AUTOMATED SCORING FOR SCALINESS OF PSORIASIS LESIONS USING EDGE DETECTION

By

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FINAL PROJECT REPORT

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CERTIFICATION OF APPROVAL

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UNIVERSITI TEKNOLOGI PETRONAS
TRONOH, PERAK

June 2007

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

Muhammad Hafizuddin B Zainal Abidin

ABSTRACT

Skin diseases affect 20-30% of the population at any one time, interfering with activities in 10%. Psoriasis, an inflammatory skin condition and currently incurable is one of the most common skin diseases. About 80% of people who develop psoriasis have plaque psoriasis, which appears as patches of raised, reddish skin covered by silvery-white scale. The Psoriasis Area and Severity Index (PASI) is the most widely used tool to assess psoriasis disease severity in clinical trials, although it can be exceedingly cumbersome for use in daily clinical practice. It is proven to be extremely effective in assessing Psoriasis. When using the PASI, psoriatic plaques are graded based on three criteria: redness, thickness, and scaliness. For the time being, the PASI-scoring are subjective since the assessments are done visually by the dermatologist. The assessment will result in inter-individual variation between estimates due to different level of experiences and visual acuity.

The aim of this project is to develop an automated scoring for scaliness of Psoriasis lesions program using MATLAB. This project will be using 2-D Psoriasis images obtained from General Hospital, Kuala Lumpur and medical database online. The MATLAB software will be used to develop algorithms that are capable to read images of Psoriasis and grade the scaliness scores using the PASI-score texture analysis. The targeted system will include subsystem for acquiring the images, image processing, segmentation, texture analysis for scaliness score and severity based on PASI system.

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INTRODUCTION

1.1 Background of Study

There are many types of skins diseases and one of the common skin diseases is Psoriasis. It is estimated that 1-3% of the world's population are infected by Psoriasis diseases often seen between 15 to 40 years of age [1]. Factors that may exacerbate Psoriasis include human immunodeficiency virus (HIV) infection, physical trauma, infection including Streptococcus and Candida, certain drugs such as lithium, beta-blockers, antimalarials and systemic corticosteroids.

Psoriasis may affect men and women equally and it can appear at any age in varying degrees. The cause of psoriasis is as yet unknown, but is now known to be genetic in origin and extensive research is being carried out. About 10-20% of people with psoriasis may develop an associated arthritis called psoriatic arthropathy, which causes pain and swelling in the joints and connective tissue, accompanied by stiffness, particularly in the mornings. Most commonly affected sites are the hands, feet, lower back, neck and knees, with movement in these areas becoming severely limited. Chronic fatigue is a common complaint linked with this condition. Treatment depends on the severity and type of psoriasis. Some psoriasis is so mild that the person is unaware of the condition. A few develop such severe psoriasis that lesions cover most of the body and hospitalization is required. These represent the extremes. Most cases of psoriasis fall somewhere in between [2].

In this project, PASI score assessment will be implemented since it has been used for more than 10 years and is widely used around the world. A patient's Psoriasis Area and Severity Index (PASI) is a measure of overall psoriasis severity and coverage. It is a commonly-used measure in clinical trials for psoriasis treatments. Typically, the PASI would be calculated before, during, and after a treatment period in order to determine how well psoriasis responds to the treatment under test (a lower PASI means less psoriasis, generally) [3].

For the time being, dermatologist diagnoses the skin lesions of Psoriasis patients visually. The clinical evaluation of the extent of the damages due to a skin in general performed on the base of clinical experience and using very low-tech and basic equipments [5]. The assessment is based on the observer's experience and their visual acuity. These procedures rely heavily on the skill of the clinicians and are not easily reproducible.

1.2 Problem Statement

1.2.1 Problem Identification

Since the determination of the PASI-score for the time being is done by visual assessment and the patient's opinion on the lesions, the severity scores appear to be highly subjective [3]. The result will be inconsistent score since the measures are being done according to their experience and dependant to the examiners perceptions. Same doctor might score the same patient differently depending on the severity of the previous patient. Doctors tend to score a patient less severely when the previous one has a severe lesion. This all adds to the fact that in the dermatological field drug efficacy in many cases is not measured accurately [10]. In avoiding this type of problems, there is a need to develop a system that can evaluate image of Psoriasis diseases. The system is expected to score PASI-score for scaliness automatically and MATLAB 7.1 will be used in implementing this project. This project hopefully will give benefit in assisting medical experts in treating Psoriasis patients.

1.2.2 Significant of the Project

Since the evaluation of PASI-score using the current method is very subjective, there is a need to build and design an automated scoring system for scaliness of Psoriasis lesions. Failure to evaluate accurately the severity will affect the tracking of Psoriasis lesions as well as the decision of treatment. Medical treatment for localized psoriasis begins with a combination of topical corticosteroids and coal tar or calcipotriene. For lesions that are difficult to control with initial therapy, anthralin or tazarotene may be tried. The primary goal of therapy is to maintain control of the lesions. Cure is seldom achieved. If control becomes difficult or if psoriasis is generalized, the patient may benefit from phototherapy, systemic therapy and referral to a physician who specializes in the treatment of psoriasis [4].

By completing this project, it is hoped that this program could help the dermatologist to evaluate more accurately the PASI-score of the Psoriasis patients. This can help the patients to get the right and proper treatment when needed.

1.3 Objectives and Scope of Study

The main objective of this research project is:

- To develop a system that can automatically generate an accurate quantitative score of scaliness for Psoriasis lesions to be used in PASI-scoring

By building and designing the automated scoring for scaliness of Psoriasis lesions, more accurate PASI score can be evaluated. The Psoriasis pictures that are provided by the General Hospital, Kuala Lumpur and gathered from the medical database online will be the data input and the PASI scores are the output. In building and designing this program, the cost that needs to be incurred is none since only MATLAB software and Psoriasis pictures are needed. This research project can be accomplished within the time frame provided in one year.

CHAPTER 2

LITERATURE REVIEW AND THEORY

2.1 What is Psoriasis?

Psoriasis is a chronic, meaning lifelong, condition because there is currently no cure. Commonly affected areas include the scalp, elbows, knees, navel and groin. Psoriasis is categorized as localized or generalized, based on the severity of the disease and its overall impact on the patient's quality of life and well-being. People often experience flares and remissions throughout their life. Controlling the signs and symptoms typically requires lifelong therapy.

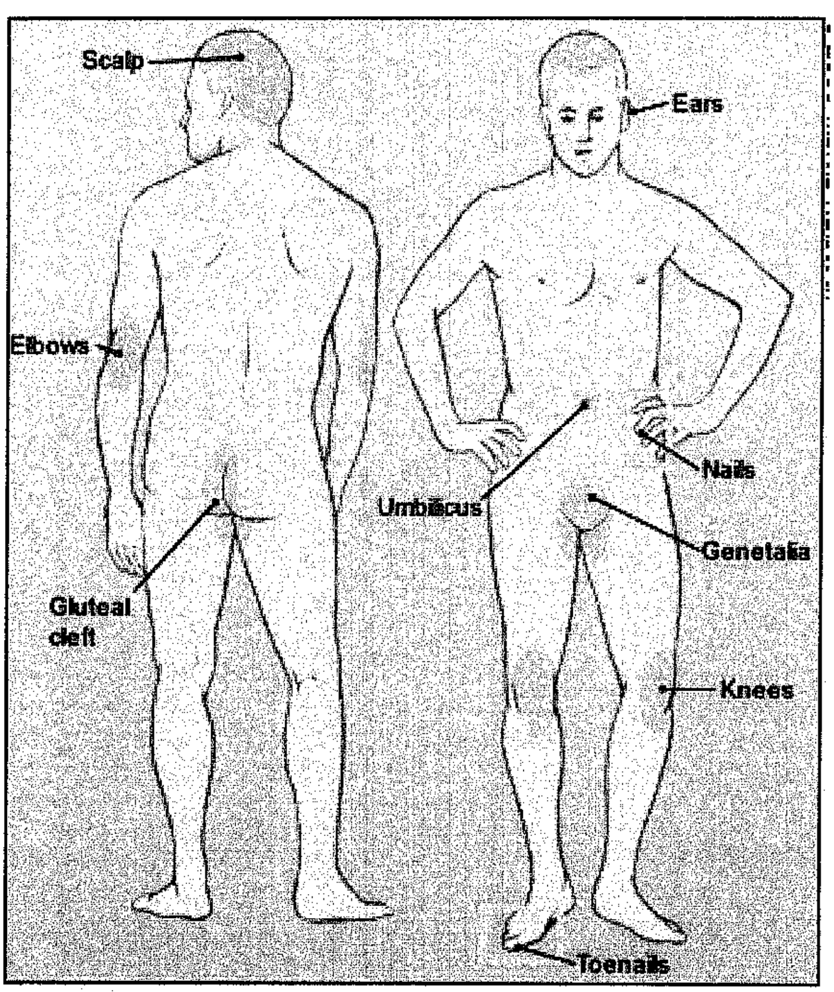


Figure 2.1: Common areas of distribution of psoriasis [16].

It is believed that psoriasis develops when the immune system tells the body to over-react and accelerate the growth of skin cells. Normally, skin cells mature and are shed from the skin's surface every 28 to 30 days. When psoriasis develops, the skin cells mature in 3 to 6 days and move to the skin surface. This causes cells to build up on the skin's surface, forming thick patches, or plaques, of red sores (lesions) covered with flaky, silvery-white dead skin cells (scales). Figure 2.2 indicates the comparison between healthy skin and Psoriasis infected skin. All types of psoriasis, ranging from mild to severe, can affect a person's quality of life. Living with this lifelong condition can be physically and emotionally challenging. Itching, soreness, cracked and bleeding skin are common. Several studies have shown that people often feel frustrated. In some cases, psoriasis limits activities and makes it difficult to perform job responsibilities [2].

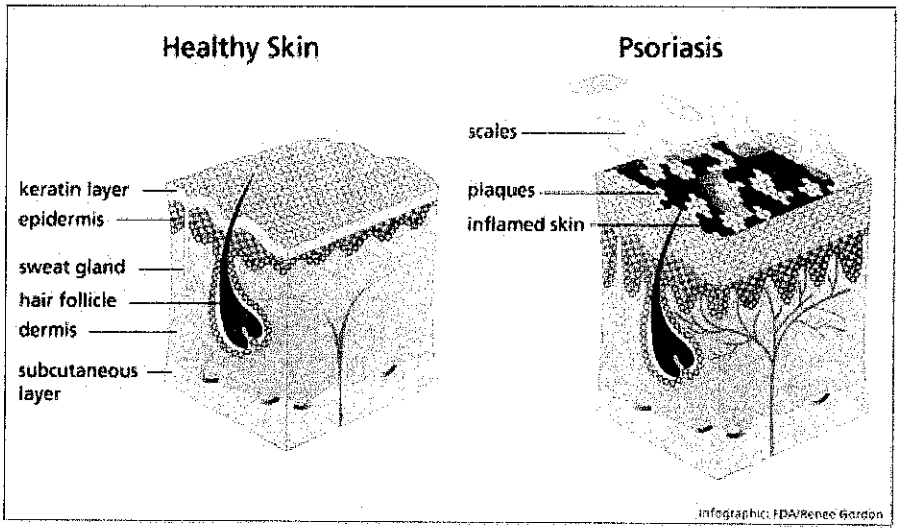


Figure 2.2: A healthy skin and Psoriasis infected skin [6].

2.1.1 Types of Psoriasis[17]

Plaque Psoriasis

About 80% of people living with psoriasis have plaque psoriasis, which is also called "psoriasis vulgaris." "Vulgaris" means "common." It is the most common form and frequently appears as raised red and scaly patches, that can be tiny or large, and which mostly appear on the knees, elbows, lower back and scalp. Figure 2.3 are some common plaque Psoriasis suffered by patients.

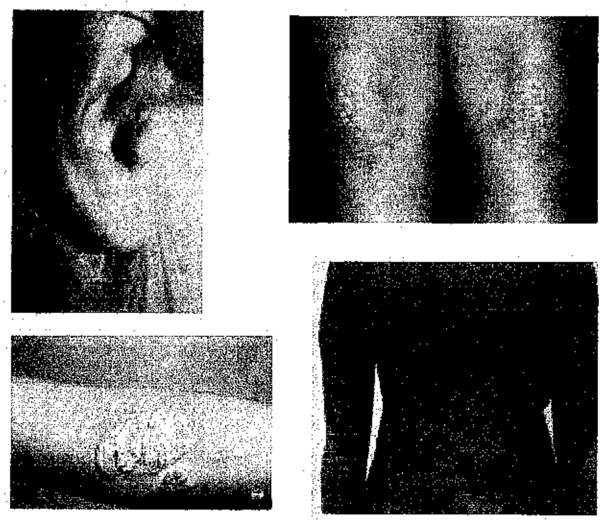


Figure 2.3: Image of Plaque psoriasis [16].

Guttate Psoriasis

About 10% of people who get psoriasis develop guttate psoriasis, making this the second most common type. It is small, drop-like lesions appear on the trunk, limbs and scalp as shown in Figure 2.4. Guttate psoriasis most frequently develops in children and young adults who have a history of streptococcal (strep) infections.

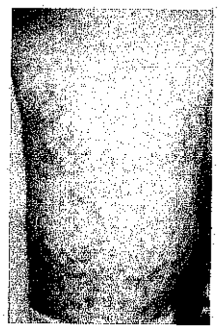


Figure 2.4: Image of Guttate psoriasis [16].

Pustular Psoriasis

This type of psoriasis occurs in less than 5% of people who develop psoriasis and primarily occurs in adults. Pustular psoriasis can be either localised or generalised on the skin and can be preceded in appearance by chronic plaque psoriasis. The localised form as shown in the Figure 2.5 affects palms and soles, hence the term palmaplanter pustular psoriasis. It can even accompany other forms of psoriasis and can appear spontaneously without warning.

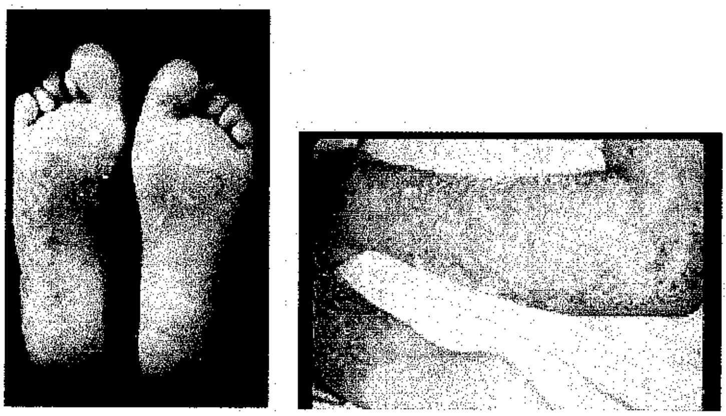


Figure 2.5: Image of Pustular psoriasis [16].

Erythrodermic Psoriasis

Also known as "exfoliative" psoriasis, this is the least common type. It occurs in about 1% or 2% of people who develop psoriasis. Erythrodermic psoriasis can be life-threatening because the skin loses its protective functions. The entire skin becomes inflamed and scaly, seriously compromising the body's fluid balance and temperature. Figure 2.6 shows images of Erythrodermic Psoriasis.

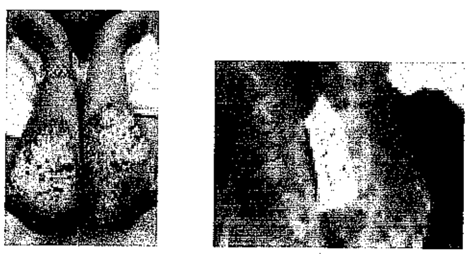


Figure 2.6: Images of Erythrodermic Psoriasis [16].

Inverse Psoriasis

Not common, inverse psoriasis also is called "skin-fold," "flexural," or "genital" psoriasis. This type of psoriasis can be severe and incapacitating. It is found in flexural sites such as the armpits, underneath the breast, skin folds between the buttocks and also the groin, as shown in Figure 2.7.

Figure 2.7: Image of Inverse psoriasis [16].

2.2 Psoriasis Area & Severity Index (PASI)

PASI-scoring system has been the most commonly used in evaluating the severity of clinical symptoms in Psoriasis. The PASI evaluates the degree of erythema (redness), thickness, and scaling of psoriatic plaques, and estimates the extent of involvement of each of these components in four separate body areas (head, trunk, upper and lower extremities). The PASI composite score, ranging from 0-72, provides a subjective measure and relies on imprecise estimates of the involved body surface area (BSA) [7]. In each of these areas, the fraction of total surface area affected is graded on a 0-6 scale (0 for no involvement; up to 6 for greater than 90 % involvement).

For the PASI calculation, the body will be divided into four section which are the Head (10% of person's skin), Arms (20% of person's skin), Trunk (30% of person's skin), and Legs (40% of person's skin). Each of these sections is scored individually and the score are combined into the total PASI. Figure 2.8 until Figure 2.11 shows the PASI body sections.

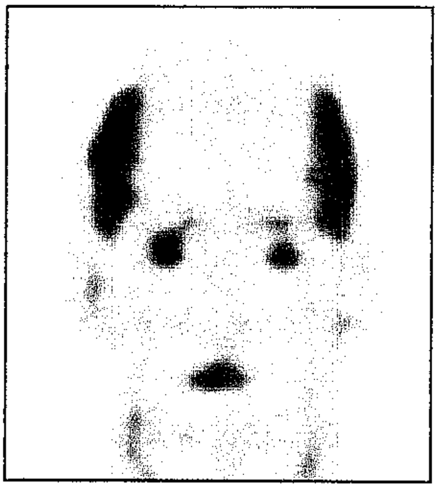


Figure 2.8: Head section [16].

Figure 2.9: Arms section [16].

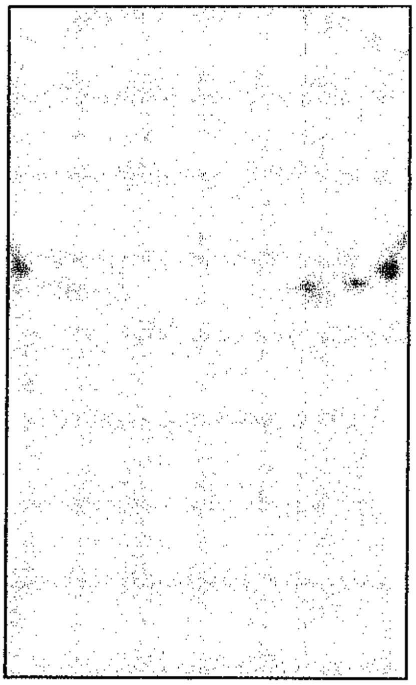


Figure 2.10: Trunk section [16].

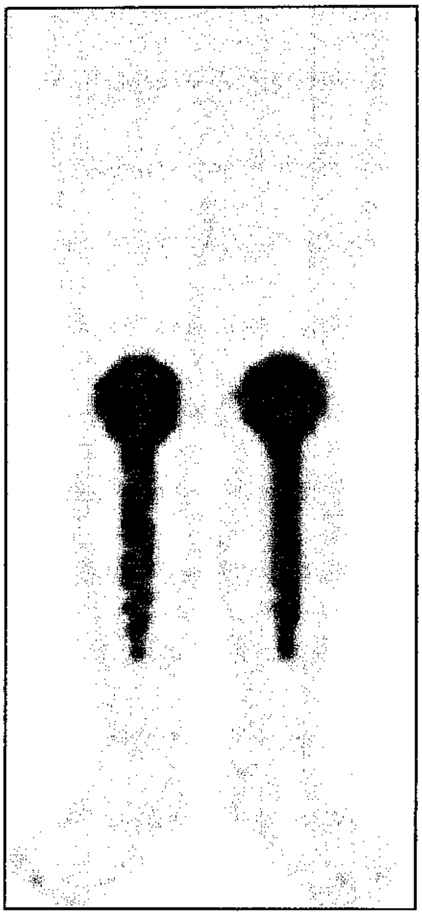


Figure 2.11: Legs section [16].

2.2.1 *Area*

The amount of skin involved for each skin section is measured as a percentage of the skin just in that part of the body, not the whole body. The score from 0 to 6 is assigned as shown by Table 2.1 [3]:

Coverage	Score
0%	0
< 10%	1
10-29%	2
30-49%	3
50-69%	4
70-89%	5
90-100%	6

Table 2.1: The area coverage score

2.2.2 *Severity*

The severity is measured by three different parameters: Erythema (redness), Scaling and Thickness (psoriatic skin is thicker than normal skin). Again, each of these is measured separately for each skin section. These are measured on a scale of 0 to 4, from none to 'maximum', according to Table 2.2 [3]:

Severity	Score
None	0
Some	1
Moderate	2
Severe	3
Maximum	4

Table 2.2: Severity score

2.2.3 *Totaling Up the Index*

PASI score is calculated when all of the above scores have been determined. For each skin section, add up the three severity scores, multiply the total by the area score, and then multiply that result by the percentage of skin in that section, as follows [3]:

- Head: $(E_{head}+S_{head}+T_{head}) \times A_{head} \times 0.1 = Total_{head}$
- Arms: $(E_{arms}+S_{arms}+T_{arms}) \times A_{arms} \times 0.2 = Total_{arms}$
- Body: $(E_{body}+S_{body}+T_{body}) \times A_{body} \times 0.3 = Total_{body}$
- Legs: $(E_{legs}+S_{legs}+T_{legs}) \times A_{legs} \times 0.4 = Total_{legs}$

where E = Erythema (Redness), S = Scaling and T = Thickness

Finally, the PASI is $Total_{head}+Total_{arms}+Total_{body}+Total_{legs}$. That's it. This PASI will range from 0 (no psoriasis) to 72 (covered head-to-toe, with complete itching, redness, scaling, and thickness). However, this project will focus on developing PASI score for scaling only.

2.3 Texture and Image Analysis

Texture refers to the properties held and sensations caused by the external surface of objects received through the sense of touch. Texture is sometimes used to describe the feel of non-tactile sensations. Texture can also be termed as a pattern that has been scaled down (especially in case of two dimensional non-tactile textures) where the individual elements that go on to make the pattern are not distinguishable [15]. Texture analysis is very important for computer graphics, vision, and image processing. In many machine vision and image processing algorithms, simplifying assumptions are made about the uniformity of intensities in local image regions. However, images of real objects often do not exhibit regions of uniform intensities.

Image texture, defined as a function of the spatial variation in pixel intensities (Gray values), is useful in a variety of applications and has been a subject of intense study by many researchers. One immediate application of image texture is the recognition of image regions using texture properties. We could also find the texture boundaries even if we could not classify these textured surfaces. This is then the second type of problem that texture analysis research attempts to solve, called texture segmentation. The goal of texture segmentation is to obtain the boundary map separating the differently textured regions in an image [11].

Image analysis techniques have played an important role in several medical applications. In general, the applications involve the automatic extraction of features from the image which is then used for a variety of classification tasks, such as distinguishing normal tissue from abnormal tissue. Depending upon the particular classification task, the extracted features capture color properties, morphological properties, and even textural properties of the image. The textural properties computed are closely related to the application domain to be used. Many methods work on images based on precise algorithms which one might consider as having morphological characteristics.

Various classification methods could be used to compute the segmentation including contextual classification and relaxation algorithms.

2.4 Image Segmentation

Segmentation is an essential part of practically any automated image recognition system, since it is necessary for further processing such as feature extraction or object recognition. In image analysis, segmentation is basically partitioning of a digital image into multiple regions according to a given criterion. Segmentation is done to locate objects of interest and is sometimes considered a computer vision problem. Texture-based segmentation algorithm are aimed at finding similarity measures to group image pixels. A pixel has the value one if it is belongs to the object, otherwise it is zero. Various approaches for textural features extraction have been developed to date [12] including co-occurrence matrices, wavelet-based methods, Fourier transform methods, and intensity histogram methods.

2.4.1 Thresholding and Edge Detection

In this project, segmentation techniques that were chosen to be used are thresholding technique and edge detection technique. There are varieties of technique for thresholding selection, as it is a fast, simple and robust method. Threshold value will have considerable effects on the boundry position and overall size of the extracted objects. This technique is based upon a simple concept. A parameter θ called the *brightness threshold* is chosen and applied to the image $a[m,n]$ as follows:

$$\text{If } a[m,n] \geq \theta \quad a[m,n] = \text{object} = 1$$

$$\text{Else} \qquad a[m,n] = \text{background} = 0$$

This version of the algorithm assumes that we are interested in light objects on a dark background. For dark objects on a light background we would use:

$$\text{If } a[m,n] < \theta \quad a[m,n] = \text{object} = 1$$

$$\text{Else} \qquad a[m,n] = \text{background} = 0$$

The output is the label "object" or "background" which, due to its dichotomous nature, can be represented as a Boolean variable "1" or "0". In principle, the test condition could be based upon some other property than simple brightness (for example, *If* (*Redness* $\{a[m,n]\} >= \theta_{red}$), but the concept is clear [9].

Edge detection technique characterizes boundaries between two intensity regions in an image. Edge detecting an image significantly reduces the amount of data and filters out useless information, while preserving the important structural properties in an image [13]. There are many methods to perform edge detection but the majority of different methods can be grouped into two categories, gradient and Laplacian. The gradient method detects the edges by looking for the maximum and minimum in the first derivative of the image while Laplacian method searches for zero crossings in the second derivatives of the image to find the edges. Basically, the edge based segmentation relies on the edges found in an image by edge detecting operator such as Roberts operator, Sobel operator and Canny operator.

2.4.2 Sobel Edge Detector

The Sobel operator performs a 2-D spatial gradient measurement on an image and so emphasizes regions of high spatial gradient that correspond to edges. Typically it is used to find the approximate absolute gradient magnitude at each point in an input grayscale image [14]. In theory at least, the operator consists of a pair of 3×3 convolution masks as shown in Figure 2.12. One mask is simply the other rotated by 90°. The cross operator:

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

Gx

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

Gy

Figure 2.12: Sobel convolution masks.

The magnitude of the gradient is then calculated using the formula:

$$|G| = \sqrt{Gx^2 + Gy^2}$$

An approximate magnitude can be calculated using:

$$|G| = |Gx| + |Gy|$$

which is much faster to compute.

Angle of the orientation of the edge (relative to the pixel grid) giving rise to the spatial gradient is given by:

$$\theta = \arctan(Gy/Gx) - 3\pi/4$$

Orientation 0 is taken to mean that the direction of maximum contrast from black to white runs from left to right on the image, and other angles are measured anti-clockwise from this. Often, this absolute magnitude is the only output the user sees where the two components of the gradient are conveniently computed and added in a single pass over the input image using the pseudo-convolution operator shown in Figure 2.13.

P_1	P_2	P_3
P_4	P_5	P_6
P_7	P_8	P_9

Figure 2.13: Pseudo-convolution masks used to quickly compute approximate gradient magnitude.

By using this mask, the approximate magnitude is given by:

$$|G| = |(P_1 + 2 \times P_2 + P_3) - (P_7 + 2 \times P_8 + P_9)| + |(P_3 + 2 \times P_6 + P_9) - (P_1 + 2 \times P_4 + P_7)|$$

CHAPTER 3

METHODOLOGY / PROJECT WORK

3.1 Procedure Identification

The research works were carried out in the following sequence as indicated in Figure 3.1.

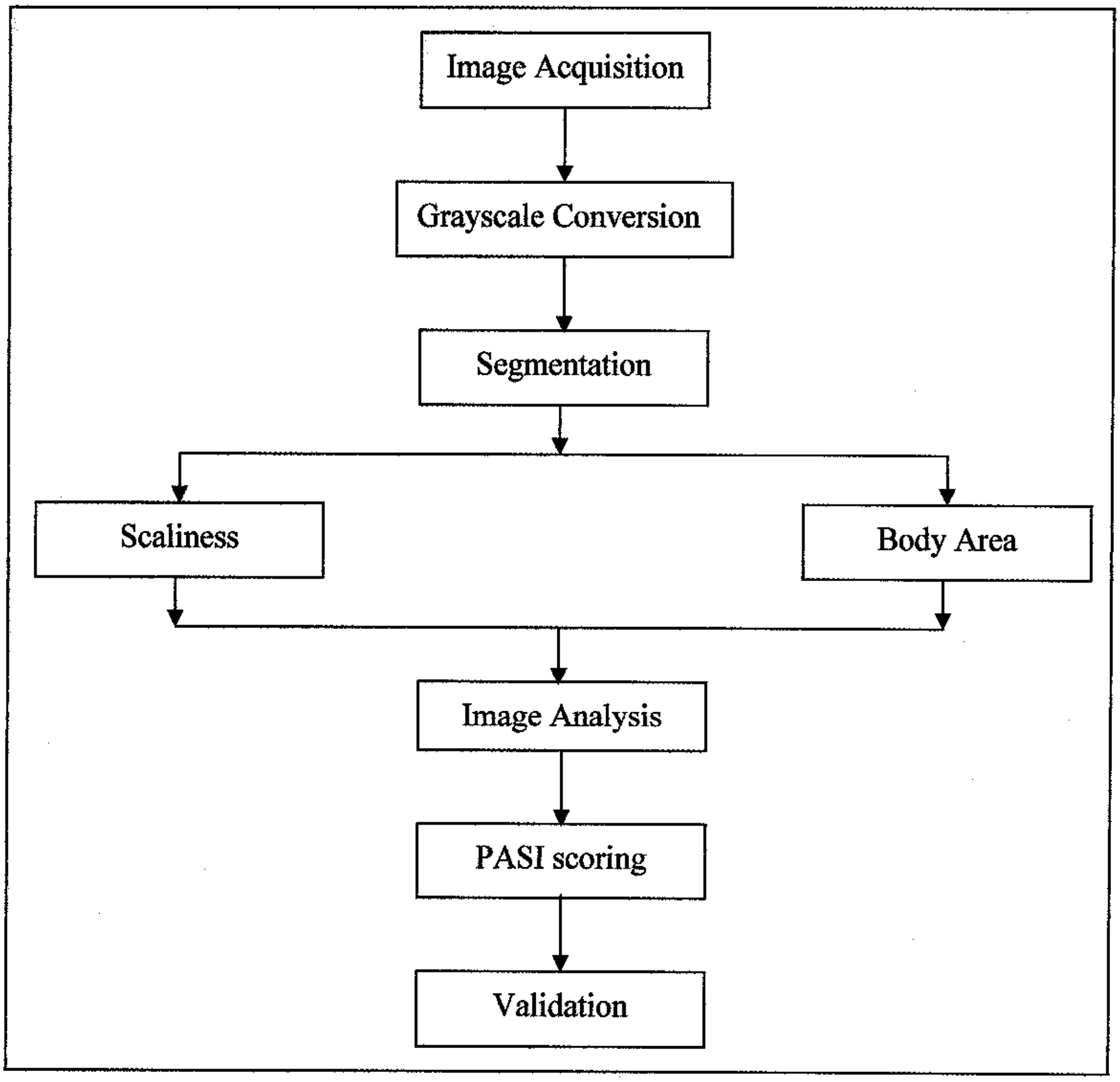


Figure 3.1: Processes involved in the project.

3.1.1 Image Acquisition

In this project, the images gathered from General Hospital, Kuala Lumpur and medical database online will be saved into the 'work' folder of the MATLAB software. The system will acquire the images from this folder. The codes that are used to read the image are:

```
I=imread ('1.jpg');              % to read the image
figure, imshow(I), title('original image');   % to display the image
```

MATLAB supports several graphics file formats, such as HDF and TIFF that can contain multiple images. By default, imread imports only the first image from a file. To import additional images from the file, use the syntax supported by the file format.

3.1.2 Grayscale Conversion

In converting RGB image to grayscale, function 'rgb2gray' is used. This function will convert RGB image to grayscale by eliminating hue and saturation information while retaining hue luminance. Original input image in RGB format will be converted into grayscale image for analyzing the image. The general syntax used is:

```
G=rgb2gray(I);                   % to convert to grayscale image
```

Figure 3.2 below show the result of grayscale conversion:

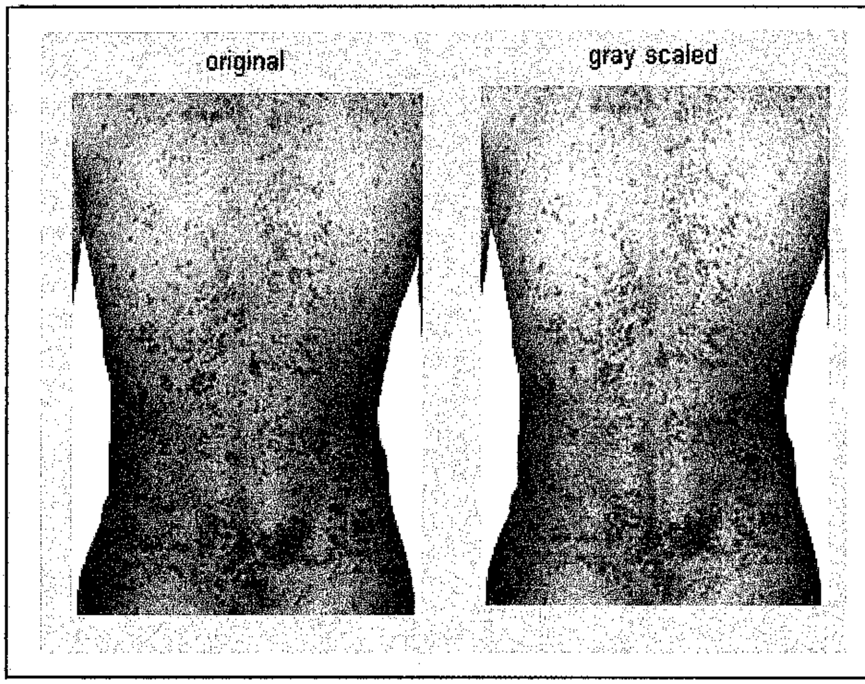


Figure 3.2: RGB image being converted to grayscale image.

3.1.3 Image Segmentation

There are two segmentation processes that are being done in this project to process the Psoriasis images:

1. Segmentation for scaliness
2. Segmentation for body area

Segmentation for scaliness

For scaliness segmentation, two types of image segmentation techniques are being used. The edge detection and thresholding method were chosen for this project. Both methods are being combined in a function called Sobel edge detector. The Sobel method finds edges using the Sobel approximation to the derivative. It returns edges at those points where the gradient of I is maximum. The syntax available are:

BW = edge(G,'sobel')	%specifies the Sobel method.
BW = edge(G,'sobel',thresh)	%specifies the sensitivity threshold for the Sobel method. edge ignores all edges that are not stronger than thresh. If you do not specify thresh, or if thresh is empty ([]), edge chooses the value automatically.
BW = edge(G,'sobel',thresh,direction)	%specifies the direction of detection for the Sobel method. 'direction' is a string specifying whether to look for 'horizontal' or 'vertical' edges or 'both' (the default).
[BW,thresh] = edge(G,'sobel',...)	%returns the threshold value.

The edge detection and thresholding segmentation techniques will be applied to the image that have been converted to grayscale to perform a simple and quick to compute, 2-D spatial gradient measurement on the image. The thresholding is done right after the edge detection process.

The result of this segmentation method is shown in Figure 3.3 below:

Figure 3.3: Result of image after the segmentation of scaliness using Sobel edge detection and thresholding techniques.

Segmentation for body area

To segment the body area, thresholding method has being chosen. The codes to perform this thresholding technique are:

```
imwrite(G,'trunk.bmp');     % to write grayscaled image to .bmp format
K=imread('trunk.bmp');      % read the image in .bmp format
P=K;
[rows colms] = size(K);
for i=1:rows
  for j=1:colms
    if K(i,j) > 220;        % the threshold value set manually for each
       P(i,j) = 0;            image
   else
       P(i,j) = 1;
    end
  end
end
J = mat2gray(P);
figure, imshow(J), title('body area');
```

The threshold value is set as the background where it will convert the background to black while the body area to white (Region of Interest) as shown in Figure 3.4. This segmentation process is important to calculate the scaling percentage and also the lesion area percentage as the percentage calculation is based on each body part sections which are the head, arms, body and legs.

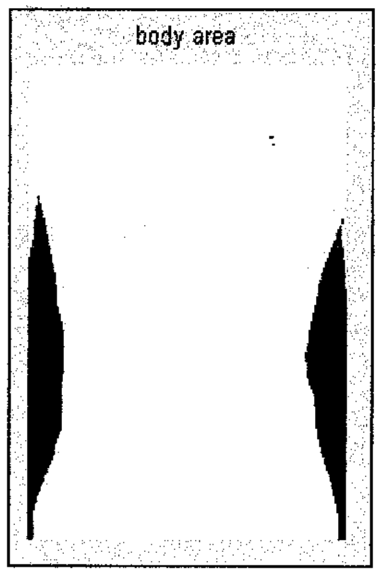


Figure 3.4: Result of image after the segmentation of body area using thresholding technique.

3.1.4 Image Analysis

In this project, texture analysis or image analysis is done to estimate the number of scaliness present in an image. The image to work on is binary image post-segmentation. The estimation of the percentage of area affected by scaling is done by using the 'bwarea' function. The scaling value of the infected skin is calculated by its pixel percentage. The pixel percentage is obtained by comparing the pixel of scale produced after the segmentation with the total pixel of the ROI image.

Total = bwarea (BW) %estimates the area of the objects in binary image BW.

'Total' is a scalar whose value corresponds roughly to the total number of on pixels in the image, but may be not exactly the same since different patterns of pixels are weighted differently. For this project, the total number of pixels calculated after the segmentation process is corresponded to the total scaling score. Hence, to get the scaling percentage could be computed by:

$$\textbf{Scaling percentage} = \frac{\textbf{Total scaling area (Pixels)}}{\textbf{Total Region of Interest (Pixels)}} \times \textbf{100\%}$$

From the result of scaling percentage of infected skin, the severity score of scaliness for PASI can be obtained. The scaling percentage calculation will be done for each body section, which are the head section, arms section, trunk section and also legs section. Scaling percentage will determine the score for severity ranged from 0 to 4 based on the percentage value that have been set. Scaling percentage of infected skin is obtained by dividing the total pixels of scaling calculated over total size of the image pixels. It means that if the scaling of the infected skin is bad, the scaling percentage will give high score resulting high PASI score. The severity score for each body section then will be used for PASI score calculation.

3.1.5 PASI scoring

Once all the above steps had been taken, the final step will be calculating the PASI score. To score the PASI, the calculated scaling percentage will be referred to Table 2.1 for scaliness severity score. The calculation for this project only consider the score for scaling severity which results in the PASI score as given by the following equation.

- Head: $(S_{head}) \times A_{head} \times 0.1 = Total_{head}$
- Arms: $(S_{arms}) \times A_{arms} \times 0.2 = Total_{arms}$
- Body: $(S_{body}) \times A_{body} \times 0.3 = Total_{body}$
- Legs: $(S_{legs}) \times A_{legs} \times 0.4 = Total_{legs}$

where S = Scaling, A = Area

PASI score for scaling is $Total_{head}$+$Total_{arms}$+$Total_{body}$+$Total_{legs}$.

3.2 Tools Required

The tools required in performing this project are:

- Psoriasis pictures obtained from General Hospital, Kuala Lumpur
- MATLAB 7.1 software
- Adobe Photoshop CS

CHAPTER 4
RESULTS AND DISCUSSION

4.1 Results

Sobel edge detector was successfully implemented in MATLAB 7.1 due to its simplicity. The edge detection and thresholding technique were applied to the grayscale image. This edge detector performed a simple, quick to compute 2-D spatial gradient measurement on the image. It therefore highlights regions of high spatial gradient which correspond to edges. The input and output to the operator was a grayscale image. Pixel values at each point in the output represent the estimated absolute magnitude of the spatial gradient of the input image at that point. In this project, the edges corresponded to the boundaries and membrane of the scaling texture with respect to the Psoriasis diseases. The thresholding was performed right after the edge detection process.

The codes that had been completed for this project were for reading the image, transforming the image to grayscale, performing segmentation for scaliness and body area (Region of Interest), and calculating the scaling percentage.

4.1.1 Results output of the system

The results of the processed images obtained as the output of the program are given in Table 4.1 to Table 4.4. The sizes of images are different since the images were taken from the internet. All image details are written under the tables.

Table 4.1: Results of the system for head section.

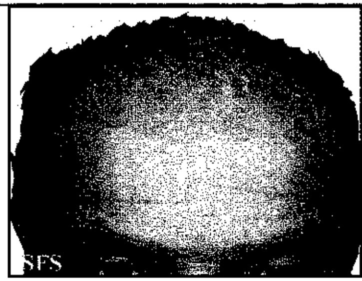
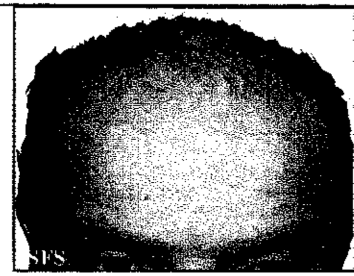
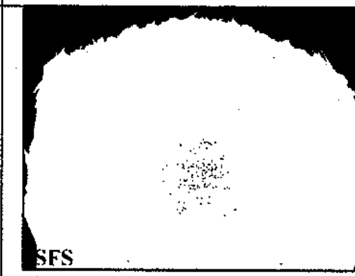
Section	Original Image	Grayscale image	Segmentation for scaliness	Segmentation for Region of Interest	Image analysis	Severity score
EAD					HeadArea = 1.4978e+005 ScalinessH = 2.1266e+003 percentageH = 1.4198	1

Image details

Dimension: 468 x 377

Type: JPEG Image

Size: 67.6 KB

Threshold value for Sobel: 0.13

Threshold value for ROI: 245

Table 4.2: Results of the system for arms section.

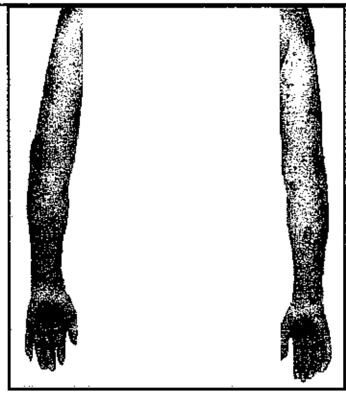
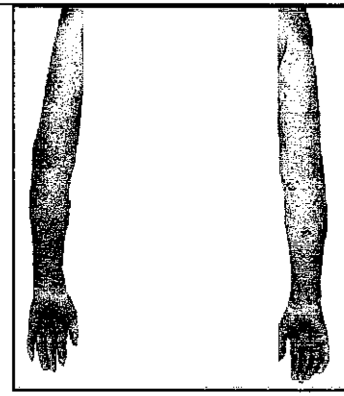
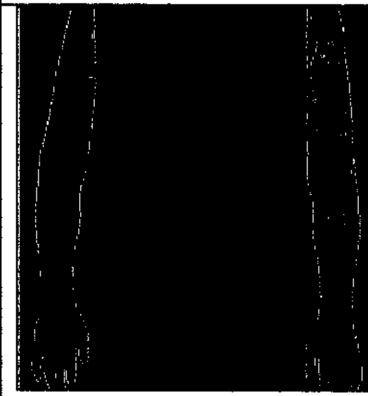
Section	Original Image	Grayscale image	Segmentation for scaliness	Segmentation for Region of Interest	Image analysis	Severity score
RMS					ArmsArea = 2.3918e+004 ScalinessA = 1.9223e+003 percentageA = 8.0370	1

Image details

Dimension: 300 x 358

Type: JPEG Image

Size: 27.3 KB

Threshold value for Sobel: 0.1

Threshold value for ROI: 220

Table 4.3: Results of the system for trunk section.

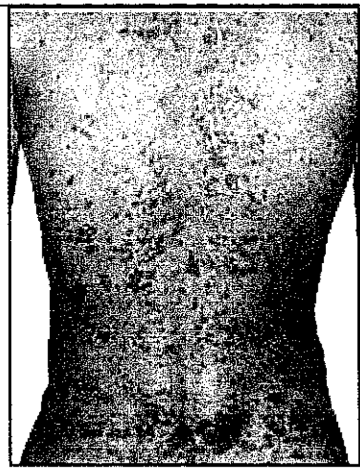
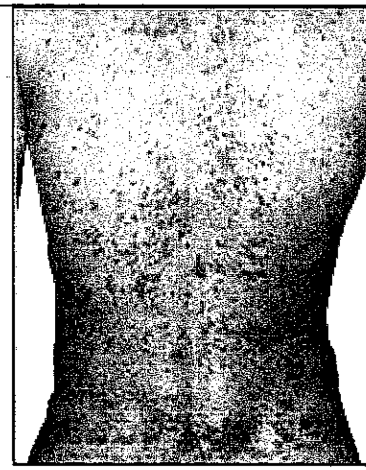
Section	Original Image	Grayscale image	Segmentation for scaliness	Segmentation for Region of Interest	Image analysis	Severity score
RUNK					TrunkArea = 4.2049e+004 ScalinessT = 817.3750 percentageT = 1.9438	1

Image details

Dimension: 180 x 260

Type: JPEG Image

Size: 34.7 KB

Threshold value for Sobel: 0.1

Threshold value for ROI: 220

Table 4.4: Results of the system for legs section.

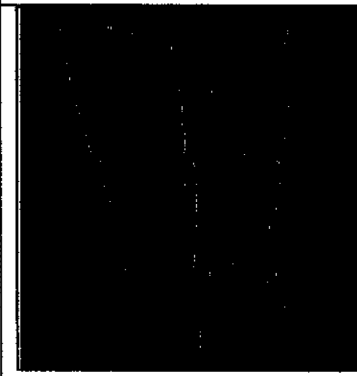
Section	Original Image	Grayscale image	Segmentation for scaliness	Segmentation for Region of Interest	Image analysis	Severity score
EGS					LegsArea = 8.6146e+004 ScalinessL = 2.9951e+003 percentageL = 3.4768	2

Image details

Dimension: 388 x 455

Type: JPEG Image

Size: 61.5 KB

Threshold value for Sobel: 0.08

Threshold value for ROI: 220

For the time being, the lesion area calculation program is still under progress and the PASI score cannot be determined yet. The severity score shown in Table 4.1 to Table 4.4 in the last column has been successfully implemented. However the score has not yet validated by dermatologist due to time limitation.

4.2 Discussion

From the results that have been obtained for the time being, the input image was successfully converted to grayscale, segmented, and analysed. The analysis of the images for calculating the scaling scores that have been done need to be verified by dermatologist. After completing the image analysis section, which is the calculation of infected area over the total size of image, the project will continues on calculating the PASI scores for scaling. But before calculating the PASI score, the scaling severity score need to be verified so that the calculated scaling percentage can be grouped accordingly based on the score range from 0 to 4. Once all the steps done, GUI for this program will be developed.

The image input of this program is different in term of quality, dimension and size. Hence, the outputs also differ with one another. Assuming the image input for this program should be as in Figure 4.1 as shown. Adobe Photoshop CS software can be used to separate the patient image input into four sections which are head, arms, trunk and legs before processing the images automatically using the system.

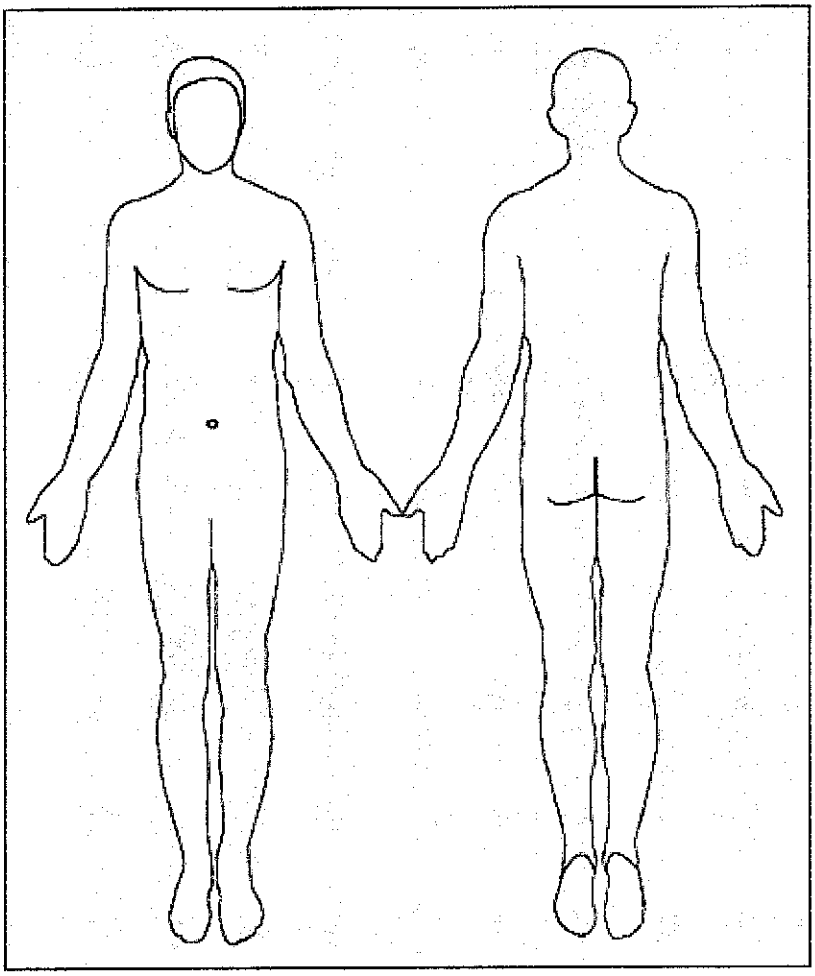


Figure 4.1: The patient orientation while capturing the image to be used as input image.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

This research project will hopefully provide an alternative to the current method of subjective PASI scoring to an automated program. Images were successfully being acquired and segmented automatically to be analyzed for scoring the scaliness. The scores were then used in the automated PASI scoring system to calculate the PASI-score. Until now, this project is still going on and already at the part of performing image analysis where the segmented images of the Psoriasis images will be calculated to obtain the score of lesion area. The score of severity had been obtained and will be used to get the PASI score. However, to get the total PASI score, the lesion area calculation must be done first. Verification of the calculated scaling percentage by dermatologist is needed at this stage to ensure the result is as precise as possible.

5.2 Recommendation

After completing this project, there are some areas that need to be improved to ensure more accurate result of the automated scoring for scaliness of Psoriasis lesion. If the project is extended, further analysis can be done to widen the project scope.

5.2.1 Input images

In order to produce a more accurate results, real images of Psoriasis diseases is needed. The real images are much better compare to the images that are obtained from the internet since it is not been adjusted yet. Images from dermatologist that can be use for this project should be captured using high quality digital camera to ensure that the input images have high quality pictures. Input images also should be free from any shadows, noise or blur.

5.2.2 Project improvement

For future purposes, this project might consider a more accurate segmentation technique that can produce more accurate output. The images also should be standardized and the on going project should be run with a help by dermatologist as the guidance to score the PASI.

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APPENDICES

APPENDIX A: Project Gant Chart

APPENDIX B: Program

APPENDIX A

Project Gant Chart

First part of Final Year Project

No.	Detail/ Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
		24/7	31/7	7/8	14/8	21/8	28/8	4/9	11/9	18/9	25/9	2/10	9/10	16/10	23/10	30/10	6/11
1	**Selection of Project Topic**																
	-Propose Topic																
	-Topic assigned to students																
2	**Preliminary Research Work**																
	-Introduction																
	-Objective																
	-Literature Review																
	-Project planning																
3	**Submission of Preliminary Report**																
4	**Project Work**																
	-Research on Texture Analysis																
	-Practical/MATLAB programming																
5	**Submission of Progress Report**									X							
6	**Project work continue**																
	-Practical/MATLAB programming																
7	**Submission of Interim Report Final Draft**													X			
8	**Oral Presentation**																X
9	**Submission of Interim Report**															X	

Second part of Final Year Project

No.	Detail/ Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
		22/1	29/1	5/2	12/2	19/2	26/2	5/3	12/3	19/3	26/3	2/4	9/4	16/4	23/4	30/4	7/5	14/5	21/5	28/5	4/6	11/6
1	**Project Work Continue**																					
	-MATLAB implementation																					
2	**Submission of Progress Report 1**				X																	
3	**Project Work Continue**																					
	-MATLAB implementation																					
4	**Submission of Progress Report 2**									X												
5	**Project Work Continue**																					
	-Results analysis																					
6	**Submission of Dissertation Final Draft**																X					
7	**Oral Presentation**																				X	
8	**Submission of Project Dissertation**																					X

APPENDIX B

Program

```
%for head section
-------------------------------------------------------------------

Ih=imread ('psoriasis25.jpg');
figure, imshow(Ih), title('original');

Gh=rgb2gray(Ih);
imwrite(Gh,'head.bmp');
figure, imshow(Gh), title('gray scaled');

BWh=edge(Gh,'sobel',0.13);
figure, imshow(BWh), title('segmented');

Kh=imread('head.bmp');
Ph=Kh;
[rows colms] = size(Kh);
for i=1:rows
    for j=1:colms
        if Kh(i,j) > 245;
            Ph(i,j) = 0;
        else
            Ph(i,j) = 1;
        end
    end
end
Jh = mat2gray(Ph);
figure, imshow(Jh), title('body area');

bwarea(Jh);
bwarea(BWh);
HeadArea=bwarea(Jh)
ScalinessH=bwarea(BWh)
percentageH=((ScalinessH)/(HeadArea))*100

Xh=percentageH;
if ((Xh<1.0) & (Xh>0))
    o=0;
```

```
elseif ((Xh<2.0) & (Xh>1.1))
    o=1;
elseif ((Xh<3.0) & (Xh>2.1))
    o=2;
elseif ((Xh<4.0) & (Xh>3.1))
    o=3;
elseif ((Xh<10.0) & (Xh>4.1))
    o=4;
end

SeverityH = o


%for arms section
-----------------------------------------------------------------------


Ia=imread ('hand.jpg');
figure, imshow(Ia), title('original');

Ga=rgb2gray(Ia);
imwrite(Ga,'arms.bmp');
figure, imshow(Ga), title('gray scaled');

BWa=edge(Ga,'sobel',0.1);
figure, imshow(BWa), title('segmented');

Ka=imread('arms.bmp');
Pa=Ka;
[rows colms] = size(Ka);
for i=1:rows
    for j=1:colms
        if Ka(i,j) > 220;
            Pa(i,j) = 0;
        else
            Pa(i,j) = 1;
        end
    end
end
Ja = mat2gray(Pa);
figure, imshow(Ja), title('body area');
```

```
bwarea(Ja);
bwarea(BWa);
ArmsArea=bwarea(Ja)
ScalinessA=bwarea(BWa)
percentageA=((ScalinessA)/(ArmsArea))*100

Xa=percentageA;
if ((Xa<5.0) & (Xa>0))
    o=0;
elseif ((Xa<10.0) & (Xa>5.1))
    o=1;
elseif ((Xa<15.0) & (Xa>10.1))
    o=2;
elseif ((Xa<20.0) & (Xa>15.1))
    o=3;
elseif ((Xa<50.0) & (Xa>20.1))
    o=4;
end

SeverityA = o


%for trunk section
------------------------------------------------------------------------

It=imread ('1.jpg');
figure, imshow(It), title('original');

Gt=rgb2gray(It);
imwrite(Gt,'trunk.bmp');
figure, imshow(Gt), title('gray scaled');

BWt=edge(Gt,'sobel',0.1);
figure, imshow(BWt), title('segmented');

Kt=imread('trunk.bmp');
Jt=Kt;
[rows colms] = size(Kt);
for i=1:rows
    for j=1:colms
        if Kb(i,j) > 220;
```

```
            Pb(i,j) = 0;
        else
            Pb(i,j) = 1;
        end
    end
end
Jt = mat2gray(Pt);
figure, imshow(Jt), title('body area');

bwarea(Jt);
bwarea(BWt);
TrunkArea=bwarea(Jt)
ScalinessT=bwarea(BWt)
percentageT=((ScalinessT)/(TrunkArea))*100

Xt=percentageT;
if ((Xt<1.0) & (Xt>0))
    o=0;
elseif ((Xt<2.0) & (Xt>1.1))
    o=1;
elseif ((Xb<3.0) & (Xt>2.1))
    o=2;
elseif ((Xt<4.0) & (Xt>3.1))
    o=3;
elseif ((Xt<10.0) & (Xt>4.1))
    o=4;
end

SeverityT = o


%for legs section
---------------------------------------------------------------------


Il=imread ('psoriasis-pustular_psoriasi.jpg');
figure, imshow(Il), title('original');

Gl=rgb2gray(Il);
imwrite(Gl,'legs.bmp');
figure, imshow(Gl), title('gray scaled');
```

```
BW1=edge(G1,'sobel',0.08);
figure, imshow(BW1), title('segmented');

K1=imread('legs.bmp');
P1=K1;
[rows colms] = size(K1);
for i=1:rows
    for j=1:colms
        if K1(i,j) > 220;
            P1(i,j) = 0;
        else
            P1(i,j) = 1;
        end
    end
end
J1 = mat2gray(P1);
figure, imshow(J1), title('body area');

bwarea(J1);
bwarea(BW1);
LegsArea=bwarea(J1)
ScalinessL=bwarea(BW1)
percentageL=((ScalinessL)/(LegsArea))*100

X1=percentageL;
if ((X1<1.5) & (X1>0))
    o=0;
elseif ((X1<3.0) & (X1>1.6))
    o=1;
elseif ((X1<4.5) & (X1>3.1))
    o=2;
elseif ((X1<6.0) & (X1>4.6))
    o=3;
elseif ((X1<10.0) & (X1>6.1))
    o=4;
end

SeverityL = o
```

```
%calculate PASI scores
-------------------------------------------------------------------

Head = SeverityH * 1 * 0.1;
Arms = SeverityA * 1 * 0.2;
Trunk = SeverityT * 1 * 0.3;
Legs = SeverityL * 1 * 0.4;

PASI=Head + Arms + Trunk + Legs;
PASI

%for the time being, area of lesion is represented as 1 in the above
PASI calculation since the lesion area calculation is still under
progress.
```