SKIN CANCER DETECTION

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Abstract:
Skin cancer is one of the most dangerous forms of cancer. Skin cancer is caused by un-repaired deoxyribonucleic acid (DNA) in skin cells, which generate genetic defects or mutations on the skin. Skin cancer tends to gradually spread over other body parts, so it is more curable in initial stages, which is why it is best detected at early stages. The increasing rate of skin cancer cases, high mortality rate, and expensive medical treatment require that its symptoms be diagnosed early. Considering the seriousness of these issues, researchers have developed various early detection techniques for skin cancer. Lesion parameters such as symmetry, color, size, shape, etc. are used to detect skin cancer and to distinguish benign skin cancer from melanoma. This paper presents a detailed systematic review of deep learning techniques for the early detection of skin cancer. Research papers published in well-reputed journals, relevant to the topic of skin cancer diagnosis, were analyzed. Research findings are presented in tools, graphs, tables, techniques, and frameworks for better understanding.

Keywords: deep learning, deep neural network (DNN), machine learning, melanoma, support vector machine (SVM), skin lesion

1. Introduction

Skin cancer is one of the most active types of cancer in the present decade [1]. As the skin is the body's largest organ, the point of considering skin cancer as the most common type of cancer among humans is understandable [2]. It is generally classified into two major categories: melanoma and nonmelanoma skin cancer [3]. Melanoma is a hazardous, rare, and deadly type of skin cancer. According to statistics from the American Cancer Society, melanoma skin cancer cases are only 1% of total cases, but they result in a higher death rate [4]. Melanoma develops in cells called melanocytes. It starts when healthy melanocytes begin to grow out of control, creating a cancerous tumor. It can affect any area of the human body. It usually appears on the areas exposed to sun rays, such as on the hands, face, neck, lips, etc. Melanoma type of cancers can only be cured if diagnosed early; otherwise, they spread to other body parts and lead to the victim's painful death [5]. There as various types of melanoma skin cancer such as nodular melanoma, superficial spreading melanoma, acral lentiginous, and lentigo maligna [3]. The majority of cancer cases lie under the umbrella of nonmelanoma categories, such as basal cell carcinoma (BCC), squamous cell carcinoma (SCC), and sebaceous gland carcinoma (SGC). BCC, SGC, and SCC are formed in the middle and upper layers of the epidermis, respectively. These cancer cells have a low tendency of spreading to other body parts. Nonmelanoma cancers are easily treated as compared with melanoma cancers. There as various types of melanoma skin cancer such as nodular melanoma, superficial spreading melanoma, acral lentiginous, and lentigo maligna [3]. The majority of cancer cases lie under the umbrella of nonmelanoma categories, such as basal cell carcinoma (BCC), squamous cell carcinoma (SCC), and sebaceous gland carcinoma (SGC). BCC, SGC, and SCC are formed in the middle and upper layers of the epidermis, respectively. These cancer cells have a low tendency of spreading to other body parts. Nonmelanoma cancers are easily treated as compared with melanoma cancers.

Therefore, the critical factor in skin cancer treatment is early diagnosis [6]. Doctors ordinarily use the biopsy method for skin cancer detection. This procedure removes a sample from a suspected skin lesion for medical examination to determine whether it is cancerous or not. This process is painful, slow, and time-consuming. Computer-based technology provides a comfortable, less expensive, and speedy diagnosis of skin cancer symptoms. In order to examine the skin cancer symptoms, whether they represent melanoma or nonmelanoma, multiple techniques, noninvasive in nature, are proposed. The general procedure followed in skin cancer detection is acquiring the image, preprocessing, segmenting the acquired preprocessed image, extracting the desired feature, and classifying it.

Deep learning has revolutionized the entire landscape of machine learning during recent decades. It is considered the most sophisticated machine learning subfield concerned with artificial neural network algorithms. These algorithms are inspired by the function and structure of the human brain. Deep learning techniques are implemented in a broad range of areas such as speech recognition [7], pattern recognition [8], and bioinformatics [9]. As compared with other classical approaches of machine learning, deep learning systems have achieved impressive results in these applications. Various deep learning approaches have been used for computer-based skin cancer detection in recent years. In this paper, we thoroughly discuss and analyze skin cancer detection techniques based on deep learning. This paper focuses on the presentation of a comprehensive, systematic literature review of classical approaches of deep learning, such as artificial neural networks (ANN), convolutional neural networks (CNN), Kohonen self-organizing neural networks (KNN), and generative adversarial neural networks (GAN) for skin cancer detection.

2. Research Methodology

The purpose of performing this systematic literature review was to select and categorize the best available approaches to skin cancer detection using neural networks (NNs). Systematic literature reviews collect and analyze existing studies according to predefined evaluation criteria. Such reviews help to determine what is already known in the concerned domain of study [10].

All data collected from primary sources are organized and analyzed. Once systematic

literature is completed, it provides a more sensible, logical, and robust answer to the underlying question of the research [11].
The population of studies considered in the current systematic literature review consisted of research papers relevant to SC detection based on deep neural network (DNN) techniques.

2.1. Research Framework

Defining the review framework was the first step in this systematic review. It consisted of an overall plan being followed in the systematic literature review. The plan consisted of three layers: a planning layer, a data selection and evaluation layer, and a results-generation and conclusion layer.

2.1.1. Research Questions

For conducting an effective systematic literature review on a topic, it is necessary to formulate research questions. The research questions formulated for the current systematic research were as follows:

Question No. 1: What are the major deep learning techniques for skin cancer detection?

Question No. 2: What are the main characteristics of datasets available for skin cancer?

2.1.2. Search Strategy

A systematic and well-planned search is very important for collecting useful material from the searched data of the desired domain. In this step, a thorough search was conducted to extract meaningful and relevant information from the mass of data. We created an automated search mechanism for filtering out the desired domain's data from all sources. Research papers, case studies, American Cancer Society reports, and reference lists of related publications were examined in detail. Websites containing information regarding skin cancer, the dangers of skin cancer, the reasons for skin cancer, and NN techniques of skin cancer detection were all carefully searched. For extraction of the desired and relevant data, we conducted our search according to the following parameters.

- Search keywords/search term identification based on research questions
- Words related to the search keywords
- Search string formulation using logical operators between search words

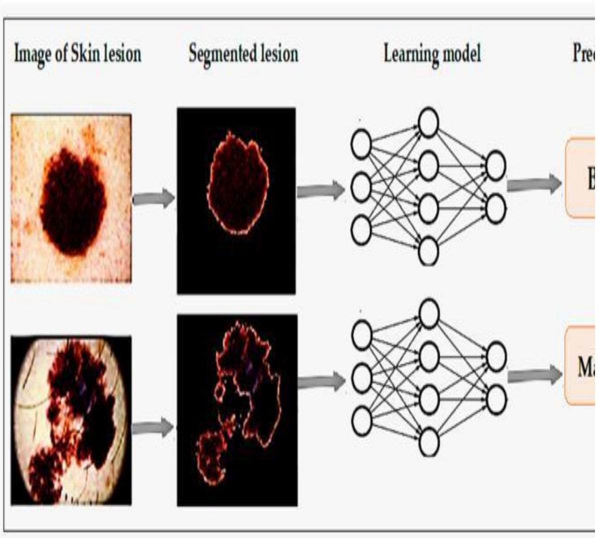
The keywords related to deep learning techniques for skin cancer detection were selected. Subsequently, the search was extended to synonyms for these keywords.

3. Deep Learning Techniques for Skin Cancer Detection

Deep neural networks play a significant role in skin cancer detection. They consist of a set of interconnected nodes. Their structure is similar to the human brain in terms of neuronal interconnectedness. Their nodes work cooperatively to solve particular problems. Neural networks are trained for certain tasks; subsequently, the networks work as experts in the domains in which they were trained. In our study, neural networks were trained to classify images and to distinguish between various types of skin cancer. Different types of skin lesion from International Skin Imaging Collaboration (ISIC) dataset are presented in Figure 2. We searched for different techniques of learning, such as ANN, CNN, KNN, and GAN for skin cancer detection systems. Research related to each of these deep neural networks is discussed in detail in this section.

3.1. Convolutional Neural Network (CNN)-Based Skin Cancer Detection Techniques

A convolution neural network is an essential type of deep neural network, which is effectively being used in computer vision. It is used for classifying images, assembling a group of input images, and performing image recognition. CNN is a fantastic tool for collecting and learning global data as well as local data by gathering more straightforward features such as curves and edges to produce complex features such as shapes and corners [28]. CNN's hidden layers consist of convolution layers, nonlinear pooling layers, and fully connected layers [29]. CNN can contain multiple convolution layers that are followed by several fully connected layers. Three major types of layers involved in making CNN are convolution layers, pooling layers, and full-connected layers [30]. The basic architecture of a CNN is presented in figure2.



4. Datasets

Several computer-based systems for skin cancer diagnosis have been proposed. Evaluating their diagnostic performance and validating predicted results requires a solid and reliable collection of dermoscopic images. Various skin cancer datasets have lacked size and diversity other than for images of nevi or melanoma lesions. Training of artificial neural networks for skin lesion classification is hampered by the small size of the datasets and a lack of diverse data. Although patients commonly suffer from a variety of non-melanocytic lesions, past research for automated skin cancer diagnosis primarily focused on diagnosing melanocytic lesions, resulting in a limited number of diagnoses in the available datasets [66]. Therefore, the availability of a standard, reliable dataset of dermoscopic images is very crucial. Real-world datasets for the evaluation of proposed skin cancer detection techniques are discussed in this section. summarizes the important details of these datasets.

4.1. HAM10000

There is a human-against-machine dataset with 10,000 training images that is referred to as HAM10000 [66]. It is the latest publicly available skin lesions dataset, and it overcomes the problem of the lack of diversity. The final dataset of HAM10000 contains 10,015 dermoscopic images, collected from two sources: Cliff Rosendahl's skin cancer practice in Queensland, Australia, and the Dermatology Department of the Medical University of Vienna, Austria. This collection has taken twenty years to compile. Before widespread use of digital cameras, photographic prints of lesions were deposited and stored at the Dermatology Department of the Medical University of Vienna, Austria. These photographic prints were digitalized with the help of Nikon-Coolscan-5000-ED scanner, manufactured by Nikon corporation Japan and converted into 8-bit color JPEG images having 300 DPI quality. The images were then manually cropped and saved at 800 × 600 pixels resolution at 72 DPI.

6. Conclusion and Future Work

This systematic review paper has discussed various neural network techniques for skin cancer detection and classification. All of these techniques are noninvasive. Skin cancer detection requires multiple stages, such as preprocessing and image segmentation, followed by feature extraction and classification. This review focused on ANNs, CNNs, KNNs, and RBFNs for classification of lesion images. Each algorithm has its advantages and disadvantages. Proper selection of the classification technique is the core point for best results. However, CNN gives better results than other types of a neural networks when classifying image data because it is more closely related to computer vision than others.

Most of the research related to skin cancer detection focuses on whether a given lesion image is cancerous. However, when a patient asks if a particular skin cancer symptom appears on any part of their body, the current research cannot provide an answer.

The idea of auto-organization has recently emerged within the area of deep learning. Auto-organization refers to the process of unsupervised learning, which aims to identify features and to discover relations or patterns in the image samples of the dataset. Under the umbrella of convolutional neural networks, auto-organization techniques increase the level of features representation that is retrieved by expert systems [47]. Currently, auto-organization is a model that is still in research and development. However, its study can improve the accuracy of image processing systems in the future, particularly in the area of medical imaging, where the smallest details of features are extremely crucial for the correct diagnosis of disease.

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