FACULTY OF ENGINEERING

DEPARTMENT OF BIOMEDICAL ENGINEERING

A NEW ALGORITHM FOR SKIN TUMOR SEGMENTATION

GRADUATION PROJECT 2.
BME402

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Our project represents the last chapter of our life as undergraduate students, and prepares us to the long way of real and practical life; this project will also be the first step for serving humanity and pushing the efforts of science.

We are grateful for every person who participated and made effort to complete this project, we can’t forget the role of chairperson of biomedical engineering department Assoc. Prof. Dr. Terin Adali who was our mentor and enlarged our minds and thinking. Then our supervisors Hasan Erdagli who had patience on us and spent time to help us finish this project. Finally we would thank all family members and friends who stood beside us during this time.

ABSTRACT

Early detection and treatment of skin cancer can significantly improve patient outcome. However, present standards for diagnosis require biopsy and histopathologic examinations that are relatively invasive, expensive, and difficult for patients with many early-stage lesions.

Here, the aim of our project is to help ease the job of a dermatologist, instead of the doctor to manually highlight every region of interest of the patient all they need to do is run the images through this program and it will automatically highlight all the region of interest for the doctor.

This system was tested by obtaining spectra from pigmented and non-pigmented skin lesions, including melanomas, and common nevi that were validated by standard pathohistologic criteria.

For diagnosis of pigmented melanoma, the data obtained achieved 90% sensitivity and specificity for test set.

Our projects establish program code that can be used to more rapidly and easily diagnose skin cancer in an accurate and automated manner.

Keywords: histopathologic, dermatologist and melanoma.

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CHAPTER 1: Research Purpose.

1.1 Introduction

Cancer is now the leading cause of dead for people of all ages because of the complexity in detection of this disease. And skin cancer is also among the most common form of cancer affecting numerous humans especially most population of people in Europe, North America, and Australia.

There are two major type of skin cancer affecting people today: malignant melanoma and non-melanoma. Melanoma is more dangerous and can be fatal if not treated. If melanoma is detected in its early stages, it is highly curable, yet advanced melanoma is lethal.

Early diagnoses of skin cancer is very important because skin cancer is also one of the most curable form of cancer. So in other to detect this in an early stage one has to visit a dermatologist for examination of the skin. Skin dermascopy is one of the popular cost-effective method for skin cancer diagnoses. The separation of lesion from background is a critical early step in the analysis of dermatoscopic imagery.

Our proposed system is to help with the analysis of dermascopic image by first doing some preprocessing of the input image, segmentation of the area of interest then the output image. All these steps will be discussed in detail in this report.

1.2 Literature Review

There have been other works from people on how to accomplish the image analysis of skin tumor;

M. Messadi, A. Bessaid proposed In their work a fast approaches in border detection of dermoscopy pigmented skin lesions images based on multi-level decomposition and classification method . These methods are tested on a set of 60 dermoscopy images. The obtained results than that the presented method achieves both fast and accurate border detection. (M. Messadi, A. Bessaid/2012).

V. Jeya Ramya, J. Navarajan, R. Prathipa and L. Ashok Kumar also proposed a method comprising of first PreProcessing the images. The weiner filter is used for the noise removal. Next the ACM segmentation method is used to extract the lesion from the

Digital camera Image. Thirdly, extracting second order statistical textural GLCM features from the segmented skin lesion. Finally classify the lesion as benign or malignant by using SVM classifier. Evaluation of the proposed method is done by calculating accuracy, specificity and sensitivity. (Ramya et al., 2015)

Rashi Goel and Saranjeet Singh proposed a system of Segmentation of skin lesion from the surrounding skin in the dermoscopic images by using Neural Network segmentation algorithm. Different segmentation techniques were applied to the dermoscopic images to segment the skin lesions and evaluated with 3 different metrics, namely sensitivity, accuracy and border error. They showed that Segmentation performance with a Neural Network based lesion segmentation has high sensitivity, accuracy and less border error. (Goel and Singh, 2015).

CHAPTER 2: Clinical Background

2.0 Anatomy and Physiology of the Skin

The skin is the body's largest organ. It creates a barrier between the external environment and the internal organs. The skin has several important functions vital to human life. Its thickness varies depending on where it is located on the body. For example, the skin on the face is thin compared to the skin on the back.

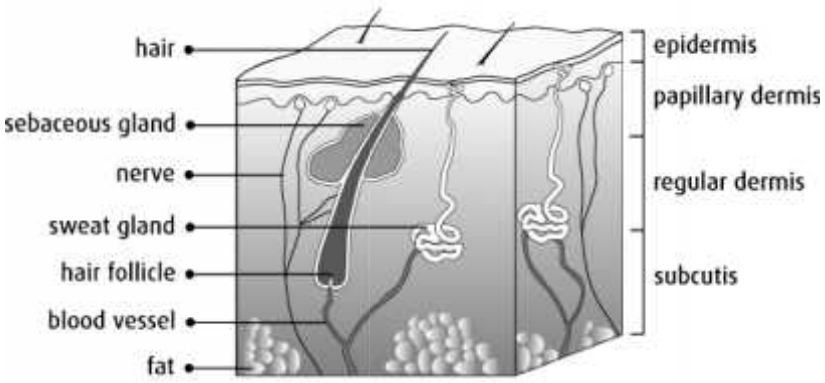

Figure 1: the skin.

2.1.1 Structure

The epidermis and dermis are the 2 main layers of the skin. They lie on top of a third layer called the subcutis.

2.1.2 Epidermis

The epidermis is the thin outer layer of the skin. It contains no blood vessels and relies on the dermis for its nutrients and waste removal. The epidermis is thinnest on the eyelids and thickest on the palms of the hands and soles of the feet. The epidermis layer itself is made up of layers of cells (basal cells and squamous cells) that work together to continually rebuild the surface of the skin. The epidermis also includes 2 other types of specialized cells: Langerhans cells (involved in immune response) and Merkel cells (believed to play a role in making the skin sensitive to touch).

2.1.3 The basal cell layer

The basal cell layer is the deepest part of the epidermis. This layer sits on top of the dermis. The round cells in this layer are called basal cells. Basal cells continually divide, producing new cells that undergo a maturing, or keratinisation, process as they push the older cells toward the surface of the skin. These older cells eventually become flattened squamous cells. Melanocytes are another type of cell found mainly in the basal cell layer. Melanocytes produce melanin, which is the substance that gives skin its colour. When the skin is exposed to the sun's ultraviolet rays, the melanocytes produce more melanin. Melanin production helps protect the body by lessening the damaging effects of the sun's ultraviolet radiation (UVR). The melanocytes in dark-skinned people are more active, so more melanin is produced. Therefore, dark-skinned people have more protection from the sun than light-skinned people. Freckles, birthmarks and age spots are areas of the skin where melanocytes have produced more melanin than in the surrounding skin.

2.1.4 The squamous cell layer

The squamous cell layer is located above the basal cell layer and occupies the major part of the epidermis. The main cells in this area are called keratinocytes. These cells contain a protein called keratin. Keratin is a tough substance that helps to protect the skin from injury. Keratin is also found in hair and nails.As keratinocytes mature and move toward the surface of the skin, they undergo gradual changes in composition and appearance. Shortly before they reach the surface, the cells die and take on a scale-like appearance (squamous cells). The surface of the skin is covered in dead cells, which are shed and replaced every 3–4 weeks by the newly divided cells in the basal cell layer that will be pushed up.

2.1.5 Dermis

The dermis is the second layer of the skin, beneath the epidermis. The dermis is the thickest of all 3 layers. It is made up of a papillary layer and a reticular layer. Collagen and elastin are produced by fibroblasts in the dermis to provide structure to the skin.

Most of the skin's specialized structures are found in the dermis: blood vessels, lymph vessels, hair follicles, sweat glands, sebaceous (oil) glands and nerve endings.

2.1.6 Subcutis

Beneath the dermis lies a fat layer known as the subcutis or hypodermis. This layer is made up mainly of fat, or adipose tissue. It helps to conserve the body's heat and protect the organs of the body. (http://www.cancer.ca/en/cancer-information/cancer-type/skin-melanoma/anatomy-and-physiology/#ixzz49CVDSbDh)

2.1.7 Melanoma

Melanoma is a growth of the color delivering cells, which are found on the skin, in the eyes, the neural framework, and additionally in the mucous layers. It is exceedingly treatable in its initial stages; however because of its forceful nature, it rapidly turns into a hazardous foe. While melanoma speaks to a minority of recently analyzed skin tumors, 80 percent of skin disease passings are because of melanoma. Stage IV metastatic melanoma has a middle survival of short of what one year. In particular, it is vital to realize that anybody can get melanoma. While people with reasonable skin, light hair and eye shading are at a higher danger, likely because of hereditary inclination, for example, the MCR1 quality, numerous darker skin sort patients build up this dangerous tumor also. Other danger variables incorporate a past filled with rankling sunburns, a wealth of nevi (spots or moles), extensive or atypical showing up nevi, a background marked by indoor tanning, a family history of melanoma, an individual history of melanoma or other skin tumor, and also a debilitated safe framework. Both environment and hereditary qualities seem to assume a part in creating melanoma, albeit numerous people build up this illness without a family history. Melanoma has turned out to be an undeniably complex immunogenic growth that is the aftereffect of a mind boggling relationship among hereditary defenselessness qualities, immunogenic pathways, and natural introduction. To date, just a couple of innate melanoma risk qualities have been recognized. In any case, a late study has distinguished another change in a quality called MITF, which has turned out to be a melanomarisk element recognized in families with various instances of melanoma. As to acquired hereditary variables, another study has indicated five recently distinguished danger qualities, all of which don't seem to show their impact by means of phenotypic characteristics, for example, moles or pigmentation as opposed to earlier inclination qualities.

2.1.8 Skin Tests

Skin biopsy: A piece of skin is removed and examined under a microscope to identify a skin condition.

Skin testing (allergy testing): Extracts of common substances (such as pollen) are applied to the skin, and any allergic reactions are observed.

Tuberculosis skin test (purified protein derivative or PPD): Proteins from the tuberculosis (TB) bacteria are injected under the skin. In someone who's had TB, the skin becomes firm.

2.1.9Skin Treatments

Corticosteroids (steroids): Medicines that reduce immune system activity may improve dermatitis. Topical steroids are most often used.

Antibiotics: Medicines that can kill the bacteria causing cellulitis and other skin infections.

Antiviral drugs: Medicines can suppress the activity of the herpes virus, reducing symptoms.

Antifungal drugs: Topical creams can cure most fungal skin infections. Occasionally, oral medicines may be needed.

Antihistamines: Oral or topical medicines can block histamine, a substance that causes itching.

Skin surgery: Most skin cancers must be removed by surgery.

Immune modulators: Various drugs can modify the activity of the immune system, improving psoriasis or other forms of dermatitis.

Skin moisturizers (emollients): Dry skin is more likely to become irritated and itchy. Moisturizers can reduce symptoms of many skin conditions.

2.2.0 Skin cancer

Each year in the U.S. more than 5.4 million instances of nonmelanoma skin disease are dealt with in more than 3.3 million individuals. Each year there are more new instances of skin cancer than the consolidated frequency of diseases of the bosom, prostate, lung and colon. Over the previous three decades, more individuals have had skin disease than every other malignancy consolidated. One in five Americans will create skin malignancy

over the span of a lifetime. Between 40 and 50 percent of Americans who live to age 65 will have either basal cell carcinoma or squamous cell carcinoma in any event once.Basal cell carcinoma (BCC) is the most widely recognized type of skin tumor. BCCs are infrequently lethal, however can be profoundly distorting if permitted to develop.Squamous cell carcinoma is the second most regular type of skin tumor. Organ transplant patients are roughly 100 times more probable than the overall population to create squamous cell carcinoma.Actinic keratosis is the most well-known precancer; it influences more than 58 million Americans.About 90 percent of non melanoma skin malignancies are connected with presentation to bright (UV) radiation from the sun.The yearly cost of treating skin malignancies in the U.S. is evaluated at $8.1 billion: about $4.8 billion for non melanoma skin growths and $3.3 billion for melanoma.

2.2.1 Skin Diseases

Skin disease is the uncontrolled development of unusual skin cells. It happens when unprepared DNA harm to skin cells (frequently brought about by bright radiation from daylight or tanning beds) triggers transformations, or hereditary imperfections, that lead the skin cells to duplicate quickly and structure dangerous tumors.

2.2.2 Skin cancer symptoms

While side effects of basal cell or squamous cell carcinoma differ, an abnormal skin development, knock or sore that doesn't leave might be the main sign of a non-melanoma skin tumor. Basal cell carcinomas on the head or neck may first show up as a pale patch of skin or a waxy translucent knock. It might be conceivable to see veins in the focal point of the knock or there might be a space in the inside. On the off chance that the carcinoma creates on the mid-section it might look more like an earthy scar or tissue hued injury. As the tumor creates, it might drain if harmed or overflow and get to be dried up in a few ranges. Squamous cell carcinomas may likewise create as a knot on the skin. Be that as it may, these firm irregularities might be unpleasant at first glance, not at all like the smooth and silvery appearance of a basal cell carcinoma. On the off chance that a knob doesn't frame, the tumor may grow more like a rosy layered patch. While a skin rash may leave with time, these harsh injury like patches remain and keep on developing

gradually. This sort of disease normally is found on the head, neck, hands or arms, yet they can likewise create in different territories, for example, the genital locale or in scars or skin bruises. However, both basal cell and squamous cell carcinomas may likewise create as a level range that does not look very different from ordinary skin, so it is vital know about the side effects of skin tumor and examine any progressions with your specialist.

2.2.3 Melanoma indications

Melanoma skin tumor signs incorporate new spots on the skin, or an adjustment in size, shape or shade of a current mole. The ABCD guideline is another approach to perceive irregular developments:

A is for Asymmetry: A mole that has an unpredictable shape, or two distinctive looking parts.

B is for Border: Irregular, obscured, unpleasant or indented edges might be indications of skin tumor.

C is for Color: Most moles are an even shading – cocoa, dark, tan or even pink – yet changes in the shade or dispersion of shading all through the mole can flag melanoma.

D is for Diameter: Moles bigger than ¼ inch (6 mm, the measure of a pencil eraser) crosswise over might be suspect, albeit a few melanomas might be littler than this.

2.2.4 Checking for skin growth side effects

Regular examination of the skin for any new or unordinary developments, or changes in the size, shape or shade of a current spot, is vital to finding and treating skin tumors early. On the discovery of anything suspicious, you ought to talk about it with your essential consideration doctor or a dermatologist. While numerous skin growths create in territories presented to the sun, they may likewise create in zones that are normally avoided the sun. It is critical to look at all of these zones. Notwithstanding analyzing the legs, trunk, arms, face and neck, it is critical to search for indications of skin disease in the territories between the toes, underneath nails, palms of the hands and soles of the feet, privates and even the eyes.

2.2.5 Factors of skin cancer.

Age

Basal cell and squamous cell skin growths grow gradually. As you get more established you have more opportunity to develop sun harm to your skin. So the more established you are, the more probable you are to get a non melanoma skin tumor. Be that as it may, skin diseases can create in more youthful individuals as well.

Family history of skin tumor

Most non melanoma skin tumors don't keep running in families. However, examine programs have found a couple of families who do appear to have a higher number than typical. On the off chance that you have a guardian who has had squamous cell skin tumor, you have a 2 to 3 times higher than normal danger of getting one yourself. Individuals who have a family history of melanoma have an expanded danger of basal cell skin cancer.Of course, skin sort keeps running in families. So individuals from reasonable cleaned families will be more at danger. Yet, there might be some other acquired qualities that expand the danger of skin malignancy in a few families.

2.2.6 Other skin conditions

People with certain skin conditions can will probably create skin growth. These incorporate the accompanying conditions.

Psoriasis is not a danger in itself. Be that as it may, a portion of the medications, (for example, bright light) may build your danger. Having had medications, for example, psoralen bright light treatment (PUVA) in the past mayincrease your danger of getting non melanoma skin disease. Be that as it may, the UV presentation is precisely observed in this treatment and it is useful for your psoriasis. The advantages and dangers will be deliberately adjusted by your specialist.

Sun powered keratosis

This is a skin condition either created by numerous years presentation to the sun or by extreme sun introduction on reasonable skin. Little harsh red patches of skin create– regularly on the face, hands or, on the off chance that you are bare, the scalp. These are an indication that your skin has as of now been harmed by the sun and you ought to take

additional consideration to conceal when you go out. Sun based keratosis can be treated with cryosurgery, chemotherapy creams, retinoids or photodynamic treatment.

Xeroderma pigmentosum

Xeroderma pigmentosum is an extremely uncommon acquired hereditary skin condition. It is for the most part there from birth. However, there is another kind of this condition called xeroderma pigmentosum variation that does not appear until the teenagers. On the off chance that you have this condition, your skin can't repair harm from the sun. You ought to keep away from all sun introduction and different wellsprings of UV light. Indeed, even in this way, individuals with this condition frequently get skin malignancies on uncovered skin

2.2.7 Importance of Early Detection.

Performed regularly, self-examination can alert you to changes in your skin and aid in the early detection of skin cancer. It should be done often enough to become a habit, but not so often as to feel like a bother. For most people, once a month is ideal, but ask your doctor if you should do more frequent checks. It is also advisable that children are taught how to detect early signs of skin cancer at an early age so they can do it themselves by the time they are teens. Coupled with yearly skin exams by a doctor, self-exams are the best way to ensure that you don't become a statistic in the battle against skin cancer.

You may find it helpful to have a doctor do a full-body exam first, to assure you that any existing spots, freckles, or moles are normal or treat any that may not be. After the first few times, self-examination should take no more than 10 minutes — a small investment in what could be a life-saving procedure.

2.2.8 Types of skin cancer.

There are three main types of skin cancer: basal cell carcinoma, squamous cell carcinoma, and melanoma. Because each has many different appearances, it is important to know the early warning signs. Look especially for change of any kind. Do not ignore a suspicious spot simply because it does not hurt. Skin cancers may be painless, but dangerous all the same. If you notice one or more of the warning signs, see a doctor right away, preferably one who specializes in diseases of the skin

2.2.8 Warning Signs Of Skin Cancer Are:

1. A skin growth that increases in size and appears pearly, translucent, tan, brown, black, or multicolored
2. A mole, birthmark, beauty mark, or any brown spot that:
3. changes color
4. increases in size or thickness
5. changes in texture
6. is irregular in outline
7. is bigger than 6mm or 1/4", the size of a pencil eraser
8. appears after age 21
9. A spot or sore that continues to itch, hurt, crust, scab, erode, or bleed
10. An open sore that does not heal within three weeks
11. Protection steps

2.2.9 Types of Non melanoma

There are 2 main types of non melanoma skin cancer − basal cell carcinoma (BCC) and squamous cell carcinoma (SCC). A history of sunburn or recreational exposure to sunlight increases the risk of BCC. Risk is especially high if you had several episodes of sunburn in childhood. This has also been to SCC in some studies. The risk of SCC is mainly linked to overall sun exposure through your life. This is also linked with BCC but to a lesser degree. This means that outdoor workers such as farm workers, gardeners and building site workers have an increased risk of non melanoma skin cancer. Fair skinned people with light coloured hair and eyes, or those more likely to burn than tan, are more at risk of skin cancer. This is because their skin makes less of the protective pigment called melanin. People with black skin are less likely to get skin cancer, but they can be at risk particularly in areas not exposed to the sun, such as the soles of the feet and palms of the hands.

Albinism is an inherited genetic condition in which the skin makes no melanin at all. Albino people have very white skin and pale blonde hair. They are at higher than average risk of skin cancer because their skin has no natural protection against the sun.

It has always been thought that UVB is the main risk for skin cancer. Sunbeds produce mostly UVA but all produce some UVB too. UVA damages the skin and is now also

linked to skin cancer. We know the use of sunbeds causes melanoma, and there is now evidence that sunbeds may increase the risk of non melanoma skin cancer. The evidence is strongest for a link between sunbeds and SCC.

2.3.0 Protection from harmful UV light

Protection from the sun's UV light can help prevent you from getting a skin cacer. About 90 percent of non-melanoma skin cancers are associated with exposure to ultraviolet (UV) radiation from the sun. Since its inception in 1979, The Skin Cancer Foundation has always recommended using a sunscreen with an SPF 15 or higher as one important part of a complete sun protection regimen. Sunscreen alone is not enough, however. Seek the shade, especially between 10 AM and 4 PM.Avoid tanning and UV tanning booths. Cover up with clothing, including a broad-brimmed hat and UV-blocking sunglasses.

The incidence of skin cancer is increasing by epidemic proportions. Basal cell cancer remains the most common skin neoplasm, and simple excision is generally curative. Squamous cell cancers may be preceded by actinic keratoses—premalignant lesions that are treated with cryotherapy, excision, curettage or topical 5-fluorouracil. While squamous cell carcinoma is usually easily cured with local excision, it may invade deeper structures and metastasize. Aggressive local growth and metastasis are common features of malignant melanoma, which accounts for 75 percent of all deaths associated with skin cancer. Early detection greatly improves the prognosis of patients with malignant melanoma. The differential diagnosis of pigmented lesions is challenging, although the ABCD and seven-point checklists are helpful in determining which pigmented lesions require excision. Sun exposure remains the most important risk factor for all skin neoplasms. Thus, patients should be taught basic "safe sun" measures: sun avoidance during peak ultraviolet-B hours; proper use of sunscreen and protective clothing; and avoidance of suntanning.

CHAPTER 3: Image Processing

3.1 What is Image Processing?

Image processing is a method to convert an image into digital form and perform some operations on it, in order to get an enhanced image or to extract some useful information from it. It is a type of signal dispensation in which input is image, photograph and output may be image or characteristics associated with that image. Usually Image Processing system includes treating images as two dimensional signals while applying already set signal processing methods to them. It is among rapidly growing technologies today, with its applications in various aspects of a business. Image Processing forms core research area within engineering and computer science disciplines too.

Image processing basically includes the following three steps. Importing the image from a digital photography.Analyzing and manipulating the image which includes data compression and image enhancement and detection of objects edges. Output is the last stage in which result can be altered image or report that is based on image analysis.

3.2 Types

The two types of methods used for Image Processing are Analog and Digital Image Processing. Digital Processing techniques help in manipulation of the digital images by using computers. As raw data from a digital camera can be crude and sometimes includes flows. To get over such flaws and to get originality of information, it has to undergo various phases of processing. The three general phases that all types of data have to undergo while using digital technique are Pre- processing, enhancement and display, information extraction. Analog techniques of image processing can be used for the hard copies like printouts and photographs. Image analysts use various fundamentals of interpretation while using these visual techniques. The image processing is not just confined to area that has to be studied but on knowledge of analyst. Association is another important tool in image processing through visual techniques. So analysts apply a combination of personal knowledge and collateral data to image processing.

3.3 Principles of image processing

In the wake of changing over picture data into a cluster of numbers, the picture can be controlled, prepared, and showed by PC. PC transforming is utilized for picture upgrade, rebuilding, division, portrayal, distinguishment, and coding, remaking, change.

The general electronic picture changing system may be separated into three sections: The information device (or digitizer), the mechanized processor, and the yield contraption (Stefanescu et al., 2004).

The digitizer changes more than a perpetual tone and spatially persevering sparkle spread f [x, y] to a discrete bunch (the propelled picture) fq[n, m], where n, m, besides fq are numbers.

- The modernized processor chips away at the propelled picture fq[n, m] to make an alternate mechanized picture gq[k, c], where k, c, and gq are numbers. The yield picture may be identified with in another heading system, in this way the use of various records k and c.
- The picture showcase changes over the propelled yield picture gq[k, c] afresh into a ceaseless tone moreover spatially steady picture g [x, y] for audit. It should be recognized that a couple of structures may not oblige a showcase (e.g., in machine vision and fake insight applications); the yield may be a touch of information. For example, a modernized imaging system that was expected to answer the request, Is there confirmation of a ruinous tumor in this x-bar picture ideally would have two possible yields (YES or NO), , i.e., a singular bit of information.

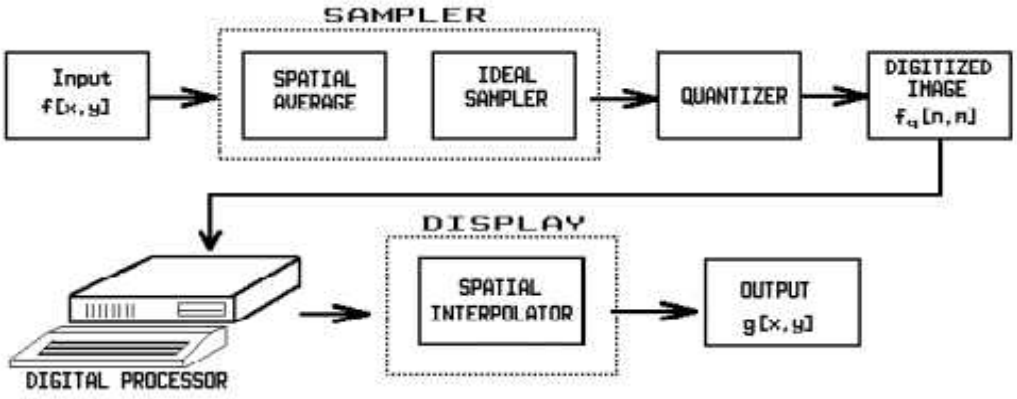

Figure 1: Digital image processing (Andrew, 2008)

3.4 Image Analysis Strategies

Image analysis involves the conversion of features and objects in image data into quantitative information about these measured features and attributes. Microscopy images in biology are often complex, noisy, artifact-laden and consequently require multiple image processing steps for the extraction of meaningful quantitative information (Gonzalez & Woods, 2001). An outline of a general strategy for image analysis is presented below:

1) The starting point in image analysis typically involves a digital image acquired using a CCD camera. Raw microscopy images obtained on digital CCD cameras are subject to various imperfections of the image acquisition setup, such as noise at low light levels, uneven illumination, defective pixels, etc… We often need to first process the image to correct for such defects and also to enhance the contrast to accentuate features of interest in the image for subsequent analysis. In section II, we introduce various image transformation and spatial filtering techniques that can be used for this purpose (Milan et al., 1998).

2) Having corrected artifacts and enhanced contrast in the images, we can apply various computational techniques to extract features and patterns from the images. In the following section, we describe various tools of morphological image processing and image segmentation that can be used for this purpose.

3) After biological important features have been segmented from images, we can then derive quantitative information from these features and objects. MATLAB provides a set of tools that can be used to measure the properties of regions; the matrix representation of images in MATLAB also allows for easy manipulation of data and calculation of quantities from microscopy images (Fan et al., 2002).

3.5 Image Enhancements

Image enhancement is basically improving the interpretability or perception of information in images for human viewers and providing 'better' input for other automated image processing techniques. The principal objective of image enhancement is to modify attributes of an image to make it more suitable for a given task and a specific observer. During this process, one or more attributes of the image are modified. The choice of

attributes and the way they are modified are specific to a given task. Moreover, observer-specific factors, such as the human visual system and the observer's experience, will introduce a great deal of subjectivity into the choice of image enhancement methods (Fan et al., 2002).

There exist many techniques that can enhance a digital image without spoiling it. The enhancement methods can broadly be divided in to the following two categories:

1. Spatial Domain Methods
2. Frequency Domain Methods

In spatial domain techniques, we directly deal with the image pixels. The pixel values are manipulated to achieve desired enhancement. In frequency domain methods, the image is first transferred in to frequency domain. It means that, the Fourier Transform of the image is computed first. All the enhancement operations are performed on the Fourier transform of the image and then the Inverse Fourier transform is performed to get the resultant image. These enhancement operations are performed in order to modify the image brightness, contrast or the distribution of the grey levels. As a consequence the pixel value (intensities) of the output image will be modified according to the transformation function applied on the input values (Gonzalez & woods, 2001).

Image enhancement simply means, transforming an image f into image g using T. (Where T is the transformation. The values of pixels in images f and g are denoted by r and s, respectively. As said, the pixel values r and s are related by the expression,

$$s = T(r)$$

Where T is a transformation that maps a pixel value r into a pixel value *s*. The results of this transformation are mapped into the grey scale range as we are dealing here only with grey scale digital images.

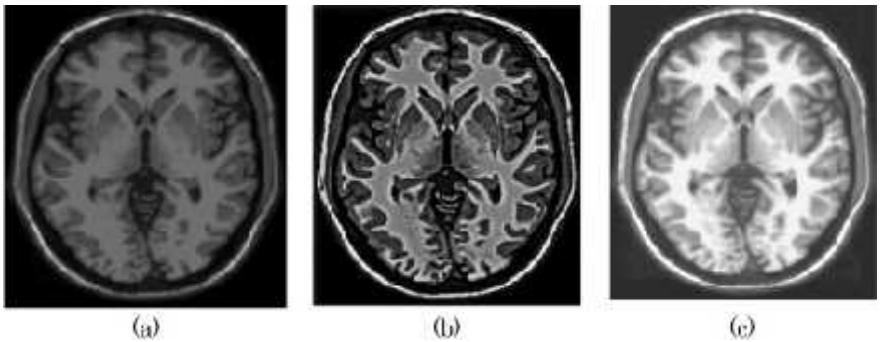

Figure 3: Example of image enhancement (Fan et al., 2002).

3.6 Contrast adjustments

Often, images have a low dynamic range and many of its features are difficult to see. We will present different intensity transformations that will improve the appearance of the images. Improving the appearance of an image does not merely serve an aesthetic role – often, it can help improve the performance of image segmentation algorithms and feature recognition.

During contrast adjustment, the intensity value of each pixel in the raw image is transformed using a transfer function to form a contrast-adjusted image. The most common transfer function is the gamma contrast adjustment:

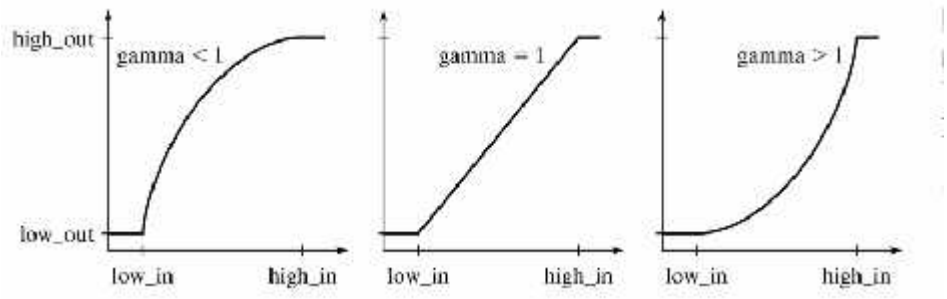

Figure 4: Gamma correction (Gonzalez & woods, 2001).

Here **low_in** and **low_high** give the low and high grayscale intensity values for the contrast adjustment, and **gamma** gives the exponent for the transfer function.

3.7 Image Segmentation

Image segmentation is the division of an image into regions or categories, which correspond to different objects or parts of objects. Every pixel in an image is allocated to one of a number of these categories. A good segmentation is typically one in which:

• Pixels in the same category have similar greyscale of multivariate values and form a connected region,

• Neighboring pixels which are in different categories have dissimilar values.

Figure 5: Edge based segmentation (Saif et al., 2012)

3.8 Edge Detection

Edges are boundaries between different textures. Edge also can be defined as discontinuities in image intensity from one pixel to another. The edges for an image are always the important characteristics that offer an indication for a higher frequency. Detection of edges for an image may help for image segmentation, data compression, and also help for well matching, such as image reconstruction and so on.

There are many methods to make edge detection. The most common method for edge detection is to calculate the differentiation of an image. The first-order derivatives in an image are computed using the gradient, and the second-order derivatives are obtained using the Laplacian. Another method for edge detection uses Hilbert Transform.

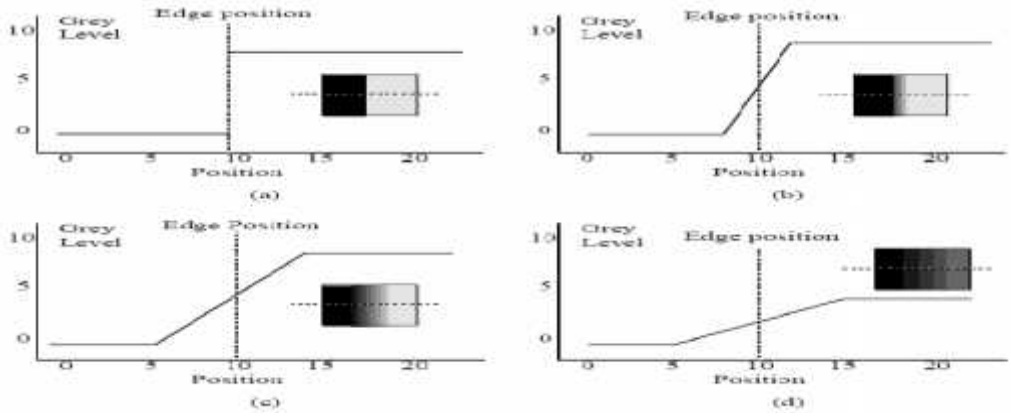

Figure 6 - Step edges. (a) The change in level occurs exactly at pixel 10. (b) The same level change as before, but over 4 pixels centered at pixel 10. This is a *ramp* edge. (c)

Same level change but over 10 pixels, centered at 10. (d) A smaller change over 10 pixels. The insert shows the way the image would appear, and the dotted line shows where the image was sliced to give the illustrated cross-section.

3.9 Image processing applications

The field of digital image has rapidly expanded in the recent years. The usefulness of this technology is clear in many different disciplines and areas (Andrew, 2008).

The fields of image processing are:

- Robotics
- Medical imaging
- Machine vision
- Digital camera images

Medical image processing

Restorative imaging has been experiencing an insurgency in the previous decade with the coming of quicker, more precise, and less obtrusive gadgets. This has driven the requirement for relating programming improvement which thusly has given a noteworthy catalyst to new calculations in sign and picture transforming (Stefanescu et al., 2004).

In particular, in therapeutic imaging we have four key issues:

1. Segmentation - automated methods that create patient-specific models of relevant anatomy from images;

2. Registration - automated methods that align multiple data sets with each other;

3. Visualization - the technological environment in which image-guided procedures can be displayed;

Imaging innovation in Medicine made the specialists to see the inside parts of the body for simple determination. It likewise helped specialists to make keyhole surgeries for coming to the inside parts without truly opening excessively of the body. CT Scanner, Ultrasound and Magnetic Resonance Imaging assumed control x-beam imaging by making the specialists to take a gander at the body's subtle third measurement. With the

CT Scanner, body's inside can be uncovered with straight forwardness and the unhealthy territories can be distinguished without bringing about either uneasiness or torment to the patient. X-ray grabs signals from the body's attractive particles turning to its attractive tune and with the assistance of its intense PC, changes over scanner information into uncovering pictures of inward organs. Image processing strategies produced for breaking down remote sensing information may be altered to dissect the yields of therapeutic imaging frameworks to get best preference to break down indications of the patients without any difficulty (Rao and Rao, 2004).

Computerized Image Processing Requirements for Medical Applications

• Interfacing Analog yields of sensors for example, magnifying lens, endoscopes, ultrasound and so forth, to digitizers and thusly to Computerized Image Processing frameworks (Fan et al., 2002).

• Image upgrades.

• Changing thickness element scope of B/W images.

• Color redress in shading images.

• Manipulating of hues inside an image.

• Contour discovery.

• Area estimations of the cells of a biomedical picture.

• Display of picture line profile.

• Restoration of images.

• Smoothing of images.

• Registration of different images.

• Construction of 3-D images from 2-D images.

• Generation of negative images.

• Zooming of images.

• Pseudo shading.

• Point to point estimations.

• Getting help impact.

CHAPTER 4: Proposed System.

4.1 Automatic Skin Tumor Image Analysis.

The aim of this project is to develop image processing algorithm that will automatically segment the tumor from the input image. This image will pass through some processes that will be discussed below. These include preprocessing, image segmentation and then the output image presentation.

4.2 Methodology

The methods for this approach includes Preprocessing of input image, Image pre-processing can significantly increase the reliability of an optical inspection. Several filter operations which intensify or reduce certain image details enable an easier or faster evaluation. The preprocessing stage involves image resampling, Greyscale contrast enhancement and Noise removal.

The next step is the image segmentation; it is needed for - Improving the analysis of an image when there is no direct correspondence between the image pixel properties and the type of tissue. Separating the pixels of an image according to region of interest. It also Involves the partitioning of an image or volume into distinct regions in a meaningful way. This is also important for finding regions of connected pixels with similar properties, boundaries between regions and Removes unwanted regions. In the segmentation phase we use thresholding techniques. Thresholding relies on intensity differences between structures in an image. Thresholding is simple to implement.

After the application of all aforementioned processes we will then arrive at the output image of the well segmented skin tumor.

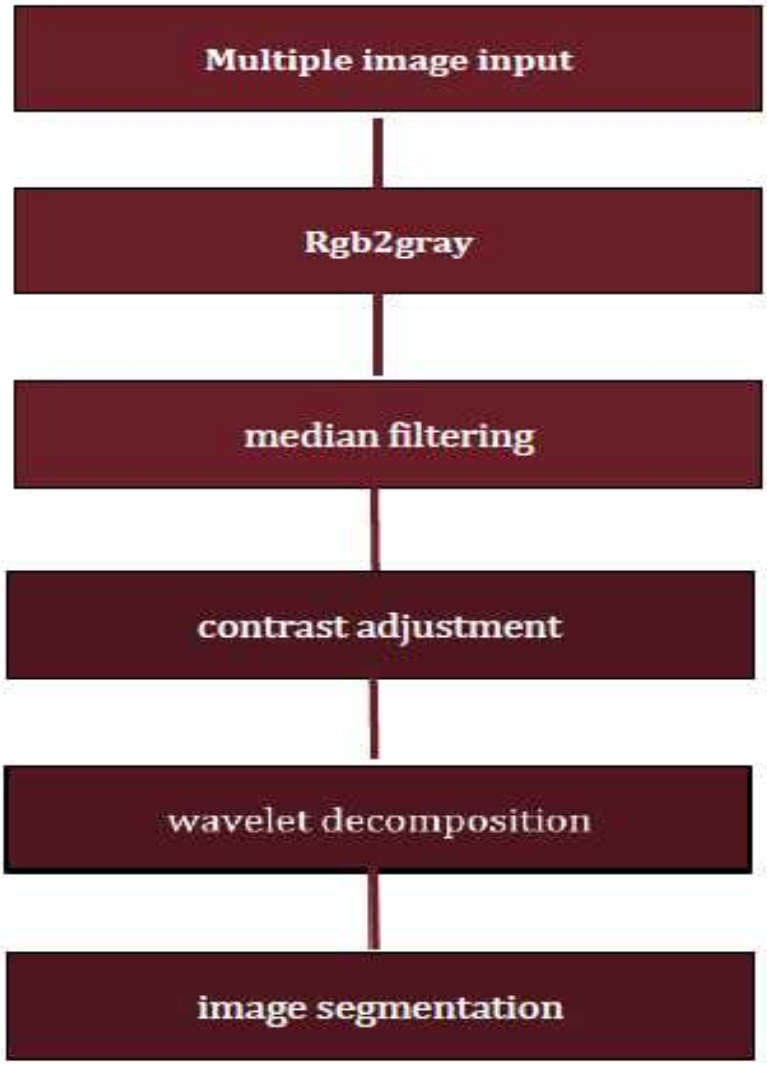

Figure 7: flow chart of the program.

4.3Techniques Used.

For now we are still in the preprocessing stage of image enhancement. We used:

4.3.1 rgb2gray

This function converts the true color image RGB to the grayscale intensity image. The rgb2gray function converts RGB images to grayscale by eliminating the hue and saturation information while retaining the luminance.

Figure 8: Conversion of original RGB image to grayscale image.

4.3.2 Filtering

There are several filtering techniques for an image but here we are working with the median filter. Median filtering is very widely used in digital image processing because, under certain conditions, it preserves edges while removing noise. The main idea of the median filter is to run through the image pixels entry by entry, replacing each entry with the median of neighboring entries. Median filtering smooths the image and is thus useful in reducing noise and it can preserve discontinuities in a step function and can smooth a few pixels whose values differ significantly from their surroundings without affecting the other pixels.

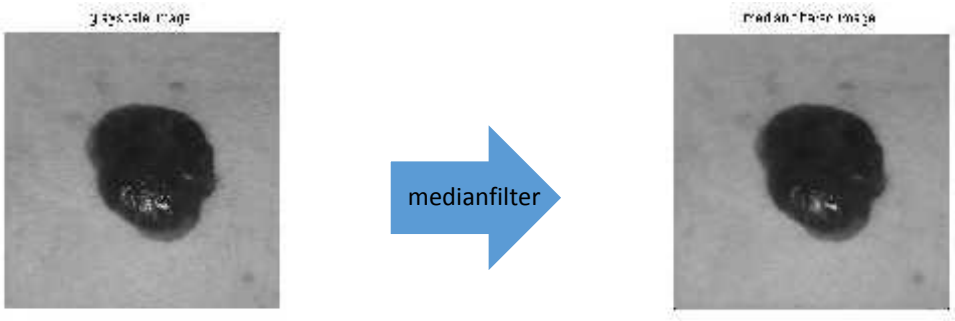

Figure 9: Median filtered image.

4.3.3 Image adjustment

Usually some of the tumor (region of interest) are not so clearly present when the image is converted into a grayscale image, so in order to improve the visibility of the cancer region after conversion to grayscale you'll need to adjust the contrast of the grayscale image. Contrast adjustment is used in this program to enhance the region of interest.

Using the MATLAB image command “imadjust” it will adjust the contrast of the grayscale image to enhance to region of interest.

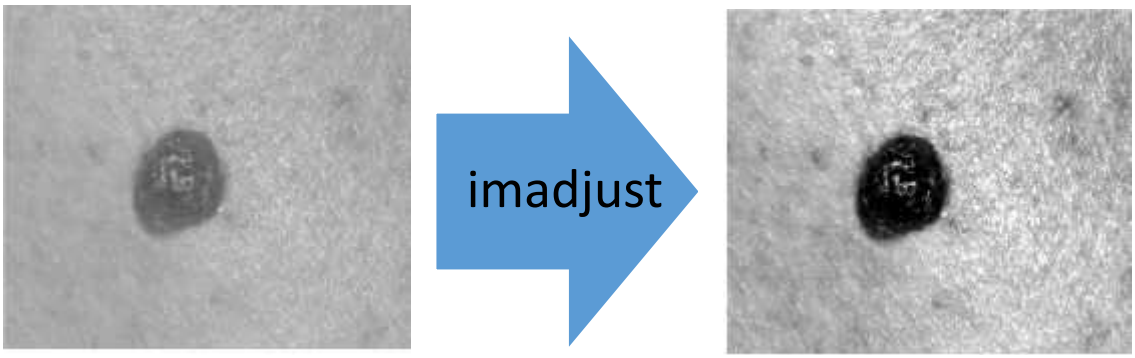

Figure 10: contrast adjusted image.

4.3.4 Wavelet decomposition

For the image segmentation, we use wavelet decomposition the analyze the image for approximation, horizontal details, vertical details and diagonal detail.

Then we reconstruct the image by using idwt2 command which performs a single-level two-dimensional wavelet decomposition with respect to a particular wavelet or particular wavelet decomposition filters (Lo_D and Hi_D) you specify.

Then we sum all the characteristics of the image together to get a well segmented image.

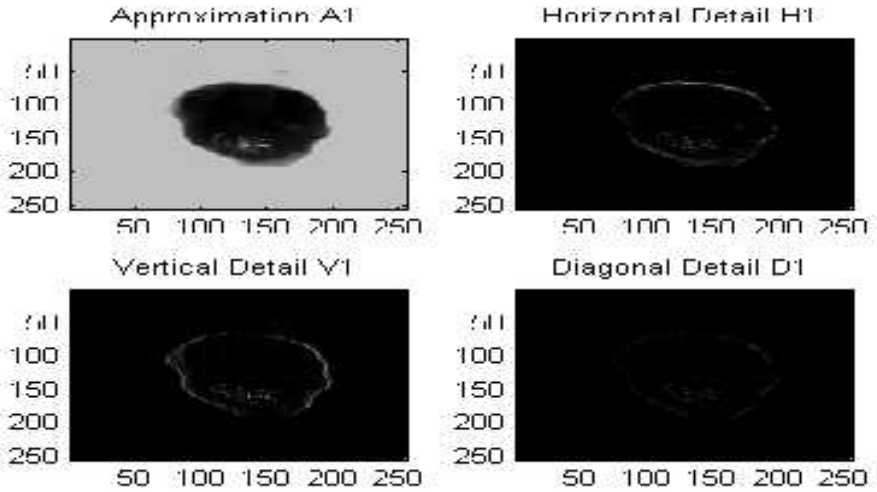

Figure 11: Wavelet decomposition.

4.3.6 Image fusion

Image fusion refers to the combination of all important images to form one image with desired characteristics without producing image. In this case show the edge of the skin tumor.

Figure 12: Summed image.

4.4 Performance of the program

- Our program is a new algorithm for skin tumor segmentation, we have tested our program with some variety of skin cancer images; Melanoma and non-melanoma images and below is a table showing our result.

Types of skin cancer.	Number of images	Number of working images	Percentage of working images (%)
Melanoma	10	10	100
Non-melanoma	23	20	87
Total	33	30	91

Figure 13: performance of tested images.

This is the table of performance for our tested images. Images were gotten from a public database of Waterloo University which is a trusted database for skin cancer research. We have improved the program from 82 percent accuracy to 91 percent accuracy as shown in the table above

Also the time taken for the program to run completely is very important. Time saving is one of our main goal for this program. We want it to be as fast as possible and so far, even though the program is not completed yet, here is a timing table for each function execution.

Profile summary.

Function	**Time taken (s)**
Imread	0.175
Rgb2gray	0.015
Imadjust	0.045
Im2bw	0.005
Imcomplemement	0.002
Bwareaopen	0.033
Imclearborder	0.192
Bwperim	0.091
Imshow	0.828
Total	1.386

Figure 14: time taken to run the functions used in the program.

CONCLUSION

Our proposed system is a new algorithm for automatic segmentation of skin tumor.

We used all they mentioned processes to make this a unique and effective program as seen from the performance of the system.

Our program has one of the best accuracy with melanoma which is the deadliest form of skin cancer. with 100 percent performance for segmentation accuracy.

The ability for the program to automatically get the images from a folder, segment it and save it to a different folder saves time and increases efficiency of the dermatologist.

KEYWORDS

Dermatologist: A physician who specializes in the diagnosis and treatment of skin problems.

Histopathologic: refers to the microscopic examination of tissue in order to study the manifestations of disease. Specifically, in clinical medicine

Melanoma: The most dangerous type of skin cancer, melanoma results from sun damage and other causes. A skin biopsy can identify melanoma.

Rash: Nearly any change in the skin's appearance can be called a rash. Most rashes are from simple skin irritation; others result from medical conditions.

Dermatitis: A general term for inflammation of the skin. Atopic dermatitis (a type of eczema) is the most common form.

Eczema: Skin inflammation (dermatitis) causing an itchy rash. Most often, it's due to an overactive immune system.

Psoriasis: An autoimmune condition that can cause a variety of skin rashes. Silver, scaly plaques on the skin are the most common form.

Dandruff: A scaly condition of the scalp may be caused by seborrheic dermatitis, psoriasis, or eczema.

Acne: The most common skin condition, acne affects over 85% of people at some time in life.

Cellulites: Inflammation of the dermis and subcutaneous tissues, usually due to an infection. A red, warm, often painful skin rash generally results.

Skin abscess (boil or furuncle): A localized skin infection creates a collection of pus under the skin. Some abscesses must be opened and drained by a doctor in order to be cured.

Rosacea: A chronic skin condition causing a red rash on the face. Rosacea may look like acne, and is poorly understood.

Warts: A virus infects the skin and causes the skin to grow excessively, creating a wart. Warts may be treated at home with chemicals, duct tape, or freezing, or removed by a physician.

Basal cell carcinoma: The most common type of skin cancer. Basal cell carcinoma is less dangerous than melanoma because it grows and spreads more slowly.

Seborrheic keratosis: A benign, often itchy growth that appears like a “stuck-on” wart. Seborrheic keratoses may be removed by a physician, if bothersome.

Actinic keratosis: A crusty or scaly bump that forms on sun-exposed skin. Actinic keratoses can sometimes progress to cancer.

Squamous cell carcinoma: A common form of skin cancer, squamous cell carcinoma may begin as an ulcer that won’t heal, or an abnormal growth. It usually develops in sun-exposed areas.

Herpes: The herpes viruses HSV-1 and HSV-2 can cause periodic blisters or skin irritation around the lips or the genitals.

Hives: Raised, red, itchy patches on the skin that arise suddenly. Hives usually result from an allergic reaction.

Tinea versicolor: A benign fungal skin infection creates pale areas of low pigmentation on the skin.

Viral exantham: Many viral infections can cause a red rash affecting large areas of the skin. This is especially common in children.

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APPENDIX: The Code

```
>>x = dir('C:\Users\ahmmed samy\Downloads\project\*.JPG'); %loop for reading
multiple images from a folder
>>for i = 1: length(x)
>> filename = strcat('C:\Users\ahmmed samy\Downloads\project\',x(i).name);
>> d1 = double(imread(filename))./255;
>> figure, imshow(d1);
>>d1=rgb2gray(d1); % Load the image, scale from 0 to 1
>>d1=imresize(d1, [256 256]);
>>imshow(d1);
>>im=d1;
>>size(im)
pause
>>m = medfilt2(im);
>>figure, imshow(m),  title('median filtered image'); %%% using median filtering
pause
>>background = imopen(m,strel('disk',10));
>>figure,imshow(background);
>>title('background');
pause
ADD the original form the background
I2 = m + background;

>>figure, imshow(I2),title('ADDED image');
pause
increase the image intensity
>>%I3 = imadjust(background);
>>I3 = imadjust(I2);

>>figure, imshow(I3), title('adjustedimage');
pause
>>d1=I3;
>> [cA1,cH1,cV1,cD1] = dwt2(d1,'Haar');
>>A1 = upcoef2('a',cA1,'Haar',1);
>>H1 = upcoef2('h',cH1,'Haar',1);
>>V1 = upcoef2('v',cV1,'Haar',1);
>>D1 = upcoef2('d',cD1,'Haar',1);
 >> colormap(map);
>>subplot(2,2,1); image(wcodemat(A1,192));
>>title('Approximation A1')
>>subplot(2,2,2); image(wcodemat(H1,192));
>>title('Horizontal Detail H1')
>>subplot(2,2,3); image(wcodemat(V1,192));
>>title('Vertical Detail V1')
>>subplot(2,2,4); image(wcodemat(D1,192));
```

```
>>title('Diagonal Detail D1')
pause
>>Xsyn = idwt2(cA1,cH1,cV1,cD1,'Haar');  %The idwt2 command performs a single-
level two-dimensional wavelet reconstruction with
respect to either a particular wavelet
>>imshow(Xsyn)
pause
>>Xsyn=imresize(Xsyn,(size(cA1)));
>>imshow(Xsyn), title('reconstructed image')
pause
>>q=Xsyn+cA1+cH1+cV1+cD1;
>>figure, imshow(q), title('summed image')
pause
>>size(q)
>>imwrite(q, 'C:\Users\ahmmed samy\Downloads\project\.jpg');
end
close all
```