RESEARCH ARTICLE OPEN ACCESS

Human Burn Diagnosis using Machine Learning

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ABSTRACT

Burn is one of the serious public health problems. A burn is a type of injury to skin, or other tissues, caused by heat, cold, electricity, chemicals, friction, or radiation. Most burns are due to heat from hot liquids, solids, or fire. In the United States, the most common causes of burns are: fire or flame (44%), scalds (33%), hot objects (9%), electricity (4%), and chemicals (3%). Usually, burn diagnoses are based on expert medical and clinical experience and it is necessary to have a medical or clinical expert to conduct an examination in restorative clinics or at emergency rooms in hospitals. But sometimes a patient may have a burn where there is no specialized facility available, and in such a case a computerized automatic burn assessment tool may aid diagnosis. In this project, a classification model to diagnose burns is presented using automated machine learning. The objective of the project is to develop the feature extraction model to classify the burn.The proposed method based on Probabilistic Neural Network (PNN) and K Nearest Neighbour (KNN) is evaluated on a standard data set of burns. Training is performed by classifying burn images into degree-1 burn, degree-2 burn, degree-3 burn. The burn images of test data set is tested with the proposed method by pre-processing the images followed by Watershed Transform applied for segmentation of the feature and performing moment based feature extraction of moment features. Post that the burn images are thereby classified using the classifier model.According to the ground truth 90.58% accuracy is obtained which is much better than the previous methods.

Keywords:- K Nearest Neighbor,Probabilistic Neural Network,Watershed Transform,Moment Feature Extraction

I. INTRODUCTION

Burn is one of the serious public health problems. In the case of death from unintentional injury, burns represent the fourth leading cause. Burn area and location are the critical factors in determining the severity of burns. Generally, superficial dermal burn, deep dermal burn, and full-thickness burn are the three types of burns and it is vital to make the difference between these three types of burns. Superficial dermal burns affect the outer part of the skin or epidermis. The affected part appears red, painful, and dry. It may also have blisters. Deep dermal burns affect the epidermis and part of the dermis layer of skin. The burn part appears red, blistered and painful. Full thickness burns destroy both epidermis and dermis and may also enter into the subcutaneous tissue. The burn affected part appears white or charred. The crucial part of this work is to label these images so that the proper treatment can be given. The primary objective of this work is to develop a classification system for burn injury images using color characteristics.

In this project, the effort on burn area estimation, specifically classification of burn based on with graft and without graft will be described. Usually, the burns surgeons differentiate types of burn based on their clinical experience. Therefore, the accuracy is also varied to the experienced burn surgeon and inexperienced from 64-76% to 50%, respectively. The recent approach uses digital image processing and machine learning approach for the classification of different types of burn. So that if grafting needed it can be done by the surgeon.

A. Problem Statement

For a successful evolution of a burn injury it is essential to initiate the correct first treatment. To choose an adequate one, it is necessary to know the depth of the burn, and a correct visual assessment of burn depth highly relies on specialized dermatological expertise. As the cost of maintaining a Burn Unit is very high, it would be desirable to have an automatic system to give a first assessment in all the local medical centers, where there is a lack of specialists. Usually, burn diagnoses are based on expert medical and clinical experience and it is necessary to have a medical or clinical expert to conduct an examination in restorative clinics or at emergency rooms in hospitals. But sometimes a patient may have a burn where there is no specialized facility available, and in such a case a computerized automatic burn assessment tool may aid diagnosis.

B. Scope and Objective

This project is mainly useful at the hospitals which lack the presence of specialized burn units to assess the degree of skin burn. It is found useful at hospitals in rural areas with less specialized clinicians and specialized doctors.

- Main objective of the project is to effectively classify the burn into 3 different types like simple medium and deep burn.
- To achieve more accuracy than existing system by using improved algorithms for the same.

II. RELATED WORKS

Yadav et al.[1], has developed the feature extraction model to classify burn based on Support Vector Machine (SVM). Training is performed by classifying images into two classes i.e. those that need grafts and those that are non-graft.In the paper of Badea et al.[2], the author has proposed a method for burn image detection and have applied the pixel-wise method which is computationally expensive and hence their classifier is not able to provide optimized results. In the paperofŞevik et al. [3], has constructed an automated system for classifying healthy and burned skin in digital photographs of burn patients using the fuzzy c-means algorithm for the segmentation, and a multilayer feed-forward artificial neural network trained by the back-propagation algorithm for the classification. Castro et al. [4], has answered one of the hard questions if the golden standard for diagnosing skin burning stages is the histological biopsy. This study demonstrates that amplitude of second derivative amide I and amide II are suitable to discriminate healthy skin with other healing stages.

In the paper ofTran et al. [5], the author proposed a model that uses one-class Support Vector Machine with color features for burn image classification to identify automatically the degrees of burns in three levels. In the paperRangaraju et al.[6], have described the clinical method to determine types of burn, a degree of burn and grafting technique. Clotting (coagulation) is used to measure the degree of burn. Collagen ratio below 0.35 is considered as superficial burn and the ratio between 0.35 and 0.65 is considered as deep dermal burn, whereas, a ratio greater than 0.65 is considered as full thickness burn. Suvarna et al. [7], has proposed a method to find an automated solution for classifying chemical skin burn which implemented a supervised classifier algorithm SVM because the two features mean and DCT overlap for different grades. Dr.MaliniSuvarna et al.[8], has proposed a method that attempts to find automated solution for classifying scalding (grade 1, grade 2, and grade 3) for burns caused from scalding. The SVM training involves nonlinear optimization technique, and this method is relatively a recent classification technique and gives good results on large sets of data.

In the paper of Charuvila et al.[9], the author has answered one of the hard questions in the assessment of mid-dermal burn depths. The aim was to compare the accuracy of the two modalities in the assessment of mid-dermal burn injuries. The results suggest that the accuracy of SIA is comparable to that of LDI and SIA indicates its potential as a cost-effective and user-friendly adjunct in decision-making. In the paper Sabeenaet al. [10], and Kumar have given a careful way using SVM for burn identification and its segmentation. The main idea behind their work is to get well burn or actedon process. Their system uses GLCM feature extraction, K-means segmentation and SVM classification. Abubakar et al.[11], has proposed a study to determine whether Machine Learning (ML) can be used to discriminate between burnt skin and normal skin images with high accuracy. The results show evidently that machines can perform binary classification with maximum accuracy that superseded human experts. In the paper of Aliyu Abubakar et al. [12], the author presented automatic classification of burns and pressure ulcer (bedsores) using RGB images. The main idea of the proposed research is to investigate the feasibility of using machine learning approach to discriminate burns and pressure ulcer.

Prateechi Singh et al.[13], has proposed a method to solve the problem of identifying the scar, size of the scar, find the degree of burn or disease mapping the redness of the scar and finding the number of clusters of scars in an image purely by using basic image processing ways. Tran et al. [14], proposed a Convolutional Neural Network (CNN) model for the degree of skin burn image recognition. B-CNN model uses the probability distribution of degree of skin burn training data information to calculate the sampling probability one-by-one degree of skin burn images training data. In the paper of Serrano et al. [15], the burn depth analysis is performed based on colour digital photographs. The colour and texture features are converted into numbers that a classifier could distinguish and special analysis performed that consists of MDS approach and SVM classifier employed for feature selection and classification respectively. Dr.MaliniSuvarna et al. [16], has proposed a method of classifying chemical skin burn into three grades, namely Superficial, Partial thickness and Full thickness using the KNN methods for classification. KNN is suitable and efficient for image data which is continuous and data set is processed number of times.

In the paper of Vertan et al. [17], the author has presented a new approach towards the selection of color image features to be used in the classification of burn wounds. The features are selected such that they generate similarity matrices and multidimensional scaling (MDS) plots that match the similarity matrix. Wearn et al. [18], have performed few comparison studies for depth assessment and results show that Laser Doppler Imaging outperforms Thermal imaging in terms of diagnostic accuracy of burn depth likely due to susceptibility of the latter due to environmental factors. Badea et al. [19], have proposed a multispectral imaging based diagnosis support system for the identification of severe burns. An ensemble method build upon fusing decision from standard classifiers and convolutional neural network for burn severity assessment is presented.In the paper of Chauhan et al. [20], the author has made first attempt to classify burnt body part images considering 4 different burnt body parts: face, hand, back, and inner arm. This presents the effectiveness of some deep learning models in addressing this problem, considering the constraint of limited number of burnt images availability.

III. PROPOSED SYSTEM

To achieve this objective, the proposed method is three fold as follows:

- Pre-process and segment the region of interest of the burn image.
- Extract moment features and perform template matching for feature extraction.
- Multi-label classification of burn using probabilistic neural network and KNN.

A. System Architecture

Architecture focuses on viewing of a system as a combination of various different components and how they interact with each other to produce the desired results. The focus is on identifying the components or sub-systems and how they are inter connected. In the high-level architecture of the proposed system, it is represents the user interaction with the system. Initially the system takes input burnt skin image. Then all the processing is carried out inside the system. The system is responsible for resizing the image which are then pre-processed. Accordingly, features are extracted, the system is trained to classify the burnt skin image into three categories and finally the desired output is obtained.

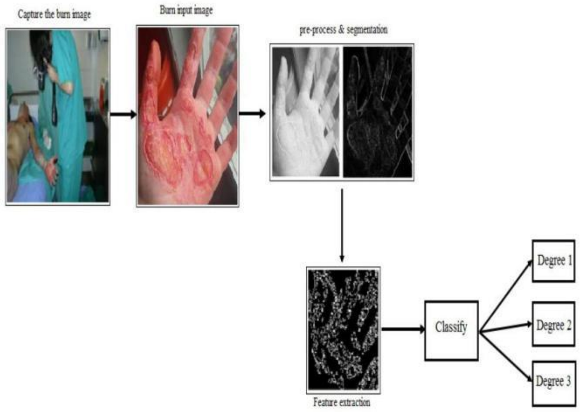

Fig. 1 System Architecture

B. DATA FLOW DIAGRAM

1. DFD Level-0

A level 0 data flow diagram (DFD), also known as a context diagram, shows a system as a whole and emphasizes the way it interacts with external entities. This DFD level 0 example shows how such a system might function.

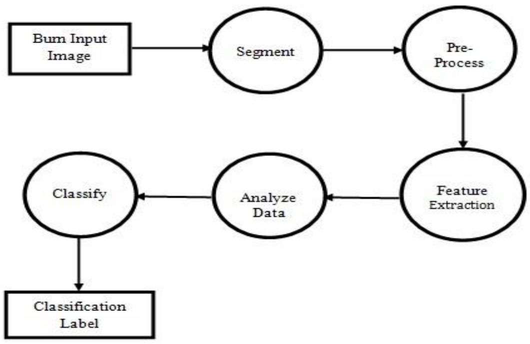

Fig. 2 DFD level-0

2. DFD Level-1

A level 1 DFD notates each of the main sub-processes that together form the complete system. We can think of a level 1 DFD as an “exploded view” of the context diagram. If no context diagram exists, first create one before attempting to construct the level 1 DFD. The following steps are suggested to aid the construction of Level 1 DFD:

- Identify processes and data stores.

- Draw the data-flows between the external entities and processes.
- Add data-flows flowing between processes and data stores within the system.
- Check diagram. Each process should have an input and an output.

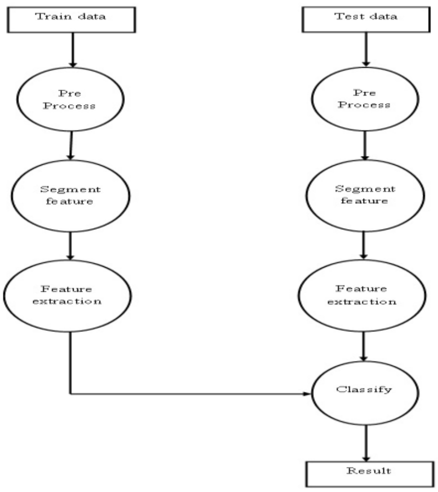

Fig. 3 DFD level-1

C. Use Case Diagram

A use case diagram is the primary form of system/software requirements for a new software program underdeveloped. Use cases specify the expected behaviour (what), and not the exact method of making it happen (how). Use cases once specified can be denoted both textual and visual representation (i.e. use case diagram). A key concept of use case modeling is that it helps us design a system from the end user's perspective. It is an effective technique for communicating system behaviour in the user's terms by specifying all externally visible system behaviour.

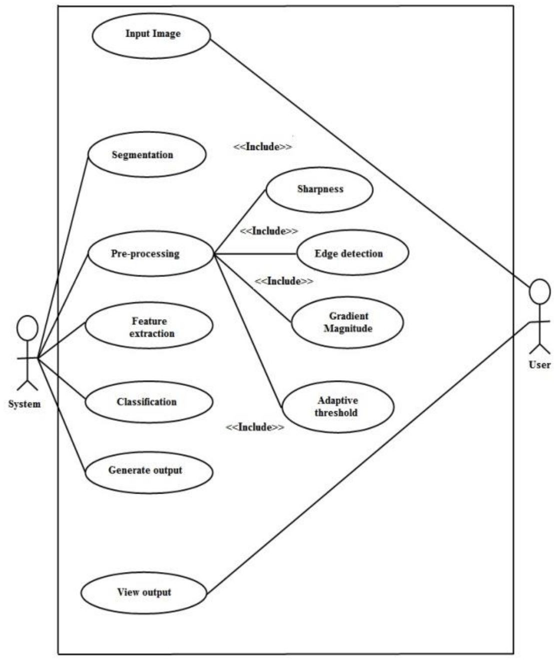

Fig. 4 Use case diagram

IV. METHODOLOGY

The proposed system consists of following modules:

Module 1: Input the burn skin image dataset

Module 2: Preprocess the image

Module 3: Feature extraction

Module 4: Classification

Module 5: Display the final output on MATLAB GUI

A. Image Pre-Processing

The first stage includes the image input where a burn image is taken as an input. The collected dataset of images are captured through the camera and stored in the .jpg format within the folder. Then these images are given into the system as the input. GUI is created using MATLAB software to fetch the input image from the folder. The image is cropped, resized and converted to grayscale. The first method in pre-processing the image involves calculating the sharpness of the image. Post that adaptive threshold is applied which separates foreground from background with non-uniform illumination. Also edge detection is performed using the canny edge detection method which finds the boundaries of the object in our case it's the burnt area within images and works by detecting the discontinuity in brightness. Lastly the gradient magnitude is performed on the image which returns as a numeric matrix of same size as image or directional gradients Gx and Gy hence it is a directional change in the intensity or color in an image. Feature segmentation uses the watershed segmentation method is used since it is more suitable. After the watershed transformation is performed we get a labeled matrix which contains positive integers corresponding to locations of each catchment basin and we use the zero valued elements located along the watershed lines to separate the objects in the original image. This way the image can be accurately segmented and boundaries can be emphasized.

B. Feature Extraction

This is a very important stage while classifying the images into different categories. The selected features represent the characters of the images belonging to particular degree of burn. The degree of burn differs based on the colour and texture of wound so these features are mainly considered for the classification. Moment feature based extraction is performed and the invariant moment features are picked up for the classifier training automatically from the area of burn. The 8 invariant moment functions are applied and features collected are fed into the probabilistic neural network for further multi-label classification.

C. Classification

This is the final process where the features are extracted from the trained dataset and are compared with the features of test input image. The probabilistic neural network and K nearest neighbour classifier is used for classifying the burn as either degree 1 or degree 2 or degree 3 burn. After the classification model is built when the test image is input to the system it compares every feature of test image with those that of the trained images present in the database and the classified result of whether the burn belongs to first, second or third degree is made to be displayed on the GUI of the framework which is integrated with panels, axes, buttons etc in the tool box.After the classification model is built when the test image is input to the system it compares every feature of test image with those that of the trained images present in the database and the classified result of whether the burn belongs to first, second or third degree is made to be displayed on the GUI of the framework which is integrated with panels, axes, buttons etc in the tool box.
The below figure shows the block diagram of the proposed work:

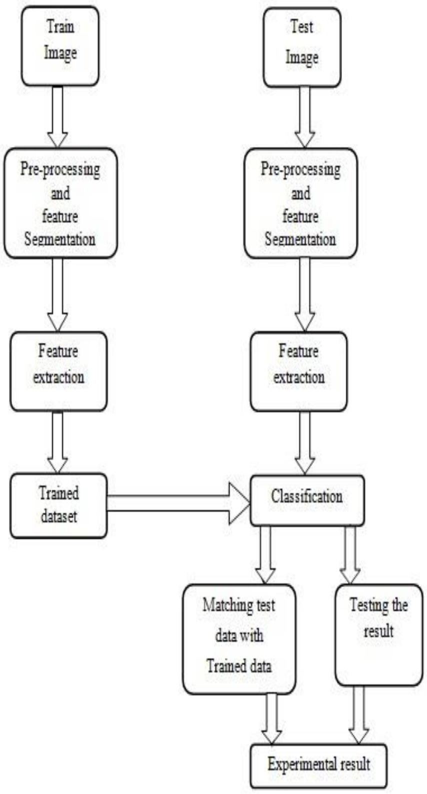

Fig. 5 Block Diagram of Proposed Work

D. Pseudocode

1. Pseudo-code for getting input image:
Step 1: Click on Input Image button in UI
Step 2: Select the image from dataset
Step 3: Convert image to grayscale and display the window
Step 4: Show the grayscale image
2. Pseudo-code for pre-processing:
Step 1: Resize the grayscale image
Step 2: Sharpen the image
Step 3: Perform Adaptive thresholding on the image
Step 4: Calculate the gradient magnitude of the image
Step 5: Perform edge detection using canny edge detector
Step 6: Display all images on UI for users
3. Pseudo-code for feature segmentation:
Step 1: Apply watershed transform on the gradient magnitude image
Step 2: Display the watershed ridge lines in UI
Step 3: Evaluate the label2rgb() function
Step 4: Display the segmented image in different colours
4. Pseudo-code for feature extraction:
Step 1: Convert rgb image to hsv

Step 2: For each channel extract the template responses and collect features
Step 3: Eight invariant moments of the image is calculated
Step 4: All features are combined to form features of complete image

5. Pseudo-code for classification:

Step 1: Collect the extracted features from the dataset of images
Step 2: Training the dataset of images
Step 3: Apply probabilistic neural network for classifying the test image
Step 4: Apply knn for assigning the class label accurately with 5 nearest neighbours
Step 5: Display the degree of burn after performing the matching

V. EXPERIMENTAL RESULT

The database of proposed system consists of 85 images, 28 images from each grade are collected from various sources like internet, photographs from Hospitals and scanned from books. All images are set to standard jpeg format and used in this work.The proposed system efficiently classifies the burn images into three categories such as degree 1, degree 2 and degree 3.

A. Input the Image

The Figure shows how the image is taken into the system. When the user clicks input image button, the browser menu opens and then the user has to select the burn image and the image selected is converted to greyscale and is shown on the left top box of the GUI.

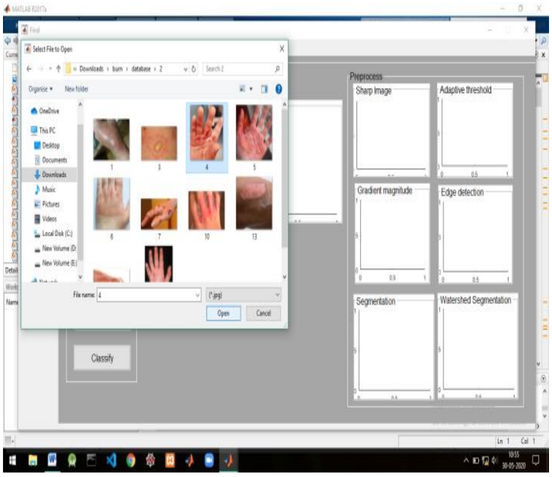

Fig. 6 Image input

B. Pre-Processing and Feature Segmentation of the Image

The image which is taken as input is a burn image. The exact burnt area is cropped and resized. The cropped image now needs to be pre-processed and binarized. The cropped image is made noise free and binarization of the image using the image pre-processing techniques is followed. The sharpness of the image, adaptive threshold, gradient magnitude and edge detection is done and is displayed at the top right corner of the GUI.After the pre-processing of the image is performed the feature segmentation is done using watershed transform as shown below and the boundaries are drawn from the image.

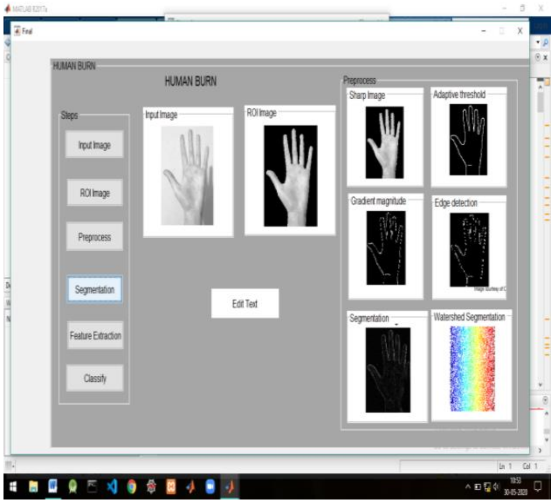

Fig. 7 Image pre-processing and Segmentation

C. Feature Extraction and Classification Of Burn

The figure shows the results of feature extraction from the image. The moment based feature extraction is followed by classification of burn as degree 1 or 2 or 3 using PNN.

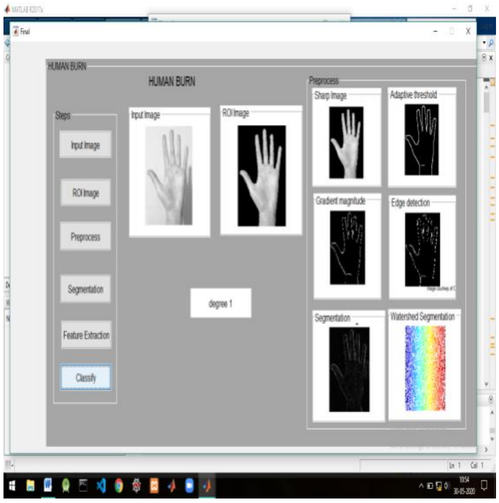

Fig. 8 Feature Extraction and Classification

CONCLUSION

In this project, we have proposed a probabilistic neural network (PNN) and K nearest neighbour (KNN) model for the degree of skin burn image classification. The model uses the probability distribution of the degree of skin burn training data information to classify them as degree 1, degree 2, or degree 3 burn. The burn images are pre-processed thereby finding the sharpness of image, adaptive threshold, gradient magnitude and detecting the edges in the grayscale image. Further segmentation of the feature is done using the watershed transform. It is followed by template based feature extraction by moment calculation. The dataset of burn images are taken and the classifer model classifies the burn images accurately enough into 3 type based on the severity of the burn.77 out of 85 dataset images correctly classifies the burn and according to the ground truth 90.58% accuracy is obtained which is much better than the previous methods.

FUTURE ENHANCEMENT

In the view of future enhancement the algorithm can be tested with significantly huge number of datasets and check for better accuracy. The proposed work considers the dataset from various different parts of body and in the future the system can be enhanced with accuracy considering one particular part of body to find various degree of burn classification. Also, the healing time of burn could also be performed.

ACKNOWLEDGEMENT

We are indeed grateful to many groups of people who have helped us with various aspects of this work. We would like to thank Prof. Saraswathi D as well as special thanks to our Head of the department Dr. Sharath kumar Y H for giving us the opportunity to do this wonderful project on “Human Burn Diagnosis using Machine Learning”.

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