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Wound Assessment System Patients of Foot Diabetes Identification

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Abstract: Diabetic foot ulcers represent a serious health issue. Today clinicians and nurses produce wound assessment by observing the wound size and healing status visually. Here the patients also have an opportunity to play an active role. This method enables the patients and clinicians to take a more active role in daily wound care which can quicken wound healing and also saves the travel cost, reduce healthcare expenses. As the pervasiveness of Smartphone's with a high-resolution digital camera, assessing wounds by analyzing the images of constant foot ulcers. A wound image analysis system is implemented on the android smart phone. The wound image is occupied by the camera on the smart phone with the help of an image capture box. Later that, the smart phone performs wound segmentation by applying the accelerated mean-shift algorithm. The outline of the foot is identified based on skin color, and the wound boundary is recognized using a simple connected region detection method. The healing status is beside assessed based on red–yellow–black color evaluation model with in the boundary of the wound. Further, the healing status is significantly assessed, based on the analysis of patient's time records. The test results on wound images collected in UMASS—Memorial Health Center Wound Clinic (Worcester, MA).

Keywords: **pervasiveness, Smartphone's, wound segmentation, accelerated mean-shift algorithm.**

I. INTRODUCTION

For individuals with type 2 diabetes, foot ulcers constitute a significant health issue affecting 5–6 million individuals in the US. Foot ulcers are painful, susceptible to infection and very slow to heal. According to published statistics, diabetes-related wounds are the primary causes of no traumatic lower limb amputations with approximately 71 000 such amputations in the US in 2004. Moreover, the cost of treating diabetic foot ulcers is estimated at $15 000 per year per individual. Overall diabetes healthcare cost was estimated at $245 billion in 2012 and is expected to increase in the coming years. There are several problems with current practices for treating diabetic foot ulcers. First, patients must go to their wound clinic on a regular basis to have their wounds checked by their clinicians. This need for frequent clinical evaluation is not only inconvenient and time consuming for patients and clinicians, but also represents a significant health care cost because patients may require special transportation, e.g., ambulances. Second, a clinician's wound assessment process is based on visual examination. He/she describes the wound by its physical dimensions and the color of its tissues, providing important indications of the wound type and the stage of healing. Because the visual assessment does not produce objective measurements and quantifiable parameters of the healing status, tracking a wound's healing process across consecutive visits is a difficult task for both clinicians and patients. Technology employing image analysis techniques is a potential solution to both these problems. Several attempts have been made to use image processing techniques for such tasks, including the measurement of area, or alternatively using a volume instrument system (MAVIS) or a medical digital photogrammetric system (MEDPHOS). These approaches suffer from several drawbacks including high cost, complexity, and lack of tissue classification.

To better determine the wound boundary and classify wound tissues, researchers have applied image segmentation and supervised machine learning algorithm for wound analysis. A French research group proposed a method of using a support vector machine (SVM)-based wound classification method. The same idea has also been employed in for the

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detection of melanoma at a curable stage. Although the SVM classifier method led to good results on typical wound images. it is not feasible to implement the training process and the feature extraction on current smart phone's due to its computational demands. Furthermore, the supervised learning algorithm requires a large number of training image samples and experienced clinical input, which is difficult and costly. Our solution provides image analysis algorithms that run on a smart phone, and thus provide a low cost and easy-to-use device for self management of foot ulcers for patients with type 2 diabetes. Our solution engages patients as active participants in their own care, meeting the recommendation of the Committee on Quality of Health Care in America to provide more information technology solutions. The widely used commodity smart phone containing a high-resolution camera is a viable candidate for image capture and image processing provided that the processing algorithms are both accurate and well suited for the available hardware and computational resources. To convert an ordinary smart phone into a practical device for self management of diabetic wounds, we need to address two tasks: 1) develop a simple method for patients to capture an image of their foot ulcers; and 2) design a highly efficient and accurate algorithm for real-time wound analysis that is able to operate within the computational constraints of the smart phone.

Our solution for task 1) was specifically designed to aid patients with type 2 diabetes in photographing ulcers occurring on the sole of their feet. This is particularly challenging due to mobility limitations, common for individuals with advanced diabetes. To this end, we designed and built an image capture box with an optical system containing a dual set of front surface mirrors, integrated LED lighting and a comfortable, slanted surface for the patients to place their foot. The design ensures consistent illumination and a fixed optical path length between the sole of the foot and the camera, so that pictures captured at different times would be taken from the same camera angles and under the same lighting conditions. Task 2) was implemented by utilizing an accurate, yet computationally efficient algorithm, i.e., the mean-shift algorithm, for wound boundary determination, followed by color segmentation within the wound area for assessing healing status. In our previous work, the wound boundary determination was done with a particular implementation of the level set algorithm, specifically the distance regularized level set evolution method. The principal disadvantage of the level set algorithm is that the iteration of global level set function is too computationally intensive to be implemented on smart phone, even with the narrow band confined implementation based on GPU. In addition, the level set evolution completely depends on the initial curve which has to be predelineated either manually or by a well-designed algorithm. Finally, false edges may interfere with the evolution when the skin color is not uniform enough and when missing boundaries, as frequently occurring in medical images, results in evolution leakage (the level set evolution does not stop properly on the actual wound boundary). Hence, a better method was required to solve these problems.

II. SYSTEM ANALYSIS

Tracking a wound's healing process across consecutive visits is a difficult task for both clinicians and patients. Technology employing image analysis techniques is a potential solution to both these problems. Several attempts have been made to use image processing techniques for such tasks, including the measurement of area, or alternatively using a volume instrument system (MAVIS) or a medical digital photogrammetric system (MEDPHOS).These approaches suffer from several drawbacks including high cost, complexity, and lack of tissue classification .To better determine the wound boundary and classify wound tissues, researchers have applied image segmentation and supervised machine learning algorithm for wound analysis.

2.1 Existing System

There are several problems with current practices for treating diabetic foot ulcers. First, patients must go to their wound clinic on a regular basis to have their wounds checked by their clinicians. This need for frequent clinical evaluation is not only inconvenient and time consuming for patients and clinicians, but also represents a significant health care cost because patients may require special transportation, e.g., ambulances. Second, a clinician's wound assessment process is based on visual examination. He/she describes the wound by its physical dimensions and the color of its tissues, providing important indications of the wound type and the stage of healing. Because the visual assessment does not produce objective measurements and quantifiable parameters of the healing status, tracking a wound's healing process across consecutive visits is a difficult task for both clinicians and patients. The wound boundary determination was done with a particular implementation of the level set algorithm; specifically the *distance regularized level set evolution* method. The principal disadvantage of the level set algorithm is that the iteration of global level set function is too computationally intensive to be implemented on smart phones, even with the

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narrow band confined implementation based on GPUs. In addition, the level set evolution completely depends on the initial curve which has to be pre-delineated either manually or by a well-designed algorithm. Finally, false edges may interfere with the evolution when the skin color is not uniform enough and when missing boundaries, as frequently occurring in medical images, results in evolution leakage (the level set evolution does not stop properly on the actual wound boundary). Hence, a better method was required to solve these problems.

2.2 Disadvantages Of Existing System

Patient has to travel with foot ulcers to their clinics to report about the ulcers. This may increase the seriousness of the ulcers instead of curing it. Patient travel exposure may cause a serious problem for them.

2.3 Proposed System

In this paper, we replaced the level set algorithms with the efficient mean-shift segmentation algorithm. While it addresses the previous problems, it also creates additional challenges, such as over-segmentation, which we solved using the *region adjacency graph* (RAG)-based region merge algorithm. In this paper, we present the entire process of recording and analyzing a wound image, using algorithms that are executable on a smart phone, and provide evidence of the efficiency and accuracy of these algorithms for analyzing diabetic foot ulcers.

2.4 Advantages Of Proposed System

Patient's travel exposure is considerably reduced. Also it will reduce the patients stress. Doctor can easily analyze the problem through images and its segmentation. So the proper report can be given to the patient on time.

III. SYSTEM DESIGN

The architecture of this system is contains patient, mobile phone, doctor and server.

Patient:
He sends image which is taken through the smart phone and he follows the suggestions and instructions given by the doctors and clinicians.

Server:
It gives analysis about wound healing to the doctor. View all Patient wound Details with all uploaded details, find Wound and provide assessment from stored details by comparing a keyword for specified wound for end users. If assessment is not found from stored details and then give own assessment (solution).View all given solutions for specified wound, view End users and Authorize. List End user transactions. List all android users.

Doctor:
He suggests patients according to their problems and Upload all Diabetic patient images with its description like patient name, wound found, wound description, wound image, paddress, email, cno .Update wound details for corresponding patient.

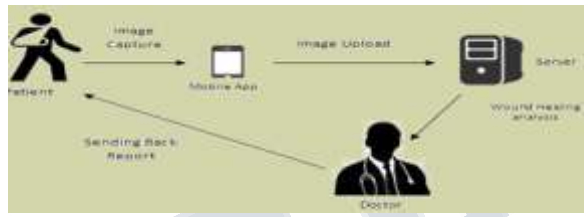

Fig 1: System Design

IV. IMPLEMENTATION

Modules:
Modules involved in the system are Wound Image Analysis System overview, Mean-Shift-Based Segmentation Algorithm, Wound Boundary Determination and Analysis Algorithms.

A. Wound Image Analysis System overview

In this module, we carry out a *Wound boundary determination* based on the foot outline detection result. If the foot detection result is regarded as a binary image with the foot area marked as "white" and rest part marked as "black," it is easy to locate the wound boundary within the foot region boundary by detecting the largest connected black" component within the "white" part. If the wound is located at the foot region boundary, then the foot boundary is not closed, and hence the problem becomes more complicated, i.e., we might need to first form a closed boundary. When the wound boundary has been successfully determined and the wound area calculated, we next evaluate the healing state of the wound by performing *Color segmentation*, with the goal of categorizing each pixel in the wound boundary into certain classes labeled as granulation, slough and necrosis. The classical self-organized clustering method called K-mean with high computational efficiency is used. After the color segmentation, a feature vector including the wound area size and dimensions for different types of wound tissues is formed to describe the wound quantitatively. This feature vector, along with both the original and analyzed images, is saved in the result database. The *Wound healing trend analysis* is performed on a time sequence of images belonging to

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a given patient to monitor the wound healing status. The current trend is obtained by comparing the wound feature vectors between the current wound record and the one that is just one standard time interval earlier (typically one or two weeks). Alternatively, a longer term healing trend is obtained by comparing the feature vectors between the current wound and the base record which is the earliest record for this patient.

B. Mean-Shift-Based Segmentation Algorithm

In this module we implement mean-shift-based segmentation, the mean-shift algorithm belongs to the density estimation based nonparametric clustering methods, in which the feature space can be considered as the empirical probability density function of the represented parameter. This type of algorithms adequately analyzes the image feature space (color space, spatial space or the combination of the two spaces) to cluster and can provide a reliable solution for many vision tasks.

C. Wound Boundary Determination and Analysis Algorithms

In this module we implement wound boundary determination, because the mean-shift algorithm only manages to segment the original image into homogeneous regions with similar color features, an object recognition method is needed to interpret the segmentation result into a meaningful wound boundary determination that can be easily understood by the users of the wound analysis system. As noted, a standard recognition method relies on known model information to develop a hypothesis, based on which a decision is made whether a region should be regarded as a candidate object, i.e., a wound. A verification step is also needed for further confirmation. Because our wound determination algorithm is designed for real time implementation on the smart phones with limited computational resources, we simplify the object recognition process while ensuring that recognition accuracy is acceptable.

V. SCREEN SHOTS

Fig 2: Home Page

This page consists of the modules that are service provider, healthcare server, end as shown in fig 1.

Fig 3: Service Provider Register Page

Through this page the service provider can register to provide service as shown in fig 2.

Fig: 4 End User Login Register Page

Fig 4 is page helps all users to register for uploading images.

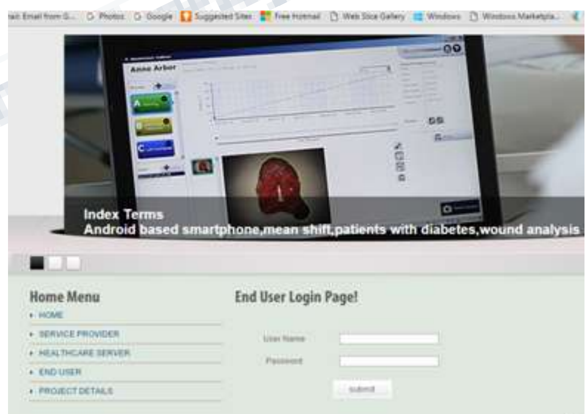

Fig: 5 End User Login Page

Fig 5 page helps the user to login in to this page.

Fig: 6 Service Provider Login Page

Fig 6 page helps the service provider's to log in for providing service.

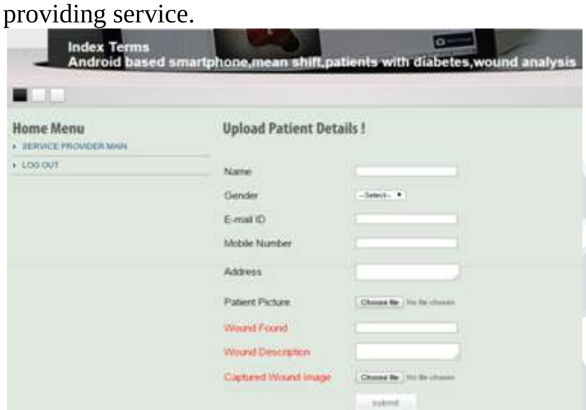

Fig: 7 Patient Details Uploading Page

Fig 7 page used to help the end users to upload the images.

Fig: 8 Wound Details Page

Fig 8 page helps the users to upload the details of the wound.

Fig: 9 Authorization Page

Fig 9 page used to authorize the user by the server.

Fig: 10 Patient Wound Details Page

Fig 10 page gives the details of the wound of the patient's.

Fig 11: HealthCare Server Page

Fig 11 page gives the details of the server.

VI. CONCLUSION

We have designed and implemented a novel wound image analysis system for patients with type 2 diabetes suffering from foot ulcers. The wound images are captured by the smartphone camera placed on an image capture box. The wound analysis algorithm is implemented on a Nexus 4 Android smartphone, utilizing both the CPU and GPU. Accuracy is enhanced by the image capture box, which is designed so that consistent image capture conditions are achieved in terms of the illumination and distance from camera to object. While different smartphone cameras do have slightly different color space characteristics, we have not included color calibration mainly because the most important aspect

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of the wound assessment system is the tracking of *changes* to the wound, both in size and color, over consecutive images captures.

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