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Thermal Image Analysis for Skin Cancer Detection

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Abstract: *New technologies are included into the medical industry only to improve the quality of life for sick and even healthy individuals. One of the technologies with some uses in the biological and medical domains is infrared technology. The possibility for skin cancer diagnosis is examined in this research using thermal infrared (IR) measurement. IR appears to have beneficial costs in addition to non-invasive and non-contact benefits. In terms of methodology and technology, it is likewise quite advanced. Numerous variables, including rising life expectancies, individual behaviors, and exposure to UV radiation, have contributed to the tangible rise in cancer in modern society. Additionally, a greater number of cancer kinds have been identified because to the substantial advancements in technology. This work's only goal is to explore further infrared technology techniques and applications that aren't yet fully developed for skin cancer detection in order to improve detection capabilities while maintaining a better level of safety. Skin cancer is among the most common and potentially fatal types of cancer worldwide. The technology of infrared thermography has advanced dramatically in recent years, and the medical world is showing increasing interest in using it for skin tissue identification. Infrared thermography is a non-invasive imaging method that documents temperature variations caused by abnormal metabolic activity in cancerous tissues.. It is possible to improve thermal images of skin lesions by choosing an appropriate cooling method, infrared camera and optimized measurement setup.*

Key Words: *Skin cancer, Thermal Infrared, skin lesion, Thermal imaging, Machine Learning (ML)*

1. INTRODUCTION:

Skin cancer is most common and rapidly increasing form of cancer .Thermography is a non-invasive method that uses colour to indicate body temperature. Effective treatment and better patient outcomes depend on early identification. For the identification of cancer, traditional diagnostic techniques like mammography and biopsy have been utilized extensively; nevertheless, their accuracy, invasiveness, and patient pain are sometimes limited. Thermal imaging has become a potential non-invasive cancer diagnosis method in recent years [1].

Infrared thermography, another name for thermal imaging, is a technology that makes it possible to see and examine the heat patterns that the human body emits. It is predicated on the idea that cancer cells produce more heat and blood in tumor areas because they have a greater metabolic rate than normal cells [2]. Thermal imaging may be able to detect aberrant tissue regions linked to cancer by recording and examining these heat patterns. The non-invasiveness of thermal imaging is one of its main benefits. Thermal imaging just involves the use of a specialised camera to take thermal pictures of the body surface, as opposed to typical diagnostic techniques that may entail unpleasant procedures or exposure to ionising radiation [3]. This makes it a safer and more comfortable choice for patients, particularly for long-term monitoring. Thermal imaging also has the ability to identify cancer early. Subtle variations in temperature and blood flow are common in early-stage tumours and may be difficult to identify with other imaging methods [4].

Thermal imaging is based on the theory that malignant tumours have higher blood circulation and metabolic activity than healthy tissues. The resulting localized temperature changes on the skin's surface can be captured by infrared cameras. Malignant regions sometimes appear as "hotspots" on thermal imaging due to their increased heat output. Medical thermography uses specifically designed thermo graphic cameras to derive diagnostic indications from infrared images that include a lot of information about the human body. Thermal imaging can visually evaluate the thermal properties of the affected skin area when processing techniques are appropriate. By comparing and linking quantitative data with diseases of interest, it may also automate the detection of various skin cancer issues [6].

However, manually interpreting thermal images is difficult and subjective. Artificial Neural Networks (ANNs) are therefore used to automatically assess thermal trends and classify lesions as benign or malignant. By mimicking the way the human brain works, ANNs are able to identify complex patterns in medical images. By collecting information such as texture, temperature fluctuation, and thermal gradients, ANN models can accurately identify cancerous areas. The integration of artificial neural networks with thermal imaging provides an automated, cost-effective, non-invasive, and efficient way to diagnose skin cancer early. This technique reduces the need for intrusive treatments while improving diagnostic accuracy, making it perfect for modern medical and biomedical engineering applications.

2. LITERATURE REVIEW:

The demand for accurate diagnoses and higher survival rates has led to a substantial increase in interest in image processing approaches for skin cancer detection. Researchers have proposed a number of different segmentation and analysis methods.

A technique for segmenting skin lesions using joint statistical texture distinctiveness was presented by Glaister et al. [1]. Their method separated lesion areas from healthy skin by using texture and colour information. The study showed that texture-based analysis offers dependable lesion border identification and increases segmentation accuracy. This approach worked well for dealing with changes in the appearance of lesions and lighting.

Sood and Shukla [2] presented a genetic algorithm-based optimised segmentation method. To enhance segmentation performance, the suggested approach used evolutionary optimisation. Their findings demonstrated that, in comparison to traditional segmentation techniques, the genetic algorithm improves accuracy and speed in identifying lesion sites. The study emphasised how crucial optimisation methods are to enhancing the segmentation of skin lesions.

A segmentation technique based on normalised graph cuts and learnt dictionaries was introduced by Flores and Scharcanski [3]. This method identified lesion structures by applying machine learning methods. Their approach produced precise segmentation results while handling intricate lesion patterns with ease. The study illustrated the benefits of integrating graph-based segmentation approaches with dictionary learning.

An autonomous imaging system with decision assistance for the diagnosis of melanoma was created by Fernandez et al. [4]. Their method combined image processing, analysis, and acquisition to help doctors make diagnoses. The method decreased human error and increased diagnostic accuracy. The importance of automated technologies in assisting with clinical decision-making was highlighted in this study.

An independent histogram pursuit technique for skin lesion segmentation was presented by Delgado Gomez et al. [5]. Their strategy was to isolate lesion regions from healthy skin and extract colour characteristics. The outcomes demonstrated that histogram-based techniques offer efficient segmentation capabilities. Their research helped increase the accuracy of segmentation through the use of statistical methods.

A fuzzy C-means clustering technique for automated picture segmentation was presented by Virk and Lal [6]. They classified pixels into lesion and non-lesion zones using clustering algorithms. The technique decreased processing complexity and offered effective segmentation. The effectiveness of clustering algorithms for medical picture segmentation was shown in this study.

A segmentation technique based on independent component analysis (ICA) was presented by Cavalcanti et al. [7]. Their technique separated independent image components to identify lesion regions. According to the study, ICA enhances segmentation performance and facilitates precise lesion detection. The value of statistical signal processing in medical imaging was demonstrated by their work.

A wavelet-based method for skin cancer detection and analysis was introduced by Indira and Priya [8]. Their approach analyzed lesion characteristics and extracted picture information using wavelet transform. Wavelet-based analysis increases detection accuracy, according to the study. Their research showed how crucial feature extraction methods are for the detection of skin cancer.

3. CLASSIFICATION OF SKIN CANCER

This research distinguishes between three types of skin cancer. Malignant melanoma, Squamous cell carcinoma, and basal cell skin cancer

3.1 Basal cell skin cancer

The least aggressive type of non-melanoma skin cancer is called basal cancer cell (BCC), which is derived from keratinocytes that resemble epidermal basal cells. BCC looks like a lump that resembles a flesh-colored pearl or a pinkish area of skin. BCC is brought on by skin exposure, especially in areas of the body that are exposed to the sun, such as the face, head, neck, arms, legs, and belly. BCC can start in the bones and nerves and spread to other parts of the body.

3.2 Squamous cell carcinoma

The cancer of keratinocyte cells on the skin's surface is known as squamous cancer cell (SCC). It looks like scaly areas of red hard lumps. Overexposure to the sun is the reason. People with pale, light complexion are more likely to have it. The ear, face, neck, chest, and back are the areas where it is most commonly encountered. Due to SCC, over a million people were impacted, and 80,000 people lost their lives. SCC has significantly increased in the US during the last three decades. SCC has a greater fatality rate than BCC, but it is less common than melanoma. The growth of invasive squamous cells that can spread to other tissues is a hallmark of SCC. Treatment options include curettage, electrodessication, tropical chemotherapy, and photodynamic treatment.

3.3 Malignant melanoma

Melanocytes, which are specialized pigmented cells that are widely distributed in the basal layer of the epidermis, are the source of melanoma. Melanoma often manifests as a black patch on the skin's epidermis, or outermost layer. It is the rapidly proliferating cancer cells that have the capacity to spread across the body's surrounding tissue. UV exposure is the cause of malignant melanoma, which indirectly destroys DNA. The most deadly type of cancer, malignant melanoma, is curable in its early stages. The most modern non-invasive methods for detecting skin cancer are suggested in this thorough review article.

4. METHODOLOGY:

Infrared thermal imaging, often known as thermography, has emerged as a promising non-invasive technique for the early detection of skin cancer. It is used to determine whether body sections have abnormally high or low temperatures. The subject's right foot in Figure 1 has cancer, and the malignant lesion is readily apparent when contrasted to the left foot. Thermal changes in an affected organ may be associated with cancer, according to research in the field of cancer diagnostics. Melanoma detection is aided by the increased heat production and rapid reheating of malignant tumours like melanoma [6]. If a lesion's malignancy or non-malignancy can be verified with technologies that can collect and quantify data that is hard for the human eye to perceive, it may raise the chance of survival and the cost of treatment [1].

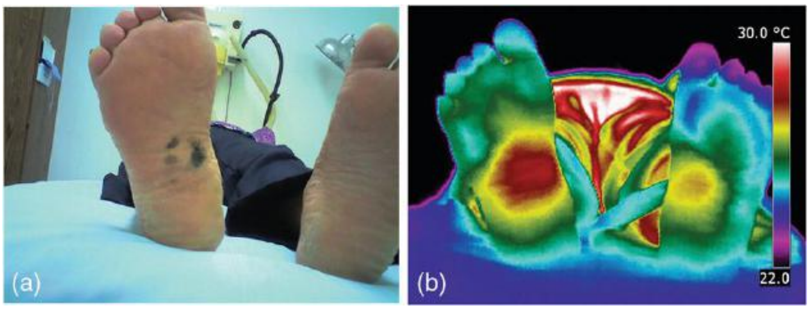
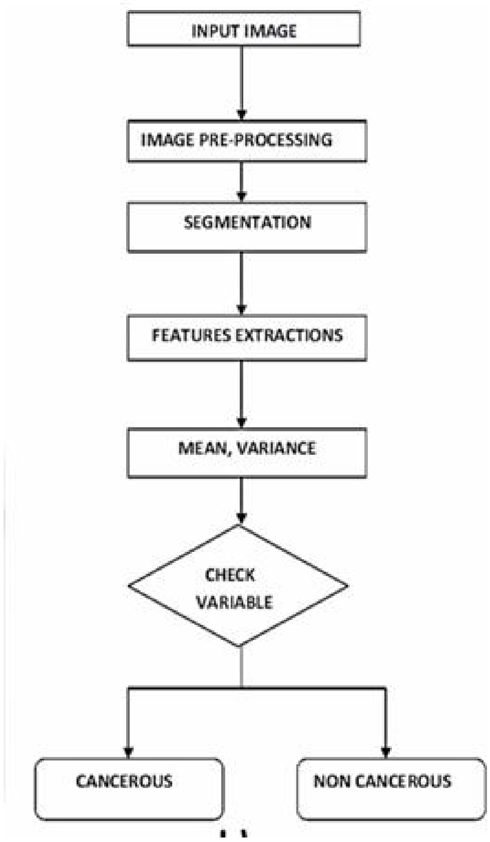


Figure 1 (a) Digital photograph (b) thermal image of a melanoma

Biomedical image processing is a vast and diverse field that has greatly improved diagnostic procedures and their results. A range of image processing methods may be investigated and used to thermal images in order to assess their effectiveness in precisely identifying diseases in their early stages. This work mainly focuses on the analysis of malignant lesions over a thermal picture of the individual and the characterization of thermal characteristics on thermal imaging in order to identify some useful insights and markers of skin cancer.

To minimize artifacts, the high-resolution camera picture obtained from the subject is pre-processed. Gaussian, mean, and median are used to overcome artifacts such as hair in the picture. The lesion is then detected using an image segmentation approach that divides the picture into separate, homogenous regions based on a selected feature, such as colour, or brightness. Feature extraction is the next step. The extraction procedure uses the ABCD rule, which verifies the obtained image's symmetry, border, colour, and diameter. Various chromatic and morphological characteristics can be measured and utilized for classification after the lesion has been localized. Flow chart is shown below for implementation.



Deep learning and visual processing are combined in the classification section of the test procedure. Instead of having the solutions preprogrammed into the computer, deep learning trains the machine to solve problems. Melanocytes are segmented from the skin pictures using a computer-aided approach. The primary goal of this segmentation is to lessen the local intensity variation. An adaptation of the means algorithm is made. Without doing any skin biopsies, computerized images of melanoma skin lesions can reveal information about the malignancy in its early stages.

5. CONCLUSION:

Thermography is a promising technology that has the potential to provide advancements and safer procedures in medical diagnostics area with its non-invasive and harm less nature. Currently there is need for further research and establishment of standard and universal protocols for image acquisition and processing along with the design and development of CAD systems for completely automated diagnostic systems capable of precise and correct segmentation, processing and classification of regions of interests.

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