RESEARCH ARTICLE OPEN ACCESS

A Smart Mobile Application for Early Detection of Skin Diseases Among Higher Education Students

W. K. ElSaid [1], Nahed Amasha [2], Nada Emara [3]

[1] Assistant Professor in Computer Science, Mansoura University, Egypt
[2] Lecturer of Computer Science, Mansoura University, Egypt
[3] Department of Computer Science, Mansoura University, Egypt

ABSTRACT

Dermatology presents itself as one of the most challenging and unpredictable fields for diagnosis, owing to its complexity. Dermatologists need extensive tests to determine the specific skin condition the patient may be facing. The duration of these tests may vary among different practitioners, influenced by their individual levels of expertise. Consequently, there arises a necessity for a diagnostic system capable of identifying skin diseases independently from such constraints.

The present research paper proposes an android application for early detection of five of the most infectious diseases in the educational institutions between students. They are (Impetigo, Scabies, Tinea, Herpes Simplex Virus (HSV), Herpes Zoster) based on Convolutional Neural Networks Algorithm (CNN). The system suggested for identification of the previously mentioned infectious dermatological conditions has undergone validation for its applicability subsequent to evaluation by a group of IT specialists and end users, yielding satisfactory outcomes. Furthermore, the accuracy of the proposed system in detecting skin diseases has been authenticated by several dermatology experts at Mansoura University, showcasing 95.2% of classification accuracy.

Keywords — Skin diseases, Mobile application, Image processing, Impetigo, Scabies, CNN.

I. INTRODUCTION

Skin is the largest organ of the body. It serves various functions such as offering a barrier for protection, maintaining homeostasis of body fluids and temperature, and facilitating sensory perception of the external surroundings [1]. Skin diseases represent most of human illness, impacting nearly 900 million individuals globally at any given moment [2]. As per the findings of the Global Burden of Disease project, skin diseases rank as the fourth major cause to non-fatal disease burden on a global scale [3]. Skin diseases are characterized as disorders that begin inside the body or start from the skin, and outwardly show on the skin [4].

Some of these diseases are exceedingly rare, whereas others frequently occurring. This can be attributed to a variety of influences such as mechanical, physical, chemical, and biological aspects. The impact extends to education, relationships, professional decisions, as well as social and leisure activities. Furthermore, dermatological diseases have the potential to induce depression, frustration, isolation, and even suicidal ideation [5]. Numerous of skin diseases may manifest symptoms such as itching, pain, and notable emotional and social impacts because of its visibility. Dermatologists can identify a variety of skin diseases through visual examination. The application of artificial intelligence in conjunction with deep learning technology for diagnostic purposes is facilitated by the distinct visual characteristics exhibited by each of these diseases [6].

Recently, smartphone-based imaging and sensing platforms have emerged as a viable approach for disease diagnosis within the healthcare sector. The most recent generation of smartphones, equipped with cameras with high-definition, large storage capacity and a powerful processor, facilitate the acquisition of digital images and the recording of videos with enhanced resolution [7]. The attributes of portability, affordability, and connectivity of smart phones make them applicable in many areas [8]. The presence of smartphones that are integrated with digital cameras facilitates the capturing of clinical images for analysis through computer-aided diagnosis (CAD) [9].

This paper proposes the design of android-based system that allows the students in educational institutions to detect the infectious skin diseases and their treatments through a new app installed on their Android smartphones.

The remaining parts of this paper are structured as follows: Section II reviews the background of the study and major related works. Section III defines the problem of the study. Section IV presents the proposed system for detecting the infectious skin diseases. Section V provides tests and results of the proposed android system. Concluding and future works are presented in the last section.

II. PROBLEM DEFINITION

Skin diseases are prevalent among the population, with an increasing prevalence of various types of allergies. The potential severity of these conditions is significant, especially if left untreated in the early stages. There is a common tendency among individuals to underestimate the gravity of certain skin ailments. Frequently, individuals attempt to remedy these skin infections using unverified methods. Nonetheless, using inappropriate treatments can exacerbate the condition. Moreover, individuals may lack awareness regarding the seriousness of their skin issues, such as skin cancers. The research problem concerned with easily

transmission of skin diseases from one individual to another in educational institutions and take long period for diagnosis.

III. RESEARCH IMPORTANCE

Skin disorders can easily transmit from one individual to another, highlighting the importance of early-stage management to prevent further dissemination. Skin diseases not only impact physical health but also have implications on mental well-being and self-assurance. Consequently, this issue has emerged as a significant concern within educational settings, emphasizing the necessity of prompt intervention to mitigate severe repercussions.

IV. RESEARCH OBJECTIVE

This study aims to:

Detect skin disease by mobile app using android platform providing valid trustworthy and useful dermatological information skin diseases. It will include name, image, description, symptoms, treatment.

This promising solution faces the challenge of diagnosing skin diseases in educational institutions by enabling students to identify skin diseases promptly through image-based recognition, thereby facilitating expedited advice or treatment. This approach streamlines the management of skin conditions, encouraging individuals to address these issues proactively in the initial phases.

V. RESEARCH HYPOTHESIS

1) The proposed android application is valid for being used as a diagnostic tool for detecting infectious skin diseases in educational institutions.
2) The proposed android application has a great significance for detecting infectious skin diseases in educational institutions.

VI. BACKGROUND & RELATED WORKS

In the literature, different methods for detecting skin diseases have been explored. In the first part of this section, we will review a brief overview of mobile technology. In the second part, we will present the CNN algorithm on which the proposed application is based. In the last part, we will present a number of previous studies related to the current research.

A. Mobile Technology

Smartphones or mobile phones are one of the rapidly advancing forms of technology in the current era. The progression of this technology within smartphones in the present age unveils novel opportunities for disease identification exclusively via smartphones. An integral component of a smartphone which plays an important role in the detection of cancer is its camera [10].

Images obtained through using smartphone cameras are capable of undergoing processing by smartphones for the purpose of identifying various objects present within the image. Furthermore, a smartphone, functioning as a detector, is equipped with wireless connectivity, the capacity to engage in high-quality photography, and remarkable portability. Presently, the identification of objects within images can be achieved through the application of a specific method derived from the field of machine learning known as deep learning [11].

Deep learning is an emerging machine learning technique that is currently experiencing rapid expansion. The sensitivity of deep learning surpasses that of alternative machine learning methodologies. Application of deep learning has been evident in the examination of biomedical data, encompassing medical imagery, biological sequences, and protein structures [12].

B. Convolutional Neural Networks Algorithm (CNN)

The image generator is a technology that applies various modifications to original images, resulting in several copies of the same image being altered. However, each duplicate differs from the other in terms of shifting, rotating, flipping, and so on. The implementation of these minor changes to the original image has no effect on its target class, but instead provides a new perspective on the actual capture of the item.

Convolutional Neural Networks (CNNs) have made significant advances in computer vision through deep learning. The image represents the most fundamental level of procedure that occurs within a CNN model.

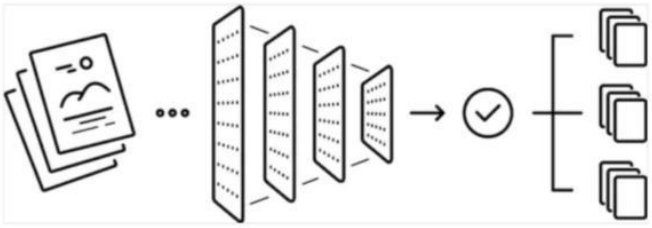

Fig. 1 Basic process inside a CNN model

The visual system design served as the inspiration for the CNN architecture, which closely resembles the connectivity patterns observed in human brain neurons. Illustrated in Fig 1, the fundamental structure of the model involves segmenting images using filters to enhance their processability while retaining crucial details. By convolving the input image with a filter, a convolution layer is formed to identify basic features such as colours and sharp edges. To optimize data processing efficiency, a pooling layer (max-pooling or pooling layer) is employed to downsize the layer containing extracted features. Each CNN layer comprises these two essential layers, and a specific number of layers can be incorporated into the training model to capture minimal stage features depending on the image complexity. Subsequently, the output is flattened for input into a traditional fully connected layer for image classification. The system is further refined by an additional layer that learns high-level features through non-linear combinations processed by the convolution layer. Following this, the image is reshaped into a column vector and supplied to a feed-forward neural network. The training process involves cycles that undergo backpropagation, allowing the model to learn to distinguish predominant and subtle image characteristics through multiple epochs [13].

1) ***TensorFlow Library:*** TensorFlow, in contrast to Keras, presents a more intricate framework yet offers a broader range of functionalities and capabilities essential for the construction of machine learning models. This open-source Python software library is instrumental in generating data flow graphs tailored for machine learning purposes. With TensorFlow, models can be executed across various platforms, be it a personal computer, cloud server, Android device, or iOS system. Unlike CNTK, TensorFlow's user-friendly interface enables users to concentrate solely on the logical aspects of the model, facilitating a more straightforward development process. Moreover, it provides developers with the ability to monitor the neural network architecture that has been established [14].

2) ***Keras Deep Learning Library:*** Keras, a high-level API known for its user-friendly interface, offers exceptional ease of use. This Python-based deep learning framework is open-source, making it freely accessible. Furthermore, it serves as a convenient interface for various Deep Learning tools, including TensorFlow. When constructing a CNN model, the integration of TensorFlow and Keras proves to be beneficial. TensorFlow is primarily utilized in the backend to leverage advanced Deep Learning functionalities during the model development process. On the other hand, Keras, with its high-level API and user-friendly characteristics, is employed in the frontend for its ease of use [15].

C. Related Works

In the scientific literature, a large number of programs have been proposed to detect skin diseases. We will highlight some of the published research papers relevant to our topic in the following:

1) A study entitled " Deep Learning-Based Skin Disease Detection Using Convolutional Neural Networks (CNN) ", conducted by " Prottasha, M.S.I., et al (2023)", suggested a system for diagnosing two types of skin diseases, Eczema and Psoriasis using deep CNN architectures. The maximum validation accuracy was 97.1%. [16].

2) A study entitled " Classification of Skin Disease from Skin Images Using Transfer Learning Technique ", conducted by " Janoria, H., et al (2020)", suggested a transfer learning-based CNN architecture for identifying various skin cancer. They used CNN for extracting the features from the images while machine learning classifiers for diagnosing the diseases. The experimental analysis shows that VGG-16 CNN model with the K-Nearest Neighbor algorithm achieved the highest accuracy of 99%.[17].

3) A study entitled " Automatic Diagnosis of Skin Diseases Using Convolution Neural Network ", conducted by " Shanthi, T., et al (2020)", suggested a CNN architecture for automatic diagnosis of skin diseases. The proposed model consists of 11 layers including multiple convolution, pooling, activation layer, and softmax classifier. The experimental analysis shows that the proposed model achieved an accuracy of around 99%.[18].

4) A study entitled " Deep - Learning - Based, Computer - Aided Classifier Developed with a Small Dataset of Clinical Images Surpasses Board - Certified Dermatologists in Skin Tumor Diagnosis ", conducted by " Fujisawa, Y. et al (2019)", suggested a pre - trained Google Net to classify 14 categories of skin tumors with an overall accuracy of 76.5% [19].

5) A study entitled " Studies on Different CNN Algorithms for Face Skin Disease Classification Based on Clinical Images ", conducted by " Wu, Z. H. E. et al (2019)", suggested a comparison between five pre - trained deep learning frameworks for the diagnosis of six facial skin conditions from a clinical image and using an InceptionResNet_V2 a precision of 77% was claimed. [20].

6) A study entitled " A Computer-Aided Diagnosis System for Classifying Prominent Skin Lesions Using Machine Learning ", conducted by " Hameed, N. et al (2018)", suggested a support vector machine (SVM) with quadratic kernel for classification of acne, eczema, psoriasis, benign and malignant melanoma with an accuracy of 83% [9].

7) A study entitled " A Model for Classification of Skin Lesions Using Image Processing Techniques and Neural Network ", conducted by " Zambales, J. et al (2017)", suggested a system for detection of three different skin diseases. They were Psoriasis, Seborrheic Keratosis, and Pyoderma. Two feature sets were experimented with one feature set having 86 color and texture features and the other having 4,182 color and texture features. [21].

8) A study entitled " The Melanoma Skin Cancer Detection and Classification Using Support Vector Machine ", conducted by " Alquran, H. et al (2017)", suggested using support vector machine (SVM) to classify melanoma skin cancer. They collected dermo copy image database, segmented it using thresholding, collected unique characteristics, calculated total dermo copy score and then classified it using SVM. The accuracy they got was 92.1% [22].

9) A study entitled " Computer-Aided Diagnosis of Four Common Cutaneous Diseases Using Deep Learning Algorithm ", conducted by " Zhang, X. et al (2017)", suggested deep learning algorithms viable for diagnosing skin diseases. They applied deep neural network algorithm in classification of four common skin diseases. The researchers developed the algorithm from GoogleNet inception V3 package. They adjusted the final layer to add their own datasets using transfer learning. It had promising results having 86.54±3.63% accuracy using the first dataset and 85±4.649% for the second dataset [23].

10) A study entitled " Melanoma Detection by Analysis of Clinical Images Using Convolutional Neural Network ", conducted by " Nasr-Esfahani, E. et al (2016)", suggested a system for classification of melanoma and benign lesions using convolutional neural network with accuracy about 81% [24].

11) A study entitled " Design and Evaluation of a Multi-model, Multi-level Artificial Neural Network for Eczema Skin Lesion Detection", conducted by " Launcelot C. De Guzman et al (2015)", suggested an Artificial Neural Network ANN-based single level system as well as a multi-model, multi-level system for eczema detection [25].

The previously mentioned researchers depended on their studies for skin disease recognition on the help of computational assistance. In this paper, we proposed a mobile app for diagnosing five of the most common infectious diseases in educational institutions by using deep learning-based CNN architectures.

VII. PROPOSED MOBILE APPLICATION

In general, the proposed mobile application includes a group of interdependent elements working together to achieve the desired objectives of the application. The details of the proposed mobile application are presented in three sub-sections: Overview, Methodology, and Implementation. Each of these sections will be discussed in detail below.

A. Application Overview

The creation of a smartphone application for Android that utilizes deep learning via Convolutional Neural Network to detect skin diseases involves three primary stages. These stages encompass the acquisition of images of the skin lesion, the utilization of deep learning algorithms for analysis, and the presentation of the findings, as depicted in Figure (2).

This paper proposes a mobile Application that is in line with the principle of Providing an educational system that can be used anytime and anywhere in educational institutions to help in prevent spreading of infectious skin diseases.

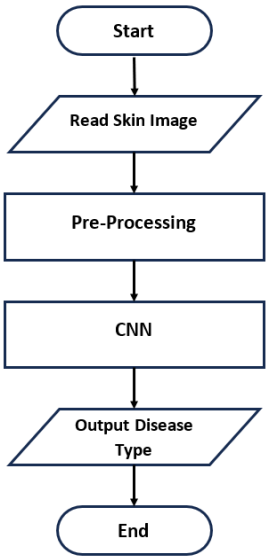

Fig.2 General flowchart of proposed mobile application

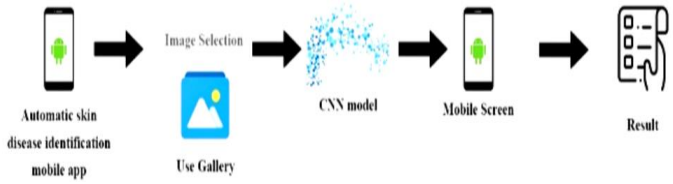

Fig.3 Main steps of proposed mobile application

B. Application Methodology

The proposed mobile application applied relied on the following proposed algorithm in diagnosing.

- The Proposed Algorithm:

Input: An image of the diseased skin of the suspected student to have an infectious disease.

Output: The name of the infectious skin disease

The suggested procedures for detecting the infectious diseases are as following:

1) The dataset originates from a fusion of available dermatology database and the color photo atlas of dermatology and that was collected manually.

2) The sets of images in the dataset contains images in jpeg extension. The images for 5 skin diseases.

3) The dataset has been divided into partitions for the training and testing of data pertaining to various categories of skin diseases. The training dataset comprises 80% of the total dataset, whereas the testing dataset constitutes 20%.

4) The existence of certain visual characteristics within a lesion might imply the existence of a particular disease. For instance, the presence of specific dermoscopic criteria (like an atypical pigment network or asymmetrical streaks) in a lesion can signal the presence of melanoma. Consequently, a technique for

classifying melanoma involves grouping dermoscopic features associated with melanoma.

5) Lesion segmentation, the process of outlining the boundaries of a lesion within an image, enables comprehensive assessment of lesion characteristics and is commonly employed for extracting image features dependent on accurate delineation of the lesion border.
6) A specific dermoscopic criterion, such as streaks associated with melanoma, can be specifically identified and classified. The process of identifying dermoscopic criteria is akin to classifying them, but it necessitates localization. This endeavor may empower healthcare providers to pinpoint areas containing criteria specific to certain diseases.
7) Artifact removal involves the elimination of potentially misleading characteristics from images and is commonly carried out as a preliminary step before the aforementioned operations.
8) color constancy has the potential to improve the process of lesion segmentation or classification.

C. Application Implementation

To allow the educational institutions members to use the proposed mobile application to differentiate between the infectious skin diseases and non-infectious skin diseases lesions, the mobile application was designed as following:

Once the proposed mobile application is started, the login screen is appeared to enable the infected students to sign-in using his secret institutional access data, including the ID and Password as shown in Figure (4).

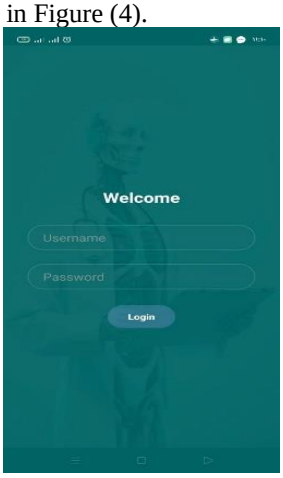

Fig.4 Login screen

After entering the login data, the authentication process is performed. The main screen shown in the Figure appeared to enable the educational institutions members to select the required operation.

Fig.5 Main screen

In the main interface, it will open many options like: Examination, Nearest Hospital, Results, Logout.

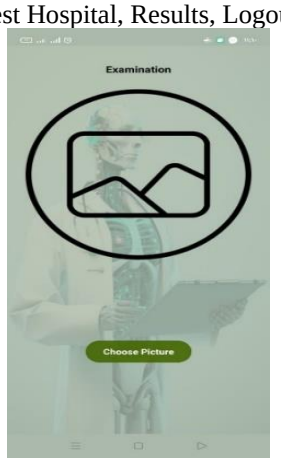

Fig.6 Selecting picture

Uploaded image for doing checkup for skin image and show the result.

When choose uploaded picture from menu, this is the first step for doing checkup and processing on the uploaded image chosen from database.

Fig.7 processing

The image uploaded successfully by being existed in database, the mobile application began automatically to adjusting contrast.

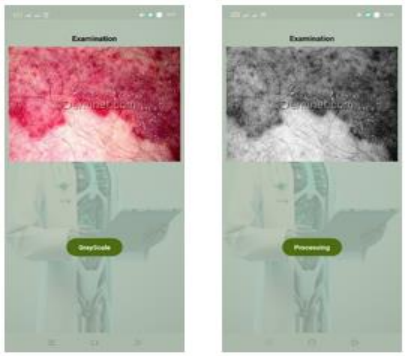

Fig.8 processing

Processing of image started (grey scale)

The application began to checkup for this image and detect the infectious skin diseases by analysis the image with suitable algorithm and analysis technique.

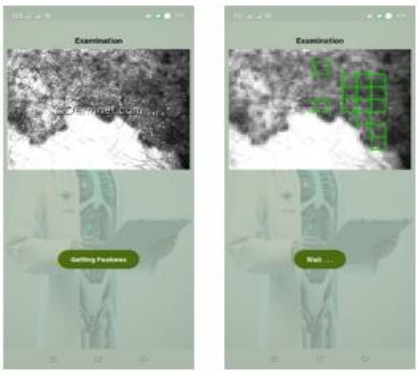

Fig.9 processing

When doing checkup on the infected skin image. The analysis technique and checkup process will take 1- 2 minutes and show the checking up result.

Fig.10 Assessment result screen

The details of detecting the skin disease results are presented, including; The state: if it is infected or non-infected, Type: the name of the infected skin disease, Accuracy: the percentage of being true, correct and exact.

Fig.11 Nearest hospital

When the educational institution members discover that they had an infectious skin disease, they can press on the nearest hospital choice and the application will locate the nearest hospital to them.

VIII. EXPERIMENTAL TESTS & RESULTS

To analyze the research hypothesis of the proposed android skin disease detection system, it was subjected to a series of experimental tests, which were conducted at two levels. Both levels are explained in more detail in the following:

A. Validity Test

The purpose of this test is to verify the validity of the first research hypothesis. A series of experiments is carried out by two teams of human evaluators to assess the effectiveness of the proposed system for early detection of infectious skin diseases. The first team consists of experts in the field of computer science, whereas the second team is composed of regular end users. These experiments focus on four main evaluation criteria: appearance, familiarity, functionality, and timeliness.

A satisfaction questionnaire form has been developed to assess the degree to which the evaluation criteria are met by the proposed system for detecting infectious skin diseases. Within this questionnaire, evaluators will find a series of inquiries aimed at gauging their satisfaction with different facets of the suggested approach for promptly identifying infectious skin conditions. The satisfaction level for each evaluation criterion is segmented into five tiers based on the satisfaction score outlined in Table (1) below.

TABLE I
DEGREE OF SATISFACTION SCORE AND LEVELS

Satisfaction Score	Satisfaction Level
1-2	Unacceptable
3-4	Poor
5-6	Good
7-8	Very Good
9-10	Excellent

The feedback from the two evaluation classes has been gathered and subsequently analyzed using descriptive quantitative statistical metrics. The outcomes pertaining to the experts' contentment with the suggested system for detecting infectious skin ailments early have been documented in Table (2) and outlined in Figure (12) below. Conversely, the satisfaction outcomes of their counterparts among the end users have been documented in Table (3) and summarized in Figure (13) below.

TABLE 2
RESULTS OF EXPERTS' SATISFACTION WITH THE ANDROID APPLICATION FOR DETECTING INFECTIOUS SKIN DISEASES

Evaluation No.	Levels of Experts' Satisfaction			
	Appearance	Familiarity	Functionality	Timeliness
1	Very Good	Very Good	Excellent	Excellent
2	Very Good	Excellent	Very Good	Very Good
3	Excellent	Very Good	Excellent	Very Good
4	Very Good	Excellent	Excellent	Very Good
…..	…..	…..	…..	…..
N	Very Good	Very Good	Excellent	Excellent
Average	(85%)	(87%)	(92%)	(88%)

Fig.12 Overall average of experts' satisfaction with the android application for detecting infectious skin diseases

TABLE 3
RESULTS OF END USERS' SATISFACTION WITH THE ANDROID APPLICATION FOR THE EARLY DETECTION OF INFECTIOUS SKIN DISEASE

Evaluation No.	Levels of End Users' Satisfaction			
	Appearance	Familiarity	Functionality	Timeliness
1	Excellent	Excellent	Excellent	Excellent
2	Very Good	Excellent	Excellent	Excellent
3	Excellent	Excellent	Excellent	Very Good
4	Excellent	Very Good	Very Good	Excellent
…..	…..	…..	…..	…..
N	Very Good	Very Good	Excellent	Excellent
Average	(91%)	(90%)	(90%)	(90%)

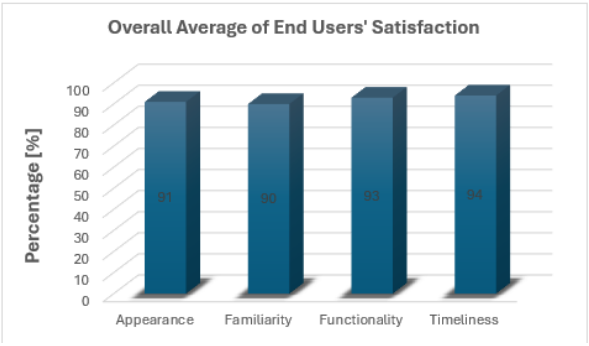

Fig.13 Overall average of end users' satisfaction with the android application for the early detection of infectious skin disease

The above-mentioned results showed that the experts' satisfaction and end users' satisfaction are unequally satisfied with the android application proposed for detecting infectious skin diseases. The same results indicated that the mean satisfaction rate of experts regarding the appearance criterion is 85%, while the mean satisfaction rate of end users on the same criterion is 91%. Similarly, the findings demonstrate that the mean satisfaction rate of experts concerning the familiarity criterion is 87%, and the mean satisfaction rate of end users on this criterion is 90%. Furthermore, the data illustrates that the mean satisfaction rate of experts on the functionality criterion is 92%, whereas the mean satisfaction rate of end users on this criterion is 93%. Lastly, the results indicate that the mean satisfaction rate of experts on the timeliness criterion is 88%, and the mean satisfaction rate of end users on this criterion is 94%.

The reason behind the discrepancy in approval of the suggested system for early identification of infectious skin ailments by the two assessment groups lies in the fact that the specialists possess a wealth of experience and expertise compared to the end-users. This allows them to assess various facets of the proposed system with precision, unlike the end-users who tend to prioritize the external presentation of the system over its functionality, casting doubt on their evaluation.

B. Classification Accuracy Test

After completing the procedures of testing the validity of the proposed mobile based skin disease detecting system for use on a large scale in educational institutions, it has subjected to another kind of experiment called accuracy test. The main goal of this test is to estimate the accuracy of the proposed system in differentiating the infected skin from the noninfected one according to the second research hypothesis.

For verifying the accuracy of the android system proposed for detecting infectious skin diseases in early stages, the system was tested by a number of dermatologists at Mansoura University. The tests were performed on a large sample of infectious skin diseases images as shown in Table (4).

TABLE 4
RESULTS OF SKIN DISEASE IMAGES TESTED BY PROPOSED MOBILE APPLICATION

Type of skin disease	Sample image	Distribution of dataset		
		Number of train images	Number of test images	Total
Impetigo		278	69	347
Scabies		251	63	314
Tinea		506	127	633
Herpes Simplex Virus (HSV)		479	120	599
Herpes Zoster		258	65	323
Total number of images	---	**1772**	**444**	**2216**

The outcomes of evaluating the classification precision of the suggested system for detecting infectious skin diseases were documented in Table (5) and illustrated in Figure (14) below.

TABLE 5
RESULTS OF ACCURACY TEST OBTAINED BY PROPOSED MOBILE APPLICATION

Disease Name	Infected (True positive)		Non infected (False positive)	
	F	%	F	%
Impetigo	49	98	1	2
Scabies	47	94	3	6
Tinea	45	90	5	10
Herpes Simplex Virus (HSV)	48	96	2	4
Herpes Zoster	49	98	1	2
Total	238	---	12	---
Overall Average	---	95.2	---	4.8

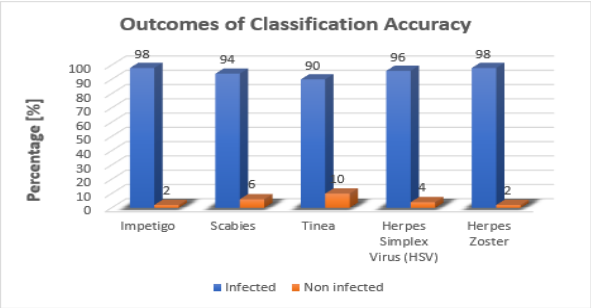

Fig.14 Accuracy percentage of android application proposed for detecting infectious skin diseases in early stages.

Generally, the above-mentioned results confirmed that the accuracy of infectious skin disease detection system is higher for Impetigo and Herpes Zoster as it achieved 98%, it also achieved 96% accuracy for detecting Herpes Simplex Virus (HSV), it achieved 94% in accuracy test for Scabies disease and 90% for Tinea disease.

The project achieved 95.2% as a total result for accuracy test in determining the five skin diseases (Impetigo, Scabies, Tinea, Herpes Simplex Virus (HSV), Herpes Zoster).

Based on these positive results, we can confirm that the proposed system for the early detection of infectious skin disease has achieved its goals efficiently, and accordingly it can be used on a large scale for detecting infectious skin disease at its early stages.

In conclusion, in order to enhance the accuracy of the model different sampling techniques and preprocessing of input data can be explore. using oversampling and data augmentation generate the most accurate result.

IX. CONCLUSIONS

This research paper can be used as an effective, low-cost solution for skin diseases detection by an android based system, it is proposed to resolve difficulties that's created from challenges faced from the dermatologist to recognize the different skin diseases easily.

To determine the effectiveness of the proposed mobile application, two types of trials were conducted. The details of both types are as follows: application validity and accuracy, which may achieve more than 94.4% accuracy for the user. We calculated and evaluated our system's accuracy using a variety of classifiers.

In the future, this system will be used by an administrator to manage data on skin diseases, recognize symptoms, recommend specific medical treatment for the diagnosed skin disease and prepare statements for users to access summary skin illness information. Additionally, this performs well and is highly reliable. The system's performance and reliability will be improved via image-based techniques.

This application was arranged for five skin conditions. They included Impetigo, Scabies, Tinea, Herpes Simplex Virus (HSV), and Herpes Zoster. We only build this for Android, so it is not yet available for other smart phones such as iOS. This application only applies to the English language. Other common languages, such as Arabic and French, will be

supported. These are our system's limits, we will work to improve it in the future.

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