Motivational Visual Aid for Periodontal Disease Patients

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Abstract— Periodontitis or Periodontal disease is an infectious disease which affects the gums and the teeth mobility. This disease is mainly due to low oral hygiene, eating habits and/or brushing habits. The symptom of Periodontal disease is inflamed bleeding gums. If left unattended, the disease gradually leads to tooth mobility and bone loss. As symptoms are not so severe, patients often tend to ignore Periodontal disease.

Surgery is the last resort for the patients who have reached the final stages of the Periodontal disease is surgery. This is necessary in order to cease further degradation of the teeth. But patients generally are not in the favour of undergoing a surgery due to fear and anxiety. In this situation, the dentists are not left with many options to stop further deterioration. This paper presents a method to provide a visual aid which will help the dentists in enlightening the patients of the severity of their disease and help them in reaching out for the right treatment at the earliest possible time

Keywords— Periodontal disease, Grey Scale, Local Binary Pattern, Inpainting

INTRODUCTION

Periodontal disease is an infectious disease the teeth supporting tissues or structures. It can infect more than one type of tissue or structures such as alveolar bone, periodontal ligament, cementum and gingiva. Periodontal disease is of many types relying upon the type of the tissues or structures that they affect. By far the most common ones are gingivitis and periodontitis. Periodontal disease which is at a very pre-mature stage is known as gingivitis. While the periodontal disease which is a very chronic stage is known as periodontitis. In some cases, gingivitis never progresses to periodontitis, while in some other cases it matures in to periodontitis.

A tooth, through fibres known as periodontal ligaments, is locked to its gum socket. Periodontal disease is a very serious bacterial disease which damages these periodontal ligaments and gums resulting in the degradation of the gum and other mouth areas. It also has a very high impact on the bones around the tooth and membrane of the tooth. This practically ruins the entire denticulation of the patient suffering from gingivitis.

There are basically two main reasons of gum recession: (i) Brushing routine (ii) Periodontal disease. Gum recession can cause severe decaying of tooth and eventually tooth loss. Gum recession leads to blackening of the enamel of the teeth which has a very negative impact on the dental health of the patient. Gum recession in worst cases causes creation of pockets. These pockets in the socket of the gum of the tooth leads to mobility of the tooth and hence tooth loss. Proper treatment is required and mostly at the earliest possible time period.

Most of the dental infections or conditions have very poignant and distinguishable symptoms. Periodontal disease not being one of such infectious disease does not have any such drastic symptoms. Periodontitis has blackening of teeth as the prime symptom. This is the main reason why the patients are oblivious to it. As it is a prolonged but has a gradual effect on the teeth, the patient is liable to pass on the check-up or bypass the prescribed treatment. Not being able to foresee the condition of the infection in future and lack of understanding of the disease leads to lack of attention to periodontal disease.

This leads to periodontitis which then has very low chances of being treated. The only way to treat periodontal disease is to detect it in as earliest stage possible. This will ensure that gingivitis does not progress to periodontitis as well as the integrity of the teeth is maintained. The health of the gums and mobility of the teeth are at great risk when suffering from periodontitis. Periodontal disease has different rate of increase according to the practices or current medical conditions such as alcoholic, tobacco consumer or a diabetic person. These factors also have an impact on the condition of periodontal disease according to the patient's routine habits. The lack of understanding and awareness regarding periodontal disease mainly leads to the large number of patients suffering from this disease.

The ultimate solution to periodontists is surgery. Most of the patients disagree to this due to uncertainty of the consequences and anxiety of the surgery. Once the gingivitis stage has been attained there is no other solution than surgical treatment. In such scenario, the patients either have to go under surgery. If not, then the consequences are severe causing the patient to lose his/ her denticulations. Orthodontists face a challenge to make the patients understand and self-aware about their situation. Pictorial depiction of a target is more impactful than verbal explanation. Hence, there is a necessity of a visual aid which shall help dentists to explain their patients for better understanding of the disease.

The proposed system will help the dentists to depict the prediction of the future state of the dental bones and help explaining their patients about the disease. Also it will motivate the patients to taken prescribed medication and treatment. In this paper, we introduce a novel system, which will provide a visual aid for portraying the future possibilities of the periodontal disease. The proposed system, will act as a helping device for orthodontists, who can utilize it for explaining the disease to their patients and prescribe appropriate treatment according to their condition.

METHODOLOGY

[1] This paper was the comprehensive study of periodontal diseases by using radiographs. It presents a method for diagnosis of periodontal diseases. This is done with the use of a single radiographic X-ray image. Dental radiography plays a vital role in being an aid for diagnosis of periodontal disease. It also helps in assessment of the results of the treatment. Using image processing increases the importance of radiography in periodontal diagnosis. The author focuses on the study of Digital Subtraction Radiography (DSR). DSR uses two images with identical gray-level distribution. Projection geometry is essential to identify the periodontal disease. In DSR, a pair of identical images can be obtained without mechanical alignment of patient, film and x-ray source. The drawback of this technique is, if there is any mechanical alignment in the camera view then mismatching will occur in the result. The author has experimented the proposed technique on about 15 samples of images. The author presents a method for automated diagnosis of periodontal diseases using a single radiographic X-ray image which eliminates the necessity of pair of images. This study will help the orthodontists to read accurate diagnosis and treatment planning over the radiographs.

[2] In this paper, the author has studied the technique of inpainting. The inpainting algorithm presented has been clearly motivated by and has borrowed from the intensive work on the use of Partial Differential Equations (PDE's) in image processing and computer vision. In this paper, the author has introduced a novel algorithm for digital inpainting which replicated the inpainting procedure adapted by professional restorators. The user needs to select the area that needs to be restored. The algorithm then automatically fills-in these regions with surrounding area information. The fill-in is done in such a way that isophote lines arriving at the regions' boundaries are completed inside. We can split the inpainting problem into two coupled variational formulations, one for the isophote direction and one for the gray-values, consistent with the estimated directions. The corresponding gradient descent flows will give two coupled second order PDE's for which formal results regarding existence and uniqueness of the solutions can be shown. The source of the information is not required unlike previous approaches. The process is fast and automatic which allows simultaneous fill-in numerous regions having entirely different structure and surrounding backgrounds. The author also proposes to eliminate all the constraints of the region on which the inpainting algorithm can be applied. Applications of this technique include restoring old or damaged photographs and films; removing superimposed textual data, subtitles or publicity; and removal of a complete object from the image which undesirable.

[3] This paper presents the morphological extraction of fingerprint minutiae based on hit or miss transform. Fingerprint is the most commonly used biometrics based personal authentication system for personal identification. Fingerprint Recognition Systems are mainly dependent on local ridge features known as minutiae, marking minutiae accurately and rejecting false ones are critically important. In this paper, the author proposes an algorithm for extracting the minutiae form fingerprint image using binary Hit or Miss Transform (HMT) or mathematical morphology. The author shows that applying this extraction algorithm which is preprocessing the fingerprint image with morphological operators before thinning removes superfluous information and extracts a clear and reliable ridge map structure from the input fingerprint image thereby giving improved results in minutiae extraction. This reduces the amount of effort required for post processing stage.

[4] In this paper, the author has surveyed all common thinning algorithms. Thinning is the process of reducing an object in a digital image to the minimum size necessary for machine recognition of that object. Post thinning algorithm, analysis can be done on the reduced size image. Thinning is very useful because it greatly speeds up any subsequent analysis of the object. Also, analysis can be easily carried out after thinning. Also thin line representation is considered to be close to the way humans recognize objects. The author has discussed numerous thinning algorithms such as iterative thinning algorithms, non-iterative thinning algorithms, sequential thinning algorithms, parallel thinning algorithms, line following methods and medial axis transforms. The author has proposed that in determining effectiveness of thinning algorithms the following traits must be taken into consideration: 1) sensitivity to noise, 2) preservation of topological and geometric properties, 3) isotropy, 4) reconstruct ability, and 5) efficiency.

[5] This paper focuses on fingerprint verification system using minutiae extraction technique. Most of the fingerprint verification techniques are based on minutiae extraction and have been studied very well. But these techniques have the drawback of not able to effectively process poor quality impressions. Distortion is one problem besetting fingerprint matching. Distortion is not constant and changes its geometric position and orientation. This brings up various matching among various impression acquired from the same fingertip. The author has combined numerus methods to build a minutiae extractor and a minutiae matcher. There is also usage of segmentation using Morphological operations, improved thinning, false minutiae removal methods, minutiae marking with special considering the triple branch counting, minutiae unification by decomposing a branch into three terminations, and matching in the unified x-y coordinate system after two-step transformation are used in the work.

This paper describes the methodology of problem solving used in algorithmic approach. The algorithms used are gray scale, Local binary pattern (LBP) and Inpainting algorithm. The input will be the teeth of the patient and output will be the image showing the effects of periodontal disease.

Gray Scale:
An image may contain many colors. This makes processing the image a bit tedious job. Hence, the image is converted into gray scale image. The pixel component ARGB is extracted. The extracted values are then quantified by computing their average. The new gray pixel value is then set by utilizing the calculated average value. This step is mandatory as the next stage i.e. LBP is applicable on gray scale images.

Local Binary Pattern:
The image contours are detected. This is done by defining a window size W and extracting the WxW neighboring pixels. Generating an array of binary numbers will depict the boundaries of the objects in the image. Resultant image will be fine edge detected image. Lastly normalization is done to adjust the size of the image generated. This algorithm can be used to extract the edges from the images.

Inpainting:
This is used for restoration or replacing a damaged part of the image. Surrounding list is generated. Selected region can be restored by replacing the selected area by its surrounding pixels which is traversed through the neighbors list. Inpainting process is used to show the final result of the input image.

ALGORITHM

In order to get a gray scale image, we shall apply the following algorithm:
1. GET INPUT IMAGE
2. SET COLOR PIXEL P
3. FOR i < height and j < width
   a. Get pixel(I,j) in p
   b. Extract pixel component ARGB
   c. Find average
   d. Set new pixel value(gray)
4. Load grayscale image in picture box.

One of the simplest form of similarity measure is calculate difference as sum of R, G, B difference of the pixels. But as we defined, a texture may contain pixels of different colours in a definitive way. If you check colours, it is plain and simple structure inpainting. So we will go a step further to define a texture pattern using Local binary pattern. Further this texture representation is extracted from gray scale image. So we need to convert the image to gray scale first.

Local binary pattern is the applied to grayscale image which is obtained. LBP can be applied using the steps below.
1. Define a window size W
2. Scan every pixel in an image, extract its WxW neighbourhood.
3. Check if a Neighbour pixel colour > Centre, if so put 1 in the matrix else 0
4. Thus we get an array of '1' s and '0's. Convert this to binary and subsequently binary needs to be converted to decimal and must replace the centre pixel. Remember bigger the value of W, larger will be number. for example, for W=4, you will get a binary number of 16 bits. But gray scale image can contain only 8 bit colours. Therefore, once entire image's LBP is extracted, it is to be normalized.
5. Normalization is performed as (Image containing local binary pattern) *255/ (maximum value in the image)

Important thing is if you take W=1, resultant image will be fine edge detected image. So you can alternatively use this theory to extract edges from images.

Finally, we shall use the fine edge detected image for inpainting algorithm. Inpainting algorithm will use the neighbour list for replacement purpose.

1. Obtain Mask
2. Define resultant image same as source region. As algo proceeds, we need to replace the marked blocks
3. Define the block for Inpainting purpose
4. check if the pixel is white (that means marked pixel in source)
5. Generate the neighbors List
6. calculate mean distance of the current pixel with all neighbors
7. update ps value which will be used to replace p in original image
8. replace p with ps in the actual image

Note that inpainting process typically takes large time. Larger image size can really take hours to complete. So you need to call the function from a thread and periodically update the resultant picture box display. It helps you to see that inpainting is happening.
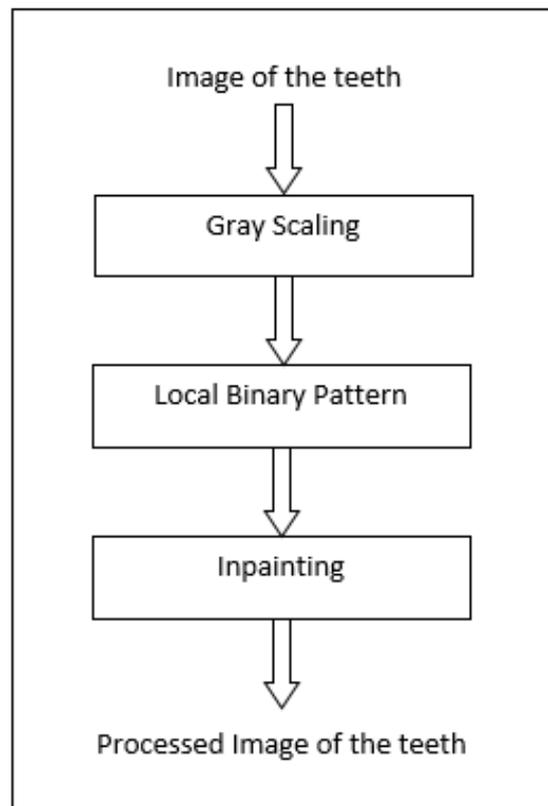

Fig. 1: Steps to obtain periodontal image

Description:

The patient's image of the teeth is given as the input. The binary image is generated using the Gray scaling algorithm. This generated binary image is then processed using (LBP) Local Binary Pattern. The LBP (Local Binary Pattern) is used to create fine edge detected image. This is done by storing 1's and 0's in an array which defines the edges of the image. The resultant image is then given as an input to the inpainting algorithm. The edges of the image are then inpainted giving us the required inpainted image showing the effects of the periodontal disease.

CONCLUSION

The system is a visual aid to the patients suffering from periodontitis. This system will predict the effects of periodontal disease if genuine care and treatment is not taken. We have proposed a framework which will support the orthodontists in explaining the severity of the ailment to their respective patients and thus persuade them to take the prescribed treatment as early as possible. The system will process the image using Gray scale, LBP and Inpainting algorithms to give an image showing the after effects of the periodontal disease.

The first algorithm, Gray scale will convert the input image into a bi-level image by averaging the ARGB component. This leads to a binary image which is essential for LBP (Local Binary Patter). The LBP leads to giving an edge detected image which represents the boundaries and contours of the objects in the image. The edge detected image, after normalization, is then applied with inpainting algorithm which gives an inpainted image. This resultant image then can be used to enlighten the patients with the severity and necessity of the treatment.

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