

# Approaches for Detection and Analysis of Wound Ulcer using Image Processing Techniques

Sudarvizhi D<sup>1</sup>, Kaavyaa A<sup>2</sup>, Nandhini N<sup>3</sup>, Lakshmi priya K<sup>4</sup>

<sup>1</sup>professor, Dept of Electronics and Communication, KPR Institute of Engineering and Technology, Tamilnadu, India

<sup>2</sup>Student, Dept of Electronics and Communication, KPR Institute of Engineering and Technology, Tamilnadu, India

\*\*\*

**Abstract** - The image is an important tool for analysis. Here, as a solution image analysis algorithm can be designed and run using a 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.

**Key Words:** Diabetic Foot Ulcer (DFU), Modified Chan Vase Algorithm, Mean Shift Algorithm, K-Means Algorithm, Decision Based Couple Window Median Filter (DBCWMF), Statistical Region Merging (SRM)

## 1. INTRODUCTION

The diabetes mellitus is the major risk component of a diabetic foot. More than 85% of major amputations are performed on people with diabetes. On an average, about 73000 amputations of lower limb, related of trauma are performed in U.S. The estimation resulted that every 30 seconds one leg is amputated, due to diabetes. Study showed that by 2 years 50% of people with diabetes tend to lose their lives. An ulcer present for more than 30 days is more likely to be infected. Osteomyelitis, which is an infection in the bone, is noticed in 15% of people with DFU.

DFU forms due to combination of factors, such as lose of feeling in foot, circulation becoming poor, deformities in foot, irritation, trauma and the duration of diabetes. The patients with diabetes tends to develop neuropathy, where reduced or lack of ability to feel pain in the feet. This is caused by elevated blood glucose levels over time, resulting in nerve damage. A pediatric medical care should be immediately taken, once when an ulcer is noticed. The reasons for treating diabetes in patients are to reduce the risk of infection and amputation, and improve the function and quality of life and to reduce health care costs. The faster the healing of wound, the lesser the chances for infection. The several key factors in the treatment of DFU are infection prevention, off loading the pressure off the area is calculated, debridement the removal of dead skin and tissue, application of medication or dressings to the ulcer, and managing blood glucose and other health

problem. For optimum heading ulcers especially on the bottom of the foot must be off loaded. Patients are asked to wear special foot gear, or a brace, specialized casting or use wheelchair or crutches.

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

Surrounding skin examined by inspection of color, discharge and texture, and palpation for warmth, swelling and tenderness. Suggesting of inflammation for visual inspection redness, which usually causes wound infection.

Black discoloration is suggestive of ischemia, while and soggy appearance is due to maceration and while and dry is usually due to increased pressure. In white skin, lesion appears of brown or red, may appear purple or black in brown or black skin.

## 2. RELATED WORKS

Implementation of modified chan vase algorithm to detect and analyze diabetic foot ulcers. The temperature variations in the feet causes 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 chan and vase ignores edges completely in the segmentation boundary in the method of “active contours without edges” implicitly with a level of set function, which is the drawback of existing method.

In the technology of thermal camera ,the heat transfer can be described in three types. The conduction requires a contact between the object and the sensor, which allows the flow of thermal energy is the first one. The second one is of heat transfer, defined as convection where the flow of hot mass, which can transfer thermal energy and third one is by radiation.[2]

For the high scanning rate and quality of captured image, the IR sensors technology is preferred. The diabetic group which guides to maintain correct position without shoes or socks, for 15 minutes in a room controlled at a stable temperature of 26+/-0.5degree Celsius, before measurement. After equilibrium, thermal images is obtained by using IR sensor. When the images have no

sufficient quality to work on it, then these images were revised again by investigator.

The risk identification in the abnormal neuropathy of diabetic patients, leads reduced sweating and skin abnormality conditions including fissures, anhydrosis 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 degreeF, between the right and left corresponding places, then it is intimated to patients.

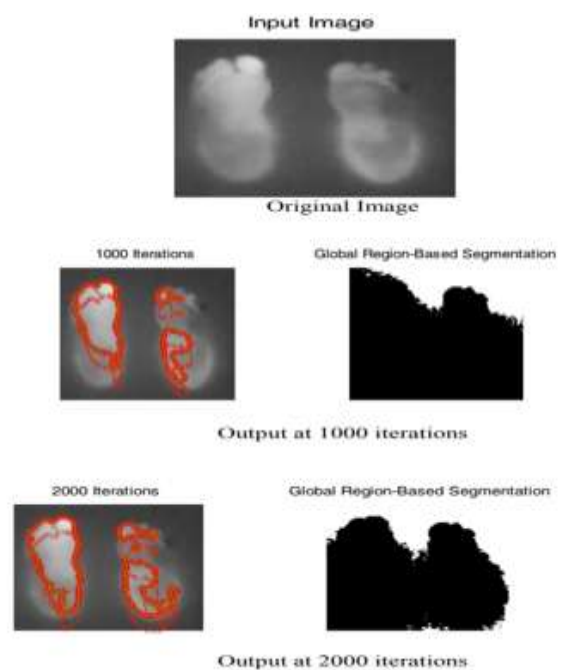


Fig -1: output of modified chan vase algorithm

In the wound tissue detection and classification, the major risk of diabetic foot ulcer, is social health and economy as it causes injurious effect on patients grade of life. Due to the leg ulcer problem, majority patients are hospitalized. The improper blood supply to the venis going towards the leg also probably causes the leg ulcer. The three types of tissues are found within the affected wound area. The new tissue is granulation red tissue, unequal concoction of slough that is yellow fibrin material and black necrotic, that is dead tissues.[1]

The determining proportion of these tissues, within wound region due to color inexactness have a problem during wound tissue identification by clinicians. The clinicians manual examination which depends on measurement methods like ruler-based technique, transparency tracing, alginate casts and other. The

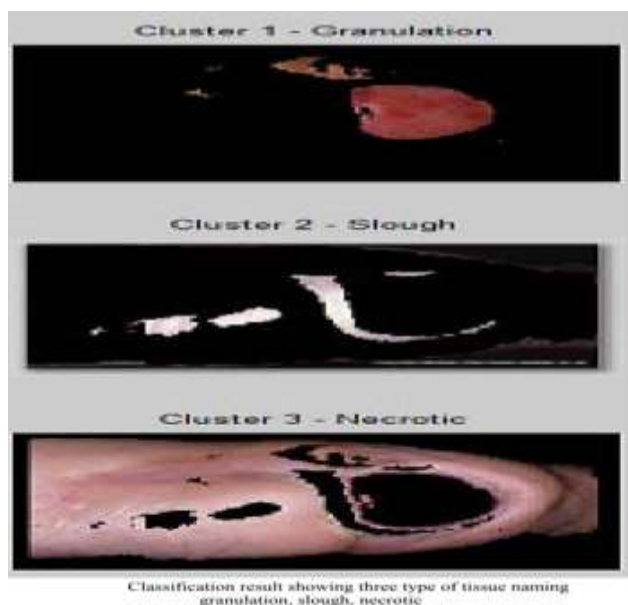
processes are often inaccurate which is ordinary, since such evaluation depends on his/her clinical experience.

The visual attributes of image processing and its application for biomedical state like color, shape and texture are extracted to characterize the image. The data are in statistical form which is given in image processing technique. The primary stage of foot ulcer can cure by clinicians and when proper treatment is provided to the patient.



**Fig -2:** Input image of wound tissue detection and classification

The operations of image preprocessing applied on the scanned input RGB image to enhance the image and to remove noise from it. The preprocessing performed by two steps, that is to convert color space from RGB to HSI and noise removal by diffusion equation. The occurrence of color non-uniformity in RGB wound image, causes diagnostic problem faced by clinicians. So, the conversion of RGB wound image into HSI color space is essential, since, it is more near to the human's visualization of color.



**Fig -3:** output image of wound tissue detection and classification

The wound image are very often affected by salt and paper noise, because of dust attached to the camera lens and rapid photography. The median filter, adaptive median filter, mean filter, gaussian filter and adaptive wiener filter for de-noising and these types of filter can be applied for noise. By using the diffusion procedure we can remove the noise from wound image.[5]

The ROI image from background is to be separated by image segmentation. The process of texture segmentation is dividing an image into different sections to recognize the boundary between different textures on the image. Region Growing, Differential evolution, Edge Detection and Gabor Filter algorithms are used to perform segmentation. Fourier based Filtering techniques may not be proper for local wear detection, but they are suitable to extract global information. The Gaussian function is to exponentially modulate the advanced gabor function, where the real and imaginary portion of each of the complex advanced gabor functions can be used for filtering.

We emphasis on dissemination and thickness of the clinical attributes, for wound depiction namely granulation, slough and necrotic tissues over wound bed. The mean, skewness, standard deviation, kurtosis and variance were extracted based on attributes of color. Texture based features like local contrast features and local binary patterns (LBP) are extracted.[7]

The series of morphological operations are applied, on the segmented portion of the wound image, because of the tissue recognition and extraction. Texture classification uses the extracted features, from the prior stage to classify the wound tissue namely granulation, slough and necrotic. The healing process of foot ulcer wound by these types of tissue identification is important because the granulation portion is higher than the healing process when proper, but if the slough and the necrotic portion is higher than healing of ulcer wound ,then it is not proper.[3]

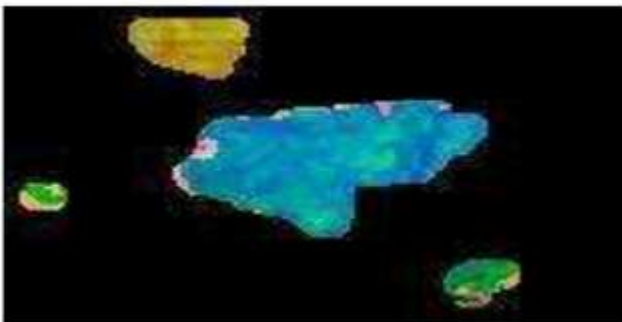
In the mean shift segmentation algorithm, the wound image is processed under different steps such as pre-processing, RGB to gray conversion, segmentation, k-means clustering algorithm, boundary line detection and healing status. The healing status depends on blue, yellow, green color model. The image 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.



**Fig -4:** input image

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 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 colour checker. In the event that the wound detection was not correct, the side bar will display to allow the algorithm's sensitivity adjustment.

The sensitivity corresponding to the height threshold for segmentation stage. From the algorithm trail, the lesions detection was successful with acceptable quality. In some cases, the detected contour might differ from lesions limits, as a consequence of softening performed. It depends only on the lesions detection, higher the detection quality, lower the error.[6]



**Fig -5:** output of mean shift segmented algorithm



**Fig -6:** output of k-means clustering algorithm

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. 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.

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 are 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<sup>th</sup> or more noisy pixels are converted into noise-free pixels.

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.

The feature extraction of images is performed by using SIFT algorithm and it is used to describe the extreme points from the whole scale space. The four most important stages of SIFTing algorithm:

- Extreme Detection of scale-space
- Localization of key points
- Assignment orientation
- Description Generation

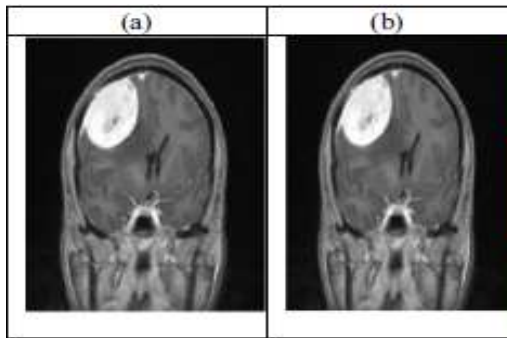


Fig -7: (a)input brain image ,(b)Filtered DBCWMF image

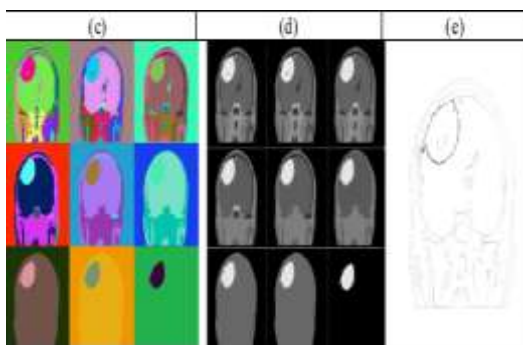


Fig -8: (c) Color SRM Segmentation in 9<sup>th</sup> level green Brain tumor was detected, (d) Grayscale SRM Segmentation in 9<sup>th</sup> level green Brain tumor was detected, (e) Tumor Outer line detection

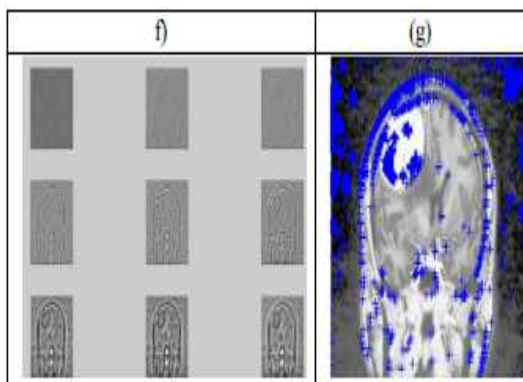


Fig -9: (f) Cat Swarm Optimization feature extraction,( g) Scale-invariant feature transform feature extraction

The BPNN is used for performing the process of training data. Since the information doesn't have an equal demonstration, the neural network cannot be applied to unprocessed data. The primary synaptic weight of the neural network ranges from -0.5 and 0.5. The organized learning and utilization, for training the network with feed forward neural network, is this technique.

### 3. 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.

### REFERENCES

- [1] Lei Wang, Peder C. Pedersen, Diane M. Strong , Bengisu Tulu , Emmanuel Agu, Ron Ignatz, Qian He, An Automatic Assessment System of Diabetic Foot Ulcers Based on Wound Area Determination, Color Segmentation, and Healing Score Evaluation, IEEE, pp. 421-428, March 2015.
- [2] Fahimuddin Shaik, Dr. Anil Kumar Sharma, Dr. Syed Musthak Ahmed, "A Novel Approach for Detection and Analysis of abnormalities in MRI Images related to Diabetic Myonecrosis", International Journal of Modern Electronics and Communication Engineering (IJMECE) Volume No.-4, Issue No.-1, January, 2016, ISSN: 2321-2152
- [3] Sudarvizhi.D, "Automatic glucose infusion and control system using solenoid valve", International journal of emerging trends in engineering and development , issue 5 vol 2 (Feb, Mar 2015) (ISSN 2249-6149) pp.143-148
- [4] Jithendra Reddy Dandu, Arun Prasath Thiyagarajan, Paalikonda Rajasekaran Murugan, Vishnuvarthanan Govindraj, "Brain and Pancreatic tumor segmentation using SRM and BPNN classification", Received: 13 October 2018 / Accepted: 12 December 2018 ©IUPESM and Springer-Verlag GmbH Germany, part of Springer Nature 2019.
- [5] C. Karthikeyini, P. Umadevi, "Analysis and Classification of diabetic foot ulcer using kernel Graph method", International Journal of Engineering Science Invention (IJESI), vol.7, No.12, pp. 49-53, 2018.

- [6] Reddy DJ, Prasath TA, Rajasekaran MP, Vishnuvarthanan G. Brain and Pancreatic Tumor Classification Based on GLCM--k-NN Approaches. In: International Conference on Intelligent Computing and Applications 2019 (pp. 293-302). Springer, Singapore.
- [7] Patel J. Doshi K. A study of segmentation methods for detection of tumor in brain MRI. Adv Electron Electr Eng. 2014;4(3):279-84.
- [8] "Study on Various Segmentation of Diabetic foot ulcer images", C. Karthikeyini and P. Umadevi, proceedings of International Conference on Artificial Intelligence, Smart Grid and Smart City Application Jan 3-5, 2019, pp. 322-324.
- [9] Dayanada K J, Kiran Kumari Patil, "Analysis of foot sole image using image processing algorithm", IEEE, pp. 57-63, December 2014.