I-DERMAT

SKIN FUNGAL DISEASE IDENTIFICATION SYSTEM

Thalpawila Kankanage Hasinie Nimeshika

(IT14119118)

Degree of Bachelor of Science (Special Honors)

Department of Information Technology

Field of Specialization: Software Engineering

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DECLARATION

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ABSTRACT

Now a days, skin fungal diseases are mostly found in people of tropical countries like Sri Lanka. A skin fungal disease is a particular kind of illness caused by fungus. These diseases have various dangerous effects on the skin and keep on spreading over time. It is important to detect these diseases at their initial stage to control it from spreading.

We have created a skin fungal disease identification system to overcome the drawbacks of manual diagnosis. The proposed system automatically detects fungal infections in digital images that would increase diagnostic quality, shorten the time-to-diagnosis and improve the efficiency of detection and treatment to skin fungal diseases that would finally result in successful treatment for skin fungal diseases.

We have used different types of image processing techniques to extract the different features of skin fungal diseases from the image to identify the disease respectively. After that the module for treatments and advices will provide the respective treatment information to the user.

As for this research we are planning to analyze four main skin fungal diseases which are most common in Sri Lanka, namely, Ring Worm, Sporotrichosis, Malassezia and Onychomycosis. Also, we will assess the final outcome of this project to provide accurate diagnosis to the patients about their disease and save their time for the treatments. From this document we will preset how we have identified Malassezia disease.

ACKNOWLEDGEMENT

We would like to express our deepest appreciation and full-hearted gratitude to our supervisor Ms.Namalie Walgampaya who guide us to success this research and give entire support to complete this research. Also we would like to thanks our Comprehensive Design and Analysis of Projects (CDAP) lecturer in charge, Mr. Jayantha Amararachchi who guided us to correct path. We would also like to thanks Dermatologists who gave important details to continue this research. Moreover we would like to thanks our family members for their encouragement and support to complete this task.

TABLE OF CONTENTS

LIST OF TABLES PAGE

LIST OF FIGURES PAGE

LIST OF ABBREVIATIONS

GLRLM	Grey Level Run Length Metrix
I-Dermat	I-Dermat is a system which is developing to identify Skin fungal disease using image processing techniques
User	Someone who interacts with the web application
Web-Portal	web application which can upload image and get output (disease)

1. INTRODUCTION

Skin Fungal Disease is an infection caused by fungi that are commonly living in the environment. Most of the fungal diseases are not very dangerous if they could be identified early and treated properly. But they could be very harmful if not identified and treated properly. It is assumed that 20 to 25% of the global human population is affected by fungal infections, with a constantly increasing incidence .[1] In tropical areas they are a major cause of being diseased due to the ideal warm and humid conditions for fungal growth [1].They could be transmitted through direct person-to-person contact or indirectly. Due to the widespread occurrence and the resulting large number of patients, it is a frequent task for dermatologists to diagnose and to treat fungal infections.

In a developing country like Sri Lanka it is expensive for a large number of people to go to dermatologist for their skin disease problems. Every year a large number of populations in the developing countries like Sri Lanka suffer due to different types of skin fungal diseases. A basic factor in their fruitful treatment is time: the speedier they are distinguished, the all the more successfully risky contamination can be prevented. So, it is very necessary for both the patients and dermatologists to have an automated skin disease detection system especially in developing countries.

Dermatologists can detect many skin fungal diseases simply by looking at them. Identifying characteristics include color, size, location and shape of infection and also the presence or absence of some other symptoms. To measure the distribution of the infection, dermatologists often asks the patient to undress completely, even though the patient may have noticed an infection on only a small area of skin.

Sometimes if a fungal disease is suspected, a dermatologist may remove small piece of skin to be examined under the microscope. Sometimes special stains and chemicals are applied to the piece of skin. Although microscopic examination is considered as an essential method for the diagnosis of fungal diseases it has some drawbacks.

Contingent upon client encounter, test condition, and test estimate, it might even now be tedious to assess finish tests. Diagnosing multiple samples at once may therefore be a tedious task that could lead to classification errors and increased intra- and inter-observer variability. And also there are some methods of examining such as culture- or DNA-based methods, but they are more expensive and time consuming.

To overcome the limitations and drawbacks of these examination techniques, we need to have an automated skin fungal disease identification system which is cheaper and reliable. And it should be focused on the most common skin fungal diseases of Sri Lanka. The aim of our research is to develop an automated skin fungal disease identification system that would increase diagnostic quality, shorten the time-to-diagnosis and improve the efficiency of detection and treatment to skin fungal diseases that would finally result in successful treatment for skin fungal diseases.

1.1.Background Literature

1.1.1. Expert System for Diagnosis of Skin Diseases [1]

This paper displays a usage of a skin infections detection system which causes client to recognize human skin ailments and gives restorative medicines opportune. For this reason, client should give an infected skin picture to the application and give responses to the inquiries which are asked to client as per the side effects of the skin. These symptoms are utilized to distinguish the disease and give a therapeutic treatment. This framework work on technologies like image processing and data mining. So the project is divide into below significant areas. Image pre-processing, segmentation and feature extraction.

- Image pre-processing, segmentation and feature extraction.
- Classification model and skin disease predication.
- Medical treatment suggestions or advice.

The image of skin disease is taken and various pre-processing techniques are applied onto that image for noise removal and image enhancement. This image is segmented

by using a segmentation technique i.e. thresholding segmentation. At last, data mining techniques are used to identify the skin disease and to provide recommendations to users. This expert system pertain disease recognition accuracy of 85% for Eczema, 95% for Impetigo and 85% for Melanoma. Image based technique and questionnaire technique increased the reliability and performance of the system.

Limitations

- This application is implemented only for Eczema, Impetigo and Melanoma which are not skin fungal diseases.
- During image capturing, the distance between camera lens and affected skin should be 5cm.
- It is compulsory to capture image without using any light effect for this system

1.1.2 Online Children Skin Diseases Diagnosis System [2]

Rule based and forward chaining inference engine methods are utilized to execute this model which is utilized to recognize the skin infection. By utilizing this framework, client is permitted to distinguish kids' skin sicknesses by means of on the web and give valuable restorative proposals or guidance timely. In this framework, it consists of diagnostic component, login component, information component, report component and administration component. There are two fundamental component called diagnosis and administration module. In the diagnose component questions are asked from the client and on the premise of answers given by the client, Children's manifestations and condition are recognized. This framework might be an option for guardians to diagnosing skin infections of kids, in response to the questions about the symptoms and the condition of kid's skin.

Limitations

- This application is implemented using rule based and forward chaining inference engine methods. No usage of image processing techniques.
- Implemented only for most common skin diseases of children which are not fungal diseases.

1.1.3 An automated system for recognizing disease conditions of human skin [3]

In this model, the state of the skin infection is detected by evaluating infected skin images by using grey normalized symmetrical simultaneous occurrence stencils (GLCM) method. The proposed framework is utilized as a part of an effective and conservative for the automatic recognition of skin sicknesses. This system is useful for the skin to reduce the error with medical diagnosis. Another is the primary test for patients in country territories, where the great specialists are absent. The framework works with relational databases to the capacity of inferring the requirement for textual skin pictures. This framework can likewise work for same sort of pictures.

Limitations

- This application is implemented only for three dermatological skin diseases, namely Dermatitis, Eczema and Urticaria which are not fungal diseases.
- Analyze only the texture of the skin.

1.1.4 Mobile-based Medical Assistance for Diagnosing Different Types of Skin Diseases Using Case-based Reasoning with Image Processing [4]

Medical field is a recent area for research purpose in artificial intelligence (AI).This paper implements a mobile based medical assistance which is used for identifying skin diseases by the use of CBR and image processing techniques. This model was implemented to help users to pre-examine their skin circumstance whether they have a disease or not. Also to build the awareness of skin diseases on what it may do to our bodies which will lead to death or infecting other people and have a treatment before it deteriorates. The proposed application is successfully implemented to identify 6 different skin diseases. The identification rate of the sample disease with

the other related disease is as follows: Eczema – 88%; Psoriasis – 61%; Acne – 75%; Skin Cancer – 51%; Scabies – 43%; and Seborrhea Dermatitis – 34%.

Limitations

- This application is developed for dermatological skin diseases which are not skin fungal diseases.
- The diagnostic rate is very low for some diseases which cause for lack of accuracy.

1.1.5 Image-Processing Scheme to Detect Superficial Fungal Infections of the Skin [5]

Fluorescence microscopy of removed skin samples is every now and again utilized for a quick appraisal of contamination. To support the dermatologist, an image-analysis method has been implemented that evaluates digital microscopic images to identify fungal hyphae. Infected skin samples consisting of small skin scales were extracted from clinical cases in a university hospital. The specimens were accumulated amid routine examination where parasitic diseases were analyzed by clinicians. Additionally, uninfected specimens from healthy users were also taken at the hospital. The specimens preparation consisting of maceration and staining with commercially available MykoColor (RSC Pharma, Giessen, Germany) was performed at the laboratory. The skin scales were located on an object slide and 0.02 mL of MykoColor was added. A cover glass is used to gently flatten the sample. And after that fluorescence microscopy image of given sample is taken by the imaging device and then it is analyzed by using image processing techniques.

Limitations

- Can only identify whether a fungal disease is present or not.
- It is time consuming to take the fluorescence microscopy image because Sample material preparation should be done to do it.

- It is costly because we should use microscopes and other chemical substances.
- To get the correct fluorescence microscopy image technological knowledge and experience is needed
- Can be only used with laboratory facilities. Cannot use the system for normal users.

1.2.Research Problem

In tropical countries like Sri Lanka Fungal Diseases are most common due to the ideal warm and humid conditions for fungal growth. Due to the widespread occurrence and the resulting large number of patients, it is a frequent task for dermatologists to diagnose and to treat fungal infections. Manual diagnosis is conducted by the dermatologists and direct microscopic examination is generally used as a screening method. But these have some drawbacks. Depending on user experience, sample condition, and sample size, it may still be time-consuming to evaluate complete samples. Diagnosing multiple samples at once may therefore be a tedious task that could lead to classification errors and increased intra- and inter observer variability.

According to the performed literature survey we have found that so many researches have been conducted to identify skin diseases using image processing techniques. But most of them are only capable of identifying few most common skin diseases in European countries, such as melanoma Eczema, Rosacea and Acne. But we found only one research on skin fungal diseases. But that is also a really long process.

Firstly, a sample from the infected area is collected and should be prepared to microscopic examination by applying chemicals and stains. Then it is kept under a microscope and an imaging device is used to take the fluorescence microscopy image of respective sample. After that image analysis scheme is used to analyze the image at cellular level. To facilitate the process of identification, for the dermatologists images classified as true-positive are presented without highlighting the identified objects. In this way experienced dermatologists can choose quickly if an image

consists hyphae as they do not explicitly need to assess every single object. So the dermatologists can decide whether fungal infection is available or not.

So this method is not capable of differentiating one skin fungal disease from another. It can be used to detect whether a fungal infection is present or not. And also it does not state whether a fungal infection is present or not. Dermatologist has to take the decision by looking at the presented true positive objects. So dermatologist should be well experienced to make the final decision. So finally there is no proper way for the identification of skin fungal diseases.

1.3.Research gap

1.3.1 Disease category which has not been explored using image processing techniques

During the literature survey we have found so many researchers conducted on the topic of skin disease detection. Most of them are conducted on limited number of diseases that are common in European countries. Due to the complexion of people in European countries, they are most likely to being diseases by skin cancers. So the most popular disease that has been identified by skin disease detection systems was skin cancers. Rather than that some of the researchers have focused on other mostly common diseases such as Eczema, Impetigo, and Urticaria etc.

Instead of going forward the same path we have decided to think on a disease category which is mostly common in Sri Lanka. And from the literature survey we learned that there is no proper researches have been conducted on the area of skin fungal diseases. But in our research our focus is on skin fungal disease which is a new topic in the image processing perspective.

1.3.2 More Features

When considering about the previous researches, most of the systems which use image processing techniques to detect skin diseases are limited to less number of feature extraction. Mostly common features are shape, color, texture etc. But in our research we are planning to implement different algorithms to extract features such as existence of hair, presence of bumps, presence of blisters, distribution of the bumps etc. So we are planning to explore more features which have not been considered yet.

1.3.3 Go beyond the existing researches [1]

During the literature survey we have found only one research that has been conducted on skin fungal diseases. The research article on the topic of "Image Processing Scheme to Diagnosing Superficial Fungal Infections of the Skin" has been published in 2015. According to the research paper it has very longer process for determining the presence or absence of fungus in an infection sample.

Infected samples consisting of small skin scales are gathered from the patients. Then the specimens has to be prepared for the microscopic examination. The specimen preparation consisting of maceration and staining with commercially available MykoColor (RSC Pharma, Giessen, Germany) should be performed at a laboratory. The laboratory person locate skin scales on an object slide and 0.02 mL of MykoColor should be added. A cover glass must be used to gently flatten the sample.

The fluorescence images of the specimens are taken with an automated device typically show a dark background with bright fluorescent structures. These structures are either hyphae that belong to a fungal disease or false-positive structures. After pre-processing the images all the single objects are stored in a dataset. Then the objects are sorted according to object size, object intensity, histogram analysis etc. To facilitate the process of diagnosis for the dermatologists images classified as true-positive are presented without highlighting the detected objects.

Problems with the existing methodology

- This method is only capable to help dermatologists to identify whether a fungal disease is present or not. It does not diagnose the disease respectively.
- This is very long process takes considerable amount of time that could not be performed for a dermatologist at the patient contact time.
- The process more costly because this uses imaging devices, microscopes and chemical substances.
- to take the final decision by looking at true-positive images it needs well trained and experienced dermatologists
- Because of the need of laboratory services this system cannot be used by normal users.

But the system we propose is,

- Capable of diagnosing the skin fungal diseases respectively.
- Dermatologist can just take a picture of infected skin area and upload to the system then it will clearly state the infection details with its stages and treatments. This can be done during patient contact time.
- Uses no special hardware devices that will make zero cost.
- No need of laboratory services. Due to that the system can be used by normal users.
- Experience of the user does not matter. Could be helpful for newly appointed doctors.

1.3.4 More users

Currently existing solutions are always limited to one user group. Some of the applications are developed for dermatologists while some of them are targeting on regular users. But the system we propose is not limited for one user group. It can be used by both user groups. Dermatologists can use it for diagnosis clarifications while normal users use it for identifying their diseases.

1.3.5 Efficient and cheap

When comparing with the analysis of the fluorescence microscopic images, our proposed system is much cheaper and efficient due to no usage of special hardware devices and fast process.

Features	Online Children Skin Diseases Diagnosis System (2013)	Artificial Neural Network Based Detection of Skin Cancer (2015)	Image-Processing Scheme to Detect Superficial Fungal Infections of the Skin (2016)	The Proposed I-Dermat application (2017)
User Friendly Interfaces	✓	✓	✓	✓
Identify fungal skin diseases	X	X	X	✓
Identify the Severity of the disease	X	X	X	✓
Generate disease detection analysis result	X	X	X	✓
Display percentage of match and mismatch to disease identified	X	X	X	✓
Display initial treatments to the disease identified	X	X	X	✓

Table 1: Comparison between I-Dermat and existing products

1.4.Research Objectives

For a project to sustain its way towards success it is a common understanding that the outcome of a team operation depends on the team members and their composition .a proper team should be selected and team combination should be perfect. The Proposed I-Dermat is a research project focused on several objectives. With the completion of the project, we are supposed to fulfill these research objectives. The main objectives of the research project are mentioned as follows

1.4.1. Main objective

In the real world there are many ways of acquiring data. Capturing details from an image is one of the essential techniques that is used in the field of medicine. With the arrival of new technology it is possible to gather details of an image that cannot be gained by simply observing the captured image.

The main objectives of the research is to implement a user friendly skin fungal disease detection system to:

- Identify whether a fungal skin infection is present.
- Identify the type of fungal skin infection.
- Capture the symptoms of the disease that cannot be captured from the image.
- Display output image marked with infected area and suspected disease

1.4.2. Specific objectives

Identifying Tinea Versicolor fungal disease through image, to develop an algorithm to extract details of the image, to reduce the cost of examination of skin and increase the speed of skin disease diagnosis, explore and understand the modern IT techniques such working with Image understanding and processing, texture analysis, program models, data analysis; and invent innovative solutions which can be adopted for the development real world situations.

- **To ease the diagnosis and treatment of skin patient**

  By automating the detection, diagnosis time will be reduced. And the patient by him/her self will be able to diagnose the infection type.

- **To develop an algorithm to extract details of the image.**

  This allows to identify that a fungal infection is present or absent. If present checks whether the infection matches with the available fungal infections in the system's database and identifies the type of fungal infection.

- **To increase the availability in the local market**

  Even though there are applications already available for detecting most skin diseases, there's no available specific application/system to detect fungal skin infections in the local market.

- **To reduce the cost of examination of skin and increase the speed of skin disease diagnosis.**

  It can reduce the health hazard in the rural communities. It is also expected that the output of the research study would result in a system that would increase the speed of fungal skin disease diagnosis.

- **Documentation and examples.**

  Prepare the documentation such as proposal, SRS for the proposed research and provide results with relevant examples.

- **Explore and Understand Modern IT techniques**

  Explore and understand the modern IT techniques such working with Image understanding and processing, texture analysis, program models, data analysis; and invent innovative solutions which can be adopted for the development real world situations.

- **User Friendly and Simple**

  Lot of similar tools in the market has a very complex interface where professional knowledge is needed in accessing it. I-Dermat is designed in

such a way where a normal person who has the basic skills of using computer and internet, can use it and get the required outputs without having any difficulties.

- **Affordable price.**

  There are number of top Disease Identification tools, software etc. in the current market and they all does the work pretty well. But the cost of them varies and vastly in high thousands which most companies will struggle to purchase. Our plan is to serve this to normal people and help them to identify their skin diseases before it become critical and unmanageable.

2. Methodology

2.1.Methodology

A methodology is a set of guidelines or principles that can be applied to a specific situation. In project duration, members must follow below guidelines. A methodology could also be a specific templates, approach, forms, and testing used over the project life cycle. Throughout the life cycle of a project a formal project methodology should lead the work of all team members.

In methodology part shows the way we are going to manage our research and how we develop our research. Inasmuch this section exaggerates the project scope, project features, and final outcome of project within time duration one year of period.

In methodology part shows the way we are going to manage our research and how we develop our research. Inasmuch this section exaggerates the project scope, project features, and final outcome of project within time duration one year of period. For the software development lifecycle we use Iterative Model. The basic idea behind iterative method is to develop a system through repeated cycles (iterative) and in smaller portions at a time (incremental), allowing software developers to take advantage of what was learned during implementation of earlier modules or versions of the system. Learning comes from both the implementation and use of the system, where possible key steps in the process start with a simple implementation of a subset of the software requirements and iteratively enhance the evolving versions until the full system is developed. At each iteration, design modifications are made and new functional capabilities are added [6].Below are several reasons for choosing Iterative Model.

- Requirements of the complete system are clearly defined and understandable.
- Our project is running through one year. It is rather big.
- Even though major requirements are clearly defined, some details can evolve with time.

• We found the importance of using Iterative Model from several resources. Below are those advantages,

• In iterative model we can only create a high-level design of the system before we actually begin to develop the system and define the design solution for the entire product. Later on we can design and built a skeleton version of that, and then 14 evolved the design based on what had been built. Functionality can be developed rapidly and demonstrated.

• In iterative model we are building and improving the product step by step. So we can identify the defects at early stages. This avoids the downward flow of the defects. Easy to manage.

• In this model for documenting is given less time while for designing it is given more time.

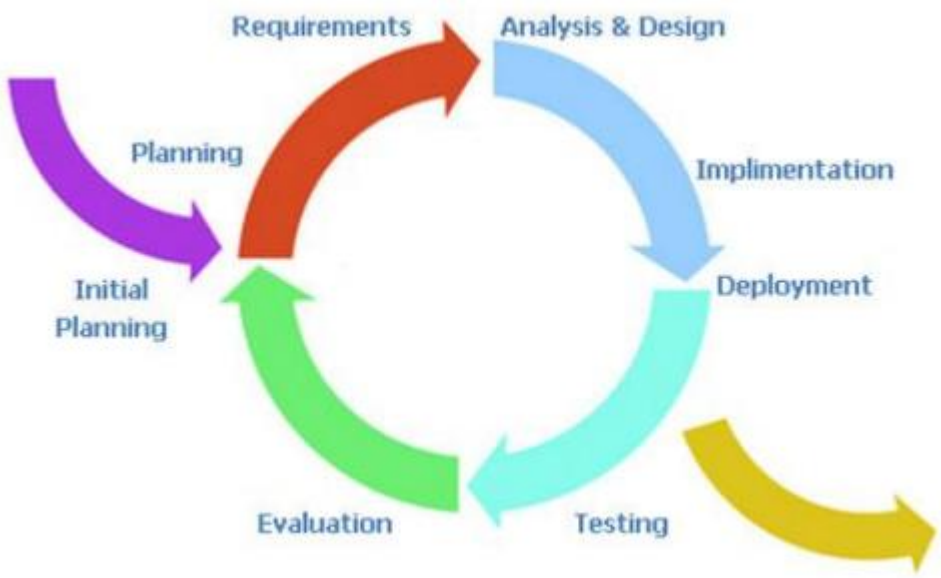

Fig.2.1. Iterative model

This module represents an implementation of a skin fungal disease diagnosis system which help user to detect or diagnose/identify the skin disease, Malassezia and provides medical treatments timely

Feasibility study

For the first step, as a team we came up with several research problems and discussed them with the supervisor. Eventually after considering all the requirements we decided to develop the "I-Dermat" to identify skin fungal diseases .The target customers for this system are novice doctors and normal users. Under Technical feasibility, we realized that this system can be developed using modern technologies such as Computer vision and Image Processing.

To identify Malassezia here are special algorithms to be developed to analyze colors, textures, and the stage of the identified disease of particular sample image.

Therefore this research project is technically feasible. Under Economic feasibility, we found out that using this system is low costly. Because the user can handle the system without special concern. Most of the people have mobile phones or computer/laptop with digital cameras. Since this software is 75% based on Image processing, they can use their respective devices to take photos and upload them to the system. He can simply insert them to the system and system will automatically process them and give the output result. Therefore this research project is financially feasible as well.

Requirement analysis and specification

As a team we read lots of previous research papers to get to know what has been done what not. After studying all those things we visited dermatologist to gather more knowledge. As a result we properly identified several problems are discussed the solutions.

We decided to identify 4 main diseases (Ring worm, Sporotrichosis, Malassezia and Onychomycosis.) using image processing techniques. These 4 diseases were distributed among the group members to study deep and further to obtain more details individually.

I have selected Malassezia and identified unique features that can identify this disease using an image.

Title: Color Analysis

DESC: System shall analyze uploaded image and get the color range of the infected area. The color of the spots can be white, pink, salmon, red, tan, or brown The spots are lighter (sometimes darker) than the surrounding skin

RAT: In order to check whether the color of the infected area matches with the Malassezia disease.

Title: Texture/patch Analysis

DESC: System shall analyze the image to identify whether there is a patch /rash in the infected area. Sometimes there will be infected areas which are ring shape, with blisters etc... But in here we will check if the infected area is a wide spread area with a rash. Texture should be smooth too.

RAT: In order to check whether the texture of the infected area matches with the Malassezia disease.

Title: Surface Area Analysis

DESC: If we could identify there is a rash that matches with the disease we shall analyze the surface area of that to analyze how fur this disease is wide spread or not. If will help to analyze the risk. This will help to differentiate Malassezia from other similar diseases.

RAT: In order to check whether the surface area of the infected area matches with the Malassezia disease and measure the risk and stage of the disease

System design

After completing the Requirement analysis phase, team moved to design phase. When everyone in the team comes to this phase has a proper understanding what is going on with their component. That includes every main processes and sub processes, correct flow of the component and how individual component join with

other components. By using these knowledge gathered, we have to design flow diagrams for each individual component of the system.

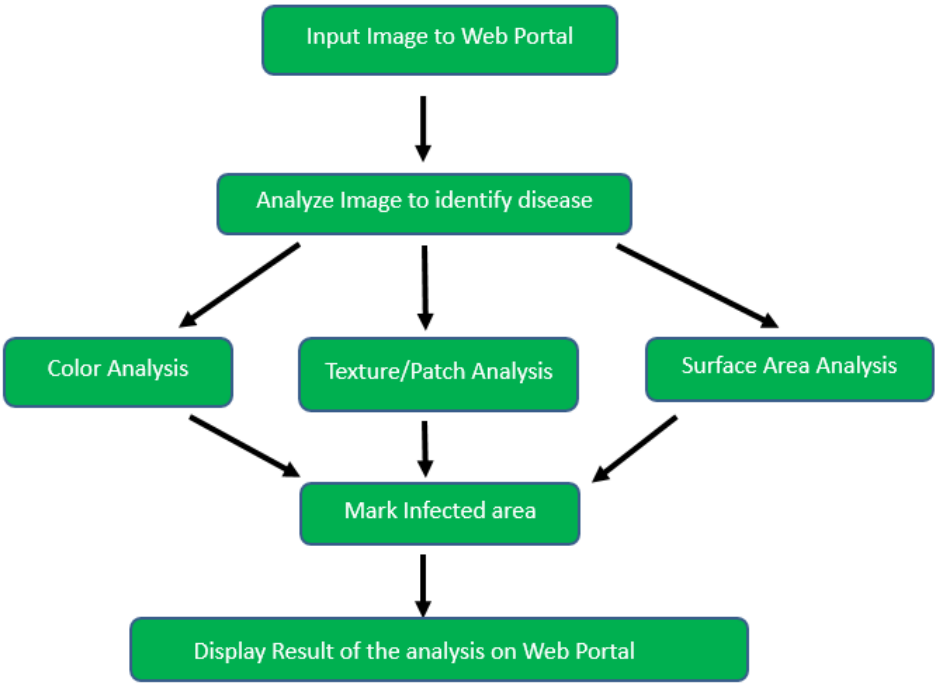

Fig.2.2. Overview of Malassezia Identification process

2.1.1. Testing & Implementation

2.1.1.1. Implementation

In this module project design should have to implement by using a programming language. In our case mainly we are using Eclipse IDE and for the programming language we use Java. In addition I have used OpenCv, ImageJ and Catalano image processing Framework to implement the requirements of the project.
This module represents the implementation of a skin fungal disease diagnosis system which help user to detect or identify the skin disease (Malassezia**)** and provides medical treatments timely. For this purpose user will have to upload a disease affected skin image to our system. So it is a primary thing required for designing and testing the system. We have gathered our own dataset by doing a survey with dermatologists in different hospitals. As images are collected through the

dermatologists, they exhibit a large intraclass variation with less interclass variations. This sensitivity was necessary in order to ensure accurate preprocessing technique such as filtering.

Methodology for Skin Fungal disease Identification is as described in below. We are typically following a procedure that involves five main steps:

- Image pre processing
- Segmentation
- Feature Extraction
- Classification of the Lesion
- Decision takes place that which type of disease is found in the infected skin image.

Image Pre Processing

In the image preprocessing basically it involves the quality enhancement of the image which is inputted to the system. In the process of quality enhancement some changes has been occurred in images like noise removal, edge detection, shaping of edge, brightness, contrast of image, hair removal, cropping or resizing. It is expected that some of the images to be used might have features like hairs and pigments which confuses analysis. These features are typically regarded as noise, and thus need to be filtered off in order to facilitate separation of the lesion area from the surrounding skin. In this work we will use some preprocessing methods such as Filtering with morphological operation, Histogram equalization, Noise removal, linear contrast adjustment, Median filtering and Etc.

Segmentation

Partitioning the image which we selected into multiple segments and simplify or change the representation of an image into something that is more meaningful and easier to analyze. This is used to locate objects and boundaries (lines, curves, etc.) in images. In this work we will use thresholding method called threshold value turn to a gray scale into a binary image , partition an image into *K* clusters called clustering methods (k means) , Edge detection , Histogram-based methods and etc.

Feature Extraction

Feature extraction is done after the preprocessing phase. The feature extraction is a technique used for collecting various features from image and dimensionality reduction. Feature extraction techniques are applied to get features that will be useful in classifying and recognition of images. In this work we use two different feature extraction methods such as HSV-histogram feature extraction, SURF and etc.… to extract the various features from enhanced images.

Classification

The unique features of the enhance images were extracted using Different methods in feature extraction step. Based on the features, the images were classified as infected skin and normal skin. Image classification analyzes the numerical properties of various image features and organizes data into categories. Classification algorithms typically employ two phases of processing like training and testing. In the initial training phase, characteristic properties of typical image features are isolated and, based on these, a unique description of each classification category, a training class, is created. In the subsequent testing phase, these feature-space partitions are used to classify image features.

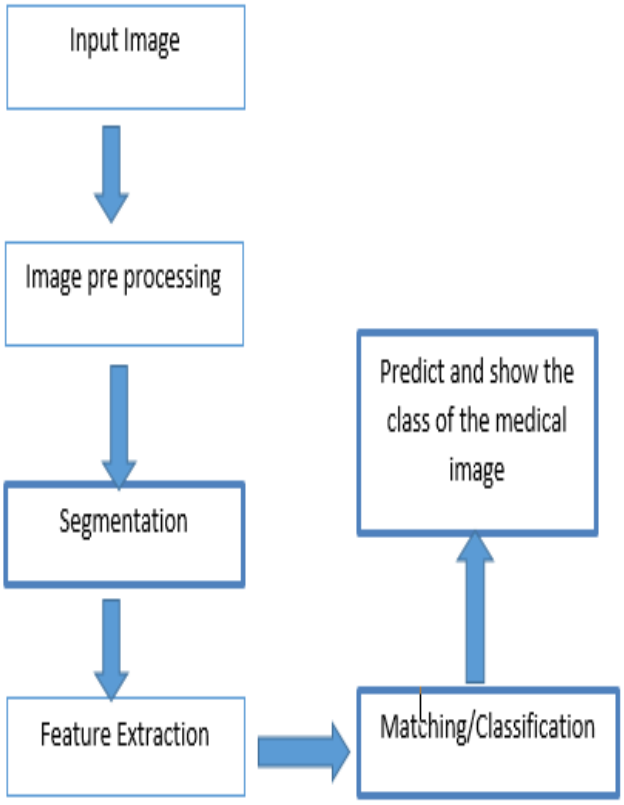

Fig 2.1.1.1. Overview of proposed architecture for skin fungal lesions classification

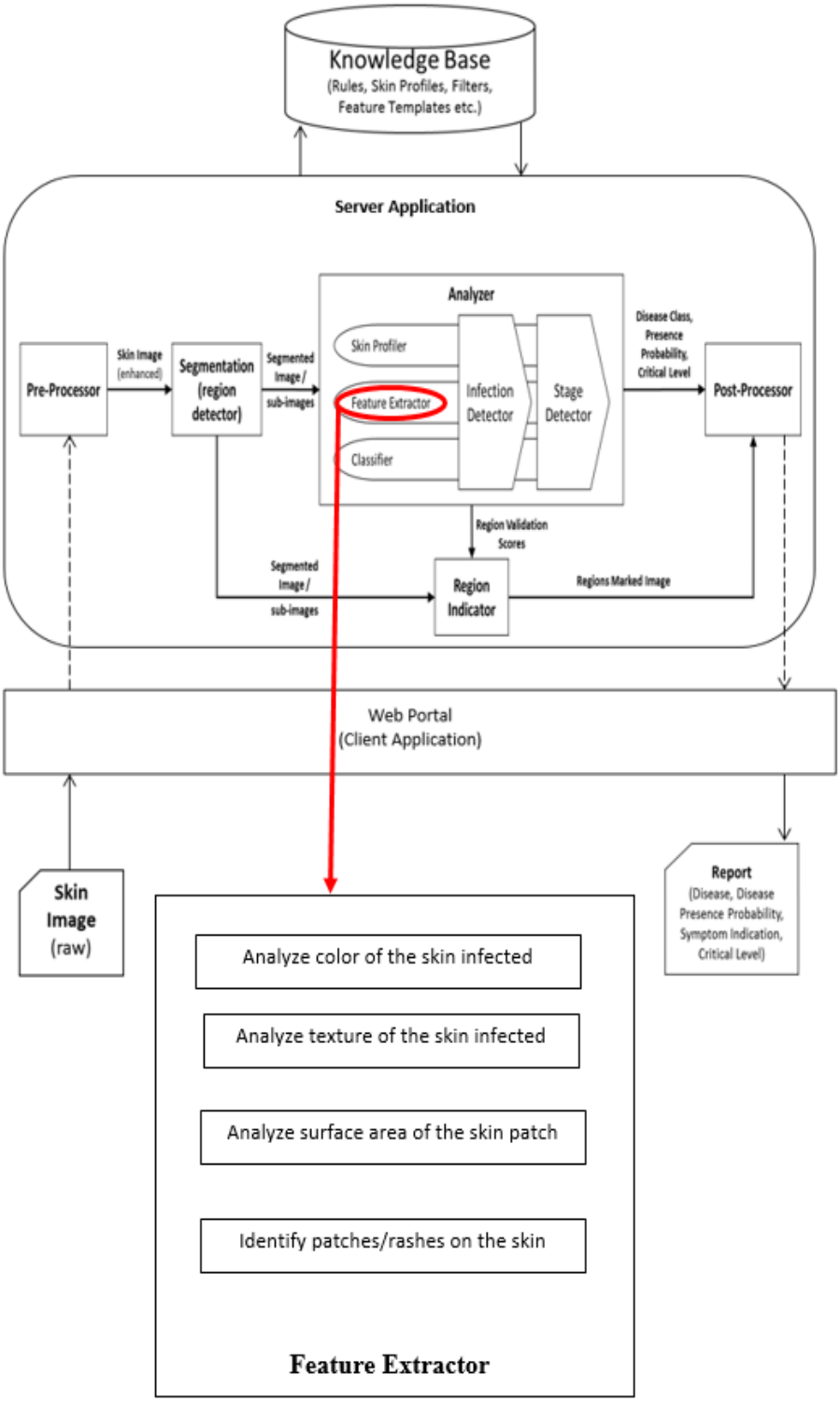

Fig 2.1.1.2. Block Diagram

2.1.1.2 Implementation of Colour Identification

To Identify the Colour of the input image I have used RGB colour model. I have converted the RGB values into their Hex colour code and then checked if that hex value is matching with the colour range which match the Malassezia disease. If input image color is matching to Malassezia disease then marked this feature (color identification) as passed. If not if would be marked ass failed.

RGB Color Model

In the retina of the eye, there are three sorts of shading receptors, called cone cells. The three sorts of cone cells are delicate to the short, medium, and long wavelengths of noticeable light, separately. The RGB shading model approximates the way human vision encodes pictures by utilizing three essential shading channels: red, green, and blue. Transmitted light sources, for example, CRT screens, level board showcases, and video projectors utilize the RGB shading model, as do picture catching gadgets, for example, camcorders and PCs.

The RGB shading model is added substance, which implies the red, green, and blue channels join to make all the accessible hues in the framework. At the point when each of the three essential shading esteems are the same, the outcome is impartial, or grayscale. For instance, if every one of the three essential hues are 0 percent, the outcome is dark. In the event that every one of the three essential hues are 100 percent (the greatest esteem), the outcome is white. [7]

At the point when every one of the three essential shading channels are almost a similar quality, the outcome seems nonpartisan with a slight shading cast, contingent upon which channel is the most grounded. For instance, if the estimation of the red channel is higher than the estimation of the blue and green channels, the outcome is a marginally red picture. Auxiliary hues are mixes of two essential hues: red in addition to green is yellow, green in addition to blue is cyan, and blue in addition to red is maroon.

Hex color code

A shading hex code depicts the creation of a specific shading in a particular shading space, generally RGB. On account of RGB, the main esteem combine alludes to red, the second to green and the third to blue, with decimal esteems going from 0 to 255, or in hexadecimal 0 to FF (#RRGGBB). RGB is an added substance shading space, implying that when every one of the three hues are assembled the outcome is (white light). For instance, the shading hex code for white is #FFFFFF or in decimal 255, 255, 255; and at the inverse end is dark #000000. Yellow is comprised of red and green, so its hex code is #FFFF00. [8]

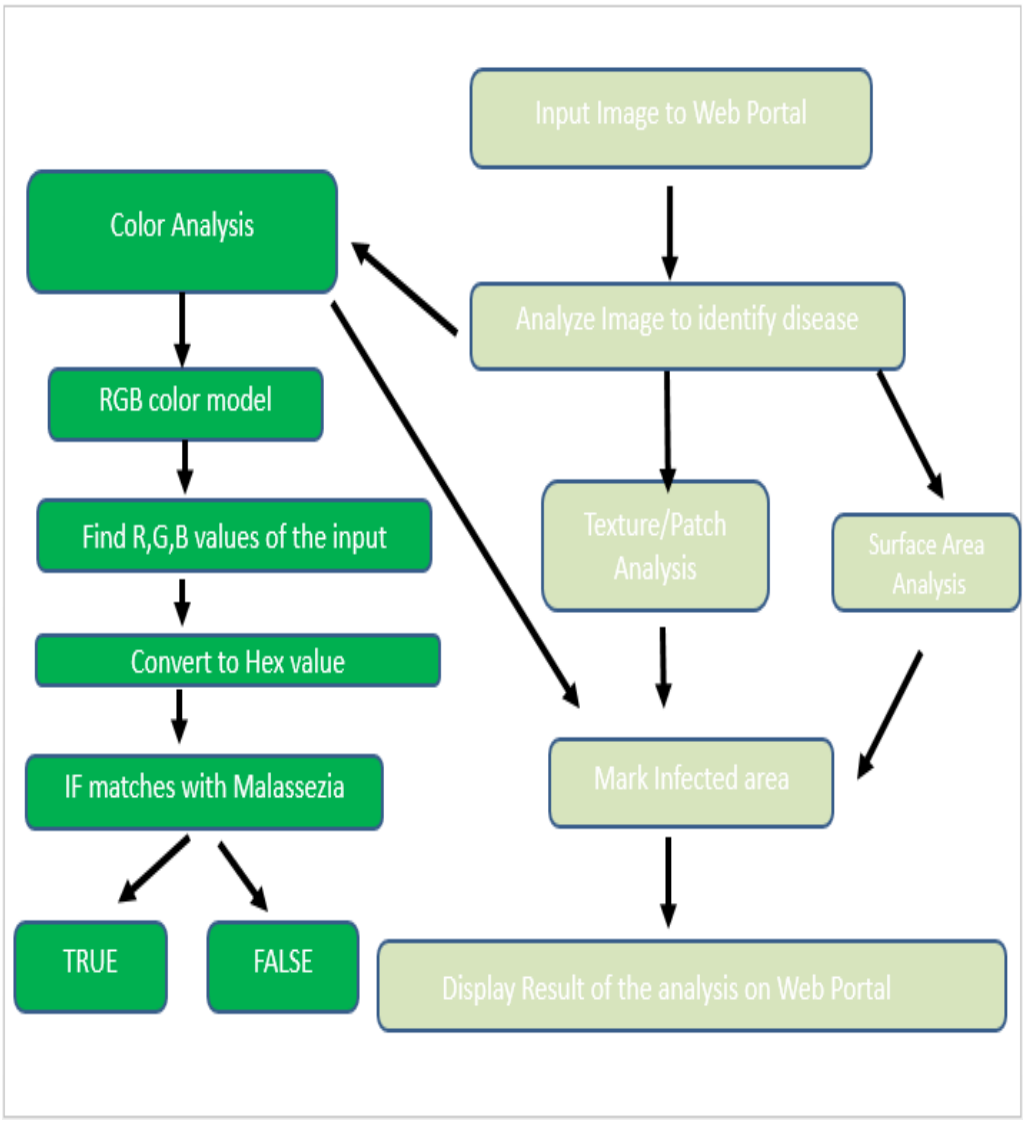

Fig 2.1.1.2.color identification

2.1.1.3 Implementation of Texture Identification

To identify the texture of the input image I have used Grey Level Run Length Matrix. (GLRLM).Grey level Run Length Method depends on figuring grey levels keeps running of different length. A Grey level run is an arrangement of directly associated pixels having a similar grey level esteem. The length of the run is the quantity of picture focuses inside the run. Coarse surfaces have a tendency to have visit long runs, while in better surfaces shorter runs will prevail. This is characterized as r(I,j|0), which gauges the quantity of times a picture contains a run length j, for a dim level 1 in the point 0 bearing, where 0 normally takes the qualities (0,π/4, π/2, 3π/4). Various GLRLM highlights have be set up and are point by point in Haralick (1979).

The primary issues with this approach are because of the way that it fluctuates under solid grey scale changes and it amazingly touchy to commotion in the picture. Likewise it doesn't gauge the vital second-arrange probabilities. Because of its poor execution it is for the most part not utilized.

1) Short-run accentuation (SRE)

This metric increments when short runs are ruling, for instance, in fine-grained surfaces.

2) Long-run accentuation (LRE)

This metric increments when long runs are ruling, for instance, in surfaces with substantial homogeneous zones or coarse surfaces.

3) Low dark level accentuation (LGRLE)

Accentuation is orthogonal to SRE, and the metric increments when the surface is overwhelmed by many keeps running of low dark esteem.

4) High dim level accentuation (HGRLE)

Accentuation is orthogonal to LRE, and the metric increments when the surface is overwhelmed by many keeps running of high dark esteem.

5) Short run, low dark level accentuation (SRLGE)

This is an inclining metric that consolidates SRE and LGRE. The metric increments when the surface is ruled by many short keeps running of low dark esteem.

6) Short-run, high dark level accentuation. (SRHGE)

This metric is orthogonal to SRLGE and LRHGE and increments when the surface is ruled by short keeps running with high energy levels

7) Long-run, low dark level accentuation. (LRLGE)

Correlative to SRHGE, it increments when the surface is ruled by long runs that have low dark levels

8) Long run, high dark level accentuation (LRHGE)

This is the reciprocal metric to SRLGE and increments with a blend of long, high-grey esteem runs.

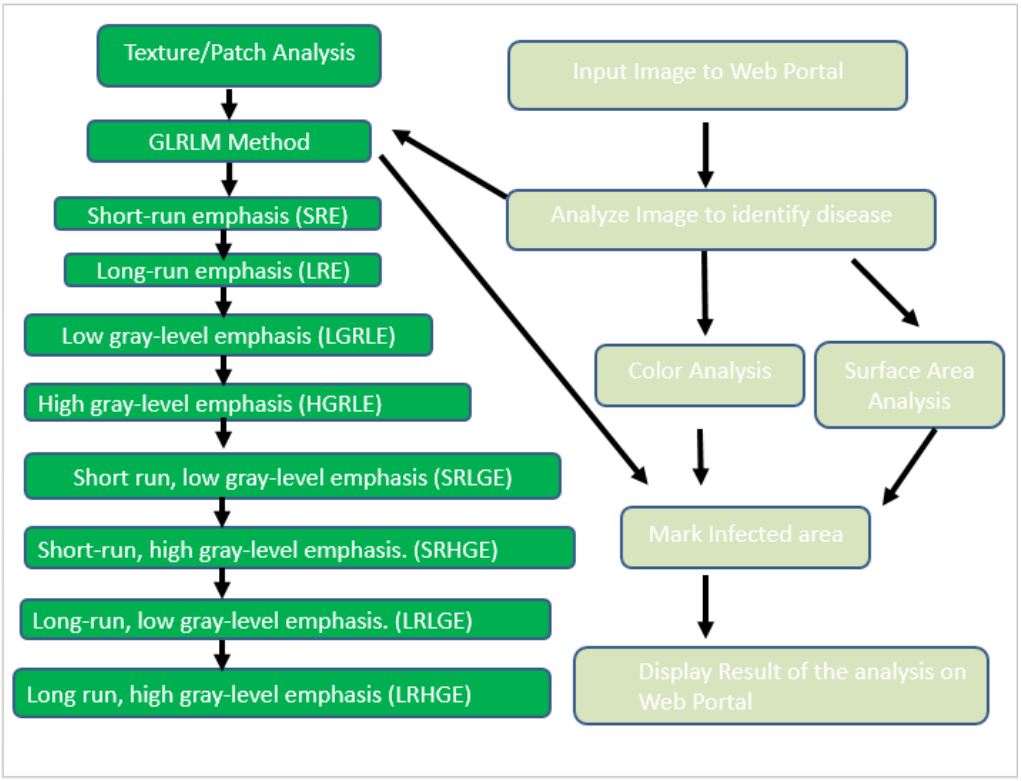

Fig 2.1.1.3.Texture identification

2.1.1.4. Implementation of Disease Stage Identification

In order to identify the disease stage/level I have decided to get the black pixel percentage of the image. To do that first of all I have converted input image into threshold image. Then I have found out count of black and white pixels along with total pixel count of the threshold image. Most of the time black pixels are in the area of the rash/patch spreaded.So I have count black pixel count and got the percentage of it.

I have consulted and get the recommendation from the dermatologist and set a percentage level to decide the criticality of the suspected disease. If the percentage is grater that 75% then it belongs to the critical level, if not it belongs to not critical level.

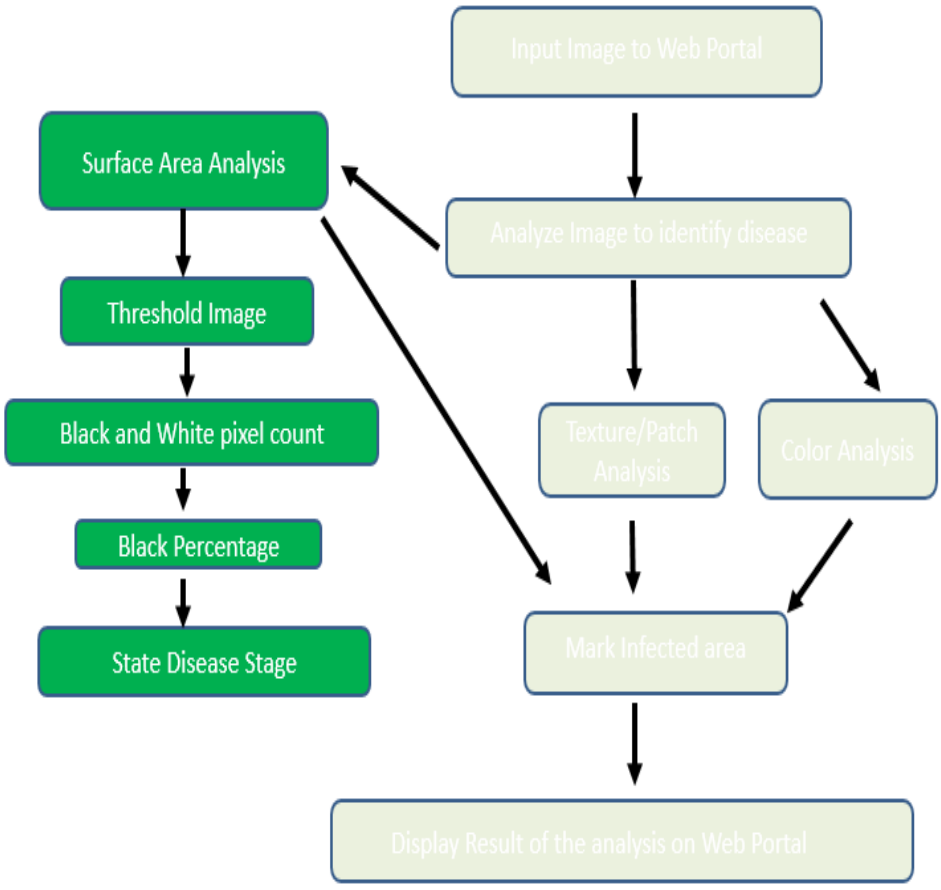

Fig 2.2.2.3.Stage identification

If both colour identification feature and texture identification feature becomes true and passed then we go to check the stage identification feature. If one of those methods fails it gives us that input image is not identified as Malassezia**.**

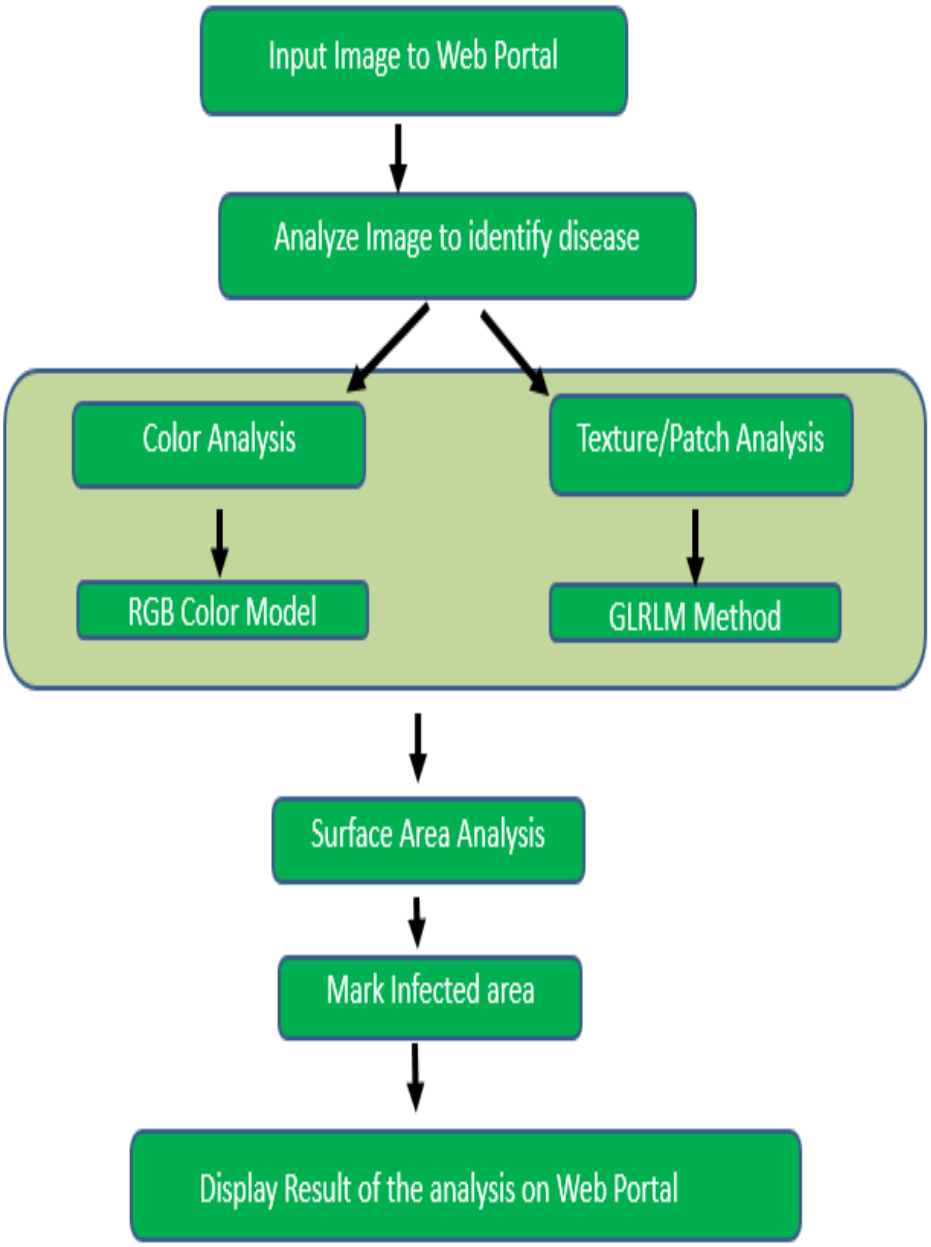

Fig 2.1.1.4.Overall Malassezia identification flow

2.1.2 Testing

Software testing is an investigation conducted to provide stakeholders with information about the quality of the product or service under test. Software testing can also provide an objective, independent view of the software to allow the business to appreciate and understand the risks of software implementation. Test techniques include, but are not limited to the process of executing a program or application with the intent of finding software bugs (errors or other defects).It involves the execution of a software component or system to evaluate one or more properties of interest.

Unit Testing

Unit testing is done by each individual member of the team regarding their component. Unit testing is performed under white-box and black box testing approach. Unit testing helps developers decide that the individual units of the program are working as per requirement and are error free.

Integration Testing

Integration testing is to test errors in integrated modules. Even if the units of the software are working fine individually, there is a need to find out if the 4 components integrated together would also work without errors. In here the testing will be done by both white box and black box testing approach.

System Testing

System testing will be done finally. The system is compiled as product and then it tested as a whole. This can be accomplished using one or more of the following tests.

- Functionality Testing :
    - ✓ Testing of all the functionalities of the software against the requirement
- Performance Testing :
    - ✓ We are doing this testing is to estimate how efficient our product is. The system will be pushed to higher and lower limits and the defects will be identified. It measures the effectiveness and average time taken by the software to do desired tasks.
- Security and Portability Testing :
    - ✓ These test are done when the software is meant to work on various platforms and accessed by number of persons.

2.2.Research Findings

The initial target of I-Dermat project is to implement a web application which can be used for eliminate some problems of skin fungal disease identification. Through I-Dermat web application implementation, we could have learned lots of things. Because project cover different areas, different technologies and had to combined up and integrated in a compatible way. I-Dermat application front end was designed using PHP, backend was designed in Eclipse using Java and image processing part was done using OpenCV, ImageJ, and Catalano framework. So we had to touch up different areas to do our research.

At very beginning of research, I did not have knowledge about the technological background of research. In the initial phase of research I have searched similar research papers and similar systems which were done in image processing. So we had searched similar disease identification research papers and similar systems using Google.

At that time variant irrelevant topics came up to my mind and filtered before the real research reading could be done. To remove unnecessary data from my mind. I had to read research papers over and over again. Finally with the gathered knowledge then select suitable way to do project.

Before start the development process, I had to practice several codes in image processing. Use one sample Malassezia image and did several image processing techniques to that image. Then only I found suitable features extraction methods to extract image features.

After completing implementation of the system using Java, we had to convert source code to Marvin. So that we could integrate all four components and build the website.

So again I had to learn how to convert eclipse java source code into Marvin and how to add external image processing libraries into Marvin.

However, some improvements are still necessary in working towards a reliable system. And also, we got an experience about how to work with many technologies at a time.

Tools and Technologies

Tools:

- Eclipse IDE

Technologies:

- Java 1.8
- OpenCV
- ImageJ
- Catalano Image Processing Framework

3. Results & Discussion

3.1.Results

User Interfaces

All the user interfaces are designed using Java and Photoshop.

Fig. 3.1.1. Main Page of the web site

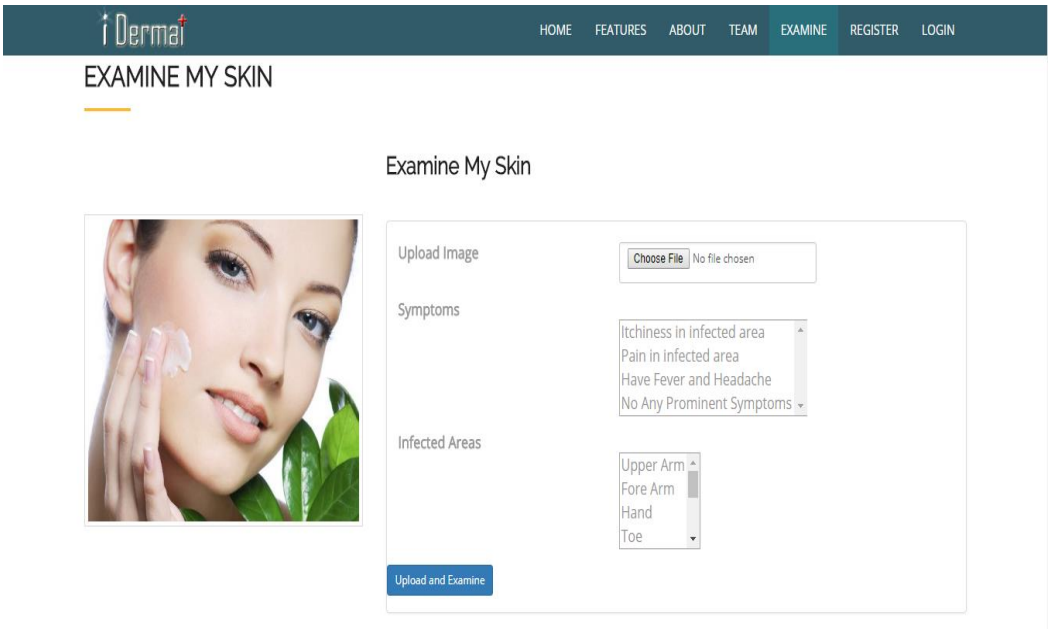

Fig. 3.1.2. Examine My Skin

When I input an image into system which is suspected to be Malassezia it will give outputs like below Fig 3.1.4 and Fig 3.1.6.

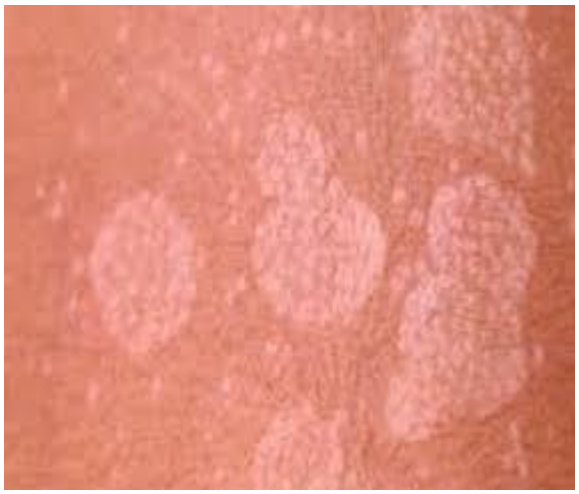

Fig 3.1.3 Input Image-Not critical stage

Fig 3.1.4 Output Image-Not Critical Stage

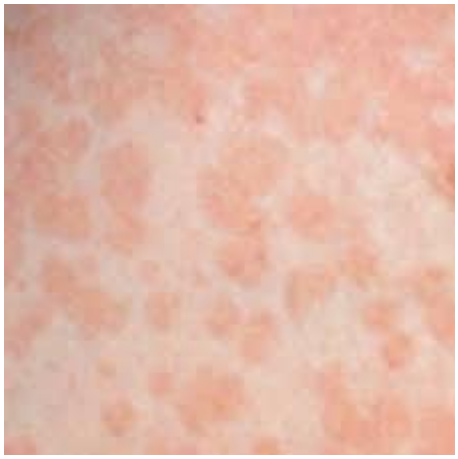

Fig 3.1.5 Input Image- critical stage

Fig 3.1.6 Output Image-Critical Stage

Figure	Description
Fig. 3.1.1. Main Page of the web site	Main Page of I-Dermat skin fungal Disease Identification System which contains all functions
Fig. 3.1.2. Examine My Skin	When you click ‘Examine My Skin’ button in Fig. 3.1.1you will be redirected to Fig 3.1.2. You can input your captured image into the system from here. If you have any other symptoms you can input them from here as well. You need to input what the infected area is in too.
Fig 3.1.4 Output Image-Not Critical Stage	When you input Fig 3.1.3 like image you can get this type of output
Fig 3.1.6 Output Image-Critical Stage	When you input Fig 3.1.5 like image you can get this type of output

Table 3.1.1. Interface Descriptions

3.2.Evidence

Test Cases

A test case is a document, which has a set of test data, preconditions, expected results and post conditions, developed for a particular test scenario In order to verify compliance against a specific requirement. The project outcomes was analyzed in qualitative and quantitative ways. Quantitative measurements depends on the quality and accuracy of the system in order to ensure the performance. To confirm that the system meets the requirement specification in Software Requirement Specification, I have carried out set of testing method like integration testing, unit testing and system testing. Develop the test plans I have used evolutionary approach. In this method of Approach, I developed a module or unit of an application, test it, and fix it. Likewise all the units are added and test separately. Finally the integrated component is tested to ensure that the intended system functions as mentioned in the SRS.

Test Case ID	01
Test Case Name	Input Image
Test Input Data	Save input image in a pre-defined directory.
Expected Outcome	System will automatically save input image in the pre-defined directory.
Actual Outcome	Successfully save input image in the pre-defined folder.

Table 3.2.1. Input Image test case

Test Case ID	02
Test Case Name	Find Colour
Test Input Data	Input image
Expected Outcome	System will automatically calculate Red, Green, Blue values of the input image.
Actual Outcome	Successfully Calculate and display Red, Green and Blue values of the input image in console.

Table 3.2.2. Find Color test case

Test Case ID	03
Test Case Name	Find Hex Colour code
Test Input Data	RGB values of the input image
Expected Outcome	System will automatically calculate Hex value of the input image.
Actual Outcome	Successfully Calculate and display Hex value of the input image in console.

Table 3.2.3.Find Hex Color code test case

Test Case ID	04
Test Case Name	Check colour similarity to Malassezia
Test Input Data	Hex colour code of the input image
Expected Outcome	System will automatically check if the hex code is matching to the colour range of the Malassezia disease.
Actual Outcome	Successfully detect if colour matches to Malassezia or not and display ‘True’ or ‘False’ on console.

Table 3.2.4. Check colour similarity to Malassezia test case

Test Case ID	05
Test Case Name	Greyscale image
Test Input Data	Input image
Expected Outcome	System will automatically convert input image into greyscale and save it in pre-defined folder.
Actual Outcome	successfully converted input image into greyscale and save it in pre-defined folder

Table 3.2.5.Greayscale image test case.

Test Case ID	06
Test Case Name	Extract image texture features
Test Input Data	Greyscale image
Expected Outcome	System will automatically calculate GLRLM texture features
Actual Outcome	Successfully detect GLRLM texture features and display on console.

Table 3.2.6. Extract image texture features test case.

Test Case ID	07
Test Case Name	Check if LRHGE is greater than other features
Test Input Data	Values of the GLRLM texture features
Expected Outcome	System will automatically compare eight GLRLM texture features and detect if LRHGE feature is greater than other seven features and mark it as ‘true’ or ‘false’
Actual Outcome	Successfully detect if LRHGE texture feature is greater than other seven features and mark it as ‘true’

Table 3.2.7. Check if LRHGE is greater than other features test case.

Test Case ID	08
Test Case Name	Check if LRLGE is in the range given
Test Input Data	Values of the GLRLM texture features
Expected Outcome	System will automatically check if LRLGE feature value is in the range given and mark it as ‘true’ or ‘false’
Actual Outcome	Successfully detect if LRLGE feature value is in the range given and mark it as ‘true’

Table 3.2.8. Check if LRLGE is in the range given test case.

Test Case ID	09
Test Case Name	Check if LRLGE and LRHGE features are both ‘true’
Test Input Data	Values of the GLRLM texture features
Expected Outcome	System will automatically check if LRLGE and LRHGE are ‘true’
Actual Outcome	Successfully detect if both LRLGE and LRHGE features are ‘true’ and

Table 3.2.9. Check if LRLGE and LRHGE features are both ‘true’ test case.

Test Case ID	10
Test Case Name	Check if user have the Malassezia disease or not
Test Input Data	Values of the LRLGE and LRHGE features
Expected Outcome	System will automatically check if LRLGE and LRHGE are ‘true’ and mark image
Actual Outcome	Successfully detect if both LRLGE and LRHGE features are ‘true’ and identify input image as Malassezia disease.

Table 3.2.10. Check if user have the Malassezia disease or not test case

Test Case ID	11
Test Case Name	Threshold image
Test Input Data	Malassezia identified image
Expected Outcome	System will threshold the image and save in a pre-defined folder.
Actual Outcome	Successfully threshold the input image and saved in the folder.

Table 3.2.11.Threshold image test case

Test Case ID	12
Test Case Name	Disease stage identification
Test Input Data	Threshold image
Expected Outcome	System will get the black pixel percentage and check if that percentage exceed given criticality level and mark the disease stage.
Actual Outcome	Successfully detect disease stage and display as ‘Not in critical stage’ or’ Critical Stage’

Table 3.2.12. Disease stage identification test case

3.3.Discussion

The discussion part is focused on how problems encounter during the project design and implementation, finally how we solve that problems. Inasmuch this section describes achievements of research. Group members are responsible for minimizing the number of bugs before releasing the product.

Share the knowledge among group members, managing groups can lead to effective outcomes. As the first step, group members selected a leader to lead the research. Then discussed several areas according to the research. At the beginning, group members came up with different ideas in image processing and computer vision field. Then decided to implement I-Dermat system. After discussing with supervisor,

project team determined four components as Ring worm, Sporotrichosis, Malassezia and Onychomycosis. Then gathered information from websites, blogs, books, journals, and articles and met Dermatologists.

After implementation is completed in java we encountered a problem in converting the application to web format. So we then identified that we can convert it to Marvin using eclipse. When adding dependencies in pom.xml file I have encountered a problem is library Catalano.Then after searching through internet resources I have resolved that issue. Even though the system is tested under the development team, there could be some hidden errors to identify Malassezia color, Malassezia texture, and disease stage properly. Therefore I am planning to test the system in real time environment with real users. If testing is similar to the User Acceptance Testing, then we can evaluate the system by their ratings and also it will allow us to evaluate our system.

Though the application is user friendly, more capable and handling the expected functionalities, if the application is more complex it won't be helpful or better solution for people who don't have the basic knowledge about operating the mobile phone. Though the application is user friendly, more capable and handling the expected functionalities, if the application is more complex it won't be helpful or better solution for people who don't have the basic knowledge about operating the PC or smart phone.

By doing this project I learned many things. I got a very big experience of how to do a complete project and come up with a good product. Also I got experience about how to do Image processing coding using different technologies.

The product has more new features than the other application. Therefore the business value of the product goes high. Also we gave a big position to the research area and I achieved it. While implementing, the system had faced several issues but I successfully faced that problems. Sometime I caught up very novel things also. During the basic level of the project, I had to come across more challenges. I solved lots of problems using very traditional long methods because the knowledge level of

the field was very poor. But I followed the new things and I tried new things. Finally I achieve our objective successfully.

4. Conclusion

The purpose of this document is to provide a detailed description of I-Dermat skin fungal disease identification system Malassezia identification component. I-Dermat web application is mainly target identifying skin fungal diseases in Sri Lanka. This application provides several benefits for users.

Before we start this research the major problem which users encountered was that there wasn't any automated system which can be used by themselves. So we decided to identify four frequent skin fungal diseases for the research. I have selected Malassezia disease and proceeded to find out more details about it.

When users input images into system it will analyze it and give output as what is the disease and current stage of the disease.

I have used color and texture analysis methods to identify Malassezia disease. I have applied RGB color model to analyze the color of the input mage and GLRLM method to analyze the texture of the input image.

If both those features are identified as passed, which means that the input image is similar to Malassezia disease.

Then only I have applied stage identification method to find out disease stage.

Finally I have marked infected area in the image and user can view the result of the analysis through web application.

English is the only language currently supported in this application. Apart from English, this mobile application can introduced to other languages such as Sinhala and Tamil. In the future development of the application our team wishes to add Sinhala language to handle this application. Finally this application achieves its objectives of "identifying skin fungal diseases" Since this application is based on web, in future this can be developed to run on multiple platforms with the same content and functionality.

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6. Appendices

Appendix - A

Figure A.1 Use Case Diagram