International Journal of Advances in Engineering and Management (IJAEM)
Volume 2, Issue 10, pp: 393-399 www.ijaem.net ISSN: 2395-5252

Premature Diagnosis of Foot Ulcer in Diabetic Patients

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Date of Submission: 20-11-2020 Date of Acceptance: 10-12-2020

ABSTRACT: Assessment of a diabetic wound is very much important to determine the healing status. Foot ulcer is most commonly observed problem of diabetic patients. A diabetic wound is observed for approximately 15 per cent of diabetic patients. Diabetic wound is a major concern of diabetes mellitus. The foot ulcer is the very much harm full problem related to diabetes mellitus. Here K means clustering is used for segmentation of diabetic wounds and classifying into three types of tissues i.e. granulation, necrotic and slough. After the segmentation the color and shape features are extracted. All these features were then fed to the classifier, K-nearest neighbour for classifying the tissue types. The experimental results showed that the classification accuracy, sensitivity, specificity respectively. Hence the K means clustering with KNN classifier could be used for the effective segmentation and classification of diabetic wound images.

Index terms: Accuracy, Sensitivity, KNN classifier, Segmentation.

I. INTRODUCTION

An image is defined as a two-dimensional function f(x,y), where x and y are spatial coordinates, and the amplitude of F at any pair of coordinates (x,y) is called the intensity of that image at that point. When x,y and amplitude values of F are finite, we call it as digital image. In other words, an image can be defined by a two-dimensional array specifically arranged in rows and columns. Digital Image is composed of a finite number of elements, each of which elements have a particular value at a particular location. These elements are referred to as picture elements, image elements, and pixels. A Pixel is most widely used to denote the elements of a digital Image.

1.1 Types of an Image

1.1.1 Binary image

The binary image as its name suggests, contain only two pixel elements i.e 0 & 1, where 0 refers to black and 1 refers to white. This image is also known as Monochrome.

1.1.2 Black and white image

The image which consists of only black and white color

1.1.3 8 Bit color format

It is the most famous image format. It has 256 different shades of colors in it and commonly known as Grayscale Image. In this format, 0 stands for black, and 255 stands for white, and 127 stands for gray.

1.1.4 16 bit color format

It is a color image format. It has 65,536 different colors in it. It is also known as high color format. In this format the distribution of color is not as same as grayscale image. A 16 bit format is actually divided into three further formats which are Red, Green and Blue.

1.2 Digital Image Processing

Digital Image Processing means processing digital image by means of a digital computer. We can also say that it is a use of computer algorithms, in order to get enhanced image either to extract some useful information.Image processing mainly include the following steps:

- Importing the image via image acquisition tools.
- Analyzing and manipulating the image.
- Output in which result can be altered image or a report which is based on analyzing that image.

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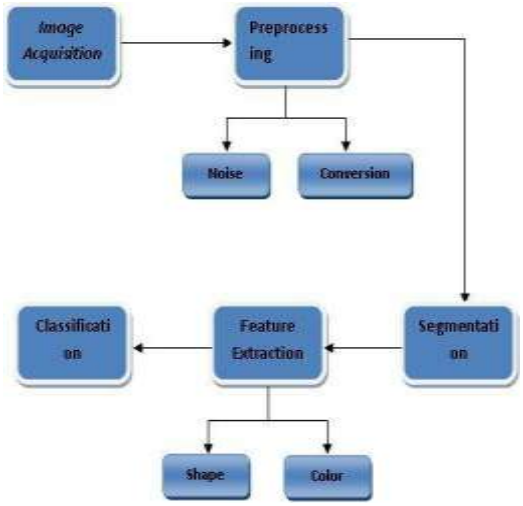
BLOCK DIAGRAM



1.3 Phases of Image Processing

1.3.1 Image Acquisition:

It is defined as the action of retrieving an image from some source, usually a hardware-based source for processing. It is the first step in the workflow sequence because, without an image, no processing is possible.Unsourced material may be challenged and removed. Image acquisition is the creation of a digitally encoded representation of the visual characteristics of an object, such as a physical scene or the interior structure of an object.

1.3.2 Preprocessing:

Pre-processing is an important step for used in foot ulcer, orientation, label, artifact removal, enhancement and segmentations. The preprocessing involved in noise removal. Noise filtration is an important step in processing foot ulcer for CAD techniques. In our work, we propose median filter for noise suppression and smoothing.

1.3.2.1 Median Filter:

The median filter performs spatial processing to determine which pixels in an image have been affected by salt and pepper noise. The median filter classifies pixels as noise by comparing each pixel in the image to its surrounding neighbor pixels.

1.3.3 Segmentation:

After the preprocessing of foot ulcer, go to color conversion for increase the efficiency of segmentation result. Then K-means clustering is preformed for segmentation.

K -means clustering algorithm is an unsupervised algorithm and it is used to segment the interest area from the background. Subtractive clustering method is data clustering method where it generates the centroid based on the potential value of the data points. So subtractive cluster is used to generate the initial centers and these centers are used in k-means algorithm for the segmentation of image.

After the initial segmentation, thresholding and morphological operation are used for enhance the segmentation result.

1.4 Diabetes:

Diabetes mellitus (DM), or simply, diabetes, is a group of diseases characterized by high blood glucose levels that result from defects in the body's ability to produce and/or use insulin. Diabetes is a disorder of metabolism, the way the body uses digested food for growth and energy. Most of the food that people eat is broken down into glucose, the form of sugar in the blood. Glucose is the main source of fuel for the body. After digestion, glucose passes into the bloodstream, where it is used by cells for growth and energy. For glucose to get into cells, insulin must be present. Insulin is a hormone produced by the pancreas, a large gland behind the stomach. When people eat, the pancreas automatically produces the right amount of insulin to move glucose from blood into the cells. In people with diabetes, however, the pancreas either produces little or no insulin, or the cells do not respond appropriately to the insulin that is produced. Glucose builds up in the blood, overflows into the urine, and passes out of the body in the urine. Thus, the body loses its main source of fuel even though the blood contains large amounts of glucose (hyperglycemia). The normal blood glucose considers the range (70 – 120 mg/dl); it is named normoglycemia.

1.4.1 Diabetic foot:

In many cases, development of diabetic foot disorders can be avoided or substantially delayed with adequate treatments that are provided at an early stage. It points out the importance of an early diagnosis of diabetic foot done by specialized medical doctors in hospitals. In diabetic foot, diabetes treatments are associated with therapeutic footwear, diabetic foot education, and regular foot care. However, the incidence of serious complications, i.e. the occurrence of an ulcer, could further be reduced according to diabetes experts. Most of the research concerning diabetic foot follows these two main directions:

- Improve the early diagnosis of diabetic foot in hospitals,
- Reduce ulcers occurrence and related amputation in diabetic foot.

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1.4.2 Diabetic foot examination

All people with diabetes should be examined at least once a year by a specialized medical doctor in a hospital for potential foot problems. Patients with demonstrated risk factor(s) should be examined more often – every 1–6 months. The absence of symptoms does not mean that the feet are healthy; the patient might have neuropathy, peripheral vascular disease, or even an ulcer without any complain. The patient's feet should be examined with the patient lying down and standing up, and their shoes and socks should also be inspected.

1.4.3 Diagnosis of diabetic foot

From this analysis, a by-risk classification is given by the medical doctor. The risk here means the risk of developing a foot ulcer. The classification used is the following:

- Grade 0: no neuropathy, no ischemia, possible foot deformations independent of
- the diabetes,
- Grade 1: small neuropathy defined as the absence of sensation at least one point of the points at risk of the feet,
- Grade 2: neuropathy + foot deformation and/or ischemia defined as the absence of 2 pedal pulses,
- Grade 3: previous amputations or ulcers that lasted more than 3 months.

A grade 0 means that the patient has no diabetic foot. Any other grade number means diabetic foot patient.

1.5 Diabetic foot ulcer examination

Foot ulcer wounds are open area on the skin that did not treat successfully with typical and ordinary healing process to properly repair the injured site, generally remaining unhealed for 8 weeks or more than this. Furthermore, the healing of the ulcer wound may be delayed if appropriate treatment is not given based on accurate diagnosis. Also leg ulcer probably co-exists with vascular insufficiency in which there is improper blood supply to the veins going towards the leg. Because of that, possibility for the gangrene and death related to the gangrene.

Unfortunately in India excessive peoples are subjected to having diabetes. As per the International Diabetes Federation, possibility of the people who will be affected by diabetes will be 69.9 million by 2025. So it is necessary to monitor injured area of foot and restraint wound by identifying and relieving the foot ulcer. Within the affected wound area, three types of tissues are found. These tissues are granulation red tissue that is new tissue, unequal concoction of slough that is yellow fibrin material and black necrotic that is dead tissues. These tissues play a primary role in understanding the healing progress of ulcer patient. However, during wound tissue identification, clinicians have a problem of determining proportion of these tissues within wound region due to color inexactness. Regular examination of wound completely depends on clinician's manual examination which depends on measurement methods like ruler-based technique, transparency tracing, alginate casts and other. Also, recognition of the category and percentage of tissues left highly arguable as recognition is done according to the visual inspection and then it is plotted on a red-black-yellow scale respectively, to the ascendant color of the dissimilar tissues visible on a wound that is, granulation, slough and necrotic. These ordinary processes are very often inaccurate since such evaluation depends on his/her clinical experience and causes extreme discomfort to the patients. These procedures are time consuming and expert vision oriented. Result is not in a consistent format and can constitute clinical overload. So to design an efficient, accurate and quick wound recognition scheme, wound tissue classification is required, so that the proportion of tissues can be quantitatively analyzed time to time for healing score assessment during the treatment.

II. PROPOSED SYSTEM

2.1 K-Means Clustering:

K-means clustering is a type of unsupervised learning, which is used when you have unlabeled data (i.e., data without defined categories or groups). The goal of this algorithm is to find groups in the data, with the number of groups represented by the variable K. The algorithm works iteratively to assign each data point to one of K groups based on the features that are provided. Data points are clustered based on feature similarity. The results of the K-means clustering algorithm are:

1. The centroids of the K clusters, which can be used to label new data
2. Labels for the training data (each data point is assigned to a single cluster)

Rather than defining groups before looking at the data, clustering allows you to find and analyze the groups that have formed organically. The "Choosing K" section below describes how the number of groups can be determined.

Each centroid of a cluster is a collection of feature values which define the resulting groups. Examining the centroid feature weights can be used

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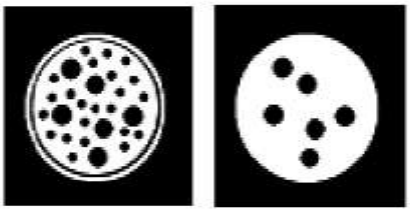
to qualitatively interpret what kind of group each cluster represents.

2.2 Classifier:

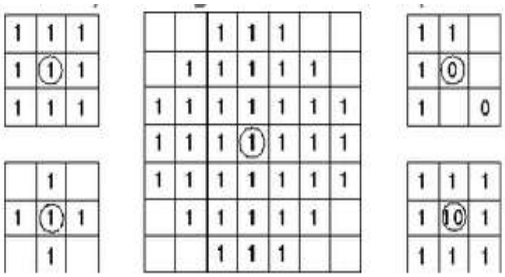
Classifier methods are also known as supervised methods. This method is pattern recognition techniques that separation a characteristic space derived from the image by using data with known labels. A trouble-free classifier is the nearest-neighbor classifier, in which each pixel is classified in the similar class as the training datum with the closest intensity. The k-nearest-neighbor classifier is a simplification of this approach. The k-nearest-neighbor classifier is well thought-out a nonparametric classifier for the reason that it makes no underlying hypothesis about the statistical structure.After that feature extraction such as color and shape features are extracted from segmented image.

2.3 Morpological Operation

Segmentation or contouring could be also obtained using morphological operations. Segmentation subdivides an image into its constituent regions or objects. The level to which the subdivision is carried depends on the problem being solved. That is, segmentation should stop when the objects of interest in an application have been isolated. For example, in the automated inspection of electronic assemblies, interest lies in analyzing images of the products with the objective of determining the presence or absence of specific anomalies, such as missing components or broken connection paths. There is no point in carrying segmentation past the level of detail required to identify those elements.



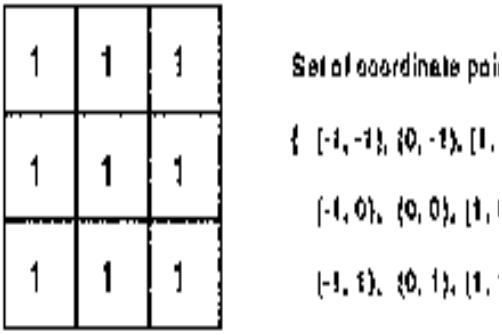
2.3.1 Structuring Element: The structuring element consists of a pattern specified as the coordinates of a number of discrete points relative to some origin.
The origin is marked by a ring around that point.



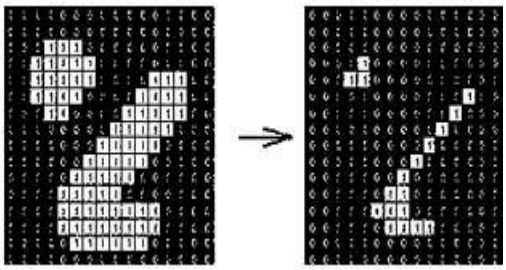
2.3.2 Erosion:
Erosion of A by B is defined as:

$$A \ominus B = \{ x | (B)_x \subseteq A \}$$

where A is the image and B is the structural element.
One simple application is eliminating irrelevant detail from a binary image.



Structuring element



Erosion

2.3.3Dilation:
Dilation of A by B is defined as:

$$A \oplus B = \{ x | (B')_x \cap A \neq \varnothing \}$$

Where B is the structural element and A is the image.
Dilation has the effect of increasing the size of an object.

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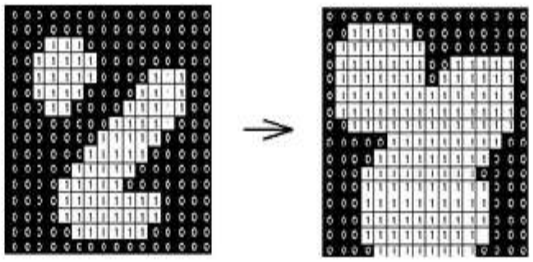


Dilation

2.3.4 Performance Analysis for proposed method:

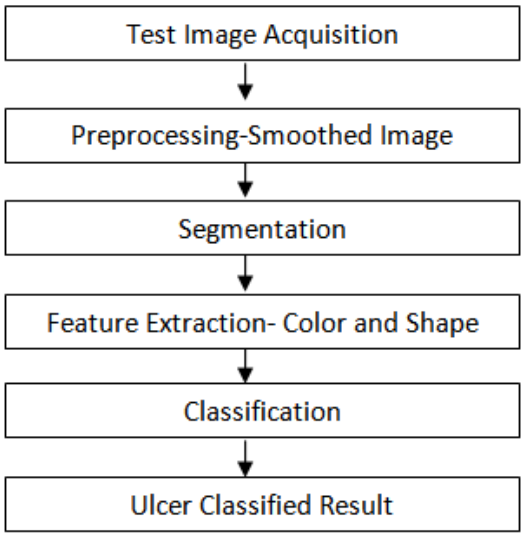
	Proposed method
Accuracy	95 %
Sensitivity	90 %
Specificity	100 %
Execution Time	31.77 s

III SYSTEM DESIGN

3.1 DATA FLOW DIAGRAM:

The DFD is also called as bubble chart. It is a simple graphical formalism that can be used to represent a system in terms of input data to the system, various processing carried out on this data, and the output data is generated by this system.

1. The data flow diagram (DFD) is one of the most important modeling tools. It is used to model the system components. These components are the system process, the data used by the process, an external entity that interacts with the system and the information flows in the system.
2. DFD shows how the information moves through the system and how it is modified by a series of transformations. It is a graphical technique that depicts information flow and the transformations that are applied as data moves from input to output.
3. DFD is also known as bubble chart. A DFD may be used to represent a system at any level of abstraction. DFD may be partitioned into levels that represent increasing information flow and functional detail.



3.2 ADVANTAGES OF PROPOSED SYSTEM:

- The rate accuracy is high.
- The computational time is less.

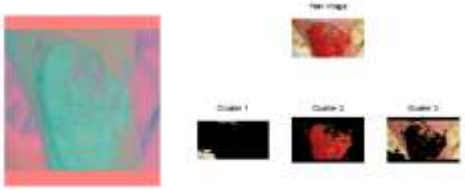
IV RESULT AND OUTPUT

FIGURE 1.1: STEP BY STEP PROCESS GRANULATION TISSUE

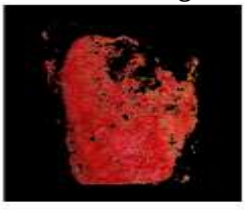
Test image Noise image Filtered image

Lab colour space

Segmented image



Segmented image using k means clustering



Final Segmented image

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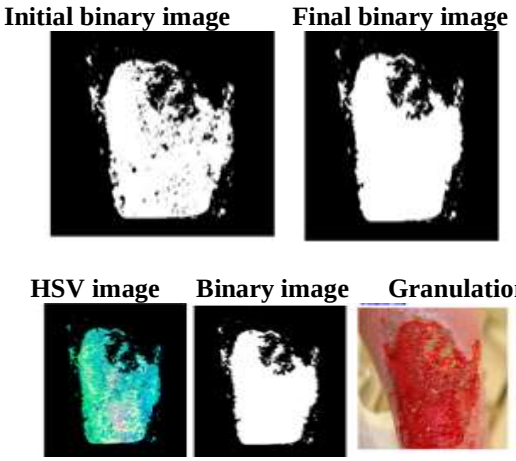


FIGURE1.2: GRANULATION IMAGE GRAPH

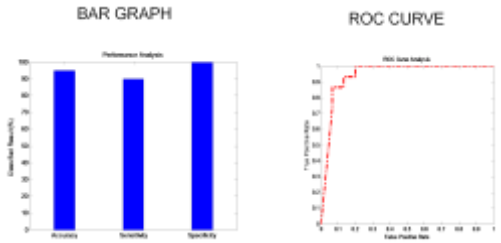


FIGURE 2.1: STEP BY STEP PROCESS NECROTIC TISSUE

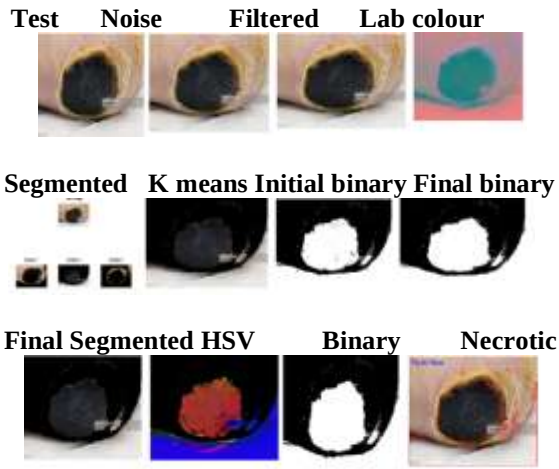


FIGURE 2.2: NECROTIC IMAGE GRAPH

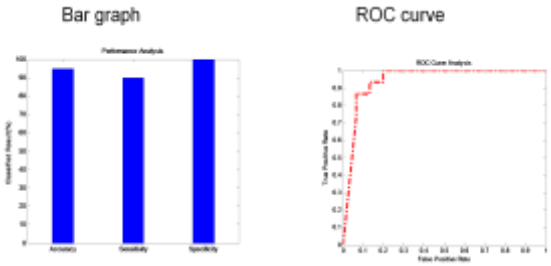
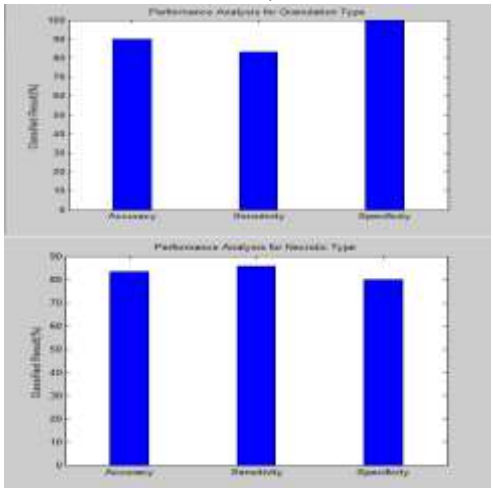


FIGURE 3.1: FINAL BAR GRAPH FOR GRANULATION, NECROTIC



CONCLUSION

In our paper, automated foot ulcer type classification is proposed using the features of shape and color. At first, the input image is preprocessed using the median filter. Furthermore, segmentation and feature extraction are performed from preprocessed image. Segmentation is done by using K-means clustering. The extracted features are classified corresponding to the category using the K-nearest neighbour. The performance analysis shows that the proposed system offers higher accuracy than the existing technique. The proposed KNN method is faster in classifying the types of the ulcers in foot.

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