CHAPTER -1

INTRODUCTION

1.1. Overview

Melanoma is the most dangerous abnormal skin tissue. Its treatment requires chemotherapy and radiotherapy and it becomes more difficult to treat when it is in advanced stages such as metastasis step, where one person die each 54 minutes. The statistics show that approximately 132, 000 melanoma cases and 2 to 3 millions of non-melanoma cases are reported annually in the world. In total, it accumulates to 1.6% of cancer cases worldwide. Despite the rarity of this diseases, the vast majority of persons affected by malignant skin cancer deaths within two years. As ozone levels are depleted, the World Health Organization (WHO) estimates that 10% of decrease in ozone level will result in an additional of 300, 000 non melanoma and 4500 melanoma cases. According to WHO and Let al., Caucasian populations generally have a much higher risk of getting skin cancer disease than dark-skinned populations [1].

Naturally, brown and black people can usually safely tolerate relatively high levels of sun exposure without getting sunburns or greatly increasing their skin cancer risk. In con- trast, people with pale or freckled skin, fair or red hair and blue eyes belong to the highest risk group. Followed by people with dark hair and eyes who do not normally get sunburns are at medium risk of skin cancer developing.

According to the World Health Organization, the following items present a set of risk factors of skin cancer: fair skin; blue, green or hazel eyes; light-coloured hair; tendency to burn rather than suntan; history of severe sunburns; many moles and/or freckles; a family history of skin cancer. In the United States and worldwide, skin cancer incidenct is reported as one of the most increasing tumor. The risk of developing invasive melanoma was estimated to 1 in 39 of Caucasian men and 1 in 58 for Caucasian women in American society in 2010.

1.2. Causes of Skin Cancer

Cancer starts when cells in the body begin to grow out of control. Cells in early any part of the body can become cancer, and can then spread to other areas of the body. Similarly, skin cancer is the uncontrolled growth of abnormal skin cells.

It occurs when unrepaired DNA damage to skin cells, most often caused by ultraviolet radiation from sunshine or tanning beds, triggers mutations, or genetic defects, that lead the skin cells to multiply rapidly and form malignant tumors**.**

1.3. Types of Skin Cancer

The multitude of benign and malignant melanoma complicates the recognition of skin lesion cases. In the clinical practice, three main types of abnormal skin cells are noticedi.e. *Basic cell carcinoma*, *Squamous cell carcinoma* and *Melanoma* .The Skin Cancer Foundation (SCF) [2], further into these, characterizes three more kinds of ab-normal cells, i.e., *Actinic keratosis*, *Merkel cell carcinoma* and *Atypical moles*, which are less common. Figure 1.1 illustrates the six types of skin lesions. It notices also that the atypical moles are the second most dangerous cells after melanoma cases

Figure 1.1 Different kinds of skin cancers classified by the Skin Cancer Foundation

According to Skin Cancer Foundation, the difference between these abnormality tissues are:

- Actinic Keratosis, also known as a solar keratosis, is a crusty and scaly growth. It is considered as pre-cancer because if left alone, it could develop into a skin cancer.
- Merkel cell carcinoma is a rare and aggressive skin cancer that is at high risk of recurring and spreading (metastasizing) throughout the body. But, it is 40 times rarer than melanoma.
- Basic cell carcinoma is the most occurring form of skin cancer. It often looks like open sores, red patches, pink growths, shiny bumps or scares. This skin cancer very rarely spreads.
- Squamous cell carcinoma is the second most common form of skin cancer. It often looks like scaly red patches, open sores, elevated growths with a central depression, or warts.
- Atypical moles are unusual-looking benign moles, also known as dysplastic nevi. They may resemble melanoma, and people who have them are at increased risk of developing melanoma in a mole or elsewhere on the body. They have 10 times or more the risk of developing melanoma.
- Melanoma is the most dangerous form of skin cancer, these cancerous growths develop when unrepaired DNA damage to skin cells, mostly caused by ultraviolet radiation from sunshine or tanning beds, triggers mutations (genetic defects) that lead the skin cells to multiply rapidly and form malignant tumors. The majority of melanomas are black or brown, but they can also be skin-colored, pink, red, purple, blue or white. If melanoma is recognized and treated early, it is almost always curable, but if it is not, the cancer can advance and spread to other parts of the body, where it becomes hard to treat and can be fatal.

It is noticed that the first cause of these skin cancer types are the damage of skin tissue from exposure to radiation Moles, brown spots and growths on the skin are usually harmless — but not always. Anyone who has more than 100 moles is at greater risk for melanoma. The first signs can appear in one or more atypical moles. That's why it's so important to get to know your skin very well and to recognize any changes in the moles on your body. Look for the ABCDE signs of melanoma, and if you see one or more, make an appointment with a physician immediately.

Responsible for 75% of all skin cancer deaths. If melanoma is diagnosed and treated in its early stages, it can be cured but if the diagnosis becomes late, melanoma can grow deeper into the skin and spread to other parts of the body. It's spread in other parts beyond the skin can be hazardous as it is difficult to treat. The presence of Melanocytes in any body part causes the Melanoma. Intensive Exposure of skin to ultraviolet radiation is the main cause of the melanoma. Dermoscopy is a non-invasive examination technique based on the use of incident light and oil immersion to make possible the visual examination of sub surface structures of the skin. Though the detection of melanoma using dermoscopy is higher than unaided observation based detection3, it's diagnostic accuracy depends on the training of the dermatologist. The diagnosis of melanoma from melanocytic nevi is not straight forward especially in the early stage.

Thus, automatic diagnosis tool is essential for physicians. Even when the expert dermatologists uses the dermoscopy for diagnosis, the accuracy of melanoma diagnosis is estimated to be about 75-84%.4 The computer aided diagnostics is helpful to increase the diagnosis accuracy as well as the speed. Computer is not more intelligent than human but it may be able to extract some information, like color variation, asymmetry, texture features, that may not be readily perceived by human eyes. There have been many proposed systems and algorithms such as the seven-point checklist, ABCD rule, and the Menzies method2,3 to improve the diagnostics of the melanoma skin cancer.

The key steps in a computer-vision based diagnosis of melanoma are: image acquisition of skin lesion image, segmentation of the skin lesion from skin region, extraction of features of the lesion blob and feature classification. Segmentation or border detection is the process of separating the lesion from the surrounding skin in order to form the region of interest. Feature extraction is used to extract the features; similar to those visually detected by dermatologists, that accurately characterizes a melanoma lesion.

The feature extraction methodology of many computerised melanoma detection systems has been largely based on the conventional clinical algorithm of ABCD-rule of dermoscopy due to its effectiveness and simplicity of implementation. Its effectiveness stems from the fact that it incorporates the main features of a melanoma lesion such as asymmetry, border irregularity, colour and diameter (or differential structures), where quantitative measures can be computed

The skin protects against heat, sunlight, injury, and infection. Skin also helps control body temperature and stores water and fat. Skin cancer is the most common type of cancer. It usually forms in skin that has been exposed to sunlight, but can occur anywhere on the body [2]. The fair complexioned population has been liable for melanoma cancer. If it diagnosed in the early stage it is assurance to be medicable, otherwise it can penetrate into the skin and disperse all other parts of the body [8]. Vigorous exposure of ultraviolet ray to skin is the prominent source of melanoma. Though the detection of melanoma using dermoscopy is higher than unaided observation based detection, its diagnostic accuracy lean on the habitude of the dermatologist.

Each year close to 55,000 people suffered from this type of cancer. As compared with other types of cancer, melanoma is quite common to all [1]. The automatic diagnosis tool is crucial for medical practitioner. Even when the accomplished dermatologist uses the dermoscopy for diagnosis, the exactness of melanoma recognition is estimated to be about 75-84%.

The computer aided diagnostics is supportive to increase the diagnosis accuracy as well as the speed. Computer is not more brilliant than human but it may be able to obtain some information, like color variation, asymmetry, texture features, that may not be readily perceived by human eyes.

In recent years, Image processing techniques have been used to detect melanoma skin cancer by many researchers. Image processing plays a vital role for producing digital images with a good brighten/contrast and detail is a strong requirement in medical field like vision, biomedical image analysis, cancer detection and orthopedics.

Arushi Bhardwaj et al. discussed that the segmentation of skin lesion from the outer skin area either uses manual, semi automatic or fully automatic techniques.

For the early diagnosis of melanoma, it is required to be image acquision done on digital images. Harpreet Kaur et al. given a review that an imageprocessing technique involves treating the image as a two-dimensional signal and applying standard signalprocessing techniques to it. A.

Bono et al. says that the other studies report the circularity index, as a measure of borders in skin images. Nilkamal.S proposed the segmentation method for melanoma detection and it has been given that the goal of segmentation is transforming the image representation into a meaningful one for simplification in image analysis. In this process every pixel is assigned by a label, which will share same visual behaviors. Mangesh Patil et al. discussed about the automation of skin cancer diagnosis could deduct the false positive or false negative in clinical remedy. It has the difficulties of over segmented because of the textured lesion area

CHAPTER 2

LITERATURE REVIEW

Skin cancer recognition on CAD systems has been an active research area for more than 30 years back. For instance, many methods have been developed and explored for melanoma detection.

Korotkov and Garcia presented an interesting overview of used and explored methods on clinical and dermoscopic images from 1984 to 2012. Their review is organized following ABCDE criteria and other methods developed in clinical and computer-aided diagnosis system (CAD) from the data acquisition step to the classification and diagnosis.

Maglogiannis and Doukas have also presented in 2009 an overview on CAD system methods. A non-exhaustive comparison of the most important implementations is reported, specifically features selection such as color and border, and wavelet coefficients. They also presented the classifiers often used in the literature, such as Artificial Neural Network and Support Vector Machine.

Masood and Al-Jumaily in 2013 presented a review of techniques and algorithms used in skin cancer, and also a comparison of performances of these methods on skin lesion recognition. Recently, in 2015, Celebi et al presented a state of the art survey on the border detection methods. The authors evaluated the subjective and objective evaluations and their impact on the quality of segmentation results of skin border lesions

According to Capdehourat , the scoring system for ABCD rule,Where p_i represents the number of points attributed to each feature and w_i is the weight factorThe classification of the ABCD system scoring is based on two thresholds following the value of S_{abcd} given in equation. Therefore, if $S_{abcd} < 4.75$ the lesion is classified as benign, if $4.75 \leq S_{abcd} \leq 5.45$ the lesion is considered as clinically doubtful and if $S_{abcd} > 5.45$ then the lesion is classified as malignant. It can be seen from the table1.1that border irregularity feature has less impact, with variation from 0 to 0.8, comparing to other features with variation from 0 to more than 2.5.

The 7-point checklist was proposed by Argenziano et al, which is another variation of pattern analysis with fewer criteria for identification and analysis . The idea of 7-point checklist system is to attribute the score of 2 for major and 1 for minor criteria.The classification is performed following a fixed threshold equal to 3 separating the pigment lesions on two classes. Thus, the pigment is classified as benign if the total value is lower than 3 (Total $\leq$ 3), on the other side it is classified as malignant if the total is greater than 3 (Total > 3) as explained in the previous chapter. Argenziano et al in 2011 and Walter et al. in 2013 presented a new version of 7-point checklist to improve the accuracy of diagnosis.

Dolianitis et al compared 4 dermoscopic algorithms, ABCD rule, pattern analysis, Menzies method and 7-point checklist. The study showed that the best results are obtained by Menzies method with an accuracy of 81.1%, followed by ABCD rule with an accuracy of 79%, 7-point checklist is in the third place with an accuracy of 77.2% and in the last position, the pattern analysis algorithm. They reached the same conclusion that Carli et al, where 7-point checklist is more sensitive than ABCD rule and pattern analysis. However, in their study (Dolianitis et al.), the Menzies method showed the highest sensitivity of 84.6%, followed by 7-point checklist with 81.4% and ABCD rule with 77.5%, and finally, pattern analysis had the lowest sensitivity of 68.4%. On the other hand, the highest value of specificity of 85.3% is reported by pattern analysis followed by ABCD rule with 80.4% and Menzies method with 77.7% and in the last position 7-point checklist with a specificity of 77.2%. This study was conducted by the ground truth of sixty-one medical experts, but only on 40 melanocytic skin lesions.

CHAPTER 3

MELANOMA DETECTION USING IMAGE PROCESSING

Detection of skin cancer in the earlier stage is very Important and critical. In recent days, skin cancer is seen as one of the most Hazardous form of the Cancers found in Humans. Skin cancer is found in various types such as Melanoma, Basal and Squamous cell Carcinoma among which Melanoma is the most unpredictable. The detection of Melanoma cancer in early stage can be helpful to cure it. Computer vision can play important role in Medical Image Diagnosis and it has been proved by many existing systems. In this paper, we present a computer aided method for the detection of Melanoma Skin Cancer using Image processing tools. The input to the system is the skin lesion image and then by applying novel image processing techniques, it analyses it to conclude about the presence of skin cancer. The Lesion Image analysis tools checks for the various Melanoma parameters Like Asymmetry, Border, Colour, Diameter, (ABCD) etc

3.1 Image Acquisition

Image acquisition Dermoscopic images are basically digital photographs/images of magnified skin lesion, taken with conventional camera equipped with special lens extension. The lens attached to the dermatoscope acts like a microscope magnifier with its own light source that illuminates the skin surface evenly. There are various types of dermoscopy equipment,but all the use the same principle and allow registering skin images with x10 magnification and above. Due to light source integrated into dermatoscope lens, there happens to be problem with skin reflections.

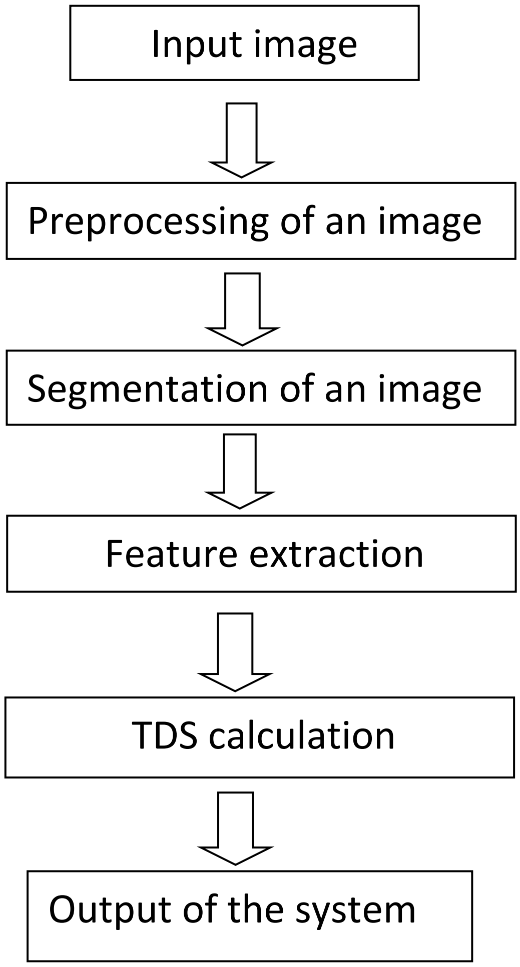


Figure 3.1 Flow chart

3.2 Image Preprocessing

Image pre-processing before analysis of any image set can take place, preprocessing should be performed on all the images. This process is applied in order to make sure that all the images are consistent in desired characteristic. When working with dermatoscopic images, pre-processing can cover number of features like: image illumination equalization, color range normalization, image scale fitting, or image resolution normalization. This can be dependent on defined prerequisites and methods applied in post processing. An example of elementary operation such as image normalization is the resolution matching.

Assuming that the image size in pixels is given, and all images are in the same proportion (e.g. aspect ratio of 4:3), It easy to find the images of smallest resolution and then scale the larger images to match the size of the smallest one. This operation allows calculating the features like lesion dimensions, lesion border length and lesions area coverage. It is possible to normalize the other parameters like color palette normalization, color saturation normalization, normalization of color components, and so on. Very common operation in preprocessing is color components normalization, known as the histogram equalization. Image histogram is the distribution of colors values in between extreme colors used in the palette. Assuming the situation where the brightest points of the grayscale image are not white and the darkest points are not black, performing histogram equalization will redistribute all the colors of the image in a way that brightest spot.

Figure 3.2 Original image

Figure 3.3 Enhanced image

3.3 Segmentation Techniques

3.3.1 Threshold Based Segmentation

Histogram thresholding and slicing techniques are used to segment the image. They may be applied directly to an image, but can also be combined with pre- and post-processing techniques.

3.3.2 Clustering Techniques

Although clustering is sometimes used as a synonym for (agglomerative) segmentation techniques, we use it here to denote techniques that are primarily used in exploratory data analysis of high-dimensional measurement patterns. In this context, clustering methods attempt to group together patterns that are similar in some sense. This goal is very similar to what we are attempting to do when we segment an image, and indeed some clustering techniques can readily be applied for image segmentation.

3.3.3 Edge Detection Based

When we know what an object we wish to identify in an image (approximately) looks like, we can use this knowledge to locate the object in an image. This approach to segmentation is called matching.

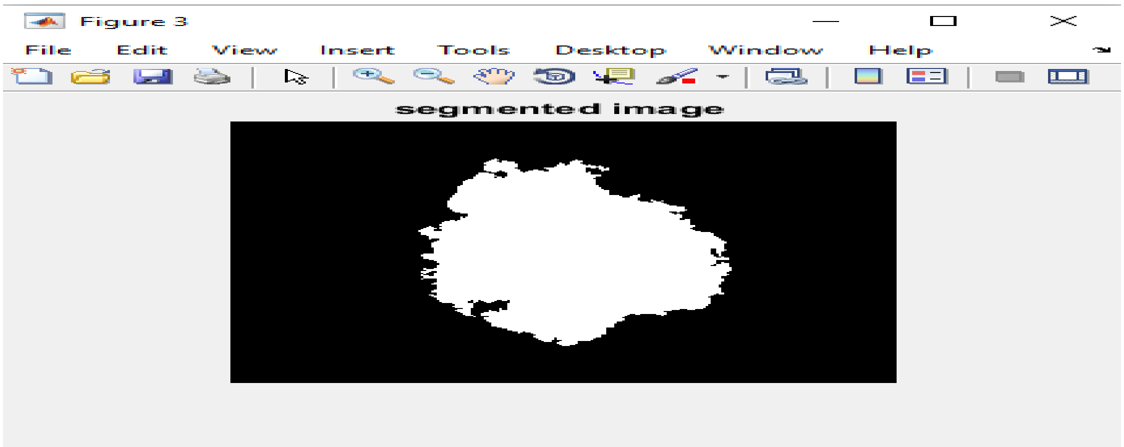


Figure3.4 Segmented image

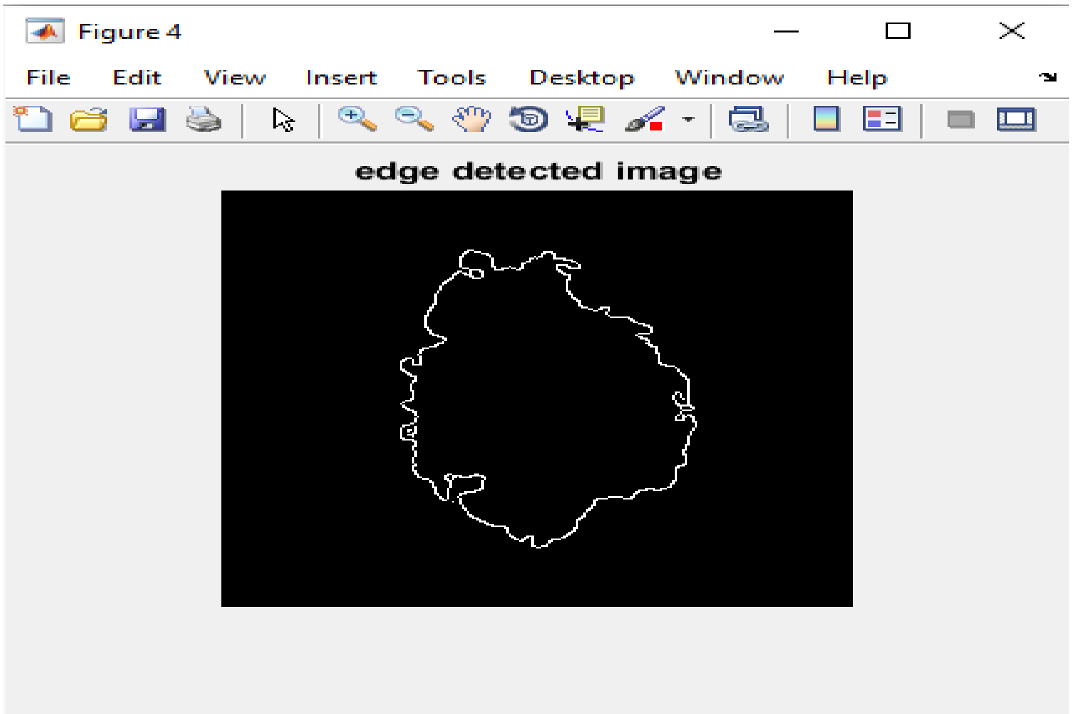


Figure 3.5 Edge detected image

3.4 Feature Extraction

As per ABCD rule the features which we need to extract include Asymmetry Index Border Color Index Diameter.

3.4.1 Asymmetry Index

Asymmetry Index is computed with the following equation:

$$AI=(A1+A2)/2Ar$$

Where, A1= Area of non-overlapped region along minor axis of the lesion.

A2= Area of non-overlapped region along major axis of the lesion.

Ar= Area of lession Implementation: Area of lesion(Ar) can be calculated using bwarea over the binary image of the segmented region.

For calculating non overlapped area over axis. The segmented region is divided along the lines passing through centroid of the region Two separate areas are generated which are then adjusted so that the areas will be overlapped by flipping one area. Using XOR over the area will generate the non-overlapped region whose area is calculated using bwarea function To generate area along x axis the bisection will be generated using first Gx pixels and the next Gx pixels along x axis and bisecting line on y axis. To generate area along y axis the bisection will be generated using first Gy pixels and the next Gy pixels along x axis and bisecting line on y axis. After calculating area of the regions Asymmetry index is calculated using the specifiedformula.

3.4.2 Border Irregularity

In order to calculate border irregularity, there are different measures such as: compactness index, fractal index, edge abruptness.

Compact Index: Compact Index can be determined by using the followingequation:

CI=(P2L)=(4AL)

Where, PL = Perimeter of the Lesion.

AL = Area of the Lesion.

Fractal Dimension: Fractal set is provided by the" box counting" method. It returns two variables whose differential log ratio provides the fractal dimension as the mean value along 4-8 index.

Edge Variation: Edge variation is calculated using the following equation

EI= ((Max Min) %6+2)/100;

Where, Max and min are length of major and minor axis. Axis lengths are calculated using regionprops function

3.4.3 Color Index:

Color index is calculated by converting the input image to hsv image value by checking the presence of the following colors. Length of all the available pixels with given values is divided by total number of pixels. The presence of color is dependent on the value of resultant not equal to zero. For each color present the Color Index is+1.

3.4.4 Diameter:

The diameter value is said to be 5 if the diameter of lesion is greater than 6mm. For other values the diameter is one less than its actual rounded value. To calculate Diameter the regionprops function is used to get the minor axis length of the lesion region. Resultant value is converted into mm value and the value is assigned to diameter

3.5 TDS Calculation

Following formula is used

TDS = 1.3A + 0.1B + 0.5C + 0.5D

If the TDS Index is lessthan 4.75, beinign (noncancerous) skin lesion.

If TDS Index is greater than 4.75 and less than 5.45,unsuspicious case of skin lesion.

If TDS Index is greater than 5.45, its malignant melanoma (cancerous) skin lesion.

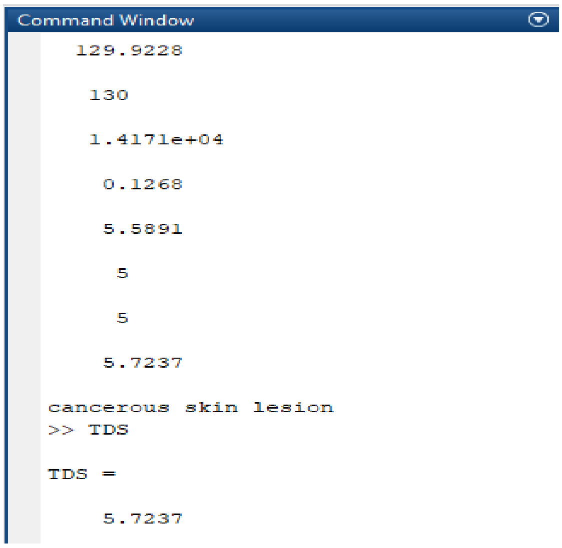


Figure 3.6 TDS value for an example image

3.6 Introduction of DIP

Image segmentation aims to separate the desired foreground object from the background. Since color and texture in natural images are very complex, automatic segmentation of foreground objects from the complex background meets a significant obstacle when foreground and background have similar features.

To address the problem, interactive image segmentation incorporates simple user interaction into image segmentation in a supervised or semi-supervised manner, and has received much attention in recent years. Interactive image segmentation extracts foreground objects from the complex background by taking advantage of the user's interactive input. User interaction is employed to get prior information from users which then play an important role in guiding image segmentation.

Thus, the challenge is to successfully make use of the limited but valuable interactive inputs. In this work, we attempt to maximize the guiding power of the given interactive information by propagating their characteristics through the whole image.

There have been expanding exercises in the examination group to create intelligent self-loader picture division systems. In the creators exhibited an intelligent picture division procedure in light of diagram cut. Clients marked seed pixels which demonstrating clear foundation and frontal area were utilized as solid priors for portioning pictures into figure and ground. In the creators demonstrated that diagram cut based division calculations could be actualized quick. In the creators exhibited a division given incomplete gathering imperatives strategy.

Client inputs were utilized as inclination to a characteristic gathering process, and the creators planned such one-sided gathering issue as a compelled advancement issue that proliferates scanty incomplete gathering data to the unlabeled information by upholding gathering smoothness and reasonableness on the marked information focuses. They utilized the standardized cut model and tackled the enhancement issue by Eigen decay.

In the creators exhibited an intuitive picture forefront extraction strategy that was computationally in light of diagram cut of however the creators presented a less complex client collaboration system to diminish client endeavors in the connection procedure and an iterative model refreshing technique to enhance exactness. In an intuitive forefront foundation division technique was presented with regards to picture tangling. The creators utilized Belief Propagation to iteratively engender client named pixels to the unlabeled pixels.

A current work has built up an enhancement-based figure ground division procedure, where a straightforwardness picture was registered by improving a quadratic cost work with client provided direct limitations. The improvement issue has a one of a kind worldwide least and can be illuminated effectively by standard numerical strategies. In this paper, we acquaint measurable priors as imperatives with take care of the enhancement issue. For a few pictures, the factual priors can give sufficient requirements to consequently get palatable figure ground division comes about.

For more troublesome cases, client cooperation is important. In such cases, we utilize the division result in view of the measurable priors as a beginning stage for intelligent figure ground division, and as a manual for help clients to put the requirements in the right areas to produce the coveted outcomes. Along these lines, the factual priors control the client as well as enable diminishing clients' works in the connection to pepare. We have likewise built up another technique to make twofold (hard) division in view of the processed nonstop straightforwardness picture.

Another commitment of this paper is the augmentation of the streamlining based intelligent figure ground division structure to intuitive multi-class division, where client can give multi-class seed pixels rather than simply frontal area foundation 2-class seeds, for dividing the given picture into the coveted number of areas by playing out a one shot advancement operation, which again has a one of a kind worldwide least and can be acquired by unraveling a vast arrangement of straight conditions.

3.7 Digital Image Processing

Computerized picture preparing is a range portrayed by the requirement for broad test work to build up the practicality of proposed answers for a given issue. A critical trademark hidden the plan of picture preparing frameworks is the huge level of testing and experimentation that typically is required before touching base at a satisfactory arrangement. This trademark infers that the capacity to plan approaches and rapidly model hopeful arrangements by and large assumes a noteworthy part in diminishing the cost and time required to land at a suitable framework execution.

3.8 What is DIP?

A picture might be characterized as a two-dimensional capacity f(x, y), where x, y are spatial directions, and the adequacy of f at any combine of directions (x, y) is known as the power or dark level of the picture by then. Whenever x, y and the abundancy estimations of are all limited discrete amounts, we call the picture a computerized picture. The field of DIP alludes to preparing advanced picture by methods for computerized PC. Advanced picture is made out of a limited number of components, each of which has a specific area and esteem. The components are called pixels.

Vision is the most progressive of our sensor, so it is not amazing that picture play the absolute most imperative part in human observation. Be that as it may, dissimilar to people, who are constrained to the visual band of the EM range imaging machines cover practically the whole EM range, going from gamma to radio waves. They can work likewise on pictures produced by sources that people are not acclimated to partner with picture.

There is no broad understanding among creators in regards to where picture handling stops and other related territories, for example, picture examination and PC vision begin. Now and then a qualification is made by characterizing picture handling as a teach in which both the info and yield at a procedure are pictures. This is constraining and to some degree manufactured limit. The range of picture investigation is in the middle of picture preparing and PC vision.

There are no obvious limits in the continuum from picture handling toward one side to finish vision at the other. In any case, one helpful worldview is to consider three sorts of mechanized procedures in this continuum: low, mid and abnormal state forms. Low-level process includes primitive operations, for example, picture preparing to decrease commotion, differentiate upgrade and picture honing. A low-level process is described by the way that both its sources of info and yields are pictures.

Mid-level process on pictures includes assignments, for example, division, depiction of that question diminish them to a frame reasonable for PC handling and characterization of individual articles.

A mid-level process is portrayed by the way that its sources of info by and large are pictures however its yields are properties removed from those pictures. At long last more elevated amount handling includes "Understanding" an outfit of perceived items, as in picture examination and at the furthest end of the continuum playing out the intellectual capacities typically connected with human vision. Advanced picture handling, as effectively characterized is utilized effectively in a wide scope of regions of outstanding social and monetary esteem.

3.9 What is an image?

A picture is spoken to as a two dimensional capacity f(x, y) where x and y are spatial co-ordinates and the adequacy of "f" at any match of directions (x, y) is known as the power of the picture by then.

Figure 3.7 Digital image

3.9.1 Gray scale image

A gray scale picture is a capacity I (xylem) of the two spatial directions of the picture plane. I(x, y) is the force of the picture at the point (x, y) on the picture plane. I (xylem) take non-negative esteems expect the picture is limited by a rectangle [0, a] '[0, b] I: [0, a] " [0, b] ® [0, data] .

3.9.2 Color image

It can be spoken to by three capacities, R (xylem) for red, G (xylem) for green and B (xylem) for blue. A picture might be persistent as for the x and y facilitates and furthermore in adequacy. Changing over such a picture to advanced shape requires that the directions and the adequacy to be digitized. Digitizing the facilitate's esteems is called inspecting. Digitizing the adequacy esteems is called quantization.

3.9.3 Coordinate convention

The consequence of inspecting and quantization is a network of genuine numbers. We utilize two vital approaches to speak to advanced pictures. Accept that a picture f(x, y) is tested so that the subsequent picture has M lines and N segments. We say that the picture is of size M X N. The estimations of the directions (xylem) are discrete amounts. For notational lucidity and accommodation, we utilize whole number esteems for these discrete directions.

In many picture handling books, the picture starting point is characterized to be at (xylem) = (0, 0). The following direction esteems along the main column of the picture are (xylem) = (0, 1). It is critical to remember that the documentation (0, 1) is utilized to imply the second example along the principal push. It doesn't imply that these are the genuine estimations of physical directions when the picture was tested. Taking after figure demonstrates the arrange tradition. Take note of that x ranges from 0 to M-1 and y from 0 to N-1 in whole number augmentations.

The organize tradition utilized as a part of the tool compartment to mean clusters is unique in relation to the former passage in two minor ways.

To start with, rather than utilizing (xylem) the tool compartment utilizes the documentation (race) to show lines and segments. Note, in any case, that the request of directions is the same as the request examined in the past section, as in the principal component of an organize topples, (alb), alludes to a line and the second to a segment.

The other distinction is that the starting point of the organize framework is at (r, c) = (1, 1); accordingly, r ranges from 1 to M and c from 1 to N in whole number additions. IPT documentation alludes to the directions. Less often the tool stash additionally utilizesanother facilitate tradition called spatial directions which utilizes x to allude to sections and y to alludes to columns. This is the inverse of our utilization of factors x and y.

3.9.4 Image as matrices

The former exchange prompts the accompanying portrayal for a digitized picture work:

f (0,0) f(0,1) … .. f(0,N-1)

f (1,0) f(1,1) … f(1,N-1)

f (xylem)= . . .

f (M-1,0) f(M-1,1) … f(M-1,N-1)

The correct side of this condition is a computerized picture by definition. Every component of this exhibit is called a picture component, picture component and pixel. The terms picture and pixel are utilized all through whatever is left of our exchanges to indicate a computerized picture and its components.

A computerized picture can be spoken to normally as a MATLAB grid:

f (1,1) f(1,2) … . f(1,N)

f (2,1) f(2,2) … .. f (2,N)

f (M,1) f(M,2) … .f(M,N)

Where f (1, 1) = f (0, 0) (take note of the utilization of a mono degree textual style to indicate MATLAB amounts). Obviously the two portrayals are indistinguishable, with the exception of the move in beginning. The documentation f (p, q) indicates the component situated in line p and the segment q.

For instance f (6, 2) is the component in the 6th line and second segment of the network f. Regularly we utilize the letters M and N individually to mean the quantity of lines and sections in a lattice. A 1xN grid is known as a line vector while a Mx1 framework is known as a section vector.

A 1x1 grid is a scalar. Lattices in MATLAB are put away in factors with names, for example, An, a, RGB, genuine exhibit et cetera. Factors must start with a letter and contain just letters, numerals and underscores. As noted in the past section, all MATLAB amounts are composedutilizing mono-scope characters. We utilize regular Roman, italic documentation, for example, f(x, y), for scientific expressions

3.9.5 Reading images

Pictures are perused into the MATLAB condition utilizing capacity imread whose punctuation is

Imread ('filename')

Arrange name Description perceived expansion

TIFF Tagged Image File Format .tif, .tiff

JPEG Joint Photograph Experts Group .jpg, .jpeg

GIF Graphics Interchange Format .gif

BMP Windows Bitmap .bmp

PNG Portable Network Graphics .png

XWD X Window Dump .xwd

Here filename is a spring containing the total of the picture document (counting any appropriate augmentation). For instance the charge line

>> f = imread ('8. jpg');

Peruses the JPEG (above table) picture trunk beam into picture cluster f. Take note of the utilization of single quotes (') to delimit the string filename. The semicolon toward the finish of a charge line is utilized by MATLAB for smothering yield, if a semicolon is excluded. MATLAB shows the consequences of the operation(s) determined in that line. The incite image (>>) assigns the start of a charge line, as it shows up in the MATLAB summon window.

3.9.6 Data classes

In spite of the fact that we work with numbers organizes the estimations of pixels themselves are not limited to be whole numbers in MATLAB. Table above rundown different information classes upheld by MATLAB and IPT are speaking to pixels esteems. The initial eight sections in the table are alludes to as numeric information classes. The ninth section is the single class and, as appeared, the last passage is alluded to as consistent information class.

Every single numeric calculation in MATLAB are done in twofold amounts, so this is likewise a regular information class experience in picture preparing applications. Class unit 8 additionally is experienced every now and again, particularly when perusing information from stockpiles gadgets, as 8 bit pictures are most normal portrayals found by and by. These two information classes, classes intelligent, and, to a lesser degree, class unit 16 constitute the essential information classes on which we center.

Numerous int capacities however bolster every one of the information classes recorded in table. Information class twofold requires 8 bytes to speak to a number uint8 and int 8 require one byte each, uint16 and int16 requires 2 bytes and unit 32.

Name Description

Twofold Double _ exactness, floating_ point numbers the Approximate.

Uint8 unsigned 8_bit whole numbers in the range [0,255] (1byte for each component).

Uint16 unsigned 16_bit whole numbers in the range [0, 65535] (2byte for each component).

Uint 32 unsigned 32_bit numbers in the range [0, 4294967295](4 bytes for every component).

Int8 marked 8_bit numbers in the range [-128,127] 1 byte for every component)

Int 16 marked 16_byte numbers in the range [32768, 32767] (2 bytes for every component).

Int 32 signed 32_byte whole numbers in the range [-2147483648, 21474833647] (4 byte Percomponent).

Single _precision gliding _point numbers with qualities.

.

CHAPTER 4

ARTIFICIAL NEURAL NETWORKS

The feature extraction methodology of many computerised melanoma detection systems has been largely depending on the conventional clinical diagnostic algorithm of ABCD-rule of dermoscopy due to its effectiveness and simplicity of implementation [14]. The effectiveness of methodology stems from the fact that it incorporates the classic features of a melanoma lesion such as asymmetry, border irregularity, colour and diameter (or differential structures), where surveyable measures can be computed.

Dermoscopy is a diagnostic technique that is used worldwide in the recognition and interpretation of copious skin lesions [4].Other than dermoscopy, a computerised melanoma detection using Artificial Neural Network classification has been adapted which is efficient than the conventional one and Melanoma detection using Artificial Neural Network is a more effective method compared to other.

4.1 Methodology

The proposed methodology for detection of Melanoma Skin Cancer using Image Processing as a key tool is shown in Figure 3.1. The input for the system is the image of the skin lesion which is speculated to be a melanoma lesion image, which is then pre- processed to upgrade the image quality. The background subtraction and edge detection are used for image segmentation. The segmented image is then given to the feature extraction block, which inheres of region lesion analysis for its classic geometrical features.

The geometrical features are advised since they are the most sophisticated features of the skin cancer lesion. The extracted features are moreover given to the feature classification stage which classifies the skin lesion as cancerous or normal by Neural Network

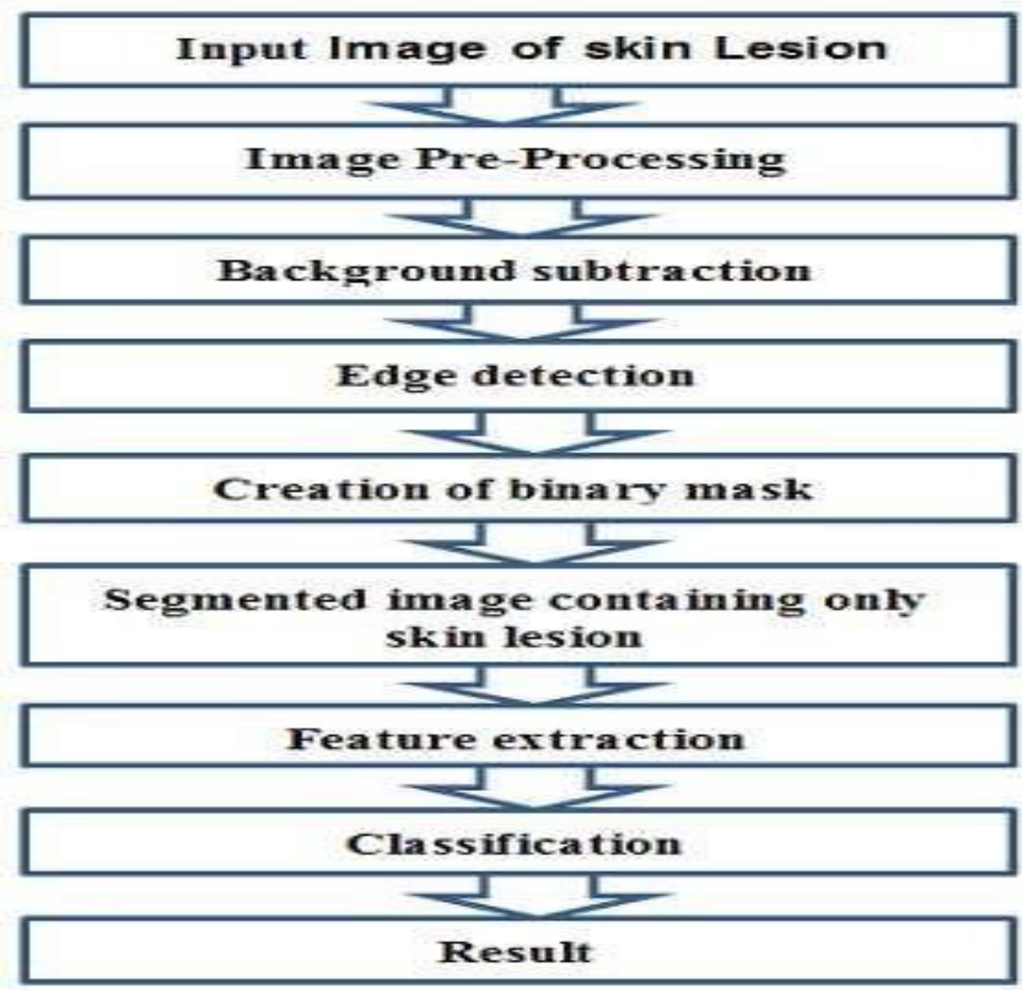


Figure 4.1 The simplified work flow of computer aided melanoma detection using ANN classifier

4.2 Image Pre-Processing :

The image of skin lesion is given to the computer diagnostic system can be captured in any lighting condition or by using any camera. Hence, it needs to pre-process. Here, the pre-processing is the process of image resizing (scaling) and contrast and brightness modification, which is done in furtherance of compensating the non-uniform illumination in theimage.

4.2.1 Image scaling

Figure 4.2 Resized image

Image scaling is the course of action of resizing a digital image. The size of an image is reduced or enlarged, the pixels that form the image become increasingly visible, making the image appear“soft”.

4.2.2 RGB to grayscale image :

The rgb2gray function converts the true color image RGB to the grayscale intensity image, by eliminating the saturation information.

``

Figure 4.3 Gray scale image

4.3 Segmentation

Image segmentation is the course of action of segregating an image into multiple parts, which is used to identify objects or other relevant information in digital images.

4.3.1 Background subtraction

Background subtraction, also known as blob detection, is an emerging technique in the fields of image processing wherein an image's foreground is extracted for further processing. Typically, an image's regions of interest are objects in its foreground.

Figure 4.4 Background Subtraction

4.3.2. Edge detection

Edge detection is a significant image processing technique for catching the boundaries of objects within images. It works by detecting discontinuities in brightness.

Figure 4.5 Edge Detection

4.3.3. Masking

Masking involves setting the pixel values in an image to zero, or some other "background" value. It is used to separate the lesion from the skin image. The masked image obtained contains only the skin lesion.

Figure 4.6 Masking

4.4.Feature Extraction

The foremost features of the Melanoma Skin Lesion are its Geometric Features. Hence, we propose to extract the Geometric Features of the segmented skin lesion. Here, we used some classic geometry features (Area, Perimeter, Greatest Diameter, Circularity Index, Irregularity Index) adopted from the segmented image containing only skin lesion, the image blob of the skin lesion is analysed to extract the geometrical features. The various Features extracted are as follows.

Area (A): Number of pixels of the lesion

Perimeter (P): Number of contour pixel

Major Axis Length (Ma L): The length of the line passing through lesion centroid and

joining the two farthest boundary points.

Minor Axis Length (Mi L): The length of the line passing through lesion blob centroid and joining the two adjacent boundary points.

Circularity Index (CI): It gives the shape uniformity.

$$CI = \frac{4A\pi}{P^2} \qquad (1)$$

Irregularity Index A (IrIA):

$$IrIA = \frac{P}{A} \qquad (2)$$

Irregularity Index B (IrIB):

$$IrIB = \frac{P}{MaL} \qquad (3)$$

Irregularity Index C (IrIC):

$$IrIc = P \times \left(\frac{1}{MiL} - \frac{1}{MaL}\right) \qquad (4)$$

Irregularity Index D (IrID):

$$IrID = MaL - MiL \qquad (5)$$

4.5. Classification:

Using the ABCD rules for the melanoma skin cancer, we use Artificial Neural Network in the classification stage. The construction of the neural network prevails in three distinctive layers with feed forward architecture . It is the most influential network architecture in use today. The input layer of the neural network is a set of the feature values extracted in the feature extraction stage. The input units (neurons) are entirely coupled to the hidden layer with the hidden units. The hidden units (neurons) are also completely linked to output layer. The output layer delivers the response of the neural network to the activation pattern implemented to the input layer. The single output from the system denotes whether the input skin contains cancer or not. The information given to a neural network is procreated layer-by-layer from the input layer to output layer through (none) one or more hidden layers.

Once a network has been formulated for a appropriate purpose, that network is capable of being trained. To start this process, the initial weights are chosen randomly. Then, the training, or learning, begins. The ANN has been trained by reporting it to sets of existing.data where the outcome is known. Multi-layer networks employ a number of learning techniques, the most paramount are back propagation algorithm. It is one of the most active approaches to machine learning algorithm developed by David Rummelhart and Robert McLelland .Informations are progress from the direction of the input layer towards the output layer. A network is trained rather than programmed.

4.6 Artificial Neural Network

Artificial neural networks (ANN) or connectionist systems are computing systems vaguely inspired by the biological neural networks that constitute animal brains.[1][2] The neural network itself is not an algorithm, but rather a framework for many different machine learning algorithms to work together and process complex data inputs.[3] Such systems "learn" to perform tasks by considering examples, generally without being programmed with any task-specific rules. For example, in image recognition, they might learn to identify images that contain cats by analyzing example images that have been manually labeled as "cat" or "no cat" and using the results to identify cats in other images. They do this without any prior knowledge about cats, for example, that they have fur, tails, whiskers and cat-like faces. Instead, they automatically generate identifying characteristics from the learning material that they process.

An ANN is based on a collection of connected units or nodes called artificial neurons, which loosely model the neurons in a biological brain. Each connection, like the synapses in a biological brain, can transmit a signal from one artificial neuron to another. An artificial neuron that receives a signal can process it and then signal additional artificial neurons connected to it.

In common ANN implementations, the signal at a connection between artificial neurons is a real number, and the output of each artificial neuron is computed by some non-linear function of the sum of its inputs. The connections between artificial neurons are called 'edges'. Artificial neurons and edges typically have a weightthat adjusts as learning proceeds.

The weight increases or decreases the strength of the signal at a connection. Artificial neurons may have a threshold such that the signal is only sent if the aggregate signal crosses that threshold. Typically, artificial neurons are aggregated into layers. Different layers may perform different kinds of transformations on their inputs. Signals travel from the first layer (the input layer), to the last layer (the output layer), possibly after traversing the layers multiple times.

The original goal of the ANN approach was to solve problems in the same way that a human brain would. However, over time, attention moved to performing specific tasks, leading to deviations from biology. Artificial neural networks have been used on a variety of tasks, include, speech recognition, social network filtering, playing board and video games and medical diagnosis.

The introduction of hidden layers was introduced with the iteration concept between two instants following some conditions .The propagation function g depends on the acceptance condition of the output o_j and controls the evolution of the weight vector w_j. There exist different models developed in the literature. The three models are detailed

4.7 Hebbian learning:

Hebbian learning is one of the oldest learning algorithms, and is based in large part on the dynamics of biological systems. A synapse between two neurons is strengthened when the neurons on either side of the synapse (input and output) have highly correlated outputs. In essence, when an input neuron fires, if it frequently leads to the firing of the output neuron, the synapse is strengthened. Following the analogy to an artificial system, the tap weight is increased with high correlation between two sequential neurons.

Mathematically, we can describe Hebbian learning as:

w_{ij}[n+1]=w_{ij}[n]+ , η x_{i}[n]x_{j}[n]}

Here, η is a learning rate coefficient, and *x* are the outputs of the *i*th and *j*th elements.

4.8 Perceptron learning rule:

In machine learning, the **perceptron** is an algorithm for supervised learning of binary classifiers. A binary classifier is a function which can decide whether or not an input, represented by a vector of numbers, belongs to some specific class.[1] It is a type of linear classifier, i.e. a classification algorithm that makes its predictions based on a linear predictor function combining a set of weights with the feature vector. It was introduced for single layer for linearly independent problems.

$$w_j(t+1) = w_j(t) + \delta w_j \quad \text{with } \delta w_j = \eta(o_j(t) - y_j(t))x_j$$

where η is the learning rate.

4.9 Back propagation learning:

A key trigger for renewed interest in neural networks and learning was Werbos's (1975) backpropagation algorithm that effectively solved the exclusive-or problem by making the training of multi-layer networks feasible and efficient. Backpropagation distributed the error term back up through the layers, by modifying the weights at each node.In the mid-1980s, parallel distributed processing became popular under the name connectionism. Rumelhart and McClelland (1986) described the use of connectionism to simulate neural processes.

Support vector machines and other, much simpler methods such as linear classifiers gradually overtook neural networks in machine learning popularity. However, using neural networks transformed some domains, such as the prediction of protein structures.

In 1992, max-pooling was introduced to help with least shift invariance and tolerance to deformation to aid in 3D object recognition. In 2010, Backpropagation training through max-pooling was accelerated by GPUs and shown to perform better than other pooling variants[4].

The vanishing gradient problem affects layered feedforward networks that used backpropagation and also recurrent neural networks (RNNs). As errors propagate from layer to layer, they shrink exponentially with the number of layers, impeding the tuning of neuron weights that is based on those errors, particularly affecting deep networks.

To overcome this problem, Schmidhuber adopted a multi-level hierarchy of networks (1992) pre-trained one level at a time by unsupervised learning and fine-tuned by backpropagation Behnke (2003) relied only on the sign of the gradient (Rprop) on problems such as image reconstruction and face localization.

Hinton et al. (2006) proposed learning a high-level representation using successive layers of binary or real-valued latent variables with a restricted Boltzmann machineto model each layer. Once sufficiently many layers have been learned, the deep architecture may be used as a generative model by reproducing the data when sampling down the model (an "ancestral pass") from the top level feature activations.In 2012, Ng and Dean created a network that learned to recognize higher-level concepts, such as cats, only from watching unlabeled images taken from YouTube videos.

Earlier challenges in training deep neural networks were successfully addressed with methods such as unsupervised pre-training, while available computing power increased through the use of GPUs and distributed computing. Neural networks were deployed on a large scale, particularly in image and visual recognition problems. This became known as "deep learning".

It defines the multiple layer and it can approximate the nonlinear functions to arbitrary accuracy .$\Delta w_{ij}(t + 1) = \eta$

CHAPTER 5

MATLAB

5.1 Introduction to MATLAB

MATLAB is an elite dialect for specialized registering. It incorporates calculation, representation, and programming in a simple to-utilize condition where issues and arrangements are communicated in natural numerical documentation. Run of the mill utilizes incorporate.

- Math and calculation
- Algorithm advancement
- Data obtaining
- Modeling, reenactment, and prototyping
- Data examination, investigation, and representation
- Scientific and designing illustrations
- Application advancement, including graphical UI building

MATLAB is an intuitive framework whose essential information component is an exhibit that does not require dimensioning. This enables you to tackle numerous specialized processing issues, particularly those with framework and vector details, in a small amount of the time it would take to compose a program in a scalar non intuitive dialect, for example, C or FORTRAN.

The name MATLAB remains for grid research facility. MATLAB was initially composed to give simple access to framework programming created by the LINPACK and EISPACK ventures. Today, MATLAB motors fuse the LAPACK and BLAS libraries, inserting the cutting edge in programming for network calculation.

MATLAB has developed over a time of years with contribution from numerous clients. In college situations, it is the standard instructional apparatus for early on and propelled courses in arithmetic, designing, and science. In industry, MATLAB is the device of decision for high-profitability research, advancement, and examination.

MATLAB highlights a group of extra application-particular arrangements called tool compartments. Important to most clients of MATLAB, tool kits enable you to learn and apply specific innovation. Tool compartments are exhaustive accumulations of MATLAB capacities (M-records) that stretch out the MATLAB condition to take care of specific classes of issues. Territories in which tool stash are accessible incorporate flag handling, control frameworks, neural systems, fluffy rationale, wavelets, recreation, and numerous others.

5.2 The MATLAB System:

The MATLAB system consists of five main parts.

5.2.1 Development Environment:

This is the set of tools and facilities that help you use MATLAB functions and files. Many of these tools are graphical user interfaces. It includes the MATLAB desktop and Command Window, a command history, an editor and debugger, and browsers for viewing help, the workspace, files, and the search path.

5.2.2 The MATLAB Mathematical Function:

This is a vast collection of computational algorithms ranging from elementary functions like sum, sine, cosine, and complex arithmetic, to more sophisticated functions like matrix inverse, matrix eigen values, Bessel functions, and fast Fourier transforms.

5.2.3 The MATLAB Language:

This is a high-level matrix/array language with control flow statements, functions, data structures, input/output, and object-oriented programming features. It allows both "programming in the small" to rapidly create quick and dirty throw-away programs, and "programming in the large" to create complete large and complex application programs.

5.2.4 Graphics:

MATLAB has extensive facilities for displaying vectors and matrices as graphs, as well as annotating and printing these graphs. It includes high-level functions for two-dimensional and three-dimensional data visualization, image processing, animation, and presentation graphics. It also includes low-level functions that allow you to fully customize the appearance of graphics as well as to build complete graphical user interfaces on your MATLAB applications.

5.2.5 The MATLAB Application Program Interface (API):

This is a library that allows you to write C and Fortran programs that interact with MATLAB. It includes facilities for calling routines from MATLAB (dynamic linking), calling MATLAB as a computational engine, and for reading and writing MAT-files.

5.3 MATLAB working environment:

5.3.1 MATLAB DESKTOP:

MATLAB Desktop is the principle MATLAB application window. The desktop contains five sub windows, the summon window, the workspace program, the present catalog window, the order history window, and at least one figure windows, which are demonstrated just when the client shows a realistic.

The order window is the place the client sorts MATLAB orders and expressions at the provoke (>>) and where the yield of those charges is shown. MATLAB characterizes the workspace as the arrangement of factors that the client makes in a work session. The workspace program demonstrates these factors and some data about them. Double tapping on a variable in the workspace program dispatches the Array Editor, which can be utilized to get data and wage cases alter certain properties of the variable.

The present Directory tab over the workspace tab demonstrates the substance of the present registry, whose way is appeared in the present index window. 1For case, in the windows working framework the way may be as per the following: C:\MATLAB\Work, demonstrating that registry "work" is a subdirectory of the primary catalog "MATLAB", which is introduced in drive C.

Tapping on the bolt in the present index window demonstrates a rundown of as of late utilized ways. Tapping on the catch to one side of the window enables the client to change the present catalog.

MATLAB utilizes an inquiry way to discover M-records and other MATLAB related documents, which are sort out in catalogs in the PC document framework. Any document keep running in MATLAB must dwell in the ebb and flow registry or in an index that is on seek way. Of course, the records provided with MATLAB and math works tool kits are incorporated into the inquiry way.

The least demanding approach to see which indexes are on the inquiry way. The simplest approach to see which catalogs are soon the hunt way, or to include or adjust an inquiry way, is to choose set way from the File menu the desktop, and after that utilization the set way exchange box. It is great practice to add any normally utilized catalogs to the pursuit way to maintain a strategic distance from over and over having the change the present index.

The Command History Window contains a record of the orders a client has entered in the charge window, including both present and past MATLAB sessions. Already entered MATLAB orders can be chosen and re-executed from the charge history window by right tapping on a summon or arrangement of orders.

This activity dispatches a menu from which to choose different choices notwithstanding executing the orders. This is helpful to choose different choices notwithstanding executing the summons. This is a valuable component while trying different things with different orders in a work session

5.3.2 Using the MATLAB Editor to create M-Files:

The MATLAB manager is both a word processor specific for making M-records and a graphical MATLAB debugger. The proofreader can show up in a window without anyone else, or it can be a sub window in the desktop. M-records are meant by the expansion .m, as in pixelup.m. The MATLAB editorial manager window has various draw down menus for errands, for example, sparing, seeing, and troubleshooting documents.

Since it plays out some basic checks and furthermore utilizes shading to separate between different components of code, this content tool is suggested as the apparatus of decision for composing and altering M-capacities. To open the proofreader, sort alter at the incite opens the M-document filename.m in a supervisor window, prepared for altering. As noted before, the record must be in the momentum catalog, or in an index in the pursuit way.

5.3.3 Getting Help:

The important approach to get help online is to utilize the MATLAB help program, opened as a different window either by tapping on the question mark image (?) on the desktop toolbar, or by writing help program at the provoke in the order window. The assistance Browser is a web program coordinated into the MATLAB desktop that shows a Hypertext Markup Language(HTML) records.

The Help Browser comprises of two sheets, the assistance pilot sheet, used to discover data, and the show sheet, used to see the data. Clear as crystal tabs other than pilot sheet are utilized to play out a pursuit.

Second, in the videos taken by moving camera setup, the situation becomes more complicated because the background may change by moving shot, we cannot track object motion precisely in the sum of difference map. Therefore, in this case, the aim is achieved by reusing the previous seam and applying it to the current frame. In order to find the seams, we use the previous seam from previous frame to search the current seam in current frame.

Our strategy is using a seam computed in frame1 (in red) to search a similar seam in frame2. For the pixels nearby the location of previous seam, we determine how much the chosen pixel would differ from the pixel of previous seam.

We use difference of the two pixels as the measure of temporal coherence. If the difference value of first seam pixel is over the threshold, we will continue to search the next seam pixel on three possible pixels (in yellow, blue and brown) in next row, until we find five consecutive pixels that also exceed the threshold.

When we cannot search the matching seam, we recalculate the energy for a new seam. We assume a seam S^{l-1} has been calculated in the previous frame, and a seam must be calculated for the current frame. For keeping the temporal coherence, we want to make a new seam close to the previous seam with the same index.

We use the difference between previous seam and all pixels at the current frame as the measure for temporal coherence, $T_c(i,j)$.

$$T_c = |I(I,j) - S^{l-1}(j)|$$

Thus we add temporal coherence cost $T_c(i,j)$ to the energy map before calculating a seam S^L. The cost T_c is zero when the frame pixels have the same value as previous seam pixels. Using our temporal coherence cost.

we can calculate the seam which has least energy and is more close to the previous seam in previous frame. Consequently, we can decrease the jittery artifacts in the videos.

CHAPTER 6

RESULTS

Figure 6.1 is the original image of melanoma without any preprocessing techniques applied. Image enhancement is the process of adjusting original image so that the resultant image is more suitable to display

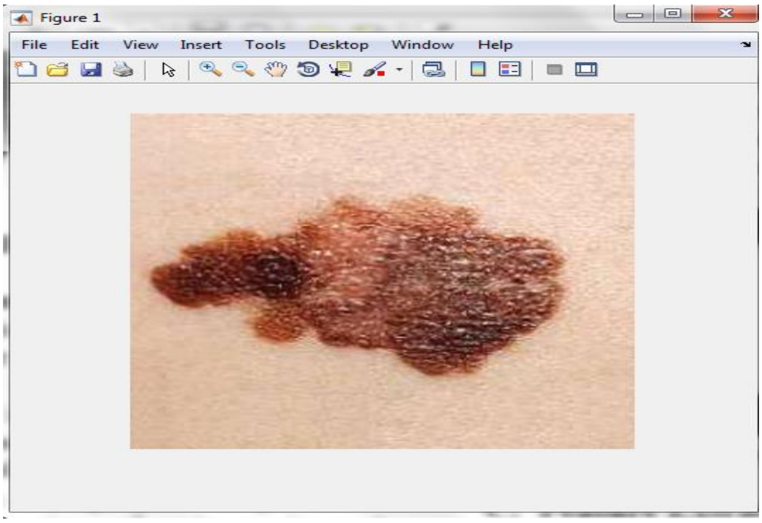


Figure 6.1 Original image

In figure 6.2 the image enhancement is the process of adjusting original image so that the resultant image is more suitable to display.By using image enhancement technique we can remove noise ,sharpen and brighten an image.

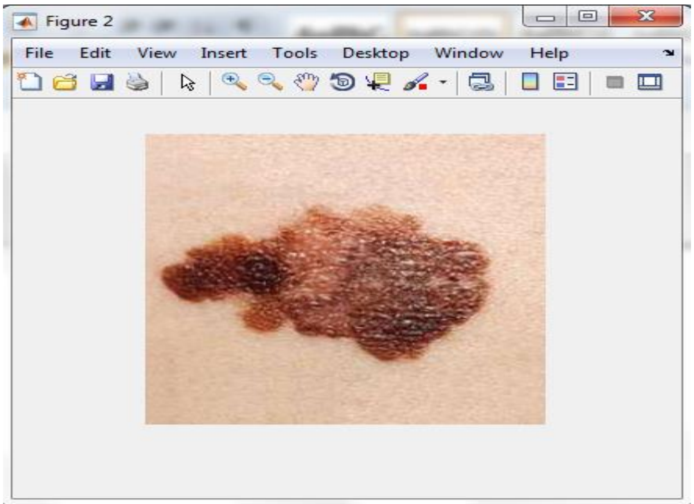


Figure 6.2 Enhanced image

In Figure 6.3 Enhanced image is converted to grayscale image by using the command rgb2gray in MATLAB.Gray scale image is a data matrix whose values represent intensities within some range.

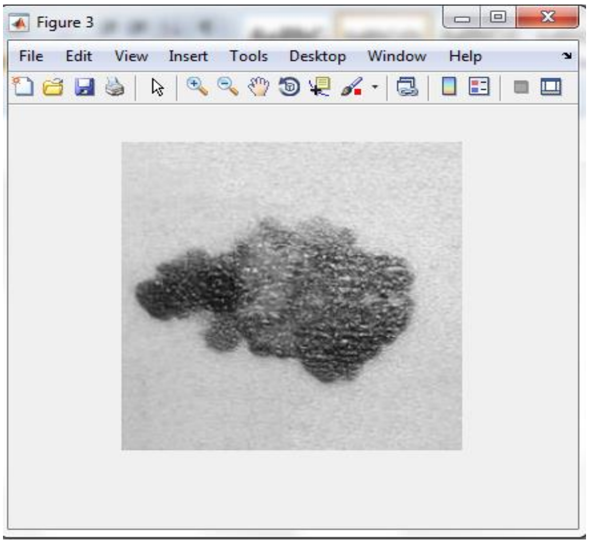


Figure 6.3 Gray scale image

In figure 6.4 Edge detection is the preliminary process in image processing.It detects important regions in an image where sharp discontinuity in pixelsintensity is found.For this image sobel edge detection is used.

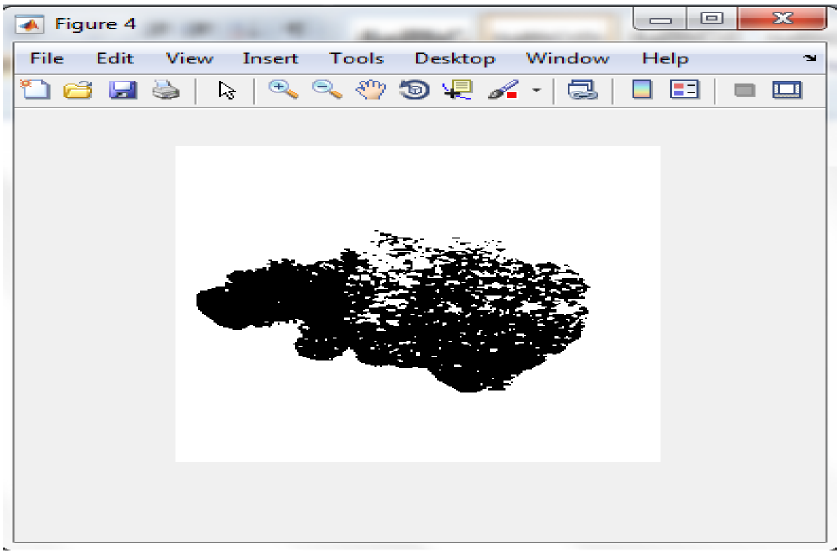


Figure 6.4 Edge detection

Figure 6.5 is a custom user interface for a block.By masking a block ,encapsulate the block diagram to have its own parameter dialog box with its own block description ,parameter prompts,and help texts.

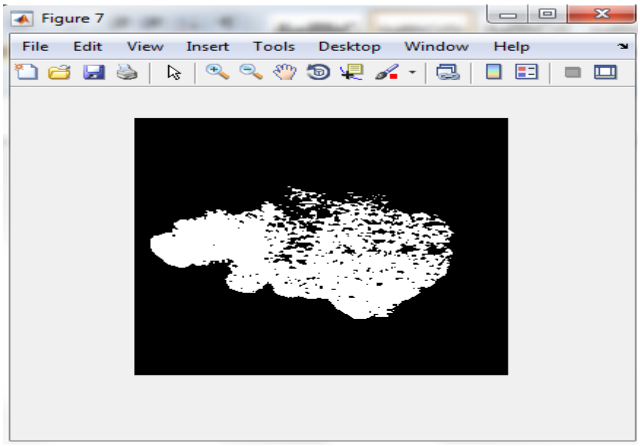


Figure 6.5 Final masked image

MATLAB and deep learning tool box provide command line functions and apps for creating ,training and simulation shallow neural networks.The apps make it easy to develop neural networks for tasks such as classification, regression etc.

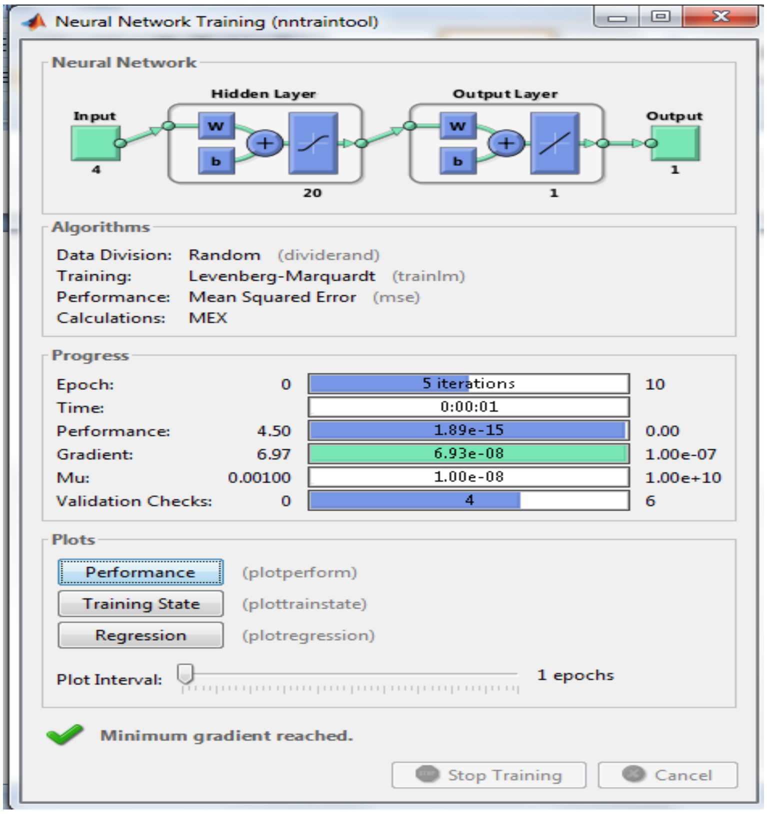


Figure 6.6 Training in ANN

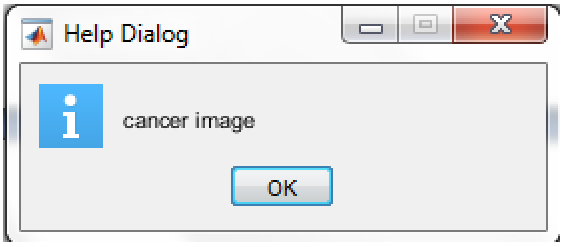


Figure 6.7 Dialog box

Accuracy with which ANN is trained.

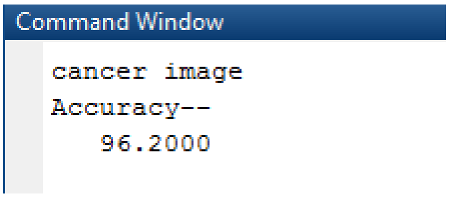


Figure 6.8 Accuracy in ANN

Figure 6.9 shows the profile summary of image processing

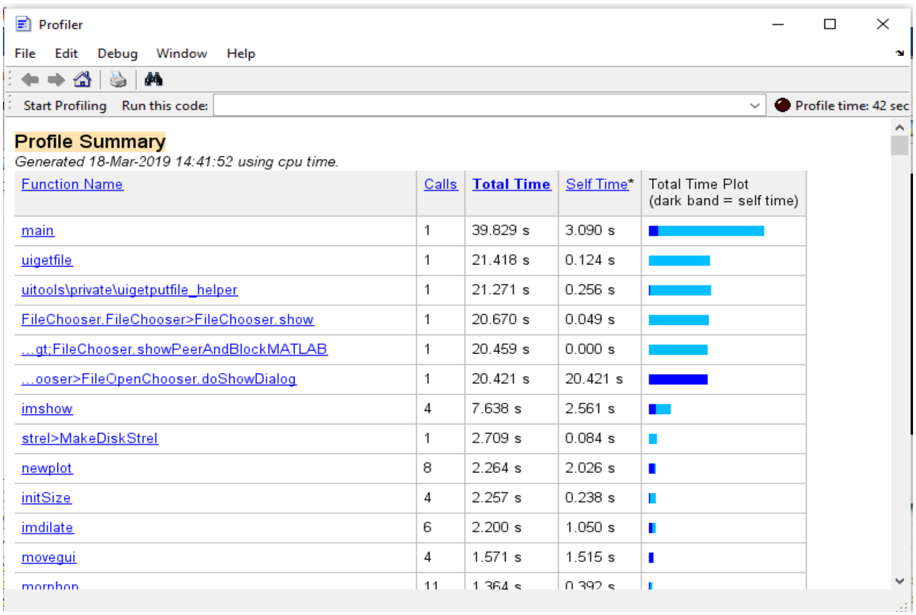
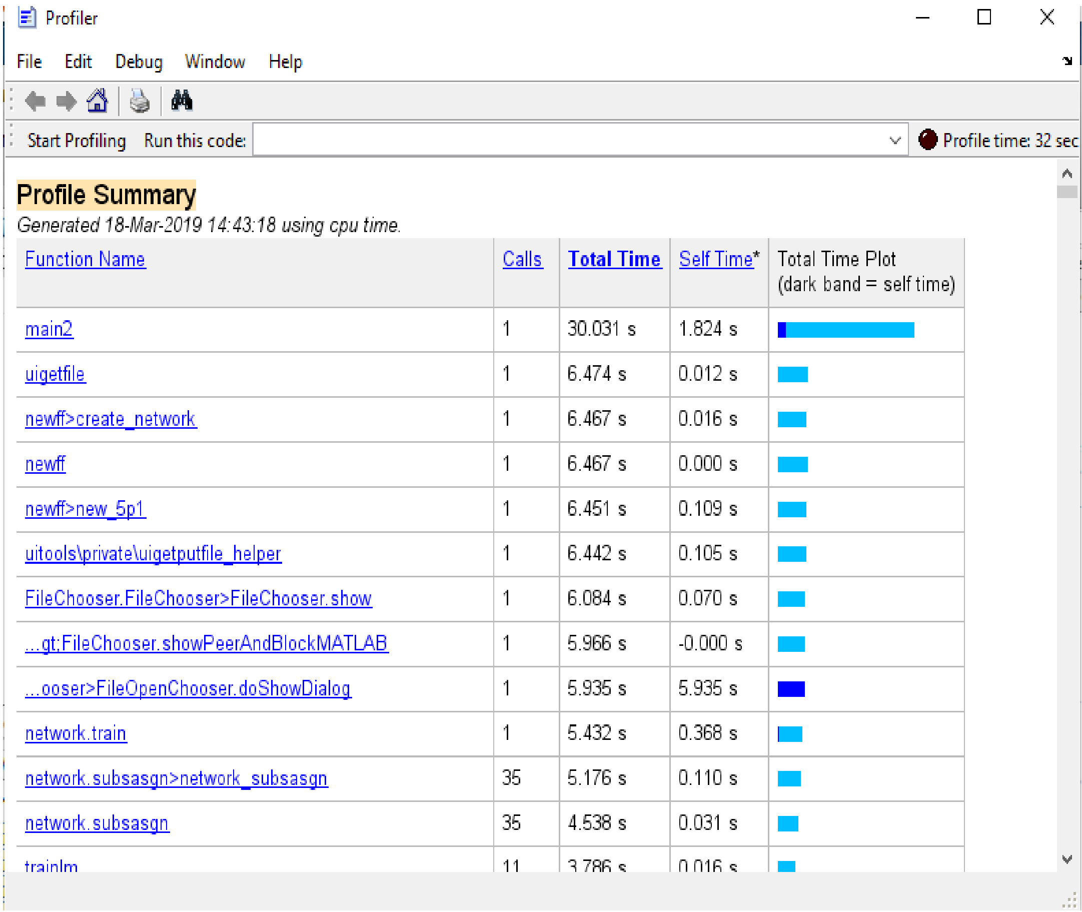


Figure 6.9 Profile Summary of Image Processing

Figure 6.10 shows the profile summary of an image trained in ANN



Function Name	Calls	Total Time	Self Time*	Total Time Plot (dark band = self time)
main2	1	30.031 s	1.824 s	
uigetfile	1	6.474 s	0.012 s	
newff>create_network	1	6.467 s	0.016 s	
newff	1	6.467 s	0.000 s	
newff>new_5p1	1	6.451 s	0.109 s	
uitools\private\uigetputfile_helper	1	6.442 s	0.105 s	
FileChooser.FileChooser>FileChooser.show	1	6.084 s	0.070 s	
...gt;FileChooser.showPeerAndBlockMATLAB	1	5.966 s	-0.000 s	
...ooser>FileOpenChooser.doShowDialog	1	5.935 s	5.935 s	
network.train	1	5.432 s	0.368 s	
network.subsasgn>network_subsasgn	35	5.176 s	0.110 s	
network.subsasgn	35	4.538 s	0.031 s	
trainlm	11	3.786 s	0.016 s	

Figure 6.10 Profile Summary of Image Trained in ANN

CONCLUSION

Incident rates of melanoma skin cancer have been rising since last two decades. So, early, fast and effective detection of skin cancer is paramount importance. If detected at an early stage, skin has one of the highest cure rates, and the most cases, the treatment is quite simple and involves excision of the lesion. Moreover, at an early stage, skin cancer is very economical to treat, while at a late stage, cancerous lesions usually result in near fatal consequences and extremely high costs associated with the necessary treatments.

After all, the best way to lower the risk of melanoma is to limit the exposure to strong sunlight and other source of Ultraviolet light. Take care of all the necessary measures such as: protecting skin with clothing, wearing hat, using sunscreen, staying in the shade (etc.). The final output given by the system will help the dermatologist to detect the lesion and its type, accordingly with his knowledge he will examine the patient to draw a final conclusion whether it can be operated or not or any other way to cure it for e.g. using medicines or ointments, etc. Skin cancer detection System will help Dermatologist to diagnose melanoma in early stages. The future scope of the skin cancer detection system is that it can be more accurate and efficient. The ABCD rule of skin cancer detection is the most adopted method of skin cancer in the world.

Computer-aided diagnosis system for detection of melanoma skin cancer with Artificial Neural Network as a classifier using Back Propagation Algorithm. The present algorithm is fast, consume only a few seconds of execution time and results are found to be better with the accuracy of 96.2%. It can be concluded from the network results that the suggested system can be capably used by patients and physicians to diagnose the skin cancer more exactly. This tool is useful for the rural areas where the experts in the diagnosis field may not be applicable. Since the tool is made more feasible and robust for images acquired in any conditions, it can deliver the purpose of automatic diagnostics of the Melanoma Skin Cancer. Image processing is a wide area where various classifiers are developed in recent days.

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APPENDIX

Program code to detect melanoma using image processing

```
%%% to read input image %%%

clc;
warning off;
[filename, pathname]=uigetfile('*.*','select an image');
i=imread(filename);
i=imresize(i,[255 255]);
figure,imshow(i),title('origional image');

 %%%%%%%%%%% image Preprocessing %%%%%%%%

 %%% image enhancement using image scale fitting %%%

a = im2double(i);
%ha=imadjust(a);
figure,imshow(a);
%get hairs using bottomhat filter
P=rgb2gray(a);
se = strel('disk',20);
hairs = imbothat(P,se);
figure, imshow(hairs),title('filtered image');
[m,n,k] = size(a);
ar = a(:,:,1);
ag = a(:,:,2);
ab = a(:,:,3);
br = 1.5*ar;
bg = 1.5*ag;
bb = 1.5*ab;
c = zeros(m,n,k);
c(:,:,1) = br;
c(:,:,2) = bg;
c(:,:,3) = bb;
figure,imshow(c),title('enhanced image');
input=c;

   %%%%%%%%%%%%% Image segmentation%%%%%%%%%%

I = rgb2gray(input);
hy = fspecial('sobel');
hx = hy';
Iy = imfilter(double(I), hy, 'replicate');
Ix = imfilter(double(I), hx, 'replicate');
gradmag = sqrt(Ix.^2 + Iy.^2);
L = watershed(gradmag);
Lrgb = label2rgb(L);
se = strel('disk', 20);
```

```
Io = imopen(I, se);
Ie = imerode(I, se);
Iobr = imreconstruct(Ie, I);
Ioc = imclose(Io, se);
Iobrd = imdilate(Iobr, se);
Iobrcbr = imreconstruct(imcomplement(Iobrd), imcomplement(Iobr));
Iobrcbr = imcomplement(Iobrcbr);
fgm = imregionalmax(Iobrcbr);
I2 = I;
I2(fgm) = 255;
se2 = strel(ones(5,5));
fgm2 = imclose(fgm, se2);
fgm3 = imerode(fgm2, se2);
fgm4 = bwareaopen(fgm3, 20);
I3 = I;
I3(fgm4) = 255;
bw = im2bw(Iobrcbr, graythresh(Iobrcbr));
figure,imshow(imcomplement(bw)),title('segmented image ');

        %%%%%%%%%%%% Extraction of ABCD features %%%%%%%%%%%%

 %%%%%% (A)- Asymmetry Index %%%%%%

a= imcomplement(bw);
%figure, imshow(a);
plp=regionprops(a,'perimeter');
pl=regionprops(a,'centroid');
pp=plp.Perimeter;
p=pl.Centroid(:,1);
disp(p);%x coordinate of centroid
pc=pl.Centroid(:,2);%y coordinate of centroid
p=round(p);
disp(p);
pc=round(pc);
a1=a(:,1:p);
a2=a(:,p+1:end);
[m, n]=size(a);
r=m-p;
if(p<=r)
   p1= r-p;
   b1=a1;
   %disp(b1);
   b4=p+p1;
   b1(:,p+1:b4)=0;
   b1 = circshift(b1,[0 p1]);
   %disp(b1);
   a1=b1;
else
  p2= p-r;
  b2=a2;
```

```
   b3=r+p2;
   b2(:,r:b3)=0;
   a2=b2;
end
a3=fliplr(a2);
a4=xor(a1,a3);
a5=bwarea(a4);
a6=bwarea(a);
disp(a6);
AI1=(a5)/a6;
a7=a(1:pc,:);
a8=a(pc+1:end,:);
r1=n-pc;
if(pc<=r1)
  p3=r1-pc;
  b5=pc+p3;
  b6=a7;
  b6(pc+1:b5,:)=0;
  a7=b6;
  a7 = circshift(a7,[p3 0]);
else
  p4=pc-r1;
  b7=r1+p4;
 b8=a8;
 b8(r1:b7,:)=0;
 a8=b8;
end
a9=flipud(a8);
a10=xor(a7,a9);
a11=bwarea(a10);
AI2=(a11)/a6;

A=(AI1+AI2)/2;
disp(A);


%%%%%%% (B) - Border Irregularity %%%%%%%

  %%% to find Compact Indexe %%%

 CI=(pp*pp)/(4*pi*a6);

  %%% to find Fractal Dimension %%%
  % detect the edge of image 'p' using the Canny algorithm
  % this gives edge as 'e2'
e2 = edge(bw,'canny');
figure,imshow(e2),title('edge detected image');

% once we have e2, set up a grid of blocks across the image
% and scan each bloch too see if the edge occupies any of the blocks.
```

```
% If a block is occupied then flag it and record it in boxCount --
% store both size of blocks (numBlocks) and no of occupied boxes (boxCount)
% in table()
Nx = size(e2,1);
Ny = size(e2,2);
for numBlocks = 1:25
   sizeBlocks_x = floor(Nx./numBlocks);
   sizeBlocks_y = floor(Ny./numBlocks);
   flag = zeros(numBlocks,numBlocks);
   for i = 1:numBlocks
      for j = 1:numBlocks
         xStart = (i-1)*sizeBlocks_x + 1;
         xEnd = i*sizeBlocks_x;
         yStart = (j-1)*sizeBlocks_y + 1;
         yEnd = j*sizeBlocks_y;
         block = e2(xStart:xEnd, yStart:yEnd);
         flag(i,j) = any(block(:));      end
   end
   boxCount = nnz(flag);
   table(numBlocks,1) = numBlocks;
   table(numBlocks,2) = boxCount;
end
x = table(:,1); % x is numBlocks
y = table(:,2); % y is boxCount
p = polyfit(x,y,1);
BestFit = polyval(p,x);

x2 = log(x);
y2 = log(y);
p2 = polyfit(x2,y2,1);
BestFit2 = polyval(p2,x2);

fractal = p2(:,1);

%%% to calculate Edge variation %%%

[x , map]=rgb2ind(input,128);
hsv=rgb2hsv(map);
L=hsv(:,3);
[Gmag, Gdir] = imgradient(L,'prewitt');
l=mean2(Gmag);
lg=var(Gmag);


B =( CI+fractal+l+lg );
disp(B)

%%%%%%%%%%%% (C) - Color Index calculation &&&&&&&&

I = im2double(input);
```

```
[index,map] = rgb2ind(I,1024);
pixels = prod(size(index));
hsv = rgb2hsv(map);
h = hsv(:,1);
s = hsv(:,2);
v = hsv(:,3);
%Finds location of black and white pixels
darks = find(v < .2)';
lights = find(s < .05 & v > .85)';
h([darks lights]) = -1;
%Gets the number of all pixels for each color bin
black = length(darks)/pixels;
white = length(lights)/pixels;
red = length(find((h > .9167 | h <= .083) & h ~= -1))/pixels;
yellow = length(find(h > .083 & h <= .25))/pixels;
green = length(find(h > .25 & h <= .4167))/pixels;
cyan = length(find(h > .4167 & h <= .5833))/pixels;
blue = length(find(h > .5833 & h <= .75))/pixels;
magenta = length(find(h > .75 & h <= .9167))/pixels;
dark_brown = length(find((h >0.9694 | h <= 0.1361) & h ~= -1))/pixels;
light_brown = length(find((h >0.9722 | h <= 0.1388) & h ~= -1))/pixels;


if(black~=0)
   b=1;
else
    b=0;
end
 if(white~=0)
     w=1;
 else
     w=0;
  end
 if(red~=0)
     r=1;
  else
     r=0;
  end
 if(blue~=0)
     bl=1;
  else
      bl=0;
  end
 if(dark_brown~=0)
    d=1;
  else
     d=0;
  end
 if(light_brown~=0)
```

```
 li=1;
 else
    li=0;
 end
 C = (w+b+r+bl+d+li);
 disp(C);


  %%%%%%%% (D) - Diameter  calculation %%%%%%%%%%


m=imcomplement(bw);
ma=regionprops(m,'majoraxislength');
mi=regionprops(m,'MinorAxisLength');
max=ma.MajorAxisLength;
min=mi.MinorAxisLength;

if(max>=min)
   DIA=min;
   if(DIA>=22.6772)
       dia=5;
   else
       dia=DIA;
    end
end
 D = dia ;
 disp(D);

 %%%%%%%%%%%% Total Dermotalogy Score (TDS) calculation


TDS= (1.3 * A) + (0.1 * B ) + ( 0.5 * C ) + ( 0.5 * D );
disp(TDS);


     %%%%%%%%%%%%% classification %%%%%%%%%%


if TDS <4.75
     disp('non can cerous skin lesion');
elseif (TDS>=4.7 && TDS < 5.45)
      disp('suspicious case of  skin lesion');
elseif (TDS >= 5.45)
     disp('cancerous skin lesion' );
    end
```

Program Code to detect melanoma using artificial neural networks:

```
clc;
clear all;
close all;
[filename,pathname]=uigetfile('*.*','pick an image');
a=imread(filename);
figure,imshow(a);

%%%% PREPROCESSING %%%%
 b=imresize(a,[256 256]);
 figure,imshow(b);
 c=rgb2gray(b);
 figure,imshow(c);
 d=im2bw(c);
 figure,imshow(d);

 %%%%

  se=strel('disk',1);
  background=imopen(d,se);
  i2=d-background;
  figure,imshow(i2);
  m=edge(i2,'sobel');
  figure,imshow(m);
   mask=d;
  src=c;
   masked = bsxfun(@times, src, cast(mask,class(src)));
   k=im2bw(masked);
   k=~k;
   figure,imshow(k);

   %%%%
   L = bwlabel(k);
  stats = regionprops(L,'all');
  m=stats(1).Area;
  n=stats(1).Perimeter;
  o=stats(1).MajorAxisLength;
  p=stats(1).MinorAxisLength;

Circularityindex= n  .^ 2 ./ (4 * pi* m);
  A=n/m;
  B=n/ o;
  C=n*((1/p)-(1/o));
  D=o-p;
  pr=size(4,1);
i=1;
pr(i,1)=A;
i=i+1;
pr(i,1)=B;
i=i+1;
```

```
pr(i,1)=C;
i=i+1;
pr(i,1)=D;

save('pr');
load('feat1.mat');
load('labels.mat');
 load('pr.mat');
 net=newff(feat1,labels,80);
net.trainParam.epochs=10;
[net1,p]=train(net,feat1,labels);
mm1=sim(net1,pr);
mm=round(mm1);
T=[0];
T1=[1];
if(mm==0)
    disp('cancer image');
    helpdlg('cancer image');
else
    disp('non cancer image');
    helpdlg('non cancer image');
end
 temp_obj_eval = objective_evaluation_core(k, im2bw(b));

disp('Accuracy--');
Sen=temp_obj_eval.Accuracy;
disp(temp_obj_eval.Accuracy);
```