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# Wound Assessment System for Foot Ulcer Patient with Diabetes Identification based on Smartphone

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***Abstract*— Now a day's 'n' no. of peoples in India are suffering with diabetics; Taking care of such peoples will be a critical task and diabetic foot ulcers give a significant health issue. Currently, treatment to such critical cases are being given by wound assessment on visual examination of wound and healing status; In our proposed system patients will have an opportunity to play an active role, user can capture the wound image and can send to the physician; Therefore this will become more quantitative and cost effective solution which saves travelling cost and reduce healthcare expenses and important time. As we are living in technological era where smartphones are part of our day to day life; these devices are equipped with high resolution digital camera, quality of wounds by analyzing images of foot ulcers is an attractive Option. In this proposed system, wound image analyses will takes place with Android enabled smartphone. The image of wound will be captured by the camera, after which using mean shift Algorithm wound segmentation is performed. Physician can easily analyze the actual problem through image segmentation. This technique will be beneficial to patients with diabetes for self-management. Specifically, the processing algorithm of Mean Shift Algorithm, Wound Boundary Detection & K-mean Algorithm will be applied. Moreover, quantitatively the healing status assessed, based on trend examination of time records for a given patient.**

***Keywords*— Wound Analysis, Mean shift, Boundary detection, K-mean, Android based Smartphone, Images of patient with diabetes.**

## I. INTRODUCTION

There are several problems with current uses for treating diabetic foot ulcers. First, patients must go to their clinic on a daily basis to have their wounds checked by their physicians. This need for frequent clinical evaluation is inconvenient and time consuming for patients and physician, but also represents significantly health care cost because patients may require special transportation, for example ambulances. Second, a clinician's wound analyses process is based on visual examination [1]. Technology employing image analysis techniques is a probable solution to both these problems. Several task have been made to use image processing method for such tasks, including the measurement of wound area, or rather than use a volume instrument system (MAVIS) or a medical digital photogrammetric system (MEDPHOS)[1].

These instruments suffer from several demerits including high cost, complexity, and less tissue classification .To better determine the boundary of wound and classify wound tissues, researchers have applied wound image segmentation and supervised machine learning algorithm for wound image analysis[3]. He/she defines the wound by its physical dimensions and the color of its tissues, providing important symptoms of the wound type and the healing status. Because the visual assessment does not gives objective measurements and quantitable parameters of the healing stage, tracking a wounds healing process across repetitive visits is a difficult task for clinicians and patients also.

In existing system [1], wound image boundary detection was done with the particular implementation of level set algorithm, mainly distanced level set evolution algorithm [4]. The main drawback of this level set evolution algorithm is too intensive, it computationally depends on the initial curve of foot and false edges may interfere with the evolution when skin color is not unique. The wound image is captured with the help of Smartphone camera. After that, the wound segmentation is performed by applying the accelerated mean-shift algorithm [3]. Specifically, the foot outline is determined, and the wound boundary is found using connected boundary detection technique [1]. Diabetic wound assessment requires long-term, repeated measurements to ensure therapy effectiveness. As the 'n' number of patients requiring wound management increases, the time required to treats simple wound becomes insufficient for doctor. Current clinical approaches have limited accurateness for wound size measurements [5]. The mostly used smartphone containing a high- resolution camera, and then the captured image is sends to the host server. The server analyzes wound image surface area. After that the experimental results are presented and analyzed then provides an overall assessment reports are send to the client side [6]. .

Design a highly efficient and accurate algorithm for real-time wound assessment that is able to operate within the computational instances of the smartphone [3].

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## II. LITERATURE SURVEY

**"Smartphone Based Wound Assessment System for Patients with Diabetes"** (Lei Wang, Peder C. Pedersen, Diane M. Strong, Bengisu Tulu, Emmanuel Agu, and Ronald Ignotz) states that a structure that Design a highly efficient and precise algorithm for real- time wound analysis that is able to operate within the significant computational constraints of the smartphone. The model outcome shows that the algorithm helps get better probability with the help of wound image and healing status analysis. This paper proposed a system that helps customers automatically wound boundary has been completely determined and the wound area calculated. [1]

**"Enhanced assessment of the wound healing method by accurate multi-views tissue classification"** (Hazem Wannous, Yves Lucas and Sylvie Treuillet) This paper represent The quantitative assessment of wounds on visual examination and manual technique to describe the shape of the wound image parameter like surface, depth and the biological nature of the skin tissues Wound surface and shape are currently measured with an ordinary technique.[2]

**"A Survey on Wound Assessment System Patients of Foot Ulcer Diabetics Identification Based on Smartphone"** (Sadhana S. Jadhav1, Prof. Manisha M. Naoghare) this paper states that the overall structure of system and control flow of algorithm. This paper include the principal components of the solution that is Image processing, Image Segmentation, Foot outline detection, Color segmentation, Wound healing. [3]

## III. PROPOSED SYSTEM

In the proposed system level set algorithms replace with the efficient mean-shift based segmentation algorithm. We present the entire technique of recording and analyzing a wound image and the wound healing status using algorithms and provide evidence of the efficiency and significant accuracy of these algorithms for analyzing diabetic foot ulcers. According to wound Assessments technique functional module in which wound image capture. Image store in database, wound image preprocessing, wound boundary detection and analysis ,wound analysis by color segmentation by using different algorithm such as mean-shift based algorithm-mean algorithm ,convert all the color image to the gray scale image ,wound trend analysis based on the time sequence of infected surface for given patient.

These entire technique steps are carried out by sequentially. Image is captured through the high resolution camera of the Smartphone.

The JPEG file path of this wound image is add into wound image database. Compress image file cannot be processed directly with our image processing algorithm. In keeping with standard RGB color mode l24 bit bitmap file based on it to need for decompressed the compressed images.

This technique of image processing step, the actual image send by patient (pixel dimensions of 3264 X2248) that distributed by "4" vertical & horizontal direction to pixel dimension is .i.e816 X612 which has proven to produce a good between the wound resolution & significant preprocessing efficiency. When the foot region boundary is detect, then the foot boundary is not closed, at that time the problem becomes more complicated. In keeping with to mean shift algorithm wound image area are easily categorized such as color space, spatial space or combination of two spaces it depends to the density based non parametric clustering method in mean shift based segmentation. In this method in which feature space can be considered as represented as density parameter.

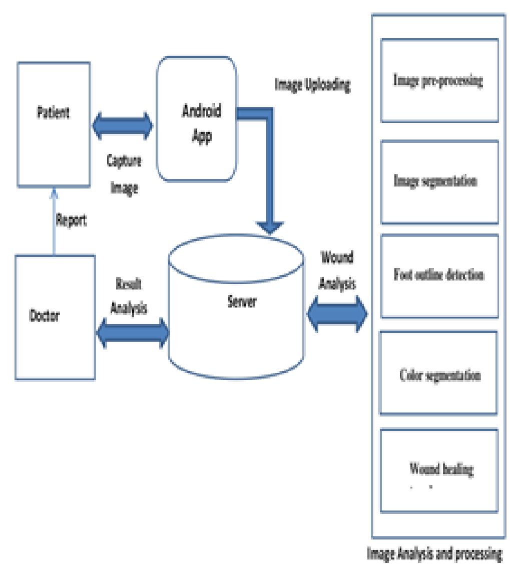


**Figure 3.1: System Architecture**

## IV. MODULES

### *4.1. Wound Image Analysis System*

In this technique, we carry out a ***Wound boundary detection*** based on the foot outline detection report.

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If the foot detection report is regarded as a binary image with the foot area detect as 'white' and remaining part mention as 'black,' it is easy to locate the wound image boundary within the foot region boundary by determining the largest attached black" component within the "white" part. If the wound is detected at the foot region boundary, if the foot boundary is not closed, so the problem

becomes more difficult, i.e., we must need to first form a closed boundary. When the boundary of has been completely determined and the wound area calculated, we next calculated the healing stage of the wound by performing ***Color segmentation***, with the goal of dividing each pixel in the wound boundary into assured classes labeled as granulation, slough and necrosis. The traditional self-organized clustering technique called K-mean with high efficiency is used. After the wound image color segmentation, a feature aim including the wound area size and dimensions for various types of wound tissues is formed to describe the wound significantly. This feature aim, along with both the original and analyzed images, is stored in the result database. The ***Wound healing trend analysis*** is depend on a time sequence of images belonging to a given patient to determine the wound healing status. The current report is obtained, comparing the wound feature vectors between the current wound report and the one that is just one standard time period earlier (typically one or two weeks). In another way, a longer term healing report is obtained by comparing the feature aim between the current wound and the base report which is the earliest record for this patient.

*4.2. Mean-Shift-Based Segmentation Algorithm*

In this technique we execute ***mean-shift-based segmentation***; the ***mean-shift algorithm*** depends to the density estimation based clustering technique, in which the feature space can be considered as the actual probability density function of the represented parameter. This type of algorithms adaptably analyzes the image feature space to cluster and can provide a efficient solution for many vision tasks.

*4.3. Wound Boundary Verification and Analysis*

In this technique we implement wound boundary verification, because the mean-shift algorithm only segment the original image into similar regions with similar color features, an object recognition technique is needed to interpret the segmentation record into a meaningful wound boundary detection that can be easily understand by the users of the wound image analysis system.

As noted, a standard recognition method depends on known model information to develop a theorem, based on which a decision is made whether a region should be observed as a candidate object, i.e., a wound. A verification stage is also required for further confirmation. Because our wound determination and analysis algorithm is designed for real time implementation on the smart phones with few computational resources, we simplified the object recognition method while ensure that recognition accuracy is acceptable.

## V. ALGORITHM

*Step 1:* The mean shift based algorithm models the feature vectors domains associated with the each pixel as instances from an unknown probability density vector (x) and then find clusters in this distribution as section. The center for each cluster form is known as mode. Given *n* data points are $x_i$ , i=1,…….,n in the d-dimensional space $R^d$ , the multivalued kernel value density estimator is shown as

$$f_{h,K}(x)=\frac{c_{k,d}}{nh^d}\sum_{i=1}^{n}k\left(\left\|\frac{x-x_i}{h}\right\|^2\right)$$

below,

Where *h* is a bandwidth instances and the a normalization function h>0 and $C_{k,d}$ is normalization constant vector. The function k(x) is the profile of the kernel defined as only for x>0.

*Step2:* for calculating the gradient of f(x) following formula is uses,

$$\nabla f(x)=\frac{2c_{k,d}}{nh^{d+2}}\left[\sum_{i=1}^{n}g\left(\left\|\frac{x-x_i}{h}\right\|^2\right)\right]\cdot m(x)$$

$$m(x)=\frac{\sum_{i=1}^{n}x_i g\left(\left\|\frac{x-x_i}{h}\right\|^2\right)}{\sum_{i=1}^{n}g\left(\left\|\frac{x-x_i}{h}\right\|^2\right)}-x$$

Where g(r)=-k(r) and *n* is the number of neighbors taken into account in the 5 dimension sample domain.

*Step 3:* In the mean-shift procedure, the current estimate of the mode $y_k$ at iteration k is replaced by its locally weighted mean graph as shown as below,

$$y_{k+1} = y_k + m(y_k) \qquad (4)$$

$$K_{hs,hr}(x) = \frac{C}{h_s^2 h_r^3} k\left(\left\|\frac{x^s}{h_s}\right\|^2\right) k\left(\left\|\frac{x^r}{h_r}\right\|^2\right)$$

Where $h_s$ and $h_r$ are different bandwidth values for spatial area and coverage area. In the bandwidth parameter are expressed to as spatial and range resolutions. The vector m(x) defined in above eq. is known as mean shift instances value since it is the differences between the current value of x and the weighted mean are the neighbors $x_i$ around the x.

## VI. Conclusion

The goal of proposed system is to provide the better wound image and healing status analysis through the Smartphone. We use the mean shift based boundary detection algorithm to analysis of accurate wound boundary determination result. This method Patients are actively involved in their own care. The wound analysis systems where by physicians can remotely access the image of wound and the result of wound healing .Overall result is store in database. Patient's traveling cost is considerably reduced. Also it will reduce the patient's rare tensity and stress. Doctor can analyze the problem easily through wound images and its segmentation.

The proper report of the healing can be given to the patient on time. It is easy to use for self-management and self-monitoring of foot ulcer for diabetic patients. The segmentation of image can be determining the outline of foot ulcer and accurate wound surface are detect. The processing algorithms are both accurate and well suited for real-time wound image analysis that design a highly efficient and accurate.

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