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Applying evolutionary computing to accelerate for melanoma cancer detection

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ABSTRACT

The incidences of malignant melanoma are increasing worldwide. This type of cancer can occur at any age which makes it one of the leading causes of loss of life in young persons. Since this cancer can be visualized easily on the skin of the patients, it is potentially detectable and thus curable at early stages. Nowadays with the help of new developments fully automatic early melanoma detection is really possible. With the advent of dermoscopy, the diagnostic ability to detect melanoma at a very early stage has been increased drastically. Large collections of dermoscopy images of melanomas and benign lesions that are validated by histopathology are now available only because of the adoption of this technology at a global level. A distinction of malignant melanoma from the many benign mimics (that do not require biopsy) is now possible due to the development of advanced technologies in the areas of image processing and machine learning. Not only the earlier detection of melanoma is now possible but also there is a reduction in needless and costly biopsy procedures, only due to these new technologies. However, 3-D feature projection in dermoscopy is a new age method to extract and detect chances of melanoma on the basis of the 3-D reconstruction. The article reviews the impact and importance of computer assisted 3-D imaging.

1. Introduction

Melanoma is the most aggressive form of skin cancer. Although it accounts for only 4% of all skin cancers incidences, it causes 75% of all skin cancer deaths, leading to a very high mortality rate. The presence of melanocytes in any body part causes melanoma. Intensive exposure of the skin to ultraviolet radiation is the main cause of the melanoma (Satheesha et al., 2017).

The global incidence of melanoma in the year 2015 was 351 880 cases with an age-standardized rate of five cases per 100000 persons. Melanoma was also responsible for 59782 global deaths with an age-standardized rate of one death per 100000 persons. The five world regions with the greatest incidence rates were Australasia, North America, Western Europe, Central Europe and Eastern Europe. Mortality rates were also highest in these five regions: Australasia, North America, Eastern Europe, Central Europe and Western Europe. The greatest burden from melanoma falls on New Zealand, Australia, and Europe, the elderly and male populations. Reasons for the disproportionate burden of melanoma in Australasia have been well documented and include a predominantly fair-skinned population, living with high ambient solar ultraviolet (UV) radiation levels, and having a cultural emphasis on tanning (Karimkhani et al., 2017).

Melanoma skin cancer can be detected using various detection techniques i.e. Pigmented skin lesions classification using dermatoscopic images; Automatic diagnosis of melanoma: A Software system based on the 7-Point check-list; Moletest: A web-based skin cancer screening system; Automatic detection of melanoma skin cancer using texture analysis; Comparison between different classification methods with application to skin cancer; Interpretable aide diagnosis system for melanoma recognition; Dermoscopic image segmentation and classification using machine learning algorithms; SKINCURE: An innovative smart phone-based application to assist in melanoma early detection and prevention; Border detection of melanoma skin lesions on a Single System on Chip

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(SoC); Automating skin disease diagnosis using image classification; Lesion segmentation in dermoscopic images using decision based neuro fuzzy model; Artificial Neural Network for skin cancer detection; Detection of melanoma skin cancer using digital camera images; and Enhanced skin cancer detection techniques using Otsu Segmentation Method (Laddha and Paliwal, 2016).

For early, effective and efficient detection of melanoma dermoscope has been vital to medical sciences. Dermoscopy images are used for examination and analysis of skin lesions because of their efficient illumination and magnification. Dermoscopy have improved the efficacy in early melanoma diagnosis. Dermoscopy is cost effective, leading to a decreased number of excised benign lesions (Massone et al., 2005). Dermoscopy which is also known as dermatoscopy or epiluminescence microscopy is a method of acquiring a magnified and illuminated image of a region of skin for increased clarity of the spots on the skin. Dermatoscopes are of two types: first is contact, which requires a layer of gel/oil to be applied between skin and dermatoscope, and second one is non-contact, where there is no skin contact and no fluid (Mishra and Celebi, 2016).

2. Dermoscopy applications in detection of melanoma

2.1. Advantages of dermoscopy in melanoma detection

Dermoscope is advantageous in melanoma diagnosis because it provides better sensitivity and specificity. Two factors that add to the advantages of Dermoscope in melanoma detection are: first, the ability to identify lesions correctly that have the potential to be melanoma; and second, the number of skin excisions performed to confirm diagnosis are minimum. The likelihood of featureless melanomas not to be overlooked and minimal excision of benign lesions are increased by the use of dermoscopic monitoring of pigmented lesions. Dermoscopy in routine practice may have major implications in large-scale melanoma screening, with a reduction in the dermatological surgery workload of false-positive lesions, leading to cost savings, reduced morbidity, and less scarring (Plüddemann et al., 2011). Dermoscopy is a non-invasive and cost-effective tool for melanoma diagnosis, which has been shown to be a reliable and sensitive method for detecting early-stage skin cancer and reducing the number of unnecessary excisions (Thomas and Puig, 2017) (Table 1).

2.2. Challenges and limitations of dermoscopy

In early detection of malignant melanoma, dermoscopic images have great potential, but their interpretation is time consuming and subjective, even for trained dermatologists. Also for the efficient handling of dermoscope highly trained individuals are required, which are not available adequately due to the lack of training. There are cases where the dermoscopy fails as a method of diagnosis of melanoma i.e. in the case of nail matrix melanoma as the nail plate dermoscopy does not permit analysis of the pigment origin in the nail matrix epithelium. Also, it has its limitation in the case of nail matrix melanoma which has a late onset (Koga, 2017).

Table 1: Advantages and disadvantages of dermoscopy (Plüddemann et al., 2011; Koga, 2017; Argenziano et al., 2003)

Advantages of dermoscopy	Disadvantages of dermoscopy
Easy to use	Modification of luminous intensity and magnification not possible
Low cost	Storage and retrospective analysis of the images is not feasible
Helps in early detection	Requires properly trained dermatologists
Requires minimum number of excisions to confirm the diagnosis	Fails to diagnose nail matrix melanoma
By using a special lens also lesions are located in particular anatomic sites	

2.3. Application of computer aided models in dermoscopy

To identify malignant melanomas in dermoscopy images many researchers have proposed Computer Aided Diagnosis (CAD) systems. CAD systems based on medical knowledge try to mimic the performance of dermatologists for the detection of pigmented region. CAD is an automatic method for skin cancer detection on dermoscopy images. First, the image is pre-processed in order to remove the noise and enhance its quality. Secondly, Fuzzy C-Means (FCM) and Markov Random Field (MRF) are used to segment the pigmented lesion from images. Upon comparison, it has been observed that this method provided good performance in achieving automatic image segmentation over dermoscopy images (Eltayef et al., 2017). FCM (Fuzzy C-Means) method is used for determining the border of pigmented skin lesions. MRF (Markov Random Field) method is a statistical method used for segmentation purposes.

2.4. Soft computing techniques in dermoscopy

Generally, the images obtained by dermoscope of melanoma lesions must be completed by any computerized diagnostic system at various specific stages. At pre-processing stage, filters for removal artifacts are applied. This process involves two key operations: hairs, reflection artifact detection and removal. For image segmentation a specific region of the lesion is separated from the rest of the original digital image. FCM and MRF were incorporated to perform the final segmentation of the images. FCM method is used to initiate the segmentation process while the MRF method is implemented to refine the previous segmentation of the images. Feature extraction is performed by using clinically-relevant features that are defined in various guides, among others the ABCD (Asymmetry, Border, Color, Differential structures), must be extracted correctly in order to interpret the lesion. Another guideline that could be implemented is a checklist of 7 criteria that define a malignant tumor. Learning and diagnosis of the malignant tumor is facilitated by employing machine learning techniques, i.e. classifiers. Therefore, intelligent systems are implemented for an accurate image segmentation process to analyze borders, colors, and structures of a lesion (Castillejos-Fernández et al., 2017)

3. Existing conceptual models using computing and other intelligence technologies for detection of melanoma

In previous decades, different techniques have been proposed to distinguish skin malignancy. These techniques with the year in which they were proposed is given in Table 2 (Laddha and Paliwal, 2016).

Table 2: Existing conceptual models using computing and other intelligence technologies for detection of melanoma

No.	Name of technique	Proposed by	Description
1.	Pigmented skin lesions classification using Dermatoscopic images	Capedehourat et al. (2009)	It is a proposed machine adapting approach to manage the Dermatoscopic pictures. It utilizes AdaBoost M1 with C4.5 choice trees, for learning and characterization stage. It has an affectability of 95% (Laddha and Paliwal, 2016).
2.	Automatic diagnosis of melanoma: A software system based on the 7-point checklist	Di Leo et al. (2010)	It is a new explanatory framework based on ELM 7-point plan which checks the surface parameters of the sores. This is a speedier and precise method as compared to the standard ABCD criteria in the determination of melanoma (Møllersen et al., 2017).
3.	Mole test	Blackledge and Dubovitski (2011)	It is an online skin development screening framework. The mix of two angles has been utilized to characterize a handling and picture investigation motor, is remarkable in its business. It utilizes fractal geometry as a focal preparing part, which makes it a more extensive innovation (Laddha and Paliwal, 2016).
4.	Automatic detection of melanoma skin cancer using Texture analysis.	Sheha et al. (2012)	It is an automated methodology for melanoma determination associated with dermoscopy picture. Various elements in this techniques were chosen utilizing fisher score technique (Møllersen et al., 2017).
5.	Interpretable aide diagnosis system for melanoma recognition	Messadi et al. (2014)	It is a guidelines based classifier to isolate a melanoma. Arrangement of tests has been performed to figure the distinctive hilter kilter estimations for the digitized shading pictures of injuries (Møllersen et al., 2017).
6.	Dermoscopic image segmentation and classification using Machine Learning Algorithms	Vennila et al. (2012)	They proposed the errands of isolating, organizing and segmenting the dermoscopic picture using the machine learning computations. The different division strategies utilized are Back Propagation Network, Radial basis network and Extreme learning machine (Massone et al., 2005).
7.	SKINCURE	Abuzaghleh et al. (2014)	For the early revelation and counteractive actions, an imaginative and totally utilitarian propelled cell telephone based application was proposed. It consist of robotized picture examination module which helps in the classification of moles as typical, atypical and melanoma (Laddha and Paliwal, 2016).
8.	Automatic black skin lesion's macroscopic image analysis	Azehoun-Pazou et al. (2013)	This technique focuses on discernible pictures division of dim skin sores. This study distinguished the noteworthy contrasts that exist between dark skin and white skin (Massone et al., 2005).
9.	Fuzzy and wavelet techniques	Ramteke and Jain (2013)	This technique propose the utilization of ABCD principle as its analytic precision. A blend of both ABCD guidelines and wavelet coefficients has been appeared to enhance the picture highlighting grouping precision by 60% (Laddha and Paliwal, 2016).
10.	Border detection of melanoma skin lesions on a Single System on Chip (SoC)	Sabouri et al. (2014)	It is a fundamental calculation created in view of ZYNQ- 7000 SoC, utilizing VIVADO High Level Synthesis (HLS) instrument. It can fragment the injury as it is critical stride before picture examination and highlight extraction for melanoma discovery. It utilizes C-to-FPGA innovation and VIVADO HLS programming to improve the efficiency and execution of the framework contrasted (Laddha and Paliwal, 2016).
11.	Artificial Neural Ntework	Choudhari and Biday (2014)	It is a neural system framework based technique for location of skin malignancy. This diagnosis system utilizes digital image processing techniques and artificial neural networks for the detection of malignant melanoma (Massone et al., 2005).
12.	Detection of melanoma skin cancer using digital camera images	Ramya et al. (2015)	It is a proposed mechanized structure for skin danger acknowledgment with commonplace and atypical classes. The components of this technique is being utilized as a part of the framework and are separated utilizing GLCM (Laddha and Paliwal, 2016; Massone et al., 2005).

4. Three dimensional feature projection

A 3-D skin lesion reconstruction technique using the estimated depth obtained from regular dermoscopic images is a new conceptual model for better detection of the melanoma tumors. Depth and 3-D shape features are extracted on basis of the 3-D reconstruction. In addition to 3-D features, regular color, texture, and 2-D shape features are also extracted.

It works in a systematic manner as first step will be 3D reconstruction from 2D dermoscopic images using depth estimation. After that 3D shape features considering the 3D lesion are constructed. Different algorithms are considered for multiclass decision making. Comprehensive skin lesion data is also considered in the study namely melanoma, in-situ melanoma, atypical nevus, common nevus, basal cell carcinoma, blue nevus, dermatobroma, haemangioma, seborrhoeic keratosis and normal mole lesions (Satheesha et al., 2017) (Fig. 1).

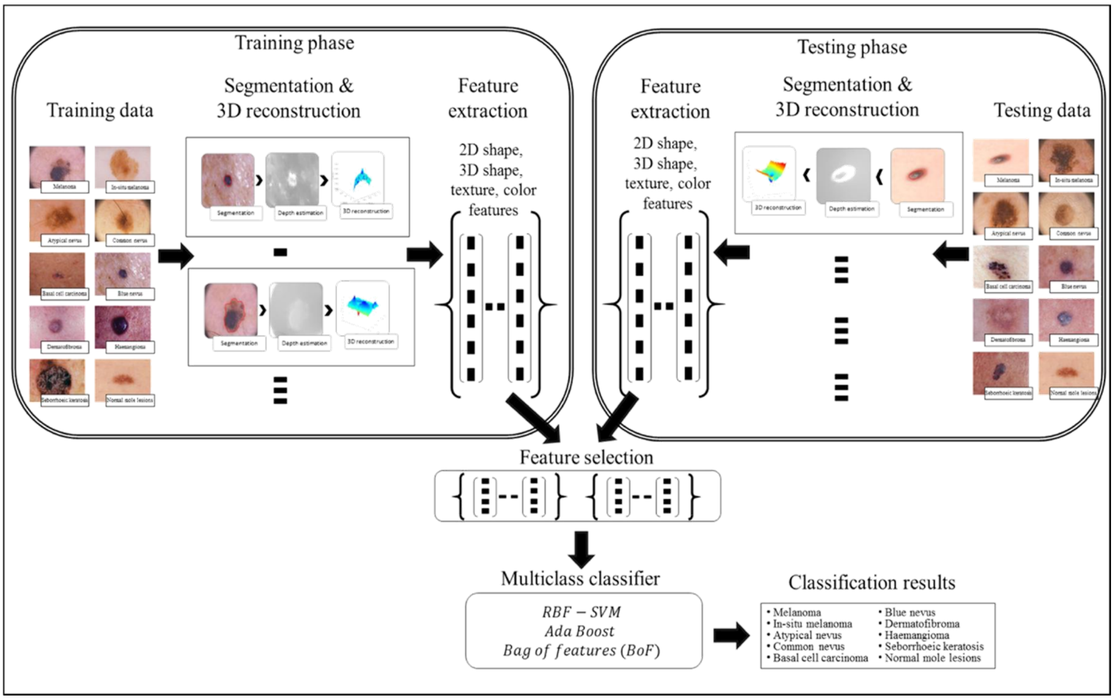

Fig. 1: Overview of the proposed computerized proposed computerized dermoscopy system for skin lesion classification (Satheesha et al., 2017)

5. Computer aided diagnosis model

Although computer systems can assist in melanoma detection, but they are not widespread in clinical practice (Møllersen et al., 2017). The proposed flowchart for melanoma skin cancer detection using computer assisted highly robust computer aided diagnosis model is given in Fig. 2 (Premaladha et al., 2014).

Image pre-processing involves the input image given to the system that can be obtained in any lighting condition or by using any camera such as mobile camera. Hence it needs to be pre-processed. Here, the pre-processing includes the image resizing and contrast and brightness adjustment. This is done in order to compensate the non-uniform illumination in the image. Image segmentation is then performed by using an automatic thresholding and masking operation. The main features of the melanoma skin lesion are its geometric feature. From the segmented image containing only skin lesion, the image blob of the skin lesion is analyzed to extract its geometrical features. The different features extracted are, Area i.e. Number of pixels of the lesion, Perimeter i.e. Number of edge pixels. Using the ABCD rules for the melanoma skin cancer, we use some pre-defined thresholds in classification stage. The feature values extracted in the feature extraction stage are compared and the skin lesion is classified as melanoma skin cancer or normal skin or mole (Jain and Pise, 2015).

6. Discussions and conclusions

This brief review discusses some of the promising current technologies as well as the needs and challenges in developing sensitive and reliable diagnostic tools for the early detection of melanoma. Melanoma is the fastest-growing cancer in terms of incidence, and the need for accurate diagnostic tools is increasing. The objective of the study was to review best automated diagnostic instruments for screening of individual lesions and full-body screening. The study also focuses on sophisticated instruments that can provide dermatologists with fine detail regarding the structure of a lesion and staging information in vivo. Early detection of skin cancer through established methods like dermoscopy is critical for reducing both skin cancer mortality and the overall skin cancer burden.

Dermoscope is advantageous over other methods in melanoma diagnosis because of its sensitivity and specificity. It has the ability to identify lesions correctly that has the potential to be melanoma. Further, dermoscopy is a non-invasive and cost-effective tool for melanoma diagnosis.

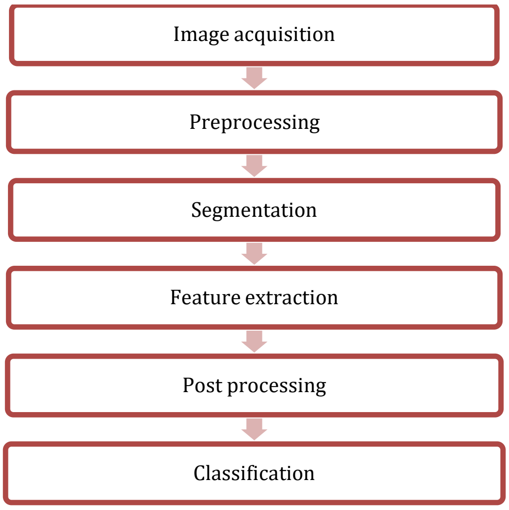

Fig. 2: Steps for the proposed flowchart for melanoma skin cancer detection using computer assisted highly robust computer aided diagnosis (Premaladha et al., 2014)

However on reviewing various models and techniques of cancer detection (Mansour 2017; Mansour, 2018; Mansour and Abdelrahim, 2017), it was assessed that 3-D projection and computer assisted method is advantageous over existing dermoscopic methods. The proposed technique plans to exploit (skin) lesion-depth information to perform diagnosis. Furthermore, a three dimensional (3D) skin lesion feature is proposed that will bring out accuracy of the melanoma cancer detection. The three dimensional (3D) feature reconstructions will be presented in 3D shape features. Further, the model also plans to integrate CAD system and computer assistance for better imaging and efficient detection of melanoma cancer.

There are some limitations to the existing dermoscopic technique, which makes it essential to find new ways for better and more sensitive ways for early detection of the melanoma. To facilitate the process of image enhancement and segmentation computer aided diagnosis is used for early detection of melanoma with less background noise and better accuracy. The existing computerized dermoscopy techniques lay marginal or no emphasis on the depth of the diagnosis, so a 3D skin lesion reconstruction technique using the 2D dermoscopic images is proposed. In future the research must be carried forward to identify the depth estimation error using clinical data and devise new techniques to minimize error. However, this article presented a review of the importance and advantages of various cancer detection techniques and the importance of dermoscopy. In the future prospect, development of the new model theoretically will be presented whereby the existing dermoscopy will be integrated with 3-D technology and computer assisted cancer detection system.

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