MACHINE LEARNING BASED DIABETICS WOUND RECOGNITION USING POLY APPROXIMATE ALGORITHM

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Abstract - This project presents a highly portable and non-Invasive method of finding wound measurement information using depth image from live video camera and RGB image from poly approximation. The aim of project is to contribute towards non-contact wound measurements, by employing a cheap and readily available RGB and as a better alternative to manual wound measurement which is performed quite predominantly even today by most of the clinicians. The application provides the user with threefold information about the wound, its depth, area and volume which are computed and displayed automatically. The user can view these parameters within a minute of capturing the pictures of the wound along with a 3D wound image. Then data will send to system, through the console image processing. The wound depth provided to the user can be used for judging the severity of the wound or for monitoring normal skin, diabetic wound and other wound. Furthermore, our proposed method for diabetic wound, normal skin and other wound measurement can be useful not only in hospitals but also for wound assessment of patients living in remote areas or those unable to visit a doctor. This wound recognition is designed by using poly approximation algorithm.

Keywords - RGB image processor, poly approximation algorithm, normal skin, diabetic wound and other wound.

I. INTRODUCTON

When projected later, the costs of treating, caring for, and preventing wounds are significant for medical services. According to, there has been an upsurge in fatality rates linked to particular wound diseases in recent years. Significant health effects result from this, particularly for at-risk groups like senior citizens. To make the right diagnosis and choose a course of therapy, a precise wound assessment is essential. Typically, this assessment is carried out visually, utilizing established scales or indices. However, it has been demonstrated that this strategy is ineffective for dealing with wound diagnosis. New applications in healthcare and medicine have been made possible by information and communications technology (RGB color). Desk research has produced a number of health-related applications, including the teaching and learning of clinical medicine, employing eyeglasses to record medical discoveries, and using marker-less augmented reality in forensic medicine, among others. Within this context, a particular category of cutting-edge applications that make use of camera technology and are focused on wound analysis has emerged. For diabetic patients, it can be challenging to recognizes wounds in the early stages. This procedure will assist patients in recognizing and treating wounds in the early stages. Through this project, it will be simple to determine whether a person's skin is normal, diabetic, or normal, allowing them to receive treatment quickly.

II. REVIEW CRITERIA

An early diagnosis of diabetes is the project's key goal. Some people treat diabetic wounds incorrectly, treating them as though they were normal wounds. This project is being implemented to show whether a wound is diabetic or not, preventing such incorrect predictions and treatments. To start treatment sooner, at the very beginning. This initiative is also intended for those who are unable to make the effort to treat diabetic wounds until it is too late. To lower the amount of money spent on determining whether a wound is diabetic or not.

III. LITERATURE SURVEY AND RELATED WORKS

[1] S. Zahia, D. Sierra-Sosa, B. Garcia-Zapirain, and A. Elmaghraby, ''Tissue classification and segmentation of pressure injuries using convolutional neural networks,'' Comput. Methods Programs Biomed., vol. 2022.
In conclusion, these methods all use manually created picture descriptors along with unsupervised methods for classification, which might not be able to tell between comparable wound attribute sub-classes. Deep neural networks are increasingly being employed for wound image evaluations as a result of their performance in numerous computer vision and image analysis applications. In order to assess wound image data, convolutional neural networks (CNNs) are the most often employed architectures.

[2] Iraj, B.; Khorvash, F.; Ebneshahidi, A.; Askari, G. Prevention of diabetic foot ulcer. Int. J. Prev. Med. 2018.
Infection and inadequate micro- and macrovascular tissue perfusion can lead to lower limb amputation. In order to avoid future complications, a diabetic patient with a "high-risk" foot requires regular doctor appointments, continued expensive medication, and hygienic personal care.

[3] Cavanagh, P.; Attinger, C.; Abbas, Z.; Bal, A.; Rojas, N.; Xu, Z.R. Cost of treating diabetic foot ulcers in five different countries. Diabetes/Metab. Res. Rev. 2019, 28, 107–111.
Patients and their families are put under a significant financial strain as a result, especially in developing countries where the cost of treating this illness can equal as much as 5.7 years of annual income.

[4] Reyzelman, A.M.; Koelewyn, K.; Murphy, M.; Shen, X.; Yu, E.; Pillai, R.; Fu, J.; Scholten, H.J.; Ma, R. Continuous temperature monitoring socks for home use in patients with diabetes: Observational study. J. Med. Internet Res. 2020.
The early detection and improved classification of foot issues may enable prompt intervention and proper therapy to either heal foot ulcers or halt the progression of amputation. Self-diagnosis at home and early observation may be beneficial in halting the start and progression of DFU. Eye inspection, the simplest monitoring technique, has some limitations, including the inability of those with obesity or vision impairment to effectively recognize minor changes.

[5] Pham, T.C.; Luong, C.M.; Hoang, V.D.; Doucet, A. AI outperformed every dermatologist in dermo scopic melanoma diagnosis, using an optimized deep-CNN architecture with custom mini-batch logic and loss function. Sci. Rep. 2021.
Finding the area of interest on each dermo copy image, as well as asymmetrical skin lesions and a variety of skin colours, are the major challenges in the field of DFU identification. You must be an authority in this field to define minute alterations in skin. A human-eye test, however, might miss these minute differences. In this regard, deep learning techniques can help doctors, possibly saving countless lives.

[6] Simonyan, K.; Zisserman, A. Very deep convolutional networks for large-scale image recognition. arXiv 2014
The image net large-scale visual recognition challenge (ILVRC) was awarded its first place in 2012. It has eight layers, three of which are completely linked layers and five of which are convolutional layers. Maxpooling layers are placed after the first two convolutional layers. The third, fourth, and fifth convolution layers are directly related. Following the fifth convolution layer is the maxpooling layer, and the output of the maxpooling layer is passed to the fully connected layer. The softmax classifier is used in the final fully connected layer for classification.

IV. EXISTING SYSTEM

- Diabetic patients have a tough time identifying wounds.
- Designed gadgets with sophisticated algorithms.
- It is expensive and unreliable to use.
- Augmented reality with no markers, among other applications in forensic medicine.
- New methods of wound diagnosis are essential since wound healing can be difficult in many disorders..

DISADVANTAGE

- In order to address various elements of wound diagnosis, image processing and computational intelligence approaches have thus not been used in various research.
- You should go to the doctor frequently to recuperate, which takes a long time.

V. PROPOSED SYSTEM

- It detects the wound and records it through the preprocessor image's first preparation of the data for primary processing or for additional analysis.
- In digital image processing and analysis, the segmentation of images approach is used to divide a picture into several portions or areas, frequently depending on the properties of the pixels in the image.
- Edge detection is a method of image processing that locates the edges of objects in pictures. A feature of the image will be extracted through the texture detection process, which will then apply edge detection to filter the image. Finally, a poly approximation algorithm that has been developed for wound detection, whether it be for normal skin, a diabetic wound, or another type of wound, will be used to access the data base.
- The image processor will next determine whether the wound is on normal skin, a diabetic wound, or anything else. Even before the diabetic patient can recognizes it, this small region of wound is known.

ADVANTAGES

- This wound will make it simple to identify it before it becomes a major issue, allowing for early treatment.
- Low cost and steady use efficiency.

VI. ARCHITECTURE DESIGN

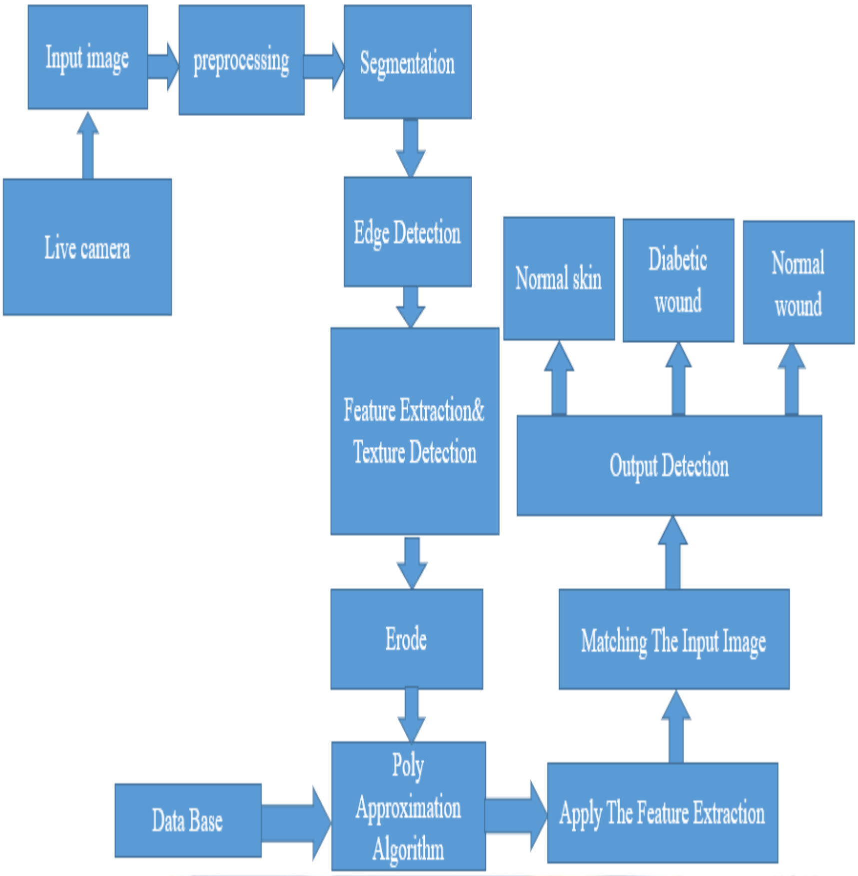


Fig.1. : Block diagram of proposed system

VII. MODULES

- **Input Module** - In this video processing, 25 frames per second will be reduced to one frame per second while a live video camera records facial expression. Pre-processing is the technique of extracting the wound from a single image once it has been converted and then removing the blur from the image.
- **open cv Module -** A Python package called OpenCV makes it possible to carry out image processing and computer vision tasks. It offers a variety of functions for tracking wounds. Then, during a process known as segmentation processing, all background images are disregarded and only the image's wound is extracted. After this segmentation processing is finished, the edges of the wound are all tracked to extract wound feature information. Image noise will be removed in order to remove the error in the image.
- **Database Module -** Thousands of photos have been gathered for testing and training on normal skin, diabetic wounds, and normal wounds in this database module. This data set is gathered to enable more precise and effective forecasting. The dataset is trained to identify if a wound is normal or diabetic.
- **Wound detection Module -** The trained and tested dataset is implemented with the poly approximation method in the wound detection module enabling absolute prediction at a very early stage. This polyaproximate algorithm will examine every pin-to-point of a wound to determine whether it is a normal wound or a wound caused by diabetes.
- **Output Module -** Through the use of a live camera feed, the output module will indicate whether the wound is on normal skin, a diabetic wound, or something else entirely.

VIII. PREPROCESSOR

The process of converting an image into a digital format and carrying out specific procedures to extract some usable information from it is known as image processing. When implementing specific specified signal processing techniques, the image processing system typically interprets all images as 2D signals.

TYPES OF IMAGE PROCESSING

- **Retrieval -** Browse and search through images from a large database of digital images that are similar to the original image.
- **Sharpening and restoration -** Create an enhanced image from the original image.
- **Pattern recognition -** Measure the various patterns around the objects in the image.
- **Visualization -** Find objects that are not visible in the image.
- **Recognition -** Distinguish or detect objects in the image.

COMPONENTS OF IMAGE PROCESSING

Computer
An image processing system uses a general-purpose computer, which could be anything from a PC to a supercomputer. To achieve a given level of performance, purpose-built computers are occasionally used in specialised applications.
Equipment for Sophisticated Image Processing
It consists of the digitizer and hardware that can do fundamental operations, such as an Arithmetic Logic Unit (ALU), which can process complete images while simultaneously performing arithmetic and logical calculations.
a lot of storing

Massive Storing
The ability is crucial for apps that use image processing. The following are the three primary types of digital storage for applications involving image processing: exist (1) short-term storage, (2) online storage for quick recall (3) archive storage, which is characterized by rare access.

Camera Storing
It makes reference to perception. Incoming light is captured by the image sensor, which then converts it into an electrical signal, measures it, and outputs the result to supporting electronics. It is made up of a two-dimensional arrangement of light-sensitive elements that change photons into electrons. Equipment like digital cameras use image sensors like CCD and CMOS to capture images. When collecting digital photos, image sensors frequently require two components. The first is a real device (sensor) that can identify the energy released by the thing we want to turn into an image of. The output of a physical sensing device is converted into digital form by a digitizer, which is the second component.

Image Display
The image processing software is made up of specialized modules that perform certain tasks.

Hardcore Equipment
A few examples of the devices used to record images are laser printers, film cameras, heat-sensitive equipment, inkjet printers, and digital technology including optical and CDROM discs.

Networking
It is a requirement to transmit visual data across a networked computer. Since image processing applications require enormous amounts of data, bandwidth is the most crucial component of picture transmission.

FUNDAMENTAL IMAGE PROCESSING STEPS:

Image Acquisition
The initial stage of image processing is image acquisition. In image processing, this stage is often referred to as pretreatment. The image must be retrieved from a source, typically one that is hardware-based.

Image Enhancement
Image enhancement is the technique of bringing out and emphasizing specific interesting characteristics in a hidden image. Changing the brightness, contrast, etc., can do this.

Image Restoration
Image restoration is the process of improving the appearance of an image. However, unlike image enhancement, image restoration is done using certain mathematical or probabilistic models.

Color Image Processing
Color image processing includes a number of color modeling techniques in a digital domain. This step has gained prominence due to the significant use of digital images over the internet.

IX. SEGMENTATION

In the region-based segmentation techniques, the algorithm divides the image into various components with corresponding properties to create segments. Simply told, these parts are nothing more than a collection of pixels. In the beginning, region-based image segmentation techniques look for some seed points in the input image, which could be smaller fragments or noticeably larger chunks
and select all of the pixel areas that met the requirements. As opposed to the region growth algorithm, this is a divide and conquer strategy.
The split process, which is only one half of the process, leaves us with numerous similarly marked regions dispersed throughout the pixels of the image. As a result, the final segmentation will include dispersed clusters of nearby regions with the same or similar characteristics. We must perform merging to finish the process, which compares nearby regions after each split and, if necessary, combines them based on degrees of similarity. These programmes are known as split-merge algorithms.

The seed points are then either further reduced or shrunk to smaller segments and merged with other smaller seed points, or more pixels are added to the seed points. Consequently, this method is based on two fundamental techniques.

Region Growing

It's a bottom-up approach in which we start with a smaller set of pixels and gradually or iteratively add to them in accordance with predetermined similarity requirements. The region growth algorithm begins by selecting a random seed pixel within the image and comparing it to its surrounding pixels.

The size of the zone is expanded by adding adjacent pixels to the initial seed pixel if there is a match or resemblance. The algorithm now selects another seed pixel, which unavoidably does not belong to any region(s) that are currently existing and starts the process anew when we hit the saturation and, consequently, the growth of that region cannot progress further.

Methods for expanding regions frequently produce good segmentation that closely matches the edges that may be seen. However, occasionally allowing a region to fully develop before attempting other seeds usually biases the segmentation in favor of the regions that are segmented first. Since no single region is allowed to completely dominate and grow, most algorithms start with user inputs of similarities first, allowing multiple regions to grow concurrently.

Like thresholding, region growth is a pixel-based method, however unlike thresholding, it only extracts neighboring pixels rather than a larger region based on similar pixels from anywhere in the image. For noisy photos, it is recommended to use region-growing algorithms because it is very challenging to detect the edges

Region Splitting and Merging

Region splitting and region merging are two fundamental approaches that are combined in the splitting and merging based segmentation methods to segment an image. While merging involves combining adjacent regions that are somewhat similar to one another, splitting involves repeatedly dividing an image into regions with similar properties.

In contrast to region development, a region split views the full input image as the area of business interest. Then, it would attempt to match a predetermined set of parameters or similarity constraints

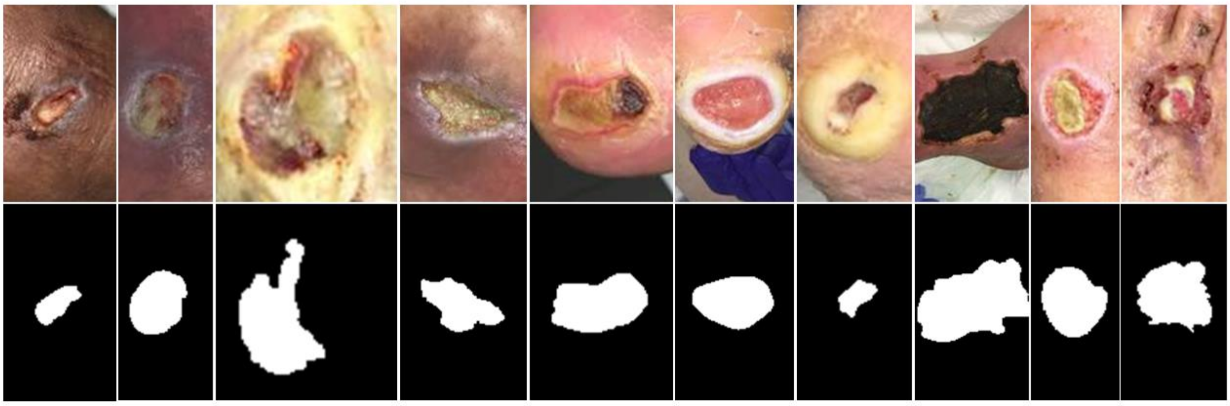


Fig.2. : Region splitting and merging

X. Edge Detection

When performing edge detection, we compute regions of an image with varying intensities using matrix math. Extreme changes in pixel intensity typically show an object's edge in those regions. We have identified all of the edges in a picture after identifying all of the significant differences in intensities. In image processing, Sobel Edge detection is a popular edge detection approach. Sobel is one of the most widely used edge detection algorithms in modern technology, along with Canny and Prewitt.

Math behind algorithm

When using Sobel Edge Detection, the image is processed in the X and Y directions separately first, and then combined together to form a new image which represents the sum of the X and Y edges of the image. However, these images can be processed separately as well. This will be covered later in this document.

When using a Sobel Edge Detector, it is first best to convert the image from an RGB scale to a Grayscale image. Then from there, we will use what is called kernel convolution. A kernel is a 3 x 3 matrix consisting of differently (or symmetrically) weighted indexes. This will represent the filter that we will be implementing for an edge detection.

When we want to scan across the X direction of an image for example, we will want to use the following X Direction Kernel to scan for large changes in the gradient. Similarly, when we want to scan across the Y direction of an image, we could also use the following Y Direction Kernel to scan for large gradients as well.

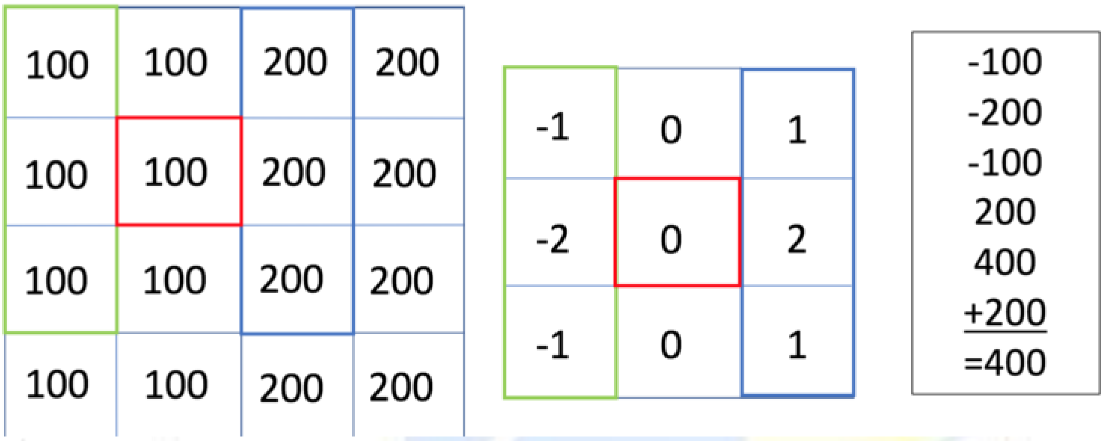
X – Direction Kernel

-1	0	1
-2	0	2
-1	0	1

Y – Direction Kernel

-1	-2	-1
0	0	0
1	2	1

By using Kernel Convolution, we can see in the example image below there is an edge between the column of 100 and 200 values.



This Kernel Convolution is an example of an X Direction Kernel usage. If an image were scanning from left to write, we can see that if the filter was set at (2,2) in the image above, it would have a value of 400 and therefore would have a fairly prominent edge at that point. If a user wanted to exaggerate the edge, then the user would need to change the filter values of -2 and 2 to higher magnitude. Perhaps -5 and 5. This would make the gradient of the edge larger and therefore, more noticeable.

Once the image is processed in the X direction, we can then process the image in the Y direction. Magnitudes of both the X and Y kernels will then be added together to produce a final image showing all edges in the image.

XI. POLYGONAL APPROXIMATION ALGORITHM

An essential method in digital image processing is the polygonal approximation of arbitrary two-dimensional curves. The widely accepted method for this purpose is to represent lines and borders using polygons that have a minimum or a small number of vertices that satisfy a specified fit criterion. The accuracy of the approximation procedure depends on how many line segments are utilized to create a polygon. An algorithm must not have more sides than are necessary to maintain the curve's true shape in order to be efficient and accurate. A polygon that has been formed in this way using just the bare minimum of necessary line segments is frequently referred to as a Minimum Perimeter Polygon. An estimated polygonal figure with more edges increases the model's source of noise. The red-hued vertices in the figure below represent the polygon that was drawn from the image's curved shape. When these vertices are connected as the blue lines indicate, they form the simple polygon P. The non-essential bends and curves are eliminated by the polygon approximation, leaving us with a discrete figure that is enclosed by line segments. A straightforward polygonal region in the plane that is surrounded by a closed, non-self-intersecting polygonal path makes up the final image. The polygonal route, often known as the boundary, is a component of the polygon.

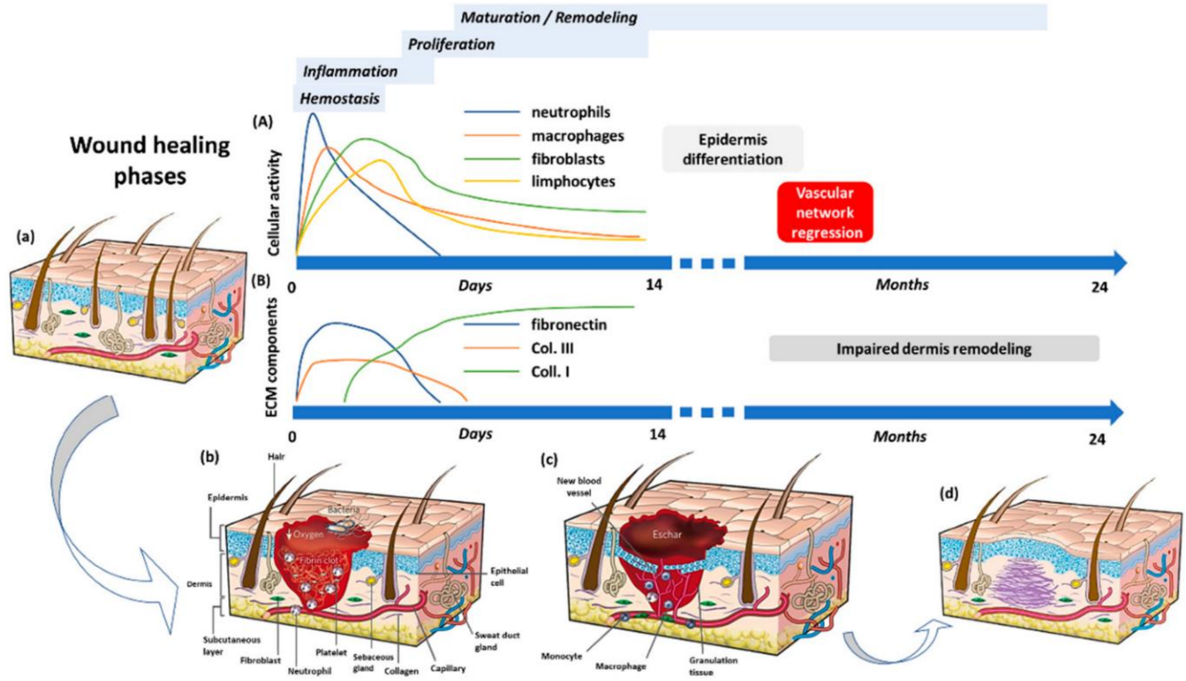


Fig.3. : Illustration of Polygon Approximation of Polygon

The polygon with red vertices in the accompanying graphic is drawn from the image's curved outline. The blue lines connect the vertices to create a straightforward polygon P. By using the approximation of minimal fitting polygon technique, non-essential bends and curves are eliminated, leaving us with a figure that is enclosed by lines. A straightforward polygonal region in the plane that is surrounded by a closed, non-self-intersecting polygonal path makes up the final image. The polygonal route, often known as the boundary, is a component of the polygon.

A closed curve's vertices, or segments of straight lines, serve as the definition of a polygonal approximation. The intended degree of any approximated curve determines the accuracy of the polygon. In order to represent a curve and eliminate noisy points from the curve, it is practical to suppress collinear points that lack meaningful information to represent the shape. Such a representation makes it easier to abstract large features for the purpose of describing and categorizing curves. There are two popular solutions to this issue.

- Criterion Function, Absolute Error, and Integral Square Error The contour points are broken into separate chunks using this method in order to quantify the collinearity those points suffer when a given criterion is met. For this method, polygonal approximation is considered a side detection problem.
- The second method reduced the number of contour points to just the most important ones, and those points were then taken into account while estimating polygons. For this method, the problem of angle detection is considered to be a polygonal approximation. The curve was divided into smaller chunks using earlier methods, which were repeated until the maximum perpendicular distance between a point and the chunk's beginning and finish fell inside the predetermined acceptability value. In some other studies, the curve is divided into smaller pieces iteratively until the gap between the points on an approximating curve within each piece is smaller than a predetermined acceptability value. Some people employ the split-and-merge strategy, which involves merging two curves when the error value is too low and dividing up the curve iteratively when the error value is too high. The process that follows fits lines to a preliminary boundary point segmentation and calculates least squares error. The first segmentation of the split and merging is problematic. Others claim that the top left corner and the bottom right corner can be taken into account when determining the closed curve's initial break point. In the split-and-merge method, the first segmentation is determined by breaking the curve up into the right number of segments. The various strategies have thus far been outlined along with their drawbacks. Let's talk about how the solution is just an approximation. For the polygonal approximation of digital planar curves, numerous algorithms have been presented, although the majority of them struggle with this issue.
- min-#: This specifies the maximum distortion value that may be used while approximating the number of points that should be utilized to depict a polygon. To roughly resemble the polygon and maintain efficiency, the threshold value will serve as a limit.
- min-: Choosing the minimum number of points necessary to approximate the polygon while maintaining efficiency. Several algorithms were proposed to solve those problems, but they are all computationally expensive. Split-based, merge-based, and split-merged-based algorithms were proposed to reduce the computational cost. Dynamic programming and graph-based algorithms address this problem optimally and produce an optimal solution, but high computation is necessary. The quality of the suboptimal polygonal approximation obtained via suboptimal techniques is frequently used to derive optimal polygonal approximations. Commonly poor techniques aim to identify the dominating points that define a form. This less-than-ideal approach minimizes the collinear points that are unimportant for the shape while interacting directly with the polygon's original

outlines. Identifying the initial set of candidate points/breakpoints and dealing with the noise are the issues with this strategy. Numerous studies found that the issue could be solved by reducing noise in the first iteration and identifying the initial set of breakpoints. The initial set of breakpoints can be improved in a novel approach that allows for a majority computation time reduction while improving the quality of the estimated polygon, as suggested by some earlier publications. An approach to NP-completeness for an optimization problem is an approximation algorithm. The optimal answer is not always ensured by this method. The approximation algorithm aims to reach the ideal answer in polynomial time as close as possible. These algorithms are referred to as heuristic or approximation algorithms.

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Features of Approximation Algorithm : Here, we'll go through the characteristics of the approximation algorithm.
Although it does not ensure the best outcome, an approximation algorithm guarantees to run in polynomial time.
An algorithm for approximations ensures the search for highly accurate and superior solutions (let's say within 1% of optimal).
With the aid of approximation techniques, an optimization issue can be solved in polynomial time with a result that is close to the (optimal) solution.

Scenario-1: Let's say we are trying to discover a close to optimal solution to an optimization problem where each possible answer has a cost. Depending on the issue, we might characterize an optimal solution as either having the highest conceivable cost or the lowest possible cost, i.e., a maximization or minimization problem.
If, for any input size n, the cost C of the solution generated by the algorithm is within a factor of P(n) of the cost C* of an ideal solution, then we say that the algorithm has an appropriate ratio of P(n). Maximum (C/C*, C*/C) = P(n).

Scenario-2: We refer to an algorithm as a P(n)-approximation algorithm if it achieves an approximation ratio of P(n). The ratio of C*/C provides the factor by which the cost of an optimal solution exceeds the cost of the approximate technique for maximization problems where 0 C C*. When solving a minimization problem, the ratio of C/C* indicates the amount by which an approximate solution is more expensive than an ideal one. ISE(Integral Square Error) / Absolute Error / Criterion Function, by using this approach the contour points are divided into different chunks and to measure the collinearity those points are experienced for any specific criterion to satisfy. Polygonal approximation is deliberated as a side detection problem for this approach.

XII. RESULTS

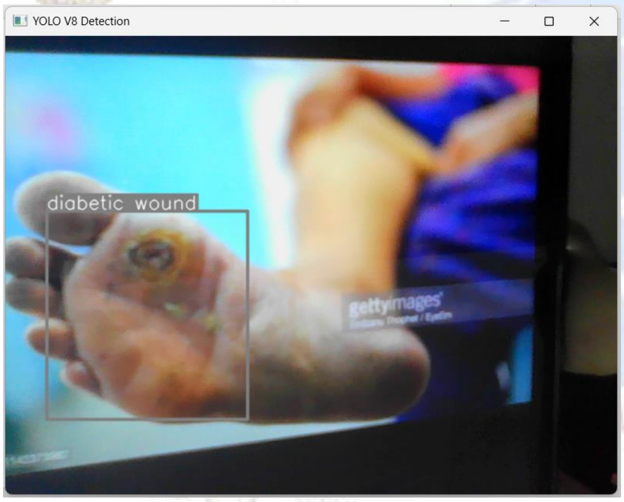

Fig.4.1 : Diabetics Wound

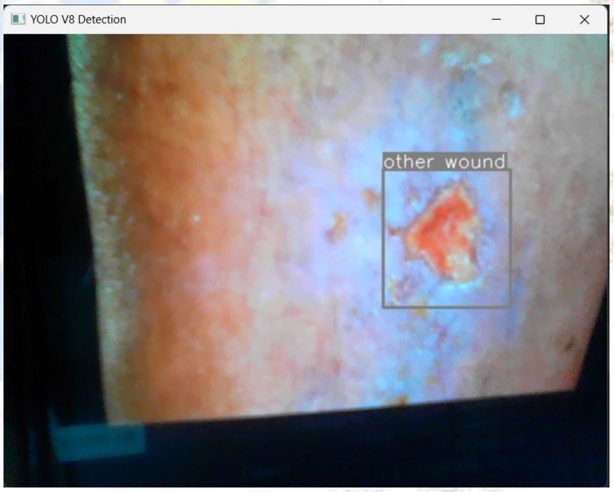

Fig.4.2 :Other Wound

XIII. TRENDS AND FUTURE DIRECTIONS

Resistive random-access memory (RRAM or ReRAM), a type of nonvolatile storage, has the capacity to alter the resistance of the solid dielectric material it is comprised of. Memristors used in ReRAM-enabled devices have variable resistance based on applied voltage. ReRAM causes oxygen vacancies, which are structural defects in an oxide layer. Similar to the electrons and holes in a semiconductor, these vacancies represent two values in a binary system.
ReRAM has a faster switching rate than other nonvolatile storage systems like NAND flash. It also boasts a high storage density and guarantees to consume less power than NAND flash. ReRAM is a fantastic memory option for sensors used in industrial, automotive, and internet of things applications because of this. Vendors have labored for years to create ReRAM technology and put chips into production. Now, a few sellers are shipping them.

Similar to Intel's Optane, 3D XPoint technology may eventually fill the gap between dynamic RAM and NAND flash memory. In the cross-point design of 3D XPoint, there are selectors and memory cells at the intersection of perpendicular wires. Despite the nonvolatile nature of 3D XPoint memory, it is slower as compared to DRAM.

XIV. CONCLUSION

The steps required for identifying normal skin, diabetic wounds, and other wounds via video processing are examined in this article. Since the erode filter offers the best joint localization in both special domains, it is used for segmentation. The categorization outcome demonstrates the identification and labelling of three different tissue types. However, the outcome needs to be verified using factors like accuracy. Additionally, this wound detection system needs to be validated using a larger data set of wound images, and the performance of various segmentation and classification algorithms based on various color, textural, and statistical features need to be explored.

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