Restoring Structures of Heart Surface Affected by Specular Reflection

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Abstract- *This paper deal with efficient approach for reconstruction of real heart image structure in the presence of disturbances such as specular reflections. Reconstruction schemes are sufficiently general for application in other fields, where disturbances in images should be eliminated ensuring continuity of local structures. Using histogram equalizing technique an efficient approach has been made for finding genuine specular reflected area in the heart image and filling those reflection affected area with the surrounding texture of heart surface. The smooth reconstruction of those areas can done by ensuring continuity of local structures using chain coding technique and anisotropic diffusion.*

Keywords- specular reflection.

I. INTRODUCTION

The specular reflection in a image act as noise for the source image. Consequently removal of the specular reflection is must to make our image data source noise free. The efficient approach has been made for reconstruction of original image structure in the presence of local disturbances such as specular reflections. During cardiac procedures (especially in minimally invasive interventions) finding the targeted vessel(s) is often complicated by accumulated adipose tissue on the external surface of the heart. Since the glossy surfaces give rise to specular reflection from light sources. There specular reflections of the point light source arise on the curved and deforming surface of the beating heart. Due to sudden and irregular occurrence these highlights disturb tracking of natural landmarks on the beating heart considerably. Reconstruction schemes are sufficiently general for application in other fields, where disturbances in images should be eliminates ensuring continuity of local structures. Without proper identification specularities are often mistaken for genuine surface markings by computer vision applications such as matching models to objects, deriving motion fields from optical flow or estimating depth from binocular stereo. Using histogram equalizing technique an efficient approach has been made for finding genuine area of specular reflection over the surface of the heart and filling those reflection affected area with the color of surrounding texture of heart surface [1].

II. SOURCE IMAGE AND METHODOLOGY

Specularities occur as highlights falls on the glossy heart surface. Since their grey values are distinctively high and independent of neighborhood intensities, simple threshold can be applied for segmentation. Structure inside specular areas is restored from local structure information determined by the well-known structure tensor. This yields reconstruction which is most likely to correspond to the original area on condition that surface structures possess some continuity as shown in figure1. Therefore intensity information mainly from boundary points along the current orientation is used.

It is not possible to develop and test in a clinical environment, thus all research activities were performed outside of the hospital. Therefore the image material used (angiographies and the live heart image sequences) were provided in digitized form by the Heart Center. The heart images are in a 720x576@24bit RGB format, while the angiograms are available as 512x512@8bit gray scale as shown in figure(1). Converting the image in RGB format to grayscale format is the best and convenient approach for any type of processing in the images. This provides us two dimensional scale images for pre-processing of images as shown in figure 1.

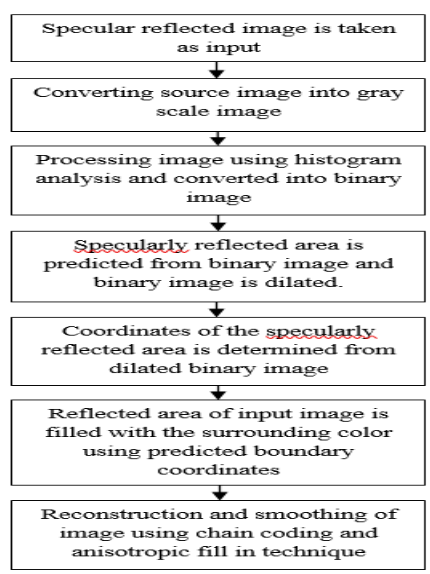

Figure1: Process chart of image pre-processing

Figure 2: Specular reflected image of heart

A. Enhancing the image

Specular reflections occur as a result of light reflects from the glossy surfaces. Due to their high intensity a threshold operator is in most cases sufficient to localize them. Histogram analysis and image enhancement increases the contrast of images by transforming the values in an intensity of image or the values in the color map of an indexed image, so that the histogram of the output image approximately matches a specific requirement for further processing of the images. The process of adjusting intensity values involves transforming the intensity values so that the histogram of the output image approximately matches a specified histogram. By using an adaptive equalizing technique the various intensity level of the image is enhanced and distinguished. An adaptive equalization performs contrast limited function of images. While histogram equalization works on the entire image, an adaptive equalization operates on small regions in the image, called tiles. Each tile's contrast is enhanced, so that the histogram of the output region approximately matches a specified histogram. After performing the equalization, adaptive histogram equation combines neighboring tiles using bilinear interpolation to eliminate artificially induced boundaries. To avoid amplifying any noise that might be present in the image and limit the contrast, especially in homogeneous areas of images. The above process in the images help to differentiate the various intensity level of image to low and high level intensity and in this way the specular reflection is more specifically predicted from the image shown in figure (3).

Figure 3: Enhanced contrast image of heart

B. Filling the specular area.

The boundary of the specular reflected area is determined by the above histogram analyzed image as shown in figure 4 (a) which is the binary image of the above figure (3). This binary image is use for the determining the exact location and boundaries of specular reflection area in the image and the result of this process is to get the coordinates of the specular reflected area in images. Dilation of the binary images is shown in figure (4)(a). Since dilation process grows or thickens white portion of the binary images as shown in figure (4)(b). From this binary dilated image is used for finding the expanded boundaries of the binary image .The coordinates of the dilated image is used to fill those area with the color of the surrounding structure texture object in the source image. This dilated image is used as reference for finding the specular reflection area of the image and filling of those areas will be done in original source image [2].

Figure 4 :(a) Black & white image (b) Dilated imaging the Black & white image.

C. Reconstruction and Smoothing

Chain coding: Chain code is an image method representation based on region boundaries. The chain code of region is determined by specifying a starting pixel and the sequence of unit vectors obtained from going either left, right, up, or down in moving from pixel to pixel along the boundary. Chain code is widely used now a day because it preserves information and allows considerable data reduction. This code follows the contour in counter clockwise manner and keeps track of the directions as we go from one contour pixel to the next. The codes involve 4– connected and 8– connected paths. The new chain codes need the binary image as the input, because chain code is the code based on boundary. The underlying image colors are then reconstructed using a fill-in technique based on chain coding. Chain coding is a reliable and fast approach for representing arbitrary plane curves. The idea is to first detect and chain code the 1 pixel wide outer bound of specularity, then traverse the chain code and replace each pixel with an averaged color of his neighbors [4].

Anisotropic Confidence-Based Filling-In: This reconstruction scheme fills specular areas from the boundary based on local structure information. It employs coherence enhancing anisotropic diffusion [5].

Coherence Enhancing Anisotropic Diffusion: Diffusion is generally conceived as a physical process that equilibrates concentration without creating or destroying mass. Applied to images, intensity at a certain location is identified with concentration. Thus the diffusion process implies smoothing of peaks and sharp changes of intensity, where the image gradient is strong. The discussed type of diffusion, designed to enhance the coherence of structures, is anisotropic and inhomogeneous. Inhomogeneous means that the strength of diffusion depends on the current image position, e.g. the absolute value of the gradient ∇f. Further, anisotropic diffusion corresponds to non-uniform smoothing, e.g. directed along structures. Thus edges can not only be preserved but even enhanced. The diffusion tensor $D=D(J_\rho(\nabla f_\sigma))$, needed to specify anisotropy, has the same set of eigenvectors v_1, v_2 as the structure tensor J_ρ, reflecting local image structure. Its eigen values λ_1', λ_2' are chosen to enhance coherent structures, which implies a smoothing preference along the coherence direction v_2 with diffusivity λ_2' increasing with respect to the coherence $(\lambda_1-\lambda_2)^2$ of J_ρ:

$$\lambda_1' \overset{\text{def}}{=} \alpha \,;\; \lambda_2' \overset{\text{def}}{=} \begin{cases} \alpha & ;\ \text{if } \lambda_1=\lambda_2 \\ \alpha+(1-\alpha)\exp\left(\frac{-c}{(\lambda_1-\lambda_2)^{2m}}\right) & ;\ \text{otherwise} \end{cases}$$

Where $C>0$, $m \in N, \alpha \in]0,1[$ and the exponential function ensures the smoothness of D. For homogeneous regions, α specifies the strength of diffusion. We follow with image $\lambda=1$, $m=1$ and $\alpha=0.001$ [6].

The anisotropic filling-in scheme preserves structure occluded by specular reflections. Inherent smoothness of the diffusion process inside and at the boundaries of specular reflections can be visually confirmed. Specularities can be eliminated if the iteration scheme is applied long enough, but not all intensity from large specular areas may be drained if time is restricted. The final image obtains which is free from all type specular reflections are shown in figure (5).

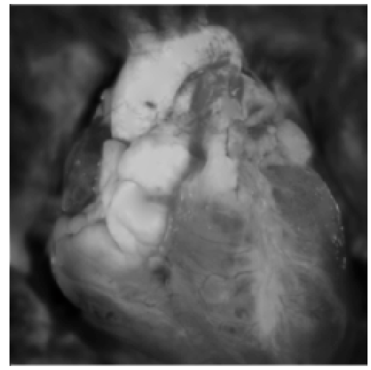

Figure 5: Image of heart free from specular reflection.

III. RESULT

An efficient approach has been made to reconstruct the image which is affected by local disturbances such as specular reflection .Histogram analysis is used for the enhancements of the image and predicting those specular areas from the enhanced image. Chain code method is effectively used for pattern recognition and image processing. Anisotropic filling-in creates inherently smooth areas; it applies a diffusion process depending on both orientation and strength of local structures. Anisotropic confidence-based filling-in employs smoothness constraints to reach an optimum solution for reconstruction as shown in figure (5).

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