Dermatologist Assistant

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Abstract

The main idea of this project is Automated Skin Diseases Detector. Our system should provide a quick result with high accuracy while decreasing false positive and false negative cases. We aim to detect several types of skin diseases like Melanoma and Nuves. We also aim to decrease the cases in which the case is diagnosed to be false positive or false negative. Our system will be a mobile application in which the skin images are acquired using the mobile camera and the system process them on our server to classify whether it's a positive or negative case. Also showing which type of the disease it corresponds to and it's treatment or the procedures that should be taken.

1 Introduction

1.1 Background

Skin diseases impact people of all ages, races, ethnicities, and sexes, it does not always affect them equally. Differences in genetics, hormones, environmental exposures, and other factors can lead to differences in risk among different groups of people.[1] Skin Diseases shared a 1.79% of the global burden of disease measured in disability-adjusted life years (DALYs), skin and subcutaneous diseases were the 18th cause of the global DALYs in 2013. Excluding mortality, skin diseases were the 4th leading cause of disability worldwide. [2] Even tho skin diseases are visible to the naked eyes, early-stage of it can be difficult to distinguish because of the similarity of appearances. This has led to many missed diagnoses and wrong treatment. The main goal of this project is to reduce skin diseases-related deaths by developing a mobile application that can be used by any user and everywhere for early detection of these skin diseases, this application will reduce the cost of diagnosing and treatment for patient. To this end we are developing the proposed dermatologist assistant application and creating a public archive of clinical and dermoscopic treatment for some of the skin diseases. [3]

1.2 Motivation

The world market has all its attention focused on the skin cancer only, not giving the different types of skin diseases its right, there is a lack in researches and systems that handle the skin infections in general not just skin cancer. This motivated us to work on a system that diagnose both skin infections and skin cancer. Even tho skin cancer statistic were the only thing that could be found, death rates in it made it clear that we still have a problem in curing these diseases and even diagnosing it. According to the following statistics, the group age of patients diagnoses with skin cancer is between 18 and above. this motivated us to sign up in the ISIC Challenge of 2019, ISIC is the organization that we are using its dataset. This challenge is broken into three separate tasks: [4]

1. Lesion Segmentation
2. Lesion Attribute Detection
3. Disease Classification

Each competitor may participate in any or all of these tasks. Cash prizes of $2500 USD will be awarded to winners of each of the tasks. The monetary prizes for the winners of the challenge will be awarded at the time of the MICCAI Workshop. The prizes are being provided by Canfield Scientific, Inc., a US company, and are subject to any restrictions incumbent on the sponsor. Winners will be asked to identify a recipient individual or entity who will be required to provide tax documentation (U.S. citizens- IRS form W-9, non-U.S. citizens Form W-8 BEN).

1.3 Problem Definitions

There is a problem that some of the dermatology whenever we are delayed in dealing with the patient is difficult to absorb the dose of treatment faster, so our project try to help the patient reveals the type of disease in the beginning to be able to overcome it faster, either by the proper treatment or go to the hospital of the seriousness of the situation

2 Project Description

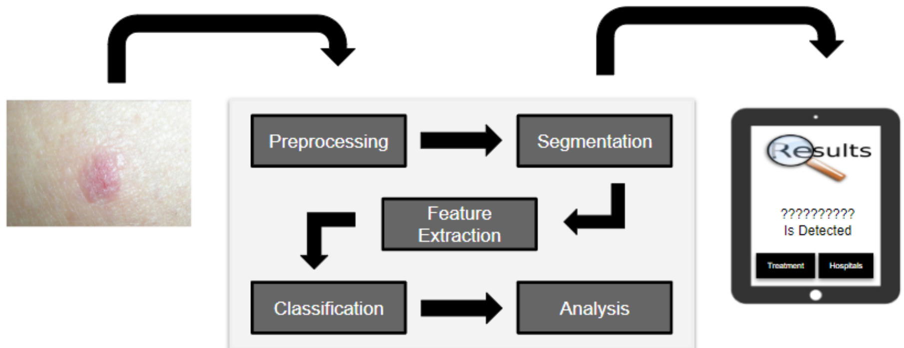

Figure 1: System Overview

2.1 Objective

Dermatology has become widespread these days for many reasons, including pollution of the atmosphere, weakness of immunity, genetic disease, . . . etc. According to the related work, there are many challenges and problems mentioned such as: different illumination, shadows, refection, cluttered background, classifier accuracy with 76 percent, performance of the classes are poor due to poor segmentation, more intra classes variations or unsuitability of extracted features. we have been selected to enhance the accuracy in cluttered background and with different illumination condition.

2.2 Scope

1. The system works to detect different types of skin diseases not all types of-skin diseases with quick and accurate results. They are benign, melanoma, nevus , malignant....

2. The system works on three phases: first pre-process the skin images to extract significant features then identifies the diseases then appropriate treatment advice or necessary to go to the hospital because of the gravity of the situation.

3. The system will not work in darkness or dim light.

2.3 Project Overview

2.3.1 Dataset

We chose ISIC Archive as our source for the dataset because The International Skin Imaging Collaboration: Melanoma Project is an academia and industry partnership designed to facilitate the application of digital skin imaging to help reduce melanoma mortality. [4]

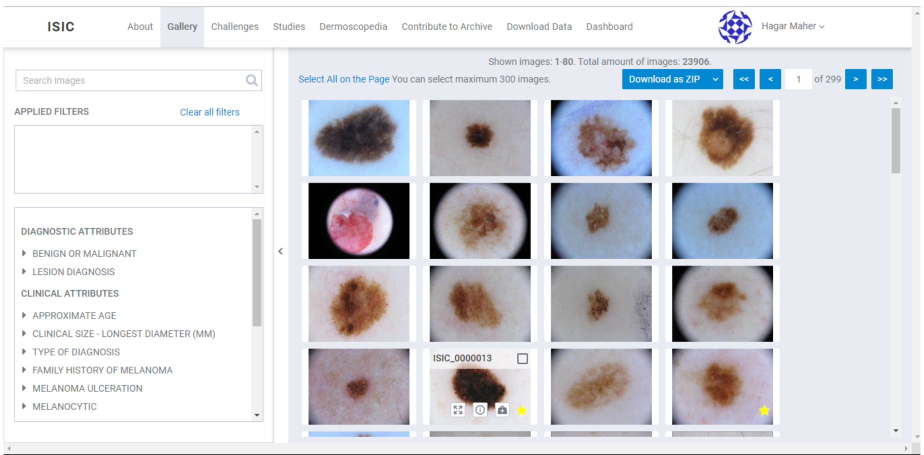

Figure 2: ISIC Arhcive

We have selected the 6 top skin diseases that occurs the most:

1. Melanoma
2. Nevus
3. Basal Cell Carcinoma
4. Actinic Keratosis
5. Seborrheic Keratosis
6. Dermatofibroma

2.3.2 Input

Our input for the system will be through a friendly interface on the mobile using our application and the mobile camera

1. The user will be asked to determine which part of the body he suspect of it having a skin infection
2. The user will be asked to take a capture of this area using his mobile cam with a certain distance between the camera and the area and in a proper light.

2.3.3 Pre-processing

- In dermoscopy images, if hair exists on the skin, it will appear clearly in the dermoscopy images, so infection can be partially covered by body hair. To detect and exclude the hair from the lesion.

  1. The hair is segmented form the lesion
  2. The image is reconstructed to fill the hair gap with actual pixels

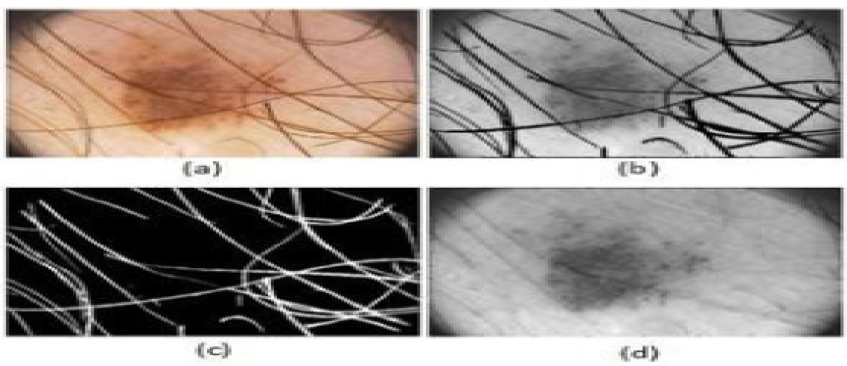

Figure 3: Hair Segmentation and refilling it's gaps

2.3.4 Processing

- Pigmented skin lesion segmentation to separate the lesion from the background. The segmentation step follow as:

  1. RGB dermoscopy image is read and converted to a gray scale image.
  2. After the Gaussian filter is applied, a global threshold is computed by Otsu's method.
  3. An optimal threshold is selected by the discriminant criterion.
  4. Removes the white corners in the dermoscopy image, The resulting image in the previous step is masked by A Mask. All white pixels in the corners are replaced with black pixels.
  5. After applying the threshold, the edges of the output image become irregular. To smoothen the edges, morphological operation is used.
  6. The morphological open operation is applied to the binary image.
  7. An algorithm is used to fill the holes in the binary image.
  8. An algorithm is applied based on active contour to segment the gray scale image.
  9. remove the small objects. To do that,

(a) The connected components are determined.
(b) The area of each component is computed.
(c) All small objects that have fewer than 50 pixels are removed.
(d) The disk structure element that was created in the previous step is used to perform a morphological close and open operation.

This operation is known as area opening.

10. The resulting image is masked with a Mask to preserve the corners.

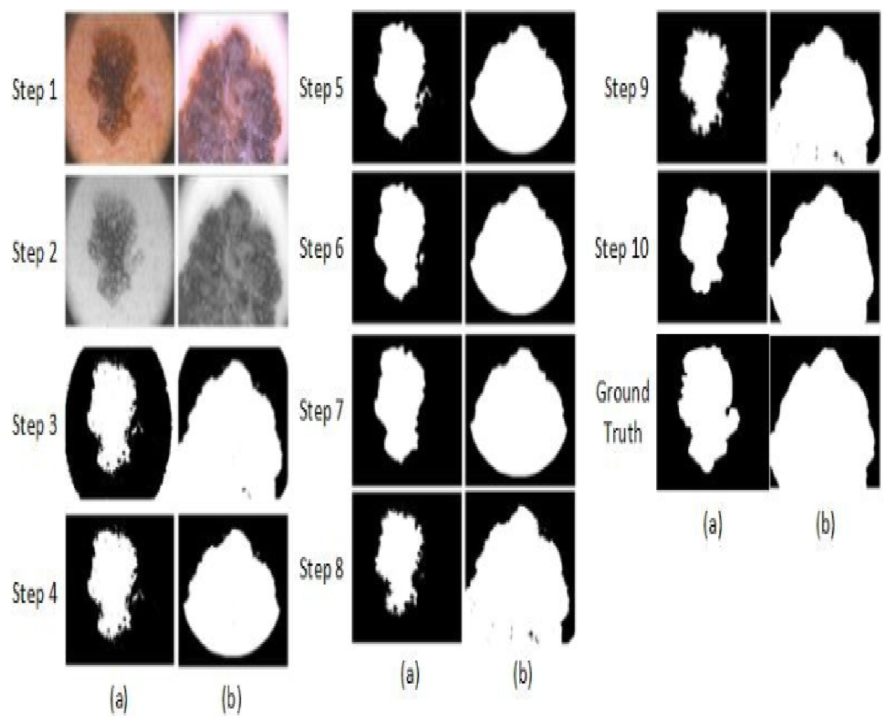

Figure 4: Image Segmentation

- Boundary detection is a critical problem in dermatoscopic images because the transition between the lesion and the surrounding skin is smooth and hard to detect accurately, even for a trained dermatologist.

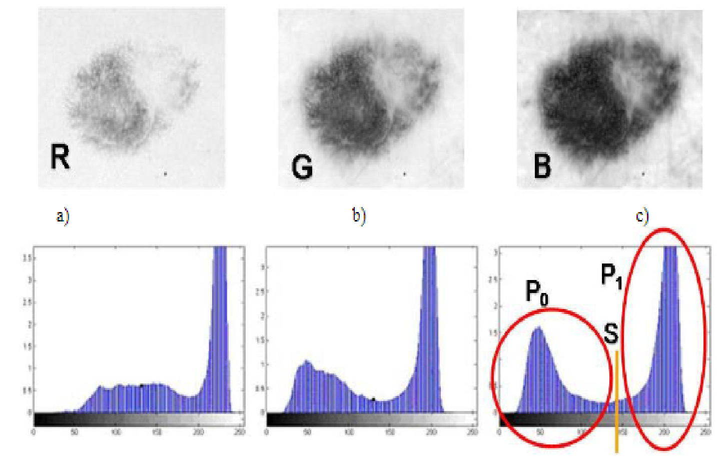

Figure 4. Monochrome images for Red, Green and Blue Planes and corresponding Intensity Histograms

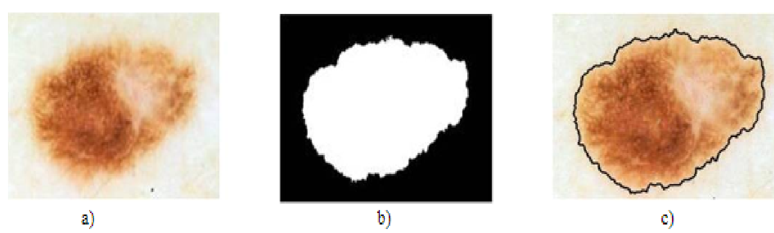

Figure 5: Boundry Detection

1. Colour to monochrome image conversion.
2. Image binarization using an adaptive threshold.
3. Border identification.
4. The disk structure element that was created in the previous step is used to perform a morphological close and open operation.

- Color Segmentation, starting from the source image and the binary mask, the infection segmentation stage is carried out with the aim of splitting the internal area into multiple chromatically homogenous regions.

1. Principal Component Analysis (PCA)
2. 2D histogram construction
3. peaks picking algorithm

4. histogram partitioning
5. lesion partitioning

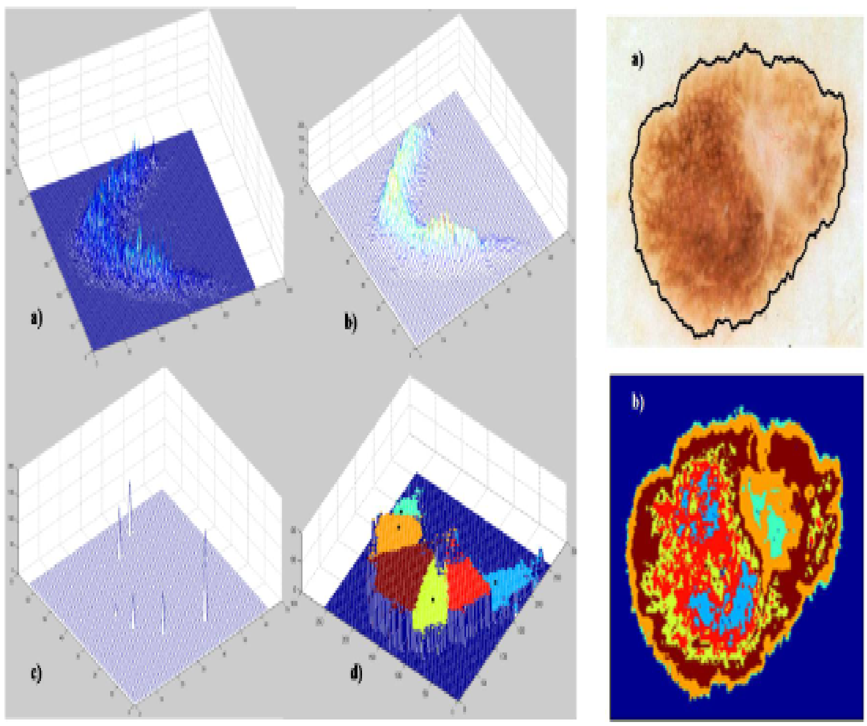

Figure 6: Color Segmentation

- Texture extraction. As to the search for the occurrence of texture, a combination of two different techniques (structural and spectral methods has been used.

  1. The structural technique, which is intended to search for primitive structures such as lines and/or points which can constitute a texture.
  2. The spectral technique is based on the Fourier analysis of the grey-level image.

- Classification will be done using SVM, the SVM is based on structural risk minimization where the aim is to find a classifier that minimizes the boundary of the expected error [58]. In other words, it seeks a maximum margin separating the hyper-plane and the closest point of the training set between two classes of data.

2.3.5 Output

1. The Result Screen: Shows the disease name.

2. The Hospital Screen: Shows the hospitals that deal with this kind of disease and this screen will only shows when the classified disease can't be self treated.

3. The Treatment Screen: Shows the treatments suitable to the classified disease.

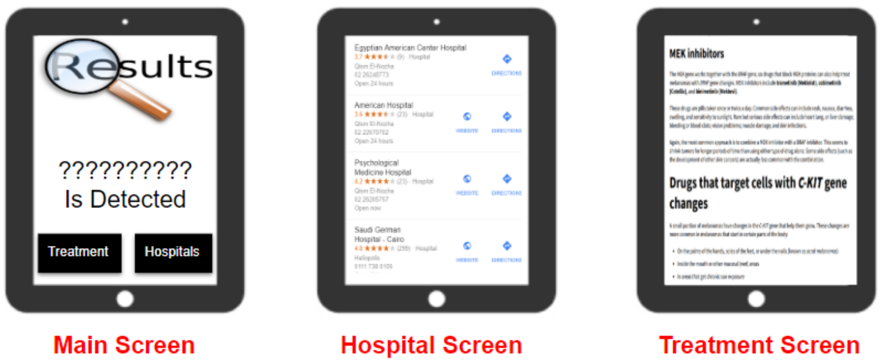

Figure 7: Output Screens

3 Similar System

3.1 Similar System Information

3.1.1 Skin Lesion Analysis Toward Melanoma Detection

[5]

1. Motivation: In an attempt to improve the scalability of dermoscopic expertise, procedural algorithms, such as "3-point checklist," "ABCD rule," "Menzies method," and "7-point checklist," were developed. However, many clinicians forgo these methods in favor of relying on personal experience, as well as the "ugly duckling" sign.

2. Problem Statement: Recent reports have called attention to a growing shortage of dermatologists per capita This has increased interest in techniques for automated assessment of dermoscopic images. However, most studies have used isolated silos of data for analysis that are not available to the broader research community. While an earlier effort to create a public archive of images was made, the dataset was too small (200 images) to fully represent scope of the task.

3. Contribution: Provide a fixed dataset snapshot to support development of automated melanoma diagnosis algorithms across 3 tasks of lesion analysis: segmentation, dermoscopic feature detection, and classification

   (a) Automated predictions of lesion segmentation from dermoscopic images in the form of binary masks.

   (b) Automatically detect the following four clinically defined dermoscopic features: "net-work," "negative network," "streaks," and "milia-like cysts,". Pattern detection involved both localization and classification.

   (c) Classify images as belonging to one of 3 categories, including "melanoma" (374 training, 30 validation, 117 test), "seborrheic keratosis" (254, 42, and 90), and "benign nevi" (1372, 78, 393), with classification scores normalized between 0.0 to 1.0 for each category.

4. Importance: Support research and development of algorithms for automated diagnosis of melanoma, the most lethal skin cancer.

3.1.2 A Software System Based on The 7-Point Check-List

[6]

1. Motivation: Despite the simplification of the ELM criteria, all the diagnostic methods described showed higher reliability if they are based on a quantitative automated system. Consequently, the early diagnosis of skin cancer using digital image-processing methods, based on a semiquantitative scale, is a very important issue

2. Problem statement: no automated systems have yet been based on the 7-point checklist. From these considerations, and from previous experiences in digital processing of medical images, the authors have tackled the problem of defining suitable image processing algorithm implementing the 7-point checklist. It would be suitable to develop an automatic system that can validate the identification of 7 parameters on each lesion observed by clinicians.

3. Contribution: This paper focuses on the main image processing techniques which can be suitably adopted for the development of a software tool which implements the 7-Point Check-List,

4. Results: The whole diagnostic software provided a lesion sensitivity and specificity greater than 85%.

5. Importance: Even tho Boundary detection is a critical problem in dermatoscopic images because the transition between the lesion and the surrounding skin is smooth and hard to detect accurately, even for a trained dermatologist, their system achieved high results.

3.1.3 An SVM Based Skin Disease Identification Using Local Binary Patterns

[7]

1. Motivation: A proper identification system to determine the skin diseases without using any invasive methodology may be useful. Such systems especially for Skin Cancer identification are commercially available and considered as a useful aid to the dermatologist. For other skin diseases, a major challenge in developing such system is caused by high similarity in skin lesion shapes and color.

2. Problem Statement: The performances of the developed systems/algorithms cannot be properly evaluated due to unavailability of any standard skin image database with proper ground truth.

3. Contribution: Develop a standard database of skin images of three common skin diseases viz. Leprosy, Tineaversicolor and Vitiligo collected from the patients and use LBP feature to recognize them. Here an attempt is

made to highlight texture representation ability of LBP over the other popular texture features like GLCM, DCT and DFT by using SVM classifiers on the newly collected dataset.

4. Results: This was the first attempt to recognize those diseases using ground truth data. Using SVM classifier They haave observed a recognition accuracy of 89.66%

5. Importance: They achieved a high accuracy despite the similarity of skin diseases features.

3.1.4 Diagnosing Skin Diseases Using an Artificial Neural Network

[8]

1. Motivation: Researches had written this paper to development of medical expert systems and will assist physicians facilitate the reasonable ordering of tests and treatments by using the artificial neural networks for predicting diagnosis and possible treatment routine.

2. Problem statement: The main problem of medical diagnosis, in general, is the subjectivity of the specialist, which may occur errors during diagnosis.

3. Contribution: Research recommended to use Using ANN to human experts and dermatologist who specializes in diagnosing and treatment of skin and related diseases and who operate in areas where there are no specialist (dermatologist) can also rely on the system for assistance.

4. Results: The system achieved a high level of success using the artificial neural network technique,with 90 percent success rate. This infers that ANN technique is an efficient method for implementing diagnostic problems.

5. Importance: This technique is important due to its accuracy which help to predict diagnosis and possible treatment routine.

3.1.5 Immunohistochemical staining of proliferating cell nuclear antigen (PCNA) in malignant and nonmalignant skin diseases

[9]

1. Motivation: Researches had written this paper to know the affect of cell nuclear antigen (PCNA) in skin from patients with various malignant and nonmalignant skin diseases using anti-PCNA monoclonal antibodies.

2. Problem statement: The main problem is Late detection of malignant diseases.

3. Contribution: Research recommended to use proliferating cell nuclear antigen because it is helpful in the early diagnosis of skin malignancies.

4. Results: The researches found that the distribution of PCNA in the skin may be helpful in the early diagnosis of skin malignancies.

5. Importance: The importance of using Immunoh is to chemical cell nuclear in medicine field.

3.1.6 Automatically Early Detection of Skin Cancer:Study Based on Neural Network Classification

[10]

1. Motivation: Researches had written this paper for Early Detection of Skin Cancer which Based on Neural Network Classification.

2. Problem statement: The main problem is Late detection of malignant diseases.

3. Contribution:Research recommended to use Neural Network because it is helpful in the early diagnosis of skin malignancies.

4. Results: The researches found that the Neural Network in the skin may be helpful in the early diagnosis of skin cancer.

5. Importance: The importance of using Neural Network for early detection of skin malignancies in medicine field.

3.1.7 Automatic imaging system with decision support for inspection of pigmented skin lesions and melanoma diagnosis

[11]

1. Motivation: The researchers made this system for early detection of Melanoma (skin cancer) and spection of pigmented skin lesions and anther skin diseases

2. Problem statement: the main problem that forced them was finding dataset and image classifier is designed for images acquired using a conventional, consumer-type of digital camera and that image scanning is not an easy task

3. Contribution: They present a solution to compensate for uneven illumination and taking an approach in which the general (epidemiological) risk criteria are added to a classifier using the dermatoscopic ABCD feature set.

4. Results: The researches reach accuracy of 86%, with a sensitivity of 94%, and specificity of 68% and automatic system for inspection of pigmented skin lesions and discriminating between malignant an benign lesions

5. Importance: This paper was very important to our work which will help us by knowing the type of classifiers and the algorithm they used and the context knowledge of (skin , age gender and part of body) of melanoma risk and the full exploitation of Threshold-Based Segmentation

3.1.8 A Survey of skin-color modeling and detection methods

[12]

1. Motivation: They made this system because Skin detection plays an important role in a wide range of image processing applications ranging from face detection, face tracking, gesture analysis, and content-based image retrieval (CBIR) systems and to various human computer interaction domains.

2. Problem statement: The problem was that Most of the research efforts on skin detection have focused on visible spectrum imaging. Skin-color detection in visible spectrum can be a very challenging task as the skin color in an image is sensitive to various factors such as(Illumination ,Camera characteristics , Ethnicity and Individual characteristics).

3. Contribution: To solve the problems, they use a lot of classifiers and some algorithms as Color spaces, and skin color classification and Gaussian classifier and mlp classifier and Bayesian network they also approach to use Neural network and Skin locus and histogram adoption.

4. Results: They present an extensive survey of the up-to-date techniques for skin detection using color information in the visual spectrum for 2D images. And a good skin classifier that can be able to discriminate between skin and nonskin pixels for a wide range of people with different skin types such as white, yellow, brown and dark and be able to perform well under different illumination conditions such as indoor, outdoor and with white and non-white illumination sources.

5. Importance:This paper is very important because it will teach me how to scan the skin without having problems of light or distance and also how classify each skin type and how skin anaylsis depend on colors and discriminating between skin and nonskin pixels.

3.1.9 Noninvasive Real-Time Automated Skin Lesion Analysis System for Melanoma Early Detection and Prevention

[13]

1. Motivation: Researchers have suggested that the use of non-invasive methods in diagnosing melanoma requires extensive training unlike the use of naked eye. In other words, for a clinician to be able to analyze and interpret features and patterns derived from dermoscopic images, they must undergo through exten-sive training.

2. Problem statement: Clinical diagnosis and prognosis of melanoma are challenging, since the processes are prone to misdiagnosis and inaccuracies due to doctors' subjectivity. Malignant melanomas are asymmetrical, have irregular borders, notched edges, and color variations, so analyzing the shape, color, and texture of the skin lesion is important for the early detection and prevention of melanoma.

3. Contribution: This paper proposes the components of a novel portable (smart phone-based) noninvasive, real-time system to assist in the skin cancer prevention and early detection. A system to prevent this type of skin cancer is being awaited and is highly in-demand, as more new cases of melanoma are being diagnosed in the U.S. each year. The proposed system has two major components. The First component is a real-time alert to help users to prevent skin burn caused by sunlight; a novel equation to compute the time for skin to burn is thereby introduced. The second component is an automated image analysis which contains image acquisition, hair detection and exclusion, lesion segmentation, feature extraction, and classification, where the user will be able to capture the images of skin moles and our image processing module will classify under which category the moles fall into; benign, atypical, or melanoma. An alert will be provided to the user to seek medical help if the mole belongs to the atypical or melanoma category.

4. Results: In this experiment they were able to classify the benign, atypical and melanoma images with accuracy of 96.3%, 95.7% and 97.5% respectively. The experimental results show that the proposed system is efficient, achieving very high classification accuracies.

5. Importance: This paper presented the components of a system to aid in the malignant melanoma prevention and early detection.

3.1.10 Noninvasive Real-Time Automated Skin Lesion Analysis System for Melanoma Early Detection and Prevention

[14]

1. Motivation: the researches make this system for isic challenge for skin lesion analysis toward melanoma detection .

2. Problem statement: Recent reports have called attention to a growing shortage of dermatologists per capita This has increased interest in techniques for automated assessment of dermoscopic images. However, most studies have used isolated silos of data for analysis that are not available to the broader research community. While an earlier effort to create a public archive of images was made, the dataset was too small (200 images) to fully represent scope of the task.

3. Contribution:Research recommend to use the Adam optimization algorithm and convolutional networks which will help them in early detection of diseases

4. Results: The whole diagnostic software provided a high score for each of the validation folds.

5. Importance:This technique is important due the classifiers they use and the algorithm to get high jaccard index score

3.2 Similar System Description

Automated skin disease detection systems based on image processing techniques have been receiving huge attention of researchers in our recent time. A proper identification system to determine the skin diseases without using any invasive methodology is wanted. Such systems are commercially available and considered as a useful aid to the dermatologist. For other skin diseases but skin cancer, a major challenge in developing such system is caused by high similarity in skin lesion shapes and color. Even, for the same disease, the color of affected skin regions may vary significantly with individuals as well as with geographical locations. Despite these challenges, several automated skin disease identification system has been reported in the literature. However, the performances of the existed systems cannot be properly evaluated due to unavailability of any standard skin image database with proper ground truth. In general, research efforts on the skin disease identification may be categorized into four major groups.

1. Creation of standard database from patients.

2. Development of algorithms to remove the hairs from the affected skin lesion and segment the skin lesion.

3. Extraction of appropriate features from the segmented regions.

4. Selection of appropriate classification scheme for recognition.

We have mentioned some of the existed systems above.Each one has reached an acceptable accuracy but the highest one was the one using SVM and K-means.

3.3 Comparison with Proposed Project

Similar System	**Infection**	**Segmentation**	**Feature Extraction**	**Classification**	**Accuracy**
Skin Lesion Analysis Toward Melanoma Detection	Melanoma, Nevus, and Seborrheic Keratosis	CNN	Finetuning CNN	AVG	90.11%
A Software System Based on The 7-Point Check-List	Melanoma	Boundary Detection	Texture: structural and spectral methods Color: (i) Principal Component Analysis (PCA); (ii) 2D histogram construction; (iii) peaks picking algorithm; (iv) histogram partitioning; (v) lesion partitioning. (i) The Principal Component Analysis	Decision Tree	85%
An SVM Based Skin Disease Identification Using Local BinaryPatterns	Leprosy, Tineaversicolor and Vitiligo	Not Mentioned	LBP, GLCM, DCT and DFT	SVM	89.66%
Diagnosing Skin Diseases Using an Artificial Neural Network	benign	ANN	histogram partitioning;	AVG	90%

Immunohistochemical staining of proliferating cell nuclear anti-gen (PCNA) in malignant and nonmalignant skin diseases	mycosis fungoides, malignant melanoma and malignant lymphoma	PCNA	(GHE) and Local Histogram Equalization (LHE)	Back-propagation neural network (BNN) and Auto-associative neural network (AANN)	70%
Automatically Early Detection of Skin Cancer:Study Based onNeural Network Classification	skin cancer	2-D wavelet packet is used and the enhanced image in gray scaled as an input	AVG	Neural Network	80.8%
Automatic imaging system with decision support for inspection of pigmented skin lesions and melanoma diagnosis	Pigmented Lesions and Melanoma	Background Correction and Threshold	Asymmetry Border, Color, Differential Structure	Decision Tree, LMT, Bayesian Networks	86%
A Survey of skin-color modeling and detection methods	None	Threshold-Based Segmentation	Color and morphological Operations, Pattern Recognition, Skin Color	Desission tree, Gaussian, MLP	84%
Noninvasive Real-Time Automated Skin Lesion Analysis Sys-tem for Melanoma Early Detection and Prevention	benign, atypical, and melanoma	Morphological Operation and Gussian Filter	2-D Fast Fourier Transform, 2-D Discrete Cosine Transform, Complexity Feature Set, Color Feature Set, Pigment Network Feature Set	SVM	96.3%, 95.7%, and 97.5%,
Skin Lesion Analysis Towards Melanoma Detection	Melmona	Morphological Operation	U-Net[1] architecture deep convolutional network	Not Mentioned	Not Mentioned

4 Project Management and Deliverables

4.1 Tasks and Time Plan

Task	Date	Deadline
Proposal evaluation	26 Sep 2018	27 Sep 2018
SRS evaluation	10 Nov 2018	10 Nov 2018
External examiner	3 Dec 2018	5 Dec 2018
SSD Evolution	14 Feb 2019	16 Feb 2019
Evaluation implantation	After spring break	After spring break
Technical evaluation	7 May 2019	7 May 2019
Final thesis	25 Jun 2019	25 Jun 2019

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