

A Proposal: Diabetic Related Complications and Image Processing Methodologies

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Abstract

Objectives: Diabetes is a major public health problem and mainly affects the eyes, the kidney and the foot. This work focuses on diabetic foot to device new strategies for early diagnosis of diabetic foot in hospitals from the analysis of thermal images. **Method/Statistical Analysis:** In the presence of a triggering factor, it may lead to ulceration and subsequent amputation. In many cases, development of diabetic foot disorders can be avoided or substantially delayed with adequate treatments that are provided at an early stage. Most of the people who are with Diabetes have some form of nerve damage. Apart from this Hyperthermia it is also a challenging issue in diabetes correlated to foot these days. A new algorithm called Global Region Based Chan-vee Algorithm is proposed to analyze the underlying problems present in acquired images. **Findings:** A pre-processing technique as well as a post-processing technique of image processing methods will be used for the development of the frame work which will be useful for easy analysis and as well as an education tool for layman. **Improvements/Applications:** In this approach The segmentation boundary is represented implicitly with a level set function, but in previously employed methods the initial curve can be placed anywhere in the image.

Keywords: Diabetes, Enhancement, Foot Ulcer, Hyperthermia, Segmentation

1. Introduction

Diabetic Mellitus (DM) is a metabolic disorder that characterized by inability of the pancreas to control blood glucose concentration. This predicament results may make out blood glucose levels out of range. According to International Diabetic Federation (IDF), India is one of

the 6 countries of the IDF SEA (South East Asia) region. 387 million people have diabetes in the world and 75 million people in the SEA Region; by 2035 this will rise to 123 million¹. There were 66.8 million cases of diabetes in India in 2014.

Diabetic nephropathy has been classified into stages: Micro albuminuria and Macro albuminuria. Diabetic

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nephropathy is a clinical syndrome characterized by the following: Persistent albuminuria (>300 mg/d or >200 μ g/min) that is confirmed on at least 2 occasions 3-6 months apart. Progressive decline in the Glomerular Filtration Rate (GFR) Elevated arterial blood pressure².

Diabetic Neuropathy is more common in those who have had the disease for a number of years and can lead to many kinds of problems. In other sense this is defined as grouped family of nerve problems. This disorder might result in non-functioning of various organs. Sedentary lifestyle (such as irregular eating habits, smoking and drinking) and mechanical injury to nerves because of prolonged non-diagnosis and treatment are some of the causes this disorder. Mainly this leads to faults in decision making capability of human by damaging or slowing the process of brain and neurologically connected parts of the body³.

In diabetic foot, the incidence of an ulcer is time and again linked with hyperthermia. Hyperthermia is defined as a temperature greater than 2.2°C in a given region of one of the foot compared to the temperature of the same region of the contralateral foot. The major imaging modality used in this diagnosis are IR based Thermograph scanners which are most sophisticated and state-of-art modules, but the installation and the equipment are expensive leading to non-availability to the poor people.

In most of the practical cases, Image Processing methods are employed to extort or derive the imperative features from the images, which can be made use for the better understanding and analysis for further processes. The organic vision system is one of the most essential means of looking at of the world to humans, making intricate task easier for betterment of understanding⁴. There are numerous algorithms that can be utilized for different applications but enhancement and segmentation are considered as most sort out methods for improving the details in an image. The judgment of a particular method or procedure in Image processing methods is not possible to say that one method is best for all applications, but one can use trial and error method as a practical approach for obtaining the perfect results⁵. Even though a good number of methods available in Digital Image Processing Literature, the foremost methods used in for

the most part of the recent day Image Processing models are Enhancement and Segmentation methods because of their ease to use and applicability. Image Enhancement is an elementary assignment in digital image processing and analysis, intended to perk up the manifestation of image in terms of human brightness perception. Whereas the Segmentation is principally helpful in categorization of objects and labelling of the features extracted from image for easy analysis. One should look into that processing of images is done exclusive of blotching the veracity of original image.

2. Objectives and Scope

The Objectives of this work are given below in a simple and obvious way that on attaining these goals will lead to the betterment of mankind to prevent further complications of diabetes.

- To study recent algorithms related to Image
- Enhancement (**Histograms, CLAHE** etc) and Segmentation (**K-Means, Fuzzy Cmeans and Watershed**) to solve the problem and attempt to modify the algorithm for specific application.
- To establish the **new approach** by combining the image processing (Enhancement and segmentation) techniques as per requirements and also to tabulate statistical comparison of image attributes.
- To explore and investigate the significance of less commonly used estimate parameters in process of medical image analysis.
- To develop a frame work for qualitative automatic medical imaging to detect and forecast the abnormalities in the considered problem for accurate diagnosis.
- To make the products of this research freely available to the academic and medical community as open standard system.

3. General Information on Diabetic Foot

In daily life of Diabetic patients other than pain and inconvenience, Diabetic foot problems have a consider-

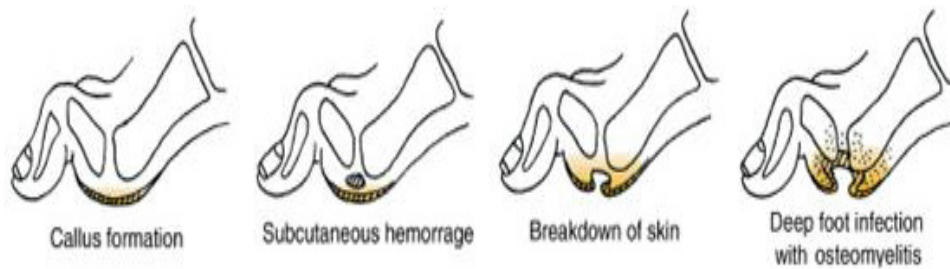


Figure 1. Foot ulcer due to repetitive stress.

able financial impact through outpatient costs, increased bed occupancy and long-drawn-out stays in hospital. In accumulation, diabetic foot problems have an imperative blow on the quality of life leading to a lot of socio-economic issues which will buildup the psychological problems resulting in unbearable situations.

Whatever the crucial causes, the patient persists walking on the insensate foot, which prejudices consequent healing (Figure 1). Peripheral vascular disease, usually in concurrence with minor trauma, may upshot in a painful, entirely ischemic foot ulcer. On the other hand, in patients with neuropathy and ischemia (neuroischaemic

ulcer), symptoms are hard to recognize and sometimes they may be absent, in spite of severe peripheral ischemia. Microangiopathy must not be customary as a prime cause of an ulcer. See Figure 1 for a visual explanation of the ulceration mechanism and illustration of foot ulcers.

4. Proposed Methodology

In Figure 2 we are using a modified Chan-vee method named “Global Region Based Chan-vee Algorithm for betterment of results. Global region thresholding used here is based on Morphological operation.

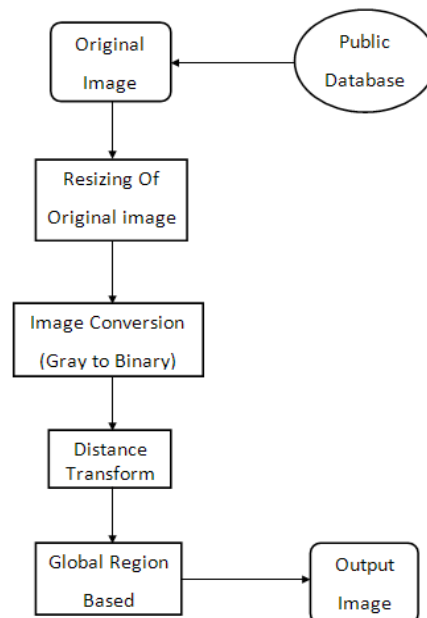


Figure 2. Global region based chan-vee algorithm.

The Methodology is given below as a step by step procedure to solve the considered application.

4.1 Medical Visual Data Base Collection

To collect the image data base (Nephropathy related images) from public database and also from Diabetic research institutes (**Already taking help from Diabetic Care Centre, Nandalur, A.P.**, The visual data consists of varied databases with documents of differing modalities and varying characteristics.

As an instance an image is used from⁶ to show in Figure 3 the difference between normal and abnormal (Diabetic) groups. Main changes observed here are with reduction in podocytes and increased mesangial cell enlargement leading to Diabetic Nephropathy.

As an instance one image is used from⁷ shown in Figure 4 which is a graphical content depicting the difference between healthy nerves and damaged nerves? It is obvious pictures that a Diabetic patient will have a some sort of nerve and blood vessel damage in his lifetime when compared to normal healthy people.

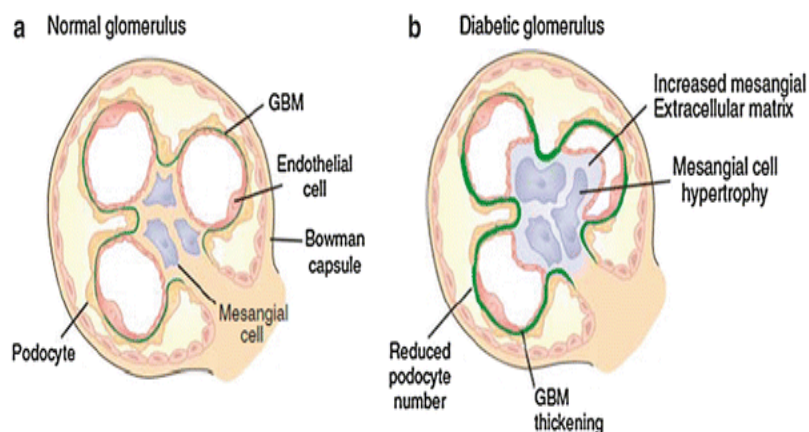


Figure 3. Characteristic glomerular changes of diabetic nephropathy. (Image Courtesy: [6])

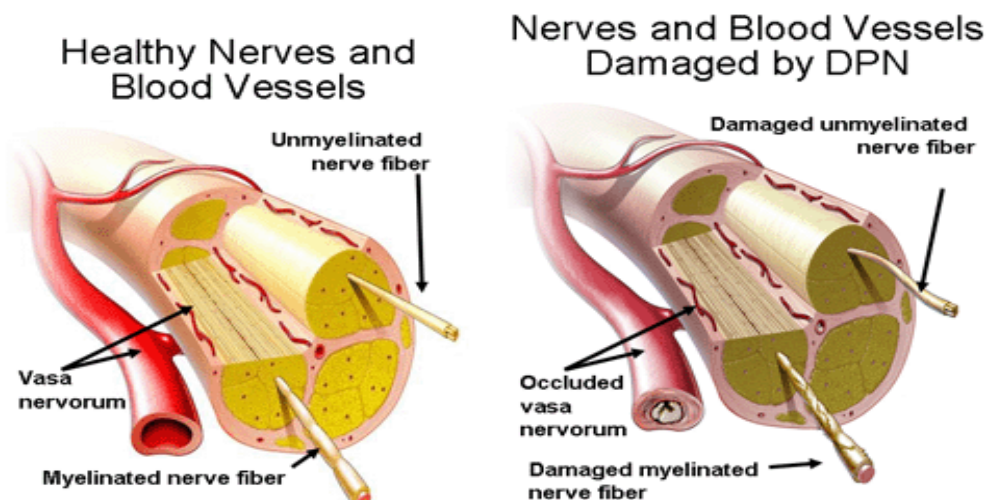


Figure 4. Diabetic neuropathy characteristics. (Image Courtesy: [7])

4.2 Implementation of Algorithms

The image enhancement and segmentation algorithms for which implementations are available will be considered for the purpose. The algorithms for which no implementation is available will be adopted as part of the project.

The preferred programming platform is **MATLAB** technical computing language (**R2010a**) using toolboxes image acquisition, image processing, fixed point and neural networks. Algorithms implemented on other platform such as medical imaging software **MIPAV**⁸.

4.3 Testing

The algorithms will be tested on the collected medical visual data base. Some algorithms may extract important features from extensive testing.

4.4 Analysis

Using the results of the tests, an assessment of the algorithm will be made. Therefore a statistical comparison and graphical representation between a normal group (DM) and abnormal group (DM with nephropathy and neuropathy) will be tabulated for each algorithm. The results will be compared with the clinical characteristics for a certain period of time taking the help of medical community. Any relative strengths or weaknesses of algorithms should be found. The concepts in the algorithms will be assessed for relevance based on the quality of the

algorithms with reference to considered problem/ application.

4.5 Modified Algorithm

Based on the analysis, one or more improvements to existing recent Image enhancement and segmentation techniques may become apparent. If this occurs, a new algorithm will be devised which demonstrates the improvements.

4.6 Test Modified Algorithm

The improved algorithm will then be evaluated on the basis of the requirements.

4.7 Expected Outcome

- Survey and analysis of existing methods.
- Strengths and weaknesses of algorithm in comparison with each other.
- Finally the research project might result in the creation of a new algorithm that combines ideas from the existing image processing techniques.

5. Results

Figure 5 shows an image obtained using the image acquisition protocol developed in this study. The background is homogeneous, and only the plantar foot surface appears



Figure 5. Thermal image of foot.

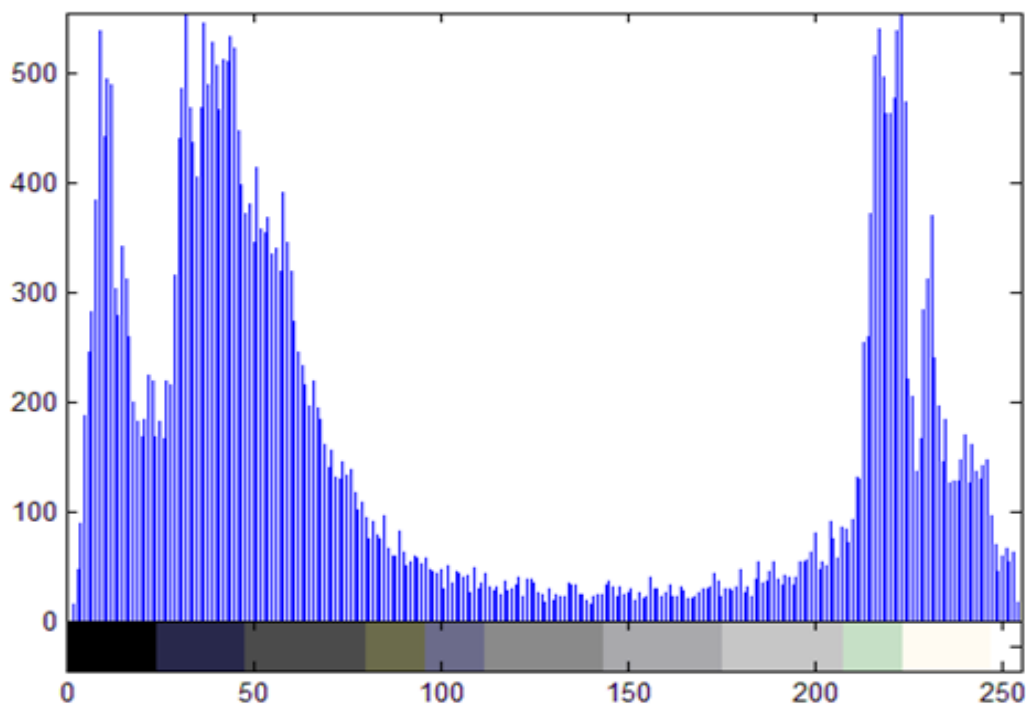


Figure 6. Histogram of the image in Figure 5.

as a homogeneous white region. However, the edges of the image are not very sharp. To confirm this analysis, Figure 6 is the histogram of the image in Figure 5. The grey levels on the x-axis vary from 0 to 255. 0 corresponds to a temperature of 21.2 °C while 255 to 33.5°C.

This histogram is bimodal as expected. The background is homogeneous in the range 22 to 25°C. The plantar foot surface temperature is in the range 30 to 33°C. There are a large number of pixels between these two main modes difficult to classify. The segmentation method should take this into consideration⁹.

5.1 Image Processing for Thermal Foot Images

The input image of the image processing method is a planar thermal foot image as that of Figure 6. It is an image of 600×600 pixels. Indeed, from the 100×100 pixels image of the FLIR i5 sensor, an interpolation is performed into the camera to provide this 600×600 pixels image. In the

image, there is also a temperature bar on the right indicating the maximal and minimal temperature in the image.

The image processing will be composed of several steps:

- Pre-processing to remove the labels and separate the two feet,
- Segmentation of the feet.

5.2 Pre-Processing

Labels are first discarded. This operation is simple since their positions and shapes are known. Following this operation, the minimum of the valley observed in the radon transform in the vertical direction is found. It is used to split the image in two sub-images shown in Figure 7. The next step is to calculate the mirror image of left foot image shown in Figure 8. It is the preparation of the segmentation and registration steps which results in Figure 9 and Figure 10.

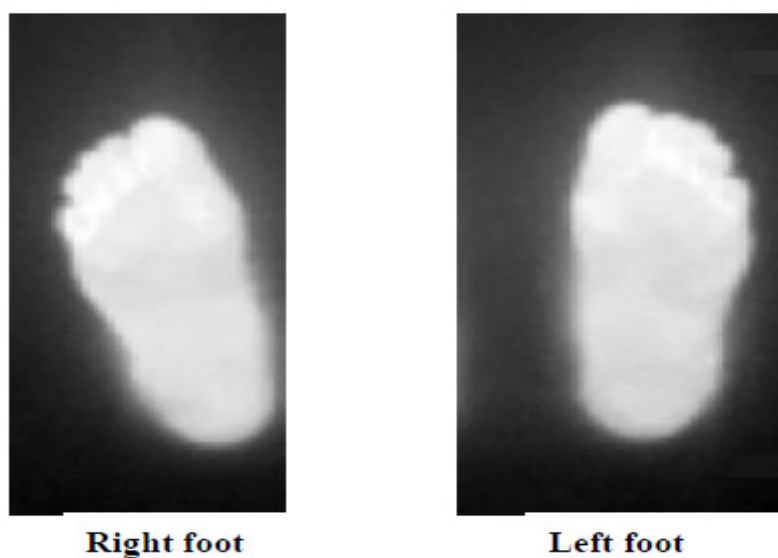


Figure 7. Radon transform in the vertical direction and sub-images of the right and left feet.

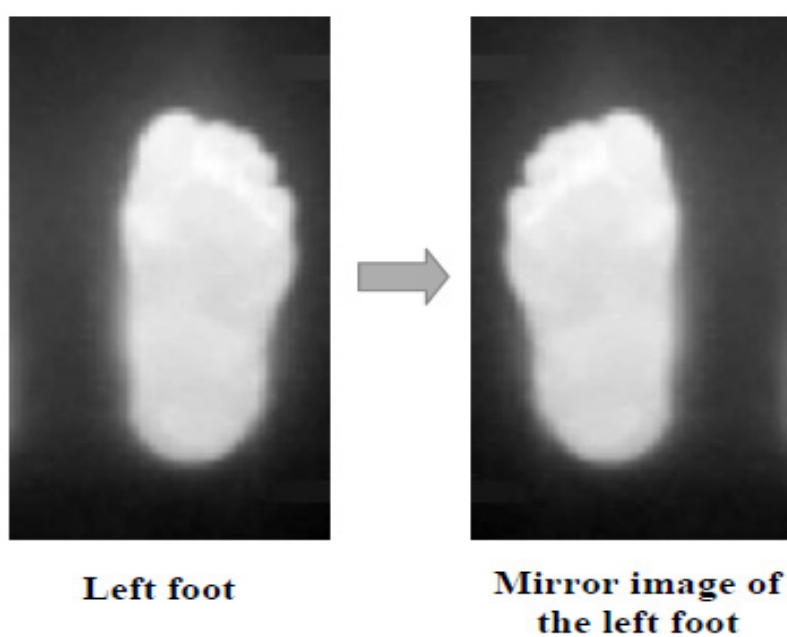


Figure 8. Mirror image of the left foot.

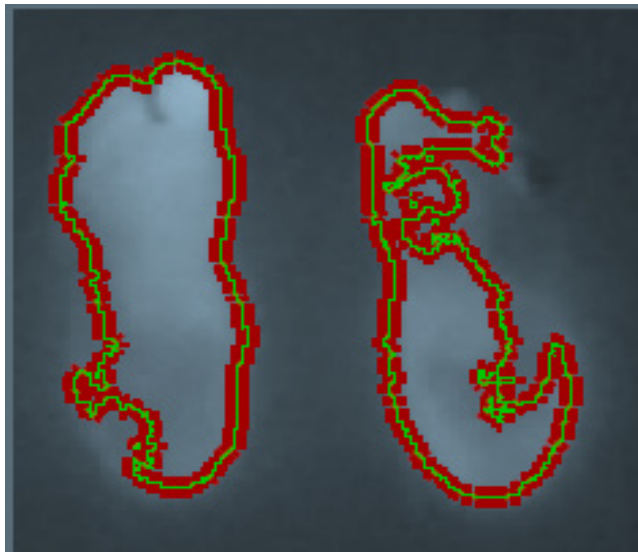


Figure 9. Automatic segmented image.

6. Conclusion

The analysis to be carried out on the simulation results using novel image processing methods will be useful even to educate common man and easy perception of about what might be the consequences one has to face if Diabetes Mellitus is not considered as a problem to be taken care off within right time. The methods concerned here are more improved with respect present invasive methods as proposed work involves sophisticated non-invasive methods to detect the abnormalities.

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Figure 10. Global region based segmentation.

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