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Diagnosing Skin Cancer using Machine Learning Techniques

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Abstract

Melanoma skin cancer is one of the deadly types of skin cancer and Biopsy is the method that is used to detect this cancer and success rate depends on performance of a trained doctor. The biopsy Process is very painful and requires considerable time. So, there is a need for a technique that can detect melanoma cancer that could avoid biopsy and that would be based on looking deep into skin cancer images. This paper has conducted a study on image classification of melanoma skin cancer using machine learning and various neural network techniques. The stages of the cancer image classification process melanoma skin in this study include the preprocessing process, segmentation, feature extraction with ABCD namely Asymmetry, Border Irregularity, Color Variation and Diameter. Subsequently, it's quantified that both the machine learning and neural network can be used for skin cancer diagnostics.

Keywords

Skin Cancer, Machine Learning, Healthcare, Melanoma.

1. Introduction

Skin cancer is a cancer of the skin layer whose main cause is ultraviolet light radiation, certain toxins and genetic factors, which result in the constituent cells of skin experiences uncontrolled growth and makes the cells that make up the skin grow into cells that are very dangerous [1,2]. Cancer will continue to grow into abnormal cells and can also spread to the normal tissues. This disease can cause death in sufferers, depending on the type of skin cancer and the level of malignancy of cancer. Due to substances in food that can be toxic to the human body and its effects on global warming, this type of disease is increasingly affecting the world community, including India. Ultraviolet rays from the sun are increasingly free to radiate and continue to damage human skin [2]. Along with breast and cervical cancer, skin cancer is one of the three malignant cancers that are frequently diagnosed in India. Skin cancer is the most prevalent type of cancer diagnosed in the United States, accounting for over 5.4 million cases annually [3-5]. A malignant skin condition is detected in one in five Americans at some point in their lives. Melanoma is one of the most aggressive forms of skin cancer that can occur. Even while melanoma accounts for only 5% of skin cancer occurrences in the US, it is the primary cause of mortality in 75% of skin cancer-related deaths in these nations [3]. This matter indicates that melanoma is a type of skin cancer that is very dangerous to have and can be overcome appropriately and quickly. Apart from the high level of malignancy, melanoma also has a shape like a mole, so its existence is often not realized. In the medical field, the diagnosis of skin cancer is carried out in the invasive and microscopy biopsy process. Parts of the cancer cells are taken to be checked in detail to tell whether these cells are cancer cells or not. This testing technique requires long enough for even an expert dermatologist to have risks alone for accidents during the biopsy process. Clinical biopsy photos from 21 certified dermatologists were used in previous studies to examine the performance of a deep neural network technique trained on 129,450 clinical photographs [19]. This demonstrates how beneficial computer technologies are to the process of identifying skin cancer. An algorithm known as "deep learning technology" is being developed to address a variety of issues facing people today. Deep learning demonstrated superior performance to humans in visual tasks including object recognition, bolstered by massive datasets and progress computations. Convolutional neural networks (CNNs), which are employed in image processing for object recognition, perform better with this technique [6].

This paper has conducted a study on image classification of melanoma skin cancer using machine learning and various neural network techniques. The stages of the cancer image classification process melanoma skin in this study include the pre-processing process, segmentation, feature extraction with ABCD namely Asymmetry, Border Irregularity, Color Variation and Diameter. Subsequently, it's quantified that both the machine learning and neural network can be used for skin cancer diagnostics.

Section 2 highlights the basic terminology and significant work done in the past. Section 3 emphasizes the potential application of machine learning in the field of skin cancer disease detection. Section 4 discusses and compares substantial research work done in the past. This section gives elaborative comparative analysis of the performances of various skin disease prediction techniques. Section 5 concludes the complete paper and offers future extension of this research.

2. Literature Review

2.1. Skin

The skin is the outermost organ of the human body that covers its layers and other organs. This organ is the part of the human body that is in direct contact with the environment and natural phenomena around it [1]. Human skin consists of the hypodermis, dermis and epidermis (outermost). The epidermis is composed of 3 cells mainly, namely squamous cells (inner layer of skin), basal cells (producing new skin cells), and melanocytes.

2.2. Melanocytes

Melanocytes are the producers of melanin, the pigment that gives skin its normal color. To protect the inner layers of the skin, melanocytes produce lots of melanin when exposed to sunlight.

2.3. Melanin

Melanin is a skin color giving enzyme that absorbs some of the ultraviolet radiation (UV) harmful rays from the sun and can reduce the damaging effects of skin cells caused by UV rays, so a deficiency or absence of this enzyme results in someone has a high potential for skin cancer [2-4].

2.4. Skin Cancer

This disease is the most common type of cancer in people, in the form of skin which grows abnormally due to genetic factors, toxins, and especially due to ultraviolet (UV) rays from sunlight [7]. Sunlight is the most common cause of this disease because the average human being is exposed to the light of the sun directly every day, but skin cancer can also appear in those areas skin that is not exposed to direct sunlight. Skin cancer grows in the lining of the outermost skin (epidermis) so that it can be seen from the outside and easily symptoms are found at an early stage.

2.5. Types of Skin Cancer

Melanoma and non-melanoma skin cancers are the two general categories of skin cancer. Basal cell carcinoma and carcinoma scuasoma cells are the two types of non-melanoma skin cancer. Depending on the cells involved, there are several forms of skin cancer, including:

2.5.1. Basal Cell Carcinoma (KSB)

This is the most prevalent kind of skin cancer in people, particularly in the elderly [8]. KSB is also known as a rat ulcer, Jacob's ulcer, Komprecher tumor, basalioma, and basal cell epithelioma. KSB is a malignant neoplasm of cells that are not keratinized lapisal basal epidermis, locally invasive, aggressive, destructive, and rare metastasis [1,2].

2.5.2. Squamous Cell Carcinoma (KSS)

This kind of skin cancer accounts for approximately 20% of all instances of skin cancer and is the second most frequent type in people [1,2]. Planocellular carcinoma, prickle cell carcinoma, epidermoid carcinoma, and spinalioma are some of the other names for KSS.

2.5.3. Melanoma

This type of cancer is the cause of more than 75% of all deaths skin cancer that occurs and is the deadliest type of skin cancer [1,2]. Skin melanocytes, which generate the dark pigment known as melanin and give skin and hair their color, are the source of melanoma. Melanoma has the highest probability of metastasis compared with other types of skin cancer. The cause of melanoma is UV radiation, melacynotic nevi or mole (a pigmented tumor that is benign), a factor genetic, sex (women under 40 years and men over 40 years), and family history of having had melanoma [1-4].

2.5.4. Skin Cancer in Melanocytes

Abnormal growth of skin tissue (skin lesions) on melanocyte cells can be nevus and melanoma. Nevuses are benign skin lesions (benign tumors) which can be feces flies (mole), birthmarks and beauty marks, but also nevus potentially develop into melanoma.

Figure 1. Examples of Skin Cancer in Melanocytes

Since the nevus's resemblance to melanoma in form, those who have it frequently overlook its existence since it seems to be just another regular mole. Based on the level of malignancy, melanoma can be classified into two types, namely:

2.5.4.1. Melanoma in Situ (MIS)

This type of melanoma is often called stage 0 melanoma and is not the type of melanoma that is directly related to death [9]. MIS is a type of melanoma that has not metastasized, so it is not too dangerous. However, MIS has the potential to develop into Malignant Melanoma so that leading dermatologists advise patients with pigmented lesions to undergo routine screening [9].

Figure 2. Melanoma in Situ

2.5.4.2. Invasive Melanoma / Malignant Melanoma (MM)

MM is a type of melanoma that has metastasized. MM has spread and grow/penetrate into deeper skin layers. According to [10], adjuvant chemotherapy is an alternative for sufferers of this type of disease. Malignant Melanoma has an asymmetrical shape and can have colors more than one.

Figure 3. Malignant Melanoma

Table 1. Characteristics of Benign and Malignant Lesions

Characteristics	Benign Lesions (Nevus)	Malignant lesions
Growth	Not growing	Grow
Bloody	Not	Yes
Location	Many places	Sun-exposed areas of the body
Shape	Regular shape with smooth and symmetrical lines	Not symmetric
Color	Color	Color may vary
Incident	Many years	New lesions

2.6. Skin Cancer Detection

According to [11], the differences in the image of skin lesions can be taken using ABCD parameters, namely:

- Asymmetry: One part is not the same as the other
- Border: Irregular, toothed, or unclear boundaries
- Color: Varies from one area to another. Has a black, brown or color sometimes white, red or blue.
- Diameter: Melanoma is usually larger than 6mm when diagnosed, but it can also be smaller.

3. Machine Learning

A subfield of artificial intelligence known as "machine learning" deals with creating algorithms for computer systems that enable them to act and learn based on real-world data, such as sensor readings from databases [12]. The primary focus of machine learning is on how computers can use data to automatically identify intricate patterns and make wise conclusions. Data are used to describe the relationships between the observed variables and capture the necessary features of the probabilities underlying the relationships between variables. According to [13], such as the case of bait shyness, where mice learn to avoid poisonous bait food. When rats find food with a strange smell and/or shape, they will eat the food in very small amounts and then depend on the taste and the psychological effects of the food on them. If the food eaten by the mice causes disease effects on their bodies, then they will assume the subsequent bite will cause poison as well so they will not continue to eat the bait. In this case, mice use their experience in eating poisonous bait food to detect other poisonous bait foods so they can avoid familiar toxins, likewise in Machine Learning computer systems learn to avoid mistakes or perform certain skills based on data which is an added experience. to the computer. The main tasks of machine learning are classification (grouping) and regression (prediction of numerical values). For example, in an expert system, when you want to determine something, you have to do something, including weighing it with a scale to get a result about weight and using computer vision to recognize a shape.

4. Previous Research

In order to diagnose skin cancer, [17] combined artificial intelligence with digital image processing in 2014. Dermoscopy pictures serve as the data source. Here, RGB color features and the GLCM (Gray Level Cooccurrence Matrix) feature extraction approach are employed to extract variations between the textures of cancer-affected skin and normal skin. to increase the genetic algorithm-optimized ANN classification accuracy. An accuracy of 88.0% was attained in this investigation.

SVM machine learning algorithms were trained in [18] using the geometric characteristics of the ABCD rule melanoma. Color space and illumination were used in experiments to improve GrabCut segmentation accuracy visualization. An accuracy of 80.0% was attained in this investigation.

Based on photos of skin lesions, the Deep Neural Network approach was utilized in [19] to classify skin cancer cases. Additionally, research from Alex et al. (2012) is cited in this study. In order to test the system, 21 qualified dermatologists evaluated its effectiveness using clinical photos and two use case classifications: malignant melanoma against benign nevi and keratinocyte carcinoma versus benign seborrheic keratosis. Research compared the results of a study of three skin cancer classes with nine skin cancer classes based on a certified dermatologist. This research was successful in achieving an accuracy of 93.3%.

In [20], used the Deep Residual Neural Network method to analyze the Basal Cell Carcinoma (KSB) dermoscopy images. The two components of modeling are segmentation and classification. The model of segmentation employs Images with lesions may be recognized by the FCRN, and foreign information can be eliminated. This section is used by the classification model, which employs a Deep Residual Neural Network 152 layer. This type operates without the need for physical labor from input to output. This research succeeded in achieving an accuracy of 93% in the detection of KSB.

In [21], Alex, et al., Used a Deep Convolutional Neural Network to classify ImageNet, which is more than 15 million labeled high-resolution images, comprising approximately 22,000 categories. The images used in this study are various, ranging from cars, ships, airplanes, bicycles, dogs, cats, tigers, lions, and others. The best model learning accuracy obtained in this study is 78.1%. This study is a large study which is the benchmark for further research in the field of image recognition using a Deep Convolutional Neural Network.

Table 2. Previous Researches

No	Researcher / Year	Research Title	Information
1	Eric Vander Putten, Ameer Kambod and Mobeen Kambod (Year 2018) [20]	Deep Residual Neural Networks for Automated Basal Cell Carcinoma Detection	In this study, the Deep Residual Neural Network method was used to analyze the KSB dermoscopy images. This study succeeded in achieving 93% accuracy in the detection of KSB.
2	Andre Esteva, Brett Kuprel, Roberto A. Novoa, Justin Ko, Susan M., Swetter, Helen M. Blau, Sebastian Thrun (Year 2017)[22]	Dermatologist level classification of skin cancer with deep neural networks	In order to test the system, 21 qualified dermatologists evaluated clinical photographs with two use case classifications: malignant melanoma against benign nevi and keratinocyte carcinoma versus benign seborrheic keratosis. The accuracy rate for this study was 93.3%.
3	Suleiman Mustafa, Ali Baba Dauda, Mohammed Dauda (Year 2017)[23]	Image Processing and SVM Classification for Melanoma Detection	In this study, the authors use geometric features of the ABCD melanoma rule to train SVM machine learning algorithms. This study managed to achieve an accuracy of 88.0%.
4	Aswin.R.B,J. Abdul Jaleel,Sibi Salim (Year 2014) [25]	Hybrid Genetic Algorithm - Artificial Neural Network Classifier for Skin Cancer Detection	GLCM (Gray Level Co-occurrence Matrix) and RGB color features are the feature extraction techniques employed in this study. Genetic algorithms are also applied to increase the classification accuracy. The accuracy achieved by this investigation was 88.0%.
5	Alex Krizhevsky, Ilya Sutskever, Geoffrey E. Hinton (Year 2012)	ImageNet Classification with Deep Convolutional Neural Networks	A Deep Convolutional Neural Network was employed in this study to categorize ImageNet, a dataset of over 15 million annotated high-resolution photos divided into around 22,000 categories. In this investigation, the best model learning accuracy was found to be 78.1%.

5. Conclusion

This section presents the findings from the application of the machine learning and neural network approach to the cat-egorization of skin cancer photos according to the degree of cancer malignancy in melanocytes, along with recommen-da-tions for future research directions. The following conclusions may be made from the testing of the machine learning and neural network-based ideal classification system for skin cancer based on the degree of malignancy in melanocytes:

- The Deep Convolutional Neural Network (DCNN) method is able to classify skin cancer images based on the level of cancer in melanocytes quite well and has an accuracy of up to 93%.
- In the image processing process, it is necessary to determine the image threshold value that is in accordance with the image because it will have a large enough effect if the Threshold value used is not suitable and will af-fect the accuracy of the system.
- Selection of batch size, number of convolutional layers, number of hidden layers in fully connected layers greatly af-fects the accuracy obtained. After going through several references, it can be analyzed that, the batch size used must match the specifications of the approach used, the more convolutional layers can make the learning pro-cess more accurate, the larger the number of hidden layers and neurons in the fully connected layer will result in an in-creased learning process time but can result in better accuracy.

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