FULLY CONVOLUTIONAL NETWORKS FOR DIABETIC ULCER SEGMENTATION

A.AKILAN, E.DINESHWARAN, A.UDHAYAKUMAR

DEPARTMENT OF CSE, PAAVAI COLLEGE OF ENGINEERING

GUIDED BY

M .SIVAKUMAR AP/CSE,

DEPARTMENT OF CSE, PAAVAI COLLEGE OF ENGINEERING

ABSTRACT

Diabetic Foot Ulcer (DFU) is a major complication of Diabetes, which if not managed properly can lead to amputation. Hence, application-based systems providing quantitative wound assessment may be valuable for accurately monitoring wound healing status, with the wound area the best suited for automated analysis. We extracted various color and texture descriptors from super pixels that are used as input for each stage in the classifier training. Specifically, color and bag-of-word representations of local dense scale invariant feature transformation features are descriptors for ruling out irrelevant regions, and color and wavelet-based features are descriptors for distinguishing healthy tissue from wound regions. Current clinical approaches to DFU treatment rely on patients and clinician vigilance, which has significant limitations such as the high cost involved in the diagnosis, treatment and lengthy care of the DFU. We set a dataset of foot images. We provide the ground truth of ulcer region and the surrounding skin that is an important indicator for clinicians to assess the progress of ulcer. Then, we propose a two-tier transfer learning from bigger datasets to train the Fully Convolution Networks (to automatically segment the ulcer and surrounding skin.

1.INTRODUCTION

Health is one of the global challenges for humanity. In the last decade the healthcare has drawn considerable amount of attention. The prime goal was to develop a reliable patient monitoring system so that the healthcare professionals can monitor the patients, who are either hospitalized or executing their normal daily life activities. Recently, the patient monitoring systems is one of the major advancements because of its improved technology. Currently, there is need for a modernized approach. In the traditional approach the healthcare professionals play the major role. They need to visit the patient's ward for necessary diagnosis and advising. There are two basic problems associated with this approach. Firstly, the healthcare professionals must be present on site of the patient all the time and secondly, the patient remains admitted in a hospital, bedside biomedical instruments, for a period of time.

In order to solve these two problems, the patients are given knowledge and information about disease diagnosis and prevention. Secondly, a reliable and readily available patient monitoring system (PMS) is required. In order to improve the above condition, we can make use of technology in a smarter way. In recent years, health care sensors along with raspberry pi play a vital role. Wearable sensors are in contact with the human body and monitor his or her physiological parameters. We can buy variety of sensors in the market today such as ECG sensors, temperature sensors, pulse monitors etc. The cost of the sensors varies according to their size, flexibility and accuracy.

In the past, the dominant products manufactured by medical device manufacturers are mainly those for

single parameter measurement. Nowadays however, a multi-parameter patient monitor is commonly used. Now in current industry the patient monitoring systems is available in two classes. Single parameters monitoring systems are capable for measuring only single physiological sign. It is quite old technology but nowadays, it is continue to be used in developing countries. The single parameter monitoring systems is available in very low cost and it is very easy to manufacturer and maintain. The single parameter monitoring system is available for measuring blood pressure of a human body, ECG (Electrocardiograph) monitor, SpO2 (Oxygen Saturation in Blood) monitor etc. A multi-parameter Patient Monitoring System (PMS) is used for multiple critical physiological signs of the patient to transmit the vital information like Electrocardiograph, Respiration Rate, Blood pressure etc.

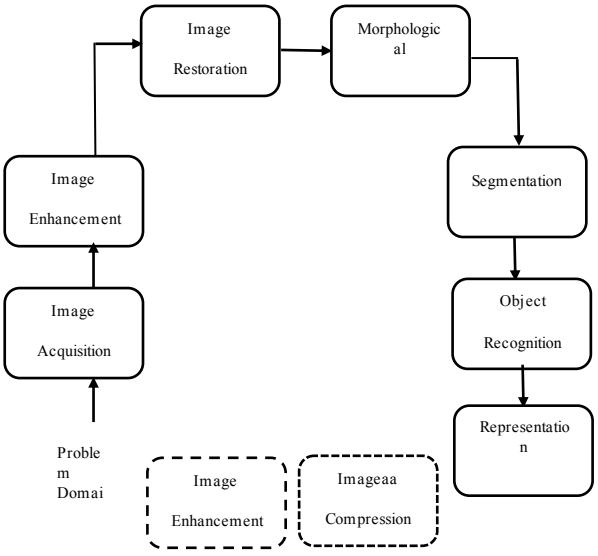


Figure Image processing Technique

Therefore, multi parameter PMS has always been occupying a very significant position Health is one of the global challenges for humanity. In the last decade the healthcare has drawn considerable amount of attention. The prime goal was to develop a reliable patient monitoring system so that the healthcare professionals can monitor the patients, who are either hospitalized or executing their normal daily life activities. Recently, the patient monitoring systems is one of the major advancements because of its improved technology. Currently, there is need for a modernized approach. In the traditional approach the healthcare professionals play the major role. They need to visit the patient's ward for necessary diagnosis and advising. There are two basic problems associated with this approach. Firstly, the healthcare professionals must be present on site of the patient all the time and secondly, the patient remains admitted in a hospital, bedside biomedical instruments, for a period of time

2.LITERATURE SURVEY

[1] In this paper, the leading field of data mining utilizes to all object to a specific group in classification. Medical image processing is associated physician diagnosis. It is used techniques like neural networks, k-nearest classification, fuzzy logic and vector machine.

[2]In this paper used identifies the heat distribution in a diabetic foot complication. It prevents the ulcers infections and amputation of the lower limb.

3.SOFTWARE DESCRIPTION

3.1 PROJECT DESCRIPTION

The proposed system that is going to be described in this phase is done using the Mat Lab Simulink model. In order to get the desired output, the simulation circuit has been designed in Mat Lab software by using the respective components that is present in the Mat Lab Simulink. This simulation circuit will be described in detail below.

3.2 MAT LAB SOFTWARE DESCRIPTION

MATLAB a high-performance language for technical computing integrates computation, visualization, and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notation. It is a prototyping environment, meaning it focuses on the ease of development with language flexibility, interactive debugging, and other conveniences lacking in performance-oriented languages like C and FORTRAN. While Mat lab may not be as fast as C, there are ways to bring it closer. We want to spend less time total from developing, debugging, running, and until obtaining results.

It is an interactive system whose basic data element is an array that does not require dimensioning. It

allows you to solve many technical computing problems, especially those with matrix and vector formulations, in a fraction of the time it would take to write a program in a scalar non interactive language such as C or FORTRAN. The name MATLAB stands for *matrix laboratory*. MATLAB was originally written to provide easy access to matrix software developed by the LINPACK and EISPACK projects. Today, MATLAB engines incorporate the LAPACK and BLAS libraries, embedding the state of the art in software for matrix computation. It has evolved over a period of years with input from many users. In university environments, it is the standard instructional tool for introductory and advanced courses in mathematics, engineering, and science. In industry, MATLAB is the tool of choice for high-productivity research, development, and analysis .Its features a family of add-on application-specific b solutions called *toolboxes*. Very important to most users of MATLAB, toolboxes allow you to *learn* and *apply* specialized technology. Toolboxes are comprehensive collections of MATLAB functions (M-files) that extend the MATLAB environment to solve particular classes of problems. You can add on toolboxes for signal processing, control systems, neural networks, fuzzy logic, wavelets, simulation, and many other areas.

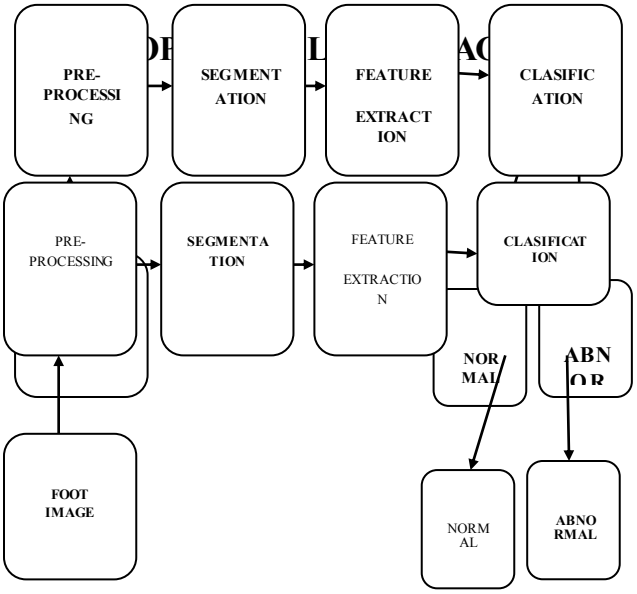
4.PROJECT DESCRYPTION

4.1 EXISTING METHOD

In the existing method we use, support vector machines (SVM) to determine the wound boundaries on foot ulcer images captured with an image capture box, which provides controlled lighting and range. After super-pixel segmentation, a cascaded two-stage classifier operates as follows: in the first stage, a set of k binary SVM classifiers are trained and applied to different subsets of the entire training images dataset, and incorrectly classified instances are collected. In the second stage, another binary SVM classifier is trained on the incorrectly classified set. We extracted various color and texture descriptors from super pixels that are used as input for each stage in the classifier training. Specifically, color and bag-of-word representations of local dense scale invariant feature transformation features are descriptors for ruling out irrelevant regions, and color and wavelet-based features are descriptors for distinguishing healthy tissue from wound regions.

4.2 PROPOSED METHOD

Diabetic Foot Ulcer (DFU) is a major complication of Diabetes, which if not managed properly can lead to amputation. DFU can appear anywhere on the foot and can vary in size, affected region, and contrast depending on various pathologies. Current clinical approaches to DFU treatment rely on patients and affected region, which has significant limitations such as the high cost involved in the diagnosis, treatment and lengthy care of the DFU. The aim of pre-processing is to convert the given thermal image into gray-scale image and to eliminate the above-mentioned filter unwanted images. We propose the Deep learning models proved to be powerful algorithms to retrieve hierarchies of features to achieve various tasks of computer vision. These convolution neural networks, especially classification networks have been used to classify various classes of objects by assigning discrete probability distribution for each class. But, these networks have limitations as they are not able to classify multiple classes in a single image and figure out the position of the objects in images.



4.3 BLOCK DIAGRAM EXPLANATION

4.3.1 IMAGE PRE-PROCESSING:

Once the image has been retrieved, methods can be used to enhance, reconstruct, or allow automated analysis so as to highlight or point out areas that may be of interest to the user. These will also be discussed here.

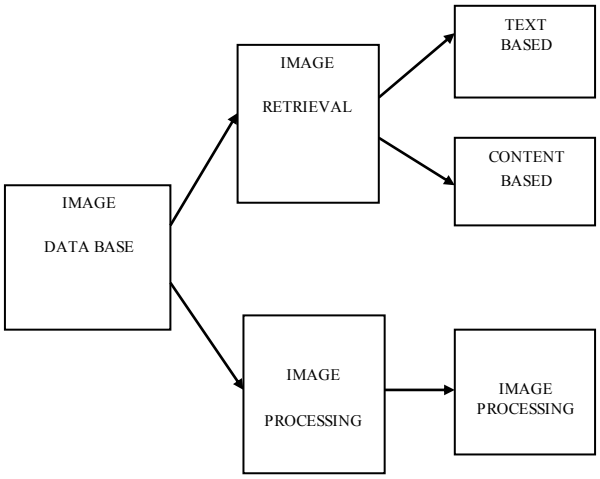


Figure Image processing technique

The first problem has to deal the vast labour required to manually annotate the images. The second difficulty is a result of the subjectivity in human perception – meaning different people may see things differently. This perceptual subjectivity may cause mismatches during retrieval.

4.3.2 PREPROCESSING:

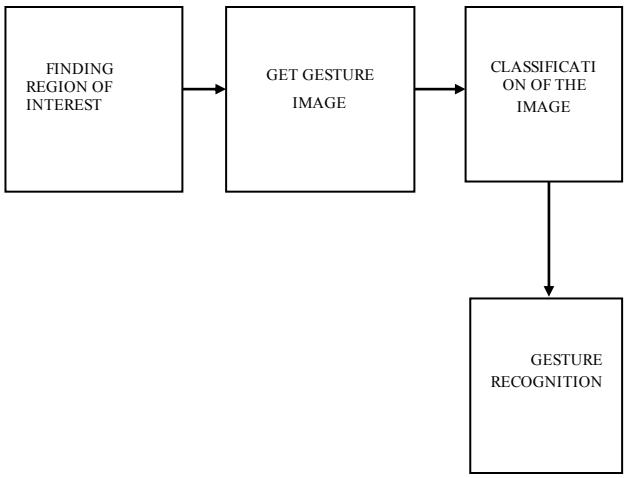


Figure Block diagram of preprocessing image

Analyzing the image quantitatively, the scanned histology slides were preprocessed once with, once without image registration the noise in both cases. Image de convolution was performed in after pre-processing to split the color image into channels. The channel image was used to generate a mask image, which separated the vessel sensitive region from the background.. The median filtering algorithm has good noise-reducing effects, but its time complexity is not desirable. The median filter that uses the correlation of the image to process the features of the filtering mask over the image

The proposed adaptive median filter preprocessing technique makes the histogram estimation of the image. Mainly preprocessing technique considers Image Enhancement that provides an accurate color variation in the image processing. Mainly the histogram analysis of a normal image refers as the histogram of pixel intensity and its values Pre-processing Techniques. Since most of the real life data is noisy, inconsistent and incomplete, so preprocessing becomes necessary. Image preprocessing is one of the Preliminary steps which are highly required to ensure the high accuracy of the subsequent steps. The CT and MRI cardiac images normally consist of some artifacts; patient specific and image processing and equipment based artifacts. Patient specific artifacts include motion beam hardening, metal artifact. Others include partial volume effect, ring and staircase artifacts. So it is needed to be removed by pre-processing procedures before any analyzing. The enhancement activities also used to remove the film artifacts, labels and filtering the images. Several de noising approaches have been surveyed and analyzed in this section.

i. Gabor Filters:

These primitive methods along with reducing the noise blur keeps the important and detailed structures necessary for subsequent steps. It is a linear filter used for edge detection. Frequency and orientation representations of Gabor filters are similar to those of the human visual

system, and they have been found to be particularly appropriate for texture representation and discrimination.

ii. Adaptive Filters:

It is developed for impulsive noise reduction of an image without the degradation of an original image. The image is processed using an adaptive filter.

iii. Morphological Operation:

Morphological techniques probe an image with a small shape or template called a structuring element. The structuring element is positioned at all possible locations in the image and it is compared with the corresponding neigh hood of pixels. Erosion and are the two fundamental operations. Erosion removes small-scale details from a binary image but simultaneously reduces the size of regions of interest. The dilation operation usually uses a structuring element for probing and expanding the shapes contained in the input image. In compound operations, many morphological operations are represented as combinations of erosion, dilation, and simple set theoretic operations such as the complement of a binary image. Opening is erosion followed by n and it is less destructive than erosion. Closing is followed by erosion. Closing is so called because it can fill holes in the regions while keeping the initial region sizes.

Mean Filters

The idea of mean filtering is simply to replace each pixel value in an image with the mean(average) value of its neigh, including itself. This has the effect of eliminating pixel values which are unrepresentative of their surroundings. Mean filtering is usually thought of as a convolution filter. Like other convolutions it is based around a kernel, which represents the shape and size of the neighborhood to be sampled when calculating the mean. Often a 3*3 square kernel is used, although larger kernels can be used for more severe smoothing. A small kernel can be applied more than once in order to produce a similar but not identical effect as a single pass with a large kernel.

Image Normalization

Normalization is a process that changes the range of pixel intensity values. Normalization is sometimes called contrast stretching or histogram stretching.

4.3 PREPROCESSING

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Step1:The pixels are read from the input images data's

Step2 : The affected-reducing performance of the median filter

$$\sigma_{med}^2 = \frac{1}{4nf^2_{\overrightarrow{(n)}}} \approx \frac{\sigma_i^2}{n+\frac{\pi}{2}-1} \cdot \frac{\pi}{2} \text{...(1)}$$

where V2i is input noise power (the variance), n is the size of the median filtering mask,)(nf is the where σ_i^2 is input noise power (the variance),in the size of the median filtering mask,$f \underset{(n)}{\rightarrow}$ is the function of the noise density.

$$\sigma_0^2 = \frac{1}{n}\sigma^2 \text{...(2)}$$

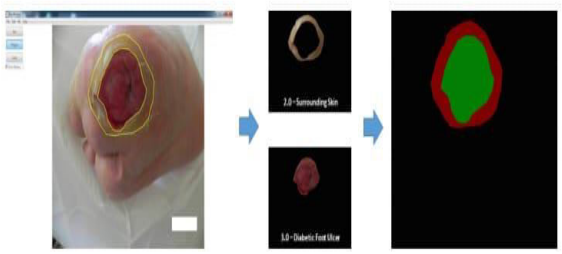
Step 3: Improvement of the filtering mask The filtering mask is mainly square mask or cross mask. Considering of the symmetry of the mask, n is commonly odd.

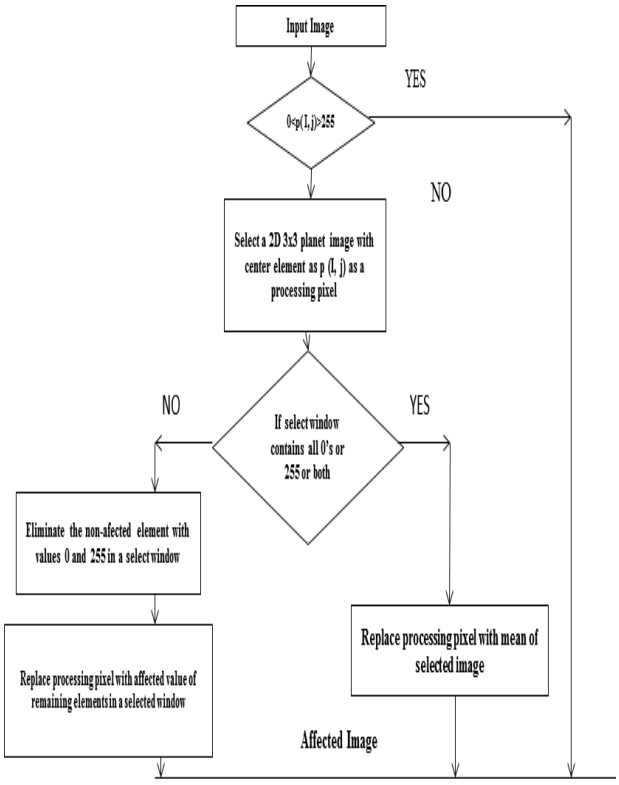
Step 4: The improved algorithm two improvements compared to the conventional median filtering algorithm.

Step 5: Comparative experiment among the standard median filtering algorithm, the fast median

Step 6: Filtering algorithm based on average and the improved algorithm in 10%, 35%, and 45% density impulse noises are respectively added to the original image of ulcer foot image.

Step 7: End image.





CONCLUSION

Our method would be extended to detect depth of diseases and ulcer complications of the diseases by analyzing with more number of images and in real time basis images can be captured by designing with good efficiency and can be subjected to further processing. There are various methods to diagnose diabetes which are invasive techniques. Infrared thermograph is a promising modality for such a system from which diabetes is noninvasively detected using the foot images. The temperature differences between corresponding areas on feet are the clinically significant parameters. Therefore, we demonstrated how reducing the number of layers and number of neurons in FC layers using the bespoke architecture of DFU Net markedly reduced processing time, while also achieving higher sensitivity and specificity.

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