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Foot-ulcer Wound Analysis Using Image Segmentation and Morphological Operations

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ABSTRACT

Diabetic Foot Ulcer (DFT) is a problem worldwide and prevention is crucial. We hypothesized that the inability of the skin to respond to skin is involved in DFU pathogenesis and could be an important predictive factor to take into account. The images are an important tool for analyzing foot ulcer. Normally foot ulcer means the underlying skin of the foot will be broken down and you will see the tissue over that damaged area due to diabetics. The would should heal in normal condition due to diabetics the healing process will take place slowly so it is difficult to identify whether the ulcer is healing or not. Here, as a solution image analysis algorithm can be used to find the depth of the wound and it run's using a MATLAB software. The image is an important tool for analysis. Here, as a solution image analysis algorithm can be designed and run using MATLAB software, and thus provide a handy, low cost and easy to use method for self- management of foot ulcers for patients with diabetes. The image processing algorithms are designed for both simple and accurate for patients to use it easier as possible with no complications.

Keywords Machine learning, foot ulcer image, foot pressure ulceration, MATLAB software.

Introduction

The Pedobarography is fundamental gait analysis and for diagnosis and research of a number of neurological and musculoskeletal diseases, such as peripheral neuropathy or parkinson. There are several problems with current practices for treaty DFU. A team work of orthopedic surgeon, endocrinologist, infections disease physician and a trained nurse in dressing is necessary for the wound. It is also advisable to add a podiatrist to the team if one is available. In current practice, medical experts primarily examine and assess the DFU patients on visual inspection with manual measurement tools to determine the severity of DFU. They also use the high resolution images to evaluate the state of DFU, which can further comprise of various important tasks in early diagnosis for DFU management and taking action to treatment by keep tracking for each particular case,

1) The medical history of patient is evaluated.

2) A wound or DFU specialist examines the DFU thoroughly.

3) Additional tests like CT scans, MRI, X-ray may be useful to develop a treatment plan.

Usually, the DFU have irregular structures and uncertain outer boundaries. The appearance of DFU and its surrounding skin varies depending upon the various stages i.e., redness, callus formation, blusters, significant tissues types like granulation, slough, bleeding, scaly skin. The skin surrounding the DFU is very important as its condition determines, if the DFU is healing and is also a vulnerable area for extension. There are many factors that

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increase the risk of vulnerable skin such as ischemia, inflammation, abnormal pressure, maceration, from exudates etc.

A recent survey of home healthcare agencies included a wound photograph as part of documentation procedures. Additionally, numerical publications that describe how to perform a wound evaluation advocate the use of wound photographs to capture wound status. Using wound photographs has some major advantage including the fact that photographs do not require that the provider come into contact with the wound. Photographs also identify the physical dimensions of the ulcer as well as type of tissue present within the wound bed. And the image processing provided that the processing algorithms are designed both simple and accurate for the patients to use as easy with no complications. Wound image analysis is implemented by using a proposed system which consists of the mean shift algorithm, wound boundary determination method and colour segmentation method to detect the wound healing status. When the skin color is not uniform enough it gives false edges and missing boundaries. So, in order to solve these issues a better method is required like adaptive mean – shift segmentation algorithm.

Literature Review

Implementation of modified chan vase algorithm to detect and analyze diabetic foot ulcers. The temperature variations in the feet cause diabetic foot ulcers. It includes neuropathy, peripheral arterial diseases, and infections. The temperature variation in foot plantar should not be less than 4 degree celcius. The importance of diabetic foot ulcer is an early detection and diagnosis, treated by specialized doctors in the hospitals. The temperature differences in the feet should not be more than 1 degree celcius, which were concerned to be in most of the research.

The goal is to reduce the rate of amputations as maximum as possible by several organizations and countries, such as WHO and the International Diabetic Federation. The diabetic foot disease are present in more than 15% of people who has type-2 DM. The infection, neuropathy, peripheral arterial disease may be the result of diabetic foot problems. The primary cause of neuropathy results by abnormal walking pattern such as walking barefoot. This leads to a chronic ulcer, abnormalities of sensation less and foot deformities.

The X-ray and CT scanning techniques are the existing methods related to DFU, in which there is no technology based on temperature difference. The scanning methods are old fashioned, therefore in some cases these techniques may result in unreliable analysis of foot.

The risk identification in the abnormal neuropathy of diabetic patients, leads reduced sweating and skin abnormality conditions including fissures, an hydrolysis and blisters. The correlation of the mean skin temperature with autonomic dysfunction, as detected by cardiovascular reflex tests. The study of characteristics were taken by trials for 18 month and 225 diabetic persons are at high- risk for the effect of ulcer, who contains either a history of DFU or loss of protective sensation, due to deformation of foot structure. If the difference in temperature is more than 4 degree F, between the right and left corresponding places, then it is intimated to patients.

Image Segmentation Techniques:

It is the process of partitioning a digital image into multiple segments. The goal of segmentation is to simplify and to change the representation of an image into something that is more meaningful and easier to analyze. Image segmentation is typically used to locate objects and boundaries in images. More precisely, image segmentation is the process of assigning a label to every pixel in an image such that pixels with the same label share certain characteristics. Each of the pixels in a region are similar with respect to some characteristics or computed property, such as color, intensity, or texture. When applied to the stack of images, typical in medical imaging, the resulting contours after image segmentation can be used to create 3D reconstructions.

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Mean shift Segmentation

In the mean shift segmentation algorithm, the wound image is processed under different steps such as pre-processing, RGB to gray conversion, segmentation, k- means clustering algorithm, boundary line detection and healing status. The healing status depends on blue, yellow, green color model. The image is collected and reduced to memory usage, then pre-processing is done to reduce noise. The k-means and mean shift segmentation algorithm are used and boundary line is detected and healing status is provided. The color conversion process is carried out and the next step, segmentation is done. It is a process of sub dividing the original image into pixel group, with color values. Wound boundary determination is done depending on the outline detection result. White area is marked as inner area and black area as outer area.

K-Means Clustering Algorithm

K-means clustering is a method of vector quantization from signal processing, popular for cluster analysis in data mining. This partitions observations into k clusters, where each observation belongs to a cluster with nearest mean, serving as prototype. One can apply the nearest neighbor classifier on the cluster centers obtained by k-means. Here mean shift algorithm is applied for color image for better resolution. The algorithm can be made adjustable by changing resolution parameters. For implementing in parallel mean shift

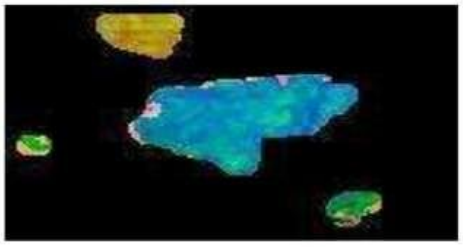
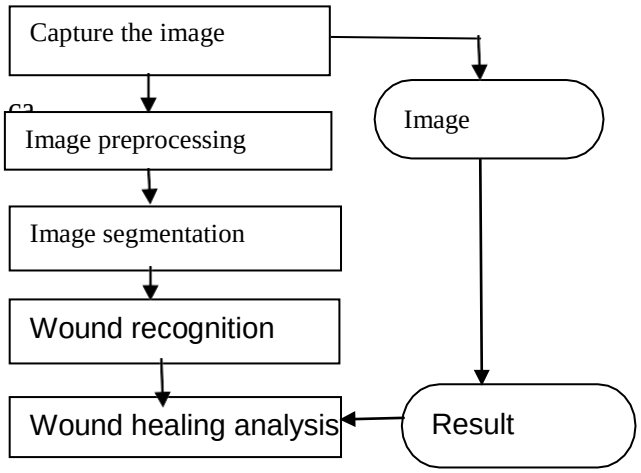


Fig 1 K-means 2 stage of Foot image

algorithm is used. If analyzing the image features such as color space, spatial color or combination of two spaces. This is mainly used for color images to segment the original image into homogeneous regions with same color features. However, the disadvantage is, the foot wound image contains irrelevant background information and sole is the same color feature. The algorithm is compared with normal skin color vector from color checker. In the event that the wound detection was not correct, the side bar will display to allow the algorithm's sensitivity adjustment.

Flow chart



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In the medical imaging field, the role of diagnosis is of primary concern, where it predicts brain and pancreatic tumors and effects caused by diseases. By using of CT and MRI scan, the radiologists analyze the body conditions of the patients[7]. The unusual growth of brain cells are the main cause of brain tumor. The brain cells are injured because of tumors, due to applying pressure on certain parts of the brain.

Decision Based Couple Window Median Filter

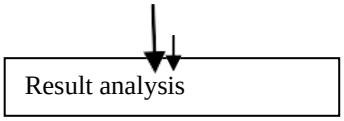
The DBCWMF(Decision Based Couple Window Median Filter) is for preprocessing and it decreases a distortion in the image which occur through blurring, caused by filtering, noisy and sometimes noise-free pixels.[4]

Image segmentation is used in extracting suspicious region from the image. The SRM(Statistical Region Merging) is a color segmentation method that depends on region merging and growing. The benefits of this method including its reduced complexity, computational efficiency and exceptional performances by using color space transformation. BPNN (Back Propagation Neural Network) is a supervised algorithm in which error is minimized by adjusting the weights through the back propagation of error.[2]

The Edge-based approach, Region-based approach and Bound approach are the three kinds of approaches for segmentation. A similarity criterion with different comparable pixels is clustered collectively to form groups. The hard clustering(K-means clustering), fuzzy clustering is the categorization of clustering methods.

In this PGDBCWMF algorithm, the boisterous pixels are changed along with the proposed median filter, selected by the window median filter. By the use of this median filter the main role of pixel processing is extracted $3/4^{th}$ or more noisy pixels are converted into noise-free pixels[6].

The SRM algorithm depends on image generation models which belong to the family of region merging and growing techniques, combining with geometrical tests in choosing and merging of regions[8].



Adaptive K-Means algorithm

K-means algorithm is most classical partition-based clustering method and it is classical data mining algorithms. It is very fast implementation of clustering an image without knowing number of clusters. The basic idea of K-means algorithm is to cluster the object closest to by clustering the K points in the space. The adaptive K-means clustering algorithm starts with the selection of K elements from the input dataset. These K elements

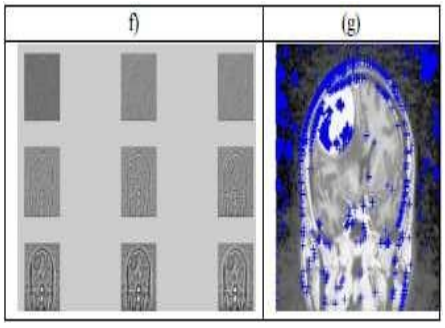


Fig 2 Adaptive segmentation of Foot image

form the seeds of clusters and are randomly selected. The adjustment rules of iterative operation to obtained by finding extreme values of functions. This function is also applied to compute distance between two elements. The

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error square sum criterion function is used as a clustering criterion function. In many cases, it is unknown in advance how many categories the given data set divided into more cases, the Euclidean distance may be sufficient is to find the optimal classification of an initial cluster. For example, the case of spectral data given by „n" dimensions, the

distance between two elements E1 and E2,

(E11 – E12)2 + (E12 – E22)2+(E1n – E2n)2 Where E1= {E11, E12, …., E1n} and E2= {E21, E22, ……, E2n}. …… 1

This method is used in this paper image of the foot ulcer that may taken by the patient and the image can be processed and pre-processed by the image segmentation technique. This segmentation technique can be used by some other morphological operation that may be used in this process.

Morphological Operations:

In this operation we take the segmented image of foot ulcer. The output of the segmented image are not cleared in this method must need the accurate image of the foot ulcer. By using various function to know the accurate result of morphological foot ulcer image. In the segmented image having the opening and closing, finally the output must be in closed operation that have some holes in image by using hole filling technique get the image clear. To remove the

Fig 3 Morphological feature of the foot image

The image capture process is captured analyzed by the wound image by using smart phone that stored in JPEG file. The image is compressed with binary image. The image preprocessing process is captured by wound image in order to remove the noise by using Gaussian filter. The wound detection process is detected by the wound in outline.

1. The distance element and clusteris0, assign the element of cluster, begin working with next element.
2. The distance between element and cluster is less than the distance, assign this element to its nearest cluster. In addition, the distance is affected cluster from every other cluster, as well as minimum distance between any two cluster is closest to each other.
3. The distance between all clusters is recomputed and two closest cluster identified over again.

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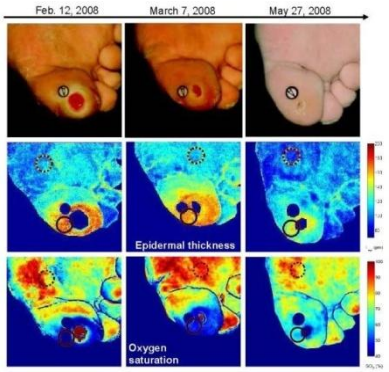

Fig 4 Gaussian filtered images at 9 stages of filtering

Discussions

Wound image analysis classifier has been implemented by MATLAB. This can be classified as the wound by considering healing status and consider various colours by identifying the formation of wound and various stages undergoes by healing process. And we collected the 500+ images to implemented in MATLAB. Collected images in various size and various colour to identify the healing process of wound. Then the result of the processed images stored in the database. And then identify the depth of the wound in foot and get the step by step result of the healing process of wound.

Millions of engineers and scientists worldwide use MATLAB to analyse and design the systems and products transforming our world. MATLAB language is the world most natural way to express computational mathematics. MATLAB helps to take our ideas beyond the desktop. We can run our analyses on larger data sets, and scale up to clusters and clouds. The matrix-based MATLAB language is the world most natural way to express computational mathematics. MATLAB code can be integrated with other languages, enabling us to deploy algorithms and applications within web, enterprise, and production system. Although MATLAB is intended primarily for numerical computing, an optional toolbox uses the symbolic computing abilities.

Conclusion

We have implemented a new wound assessment system for patients. We used a sequence of steps in detection of foot ulcer namely, preprocessing, filtering and color conversion followed by image segmentation using partial differential equation segmentation algorithm.The feature is extracted using GLCM algorithm and the image is sent for image classification using Recurrent Neural Network. Moreover, the results of this foot ulcer detection system with more set of leg ulcer wound images and the exploration of the performance of different segmentation and classification algorithms based on color, textural and statistical features.

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The foot ulcer images are taken through online data warehouses and do not have any conflict of interest with any third party agencies.

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