of normal and stress-bearing trabecular bone.
7: Use of star volume operation on the processed images to compare normal trabecular pattern and that of apical periodontal cyst
8: Combination of different structuring element and equations
9: Implementation of mathematical morphology based CAD on PACS

This study might develop an effective tool in diagnosing jaw bone diseases using mathematical morphology operations on digital oral and maxillofacial radiologic images.

Key words　mathematical morphology　computer-assisted diagnosis　IMACS

二、緣由與目的

Mathematical morphology is a morphological operation that can extract a specific pattern on a digital image. The pattern of maxilla and mandible captured on a radiograph usually change when a disease is present or progressing. Therefore, it is possible to facilitate diagnosis with a computer running mathematical morphology. It is the aim of this project to develop the morphological operations that are helpful in extracting skeletal pattern of jaw bone in various lesions.

Morphological operation:

Morphological operation refers to a method of recognition of the object shape with a structuring element. When the structuring element fits into the pattern of the analyzed object, this pattern can be recognized and extracted. This is similar to analyze an object in the darkness with our hands. Two parameters are very important in this operation process. One is the shape of the structuring element. This determines the pattern that can be extracted. The other is the procedure follow that this structuring element is used. This is the equation that is used to handle this structuring element.

For example, bone trabeculae on digital image has lower pixel values than adjacent soft tissues. These low pixel values are similar to the valleys in a landscape.

Computed radiography:

Conventional radiography uses film as the sensor to register transmitted x-rays, while computed radiography uses an image plate as sensor. The sensing component of the imaging plate is photostimulable phosphor which is a crystalline halide composed of europium-activated fluorohalide compounds. This compound can register the transmitted x-ray energies by trapping excited electrons with halogen ion vacancies. A second excitation with He-Ne laser can release the trapped electrons via fluorescent blue light. The intensity of the blue light is recorded to form the digital x-ray images. Among other advantages, a wider dynamic range of 10E4 compared to 10 E2 of film. This CR technologies in many situations have replaced film as the most used modality for radiographic image acquisition. It has also been applied into oral and maxillofacial imaging since mid-ninties (Kashima's article)

Trabecular pattern:

Clinically, the trabeculae pattern are not easily extracted because of many limitations. Firstly, the overlying soft tissue can obscure the acquired image. Furthermore, the radiographical conditions are not usually optimal clinically. Several spatial frequencies texture analysis have been applied to extract trabecular bone pattern, including power spectrum method, fractal analysis, and run length analysis. However, extracted bone trabecular pattern were sometimes not well defined due to incomplete extraction at some frequencies. Therefore, extraction of the trabecular pattern remains an unsolved problem.

Computer assisted diagnosis:

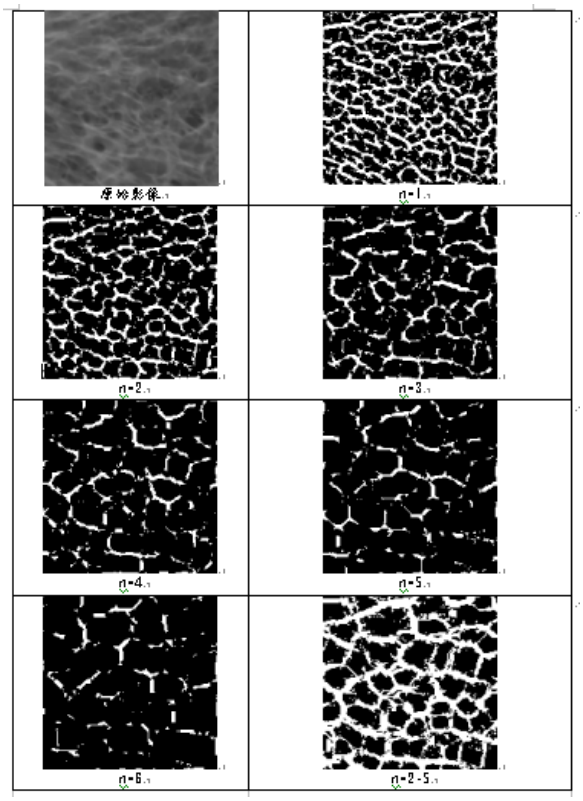
CAD aims at improving diagnosis accuracy by preventing oversights of abnormalities and subjective judgments. In the field of CAD in medical imaging, many imaging processing techniques have been applied. The application of mathematical morphology theory into image processing has been the center of interests.

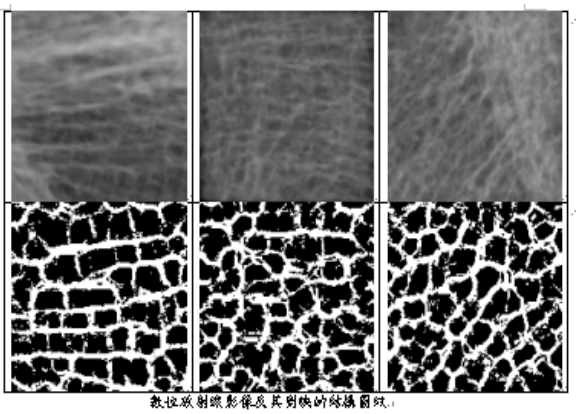
三、結果與討論

Aims Set up digital image acquisition protocol, compare digital image from various modalities and with different resolution., including CR image acquisition

Develop morphological filtering, Gray scale image dilation and closing, 5x5 disk like structuring element, Iterations, Subset and sumset.

成果包括：





數位放射線影像及其射映的結構圖紋

四、計畫成果自評

以 Computed Radiography 方式使用不同解像度擷取之口腔顎面數位放射線影像是較可行的方法，目前已發展出結合蝕刻與封閉處理之數學型態分析法，是採用環型結構元素，已可採用線性元素法，效果仍需評估。將繼續進行結合蝕刻、擴張、開放與封閉處理之數學型態分析法。

Skeletonization 之結果已可以 Star Volume Analysis 得到初步結果，將應用開發出之技術比較正常顎骨的骨小樑與受力顎骨的骨小樑的結構圖紋以及應用開發出之技術比較正常顎骨的骨小樑與根尖周囊腫顎骨的骨小樑的結構圖紋。

本年計劃將繼續結合不同結構元素與分析方程式之數學型態分析法，將應用數學形態分析法於數位放射線影像以輔助診斷顎骨病變之方法與口腔顎面數位放射線影像存取與傳輸系統結合

此計畫將開發出應用數學形態分析法於數位放射線影像以輔助診斷顎骨病變

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