LITERATURE SURVEY

SKIN CANCER DETECTION USING ARTIFICIAL INTELLIGENCE

Introduction

Cancer is one of the major healthcare burdens across the world. Global statistics suggest almost 10.0 million deaths (9.9 million excluding non-melanoma skin cancer) due to cancer in the year 2020. The most commonly diagnosed cancers include breast cancer in females, lung cancer, and prostate cancers. Lung, liver, and stomach cancers are the major contributors of cancer related deaths . Skin cancer, including both malignant melanoma and non-melanoma skin cancer (NMSC), are common cancers in Caucasians and their incidence is on the rise . According to the US Skin Cancer Foundation, skin cancer affects more people in the United States each year than all other cancers combined .

Melanoma is the skin cancer with the worst prognosis. If diagnosed early, it can be treated successfully with surgical procedures. However, once there is metastasis, rates of survival are reduced significantly . Diagnosis of melanoma depends on the clinical examination and classic findings on the lesion biopsy. Examples of NMSC include basal cell carcinoma (NMSC) and squamous cell carcinoma. The success of skin cancer depends on early diagnosis and appropriate treatment. Visual inspection may not be sufficient to differentiate benign lesions from malignant tumors. The gold standard procedure is histopathology examination of the skin biopsy. The invasive nature of the procedure, associated pain, and the need for repeated samples in suspected lesions with varied presentations are some of the limitations for skin biopsy. Non-invasive tools can also assist in clinical diagnosis . Expertise, cost, and availability are the challenges for the widespread use of these tools. Several advancements in science and technology have resulted in the availability of different non-invasive imaging methods to detect melanoma . The accuracy of these methods in the diagnosis of melanoma and other skin cancers is still a point of discussion.

Overall, early detection is key for the effective treatment and better outcomes of skin cancers. Specialists can accurately diagnose the cancer, however, considering their limited numbers, there is a need to develop automated systems, which can diagnose the disease efficiently to save lives and reduce health and financial burdens on the patients. Skin tumors can be difficult to recognize from common benign skin lesions, and melanoma has a particularly varied look. AI can aid in the early detection of skin cancer, lowering the burden of morbidity and mortality associated with the diseas. In addition to reducing the workload, AI-based systems can also help by improving skin lesion diagnostics .

Artificial intelligence (AI), a branch of computer science that uses machines and programs to mimic intelligent human behavior via a constellation of technologies, is a key driver of the fourth industrial revolution. Machine learning (ML) is an AI technique involving statistical models and algorithms that can progressively learn from data to predict the characteristics of new samples and perform a desired task. Thus, the complex algorithms are designed to perform the tasks that otherwise would be difficult for human brains to do. Convolutional neural network (CNN) is a type of ML that simulates the processing of biological neurons and is the state-of-the-art network for pattern recognition in medical image analysis. AI is poised to bring transformation in healthcare because of its advantages over traditional analytical techniques. There is rising optimism regarding applications of AI in healthcare, ranging from assistance in medical diagnostics, treatment and administrative support to reduce timelines of new drug development. It may also be of benefit as an adjuvant in clinical decision making . Dermatology, as a visually intensive field, is at the precipice of an AI revolution. The association for the advancement of AI defines it as "the scientific knowledge of the mechanisms underlying mind and intelligent behavior and its implementation in machines" . AI uses computer systems to accomplish tasks that would ordinarily need human intelligence, such as identifying the type of flower or recognizing a person's voice. To emulate the actions of the human brain, AI uses a variety of technologies and techniques, including robotics, ML, and the internet. AI has the potential to exceed humans, due to its endless processing power and storage capacity . Apple's Siri, Amazon's Alexa, and Google Assistant are the most popular instances of AI currently in use by ordinary people .

Because skin disease diagnosis is mostly based on visual perception, computer vision algorithms may be able to recognize skin lesions based on their morphology.

By September 2018, the US Food and Drug Administration (FDA) had authorized AI approaches for clinical usage, including devices to detect skin cancer from clinical photos obtained via a smartphone appbond.

The field of AI Is growing dynamically, and research in this area is evolving at a rapid speed. The objective of this article is to provide update on usefulness of AI in diagnosis and management of skin cancer. We reviewed the latest research and key discoveries in ML encompassing various subfields of dermatology related cancers. Literature review was performed to screen the articles published in "PubMed" and "Google Scholar" through August 2021. The search words included "Artificial intelligence AND skin cancer" "Machine learning AND skin cancer" and "Deep learning AND skin cancer". Relevant references of the screened articles were also included for qualitative analysis. Important websites related to skin cancer and related AI resources were also browsed to gather information on the topic.

Keywords: artificial intelligence, machine learning, skin cancer

Title:Real time THz imaging—opportunities and challenges for skin cancer detection

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Applied Physics Letters 118 (23), 230501, 2021

ABSTRACT

It was first suggested that terahertz imaging has the potential to detect skin cancer twenty years ago. Since then, THz instrumentation has improved significantly: real time broadband THz imaging is now possible and robust protocols for measuring living subjects have been developed. Here, we discuss the

progress that has been made as well as highlight the remaining challenges for applying THz imaging to skin cancer detection.

The greatest benefit from THz imaging of skin cancer would be if it could be used for real time diagnosis of patients, and for that, we need real time THz imaging in a configuration that would be suitable for imaging various skin locations. Real time THz imaging has, until recently, only been possible using THz array cameras and high-power THz beams produced using, for example, high power femtosecond lasers or THz quantum cascade lasers. The former are expensive, not portable, and could affect gene expressions due to the high peak-intensity, while the latter work mainly at cryogenic temperatures adding high running costs. Breakthroughs made in THz spatial light modulation have enabled compressive sampling techniques to be applied to room temperature THz spectroscopy systems and achieve real time imaging.1,2 In compressive imaging, a pattern is imprinted onto the THz beam, which is measured by a single THz detector. By rapidly changing the pattern, a THz image can be reconstructed computationally. To create the pattern, THz modulators based on silicon are currently a good choice, where optical illumination (which causes photo modulation of the silicon) is controlled by a digital mirror device. We envisage that this “single-pixel imaging” approach will likely be the way forward for in vivo cancer diagnosis.

The Incidence of basal cell carcinoma (BCC) in the UK has increased by approximately 250% since the 1990s, with 137 000 new cases in the UK each year. There is a pressing need to improve the efficiency of in vivo diagnostics and surgical procedures. Delayed diagnosis and incomplete excision of tumors are key factors in squandering resources, greatly increasing patient morbidity. Existing techniques for diagnosis and treatment of several cancers have their limitations, e.g., for skin cancer; the initial diagnosis is performed by visual inspection and biopsy (which typically takes two weeks to process). The gold standard for skin cancer removal is Mohs micrographic surgery during which tissue is removed and then examined under a microscope until the margins are clear, which is time consuming and expensive. If the extent of tumors could be determined using THz imaging prior to surgery, procedures would be faster, excision would be definitive, and reconstruction better planned.

THz light is fundamentally more suited to detecting abnormalities in tissues than other emerging technologies, such as Optical Coherence Tomography (OCT), owing to its wavelength. In particular, water has strong absorption at THz frequencies resulting from hydrogen bonds. Optical frequencies do not resonate with hydrogen bonds, and while the shorter wavelength (λ) of optical light means that it is easier to achieve higher resolution, there is also more scattering (proportional to 1/λ) and more attenuationThis makes it harder for optical techniques to image deeper into the tissue. X-ray computed tomography (CT) using contrast enhancers and MRI functional imaging are able to identify cancer in the gastrointestinal tract with millimeter resolution, but it is difficult to map their information precisely to the patient during surgical removal. THz light offers the perfect middle ground for resolution and penetration depth and is also complemented by its intrinsic sensitivity to hydrogen bonds.

In vivo THz images from a case study of patients with BCC in 2004 suggested that it is possible to detect skin cancer hidden beneath the skin using THz imaging Spectroscopic studies by MacPherson and colleagues in 2006 showed that the fundamental THz properties of freshly removed (excised) skin cancer tumors are statistically significantly different from healthy tissue, and it is thought that the differences are primarily due to changes in water content of the tissue.More recently, Zaytsev et al. performed in vivo measurements of healthy skin, dysplastic nevi (precancerous moles), and non-dysplastic nevi (regular moles) on four patients. It was found that there was significant contrast between the tissue types. This reveals the potential of THz imaging for identifying not only the presence of skin cancer but also features in the skin which if left could develop into cancer.

The high sensitivity of THz light to water also means that the THz signal is strongly attenuated and has a very limited penetration depth in tissue—thus, THz scanning would experience great difficulty in detecting deep tumors. The penetration depth depends on the signal-to-noise ratio of the THz imaging system; therefore, global efforts to improve the signal processing and/or the THz instrumentation have significant impact on the feasibility of this application. The early studies which identified the contrast between healthy and cancerous tissues opened the door to further research investigating the origin of the contrast and which other types of cancer can be identified using THz imaging. However, due to the limited penetration depthof THz light in biological tissues, the in vivo studies are largely focused on observing the skin while other cancer types have been identified following the removal of the tissue in ex vivo studies. In 2006, Fitzgerald et al. demonstrated that THz imaging can be used to identify areas of cancerous tissue in excised breast samples from cancer patients. The area of the cancerous region identified from the THz image was found to have moderate correlation with the results obtained when the samples underwent routine histological tests. Bowman et al. also found contrast between breast cancer, the healthy fibrous tissue surrounding the tumor and the healthy fatty tissue in the breast.10,11 In addition to investigating potential applications of THz imaging for the diagnosis of various cancers, studies have also been performed using THz imaging to investigate other diseases or changes in the skin. One of the largest scale tests of the potential of THz imaging to address a clinical need is the study by Hernandez-Cardoso et al. which demonstrates the success of THz imaging in diagnosing diabetic foot syndrome.12 This study was able to find significant differences in the THz response of the skin on the underside of the feet of healthy and diabetic subjects.

Tittle:Review of smartphone mobile applications for skin cancer detection: what are the changes in availability, functionality, and costs to users over time?

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International Journal of Dermatology 60 (3), 289-308, 2021

Abstract

Smartphone applications (apps) are available to consumers for skin cancer prevention and early detection. This study aims to review changes over time in the skin cancer apps available to consumers as well as their functionality and costs. Apps for the prevention of skin cancer were searched on two major smartphone app stores (Android and iOS) in June 2019. The number, functionality, ratings, and price of the apps were described and compared to similar reviews of the skin cancer app market from 2014 to 2017. Overall, the June 2019 search identified 66 apps. Of 39 apps found in 2014, 30 were no longer available in 2019 representing an attrition rate of 77%; of 43 apps available in 2017, attrition was 46.5%. In 2019, 63.6% (n = 42/66) of apps were free to download compared to 53.5% (n = 23/43) in 2017. Input from clinician/professional bodies was evident for 47.0% (n = 31/66) of the apps in 2019 compared to 34.9% (15/43) in 2017. The most common app functionality offered in 2019 was monitoring/tracking of lesions at 48.5% (n = 32/66). Since 2014, there has been a steady increase in the number of apps available for the general public to support the prevention or early detection of skin cancers. There

continues to be a high turnover of apps, and many apps still appear to lack clinician input and/or evidence for their safety and value.

Tittle:The impact of patient clinical information on automated skin cancer detection

Andre GC Pacheco, Renato A Krohling

Computers in biology and medicine 116, 103545, 2020

Highlights

- A new skin cancer dataset containing clinical data and images is presented.
- A straightforward approach to combine both types of data is proposed.
- Well-known deep learning models are applied to the presented dataset.
- The results considering clinical data and images present a notable improvement.

Abstract

Skin cancer is one of the most common types of cancer worldwide. Over the past few years, different approaches have been proposed to deal with automated skin cancer detection. Nonetheless, most of them are based only on dermoscopic images and do not take into account the patient clinical information, an important clue towards clinical diagnosis. In this work, we present an approach to fill this gap. First, we introduce a new dataset composed of clinical images, collected using smartphones, and clinical data related to the patient. Next, we propose a straightforward method that includes an aggregation mechanism in well-known deep learning models to combine features from images and clinical data. Last, we carry out experiments to compare the models' performance with and without using this mechanism. The results present an improvement of approximately 7% in balanced accuracy when the aggregation method is applied. Overall, the impact of clinical data on models' performance is significant and shows the importance of including these features on automated skin cancer detection.

Keywords

Skin cancer detection,Deep learning,Data aggregation,Clinical images,Clinical information

Title:A de-ann inspired skin cancer detection approach using fuzzy c-means clustering

Manoj Kumar, Mohammed Alshehri, Rayed AlGhamdi, Purushottam Sharma, Vikas Deep

Mobile Networks and Applications 25 (4), 1319-1329, 2020

Abstract

As per recent developments in medical science, the skin cancer is considered as one of the common type disease in human body. Although the presence of melanoma is viewed as a form of cancer, it is challenging to predict it. If melanoma or other skin diseases are identified in the early stages, prognosis can then be successfully achieved to cure them. For this, medical imaging science plays an essential role in detecting such types of skin lesions quickly and accurately. The application of our approaches is to Improve skin cancer detection accuracy in medical imaging and further, can be automated using electronic devices such as mobile phones etc. In the proposed paper, an improved strategy to detect three type of skin cancers in early stages are suggested. The considered Input is a skin lesion image which by using the proposed method, the system would classify it into cancerous or non-cancerous type of skin. The image segmentation is implemented using fuzzy C-means clustering to separate homogeneous image regions. The preprocessing is done using different filters to enhance the image attributes while the other features are assessed by implementing rgb color-space, Local Binary Pattern (LBP) and GLCM methods altogether. Further, for classification, artificial neural network (ANN) is trained using differential evolution (DE) algorithm. Various features are accurately estimated to achieve better results using skin cancer image datasets namely HAM10000 and PH2. The novelty of the work suggests that DE-ANN is best compared among other traditional classifiers in terms of detection accuracy as discussed in result section of this paper. The simulated result shows that the proposed technique effectually detects skin cancer and produces an accuracy of 97.4%. The results are highly accurate compare to other traditional approaches in the same domain.

Title:Deep learning solutions for skin cancer detection and diagnosis

Hardik Nahata, Satya P Singh

Machine Learning with Health Care Perspective, 159-182, 2020

Abstract

Skin cancer, a concerning public health predicament, with over 5,000,000 newly identified cases every year, just in the United States. Generally, skin cancer is of two types: melanoma and non-melanoma. Melanoma also called as Malignant Melanoma is the 19th most frequently occurring cancer in women and men. It is the deadliest form of skin cancer [1]. In the year 2015, the global occurrence of melanoma was approximated to be over 350,000 cases, with around 60,000 deaths. The most prevalent non-melanoma tumours are squamous cell carcinoma and basal cell carcinoma. Non-melanoma skin cancer is the 5th most frequently occurring cancer, with over 1 million diagnoses worldwide in 2018 [2]. As of 2019, greater than 1.7 Million new cases are expected to be diagnosed . Even though the mortality is significantly high, but when detected early, survival rate exceeds 95%. This motivates us to come up with a solution to save millions of lives by early detection of skin cancer. Convolutional Neural Network (CNN) or ConvNet, are a class of deep neural networks, basically generalized version of multi-layer perceptrons. CNNs have given highest accuracy in visual imaging tasks . This project aims to develop a skin cancer detection CNN model which can classify the skin cancer types and help in early detection . The CNN classification model will be developed in Python using Keras and Tensorflow in the backend. The model is developed and tested with different network architectures by varying the type of layers used to train the network including but not limited to Convolutional layers, Dropout layers, Pooling layers and Dense layers. The model will also make use of Transfer Learning techniques for early convergence. The model will be tested and trained on the dataset collected from the International Skin Imaging Collaboration (ISIC) challenge archives.

Keywords

- Neural networks
- Skin cancer
- Deep learning

- Machine learning
- Cancer detection
- Cancer diagnosis
- Convolution neural network
- CNN

Title:Region-of-interest based transfer learning assisted framework for skin cancer detection

Rehan Ashraf, Sitara Afzal, Attiq Ur Rehman, Sarah Gul, Junaid Baber, Maheen Bakhtyar, Irfan Mehmood, Oh-Young Song, Muazzam Maqsood

IEEE Access 8, 147858-147871, 2020

Abstract

Melanoma is considered the most serious type of skin cancer. All over the world, the mortality rate is much high for melanoma in contrast with other cancer. There are various computer-aided solutions proposed to correctly identify melanoma cancer. However, the difficult visual appearance of the nevus makes it very difficult to design a reliable Computer-Aided Diagnosis (CAD) system for accurate melanoma detection. Existing systems either uses traditional machine learning models and focus on handpicked suitable features or uses deep learning-based methods that use complete images for feature learning. The automatic and most discriminative feature extraction for skin cancer remains an important research problem that can further be used to better deep learning training. Furthermore, the availability of the limited available images also creates a problem for deep learning models. From this line of research, we propose an intelligent Region of Interest (ROI) based system to identify and discriminate melanoma with nevus cancer by using the transfer learning approach. An improved k-mean algorithm is used to extract ROIs from the images. These ROI based approach helps to identify discriminative features as the images containing only melanoma cells are used to train system. We further use a Convolutional Neural Network (CNN) based transfer learning model with data augmentation for ROI images of DermIS and DermQuest datasets. The proposed system gives 97.9% and 97.4% accuracy for DermIS and DermQuest respectively. The proposed ROI based transfer learning approach outperforms existing methods that use complete images for classification.

Title:Skin cancer detection: Applying a deep learning based model driven architecture in the cloud for classifying dermal cell images

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Informatics in Medicine Unlocked 18, 100282, 2020

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Skin cancer detection: Applying a deep learning based model driven architecture in the cloud for classifying dermal cell images

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Abstract

Background

Skin cancer is a common form of cancer, and early detection increases the survival rate.

Objective

To build deep learning models to classify dermal cell images and detect skin cancer.

Methods

A model-driven architecture in the cloud, that uses deep learning algorithms in its core implementations, is used to construct models that assist in predicting skin cancer with improved accuracy. The study illustrates the method of building models and applying them to classify dermal cell images.

Results

The deep learning models built here are tested on standard datasets, and the metric area under the curve of 99.77% was observed.

Conclusions

A practitioner can use the model-driven architecture and quickly build the deep learning models to predict skin cancer.

Keywords

Deep learning,AIModel ,driven architecture,Deep cognition studio,CNN,Cancer,Image classification

Title:Intelligent skin cancer detection using enhanced particle swarm optimization

Teck Yan Tan, Li Zhang, Siew Chin Neoh, Chee Peng Lim

Knowledge-based systems 158, 118-135, 2018

Highlights

- We conduct intelligent skin cancer diagnosis using dermoscopic images.
- An enhanced PSO algorithm is proposed for feature selection.
- It integrates subswarms, mutation mechanisms and dynamic matrix representations.
- It follows leaders and avoids enemies in every or randomly selected sub-dimensions.
- It outperforms other optimization methods and related research significantly.

Abstract

In this research, we undertake intelligent skin cancer diagnosis based on dermoscopic images using a variant of the Particle Swarm Optimization (PSO) algorithm for feature optimization. Since the identification of the most significant discriminative characteristics of the benign and malignant skin lesions plays an important role in robust skin cancer detection, the proposed PSO algorithm is employed for feature optimization. It incorporates not only subswarms, local and global food and enemy signals, attraction and flee operations, and mutation-based local exploitation, but also diverse matrix representations to mitigate premature convergence of the original PSO algorithm. Specifically, two remote swarm leaders, which show similar fitness but low position proximity, are used to lead the subswarm-based search and to enable the exploration of more distinctive search regions. Modified velocity updating strategies are also proposed to enable the particles to follow multiple swarm leaders and avoid the local and global worst individuals, partially (i.e. in randomly selected sub-dimensions) and fully (in every dimension), with an attempt to search for global optima. Probability distribution and dynamic matrix representations are used to diversify the search process. Evaluated with multiple skin lesion and UCI databases and diverse unimodal and multimodal benchmark functions, the proposed PSO variant shows a superior performance over those of other advanced and classical search methods for identifying discriminative features that facilitate benign and malignant lesion classification as well as for solving diverse optimization problems with different landscapes. The Wilcoxon rank sum test is adopted to further ascertain superiority of the proposed algorithm over other methods statistically.

Keywords

Skin cancer detection,Feature selection,Evolutionary algorithm,Dermoscopic images

Title:Skin cancer detection by deep learning and sound analysis algorithms: A prospective clinical study of an elementary dermoscope

Avi Dascalu, EO David

EBioMedicine 43, 107-113, 2019

EBioMedicine

Volume 43, May 2019, Pages 107-113

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Abstract

Background

Skin cancer (SC), especially melanoma, is a growing public health burden. Experimental studies have indicated a potential diagnostic role for deep learning (DL) algorithms in identifying SC at varying sensitivities. Previously, it was demonstrated that diagnostics by dermoscopy are improved by applying an additional sonification (data to sound waves conversion) layer on DL algorithms. The aim of the study was to determine the impact of image quality on accuracy of diagnosis by sonification employing a rudimentary skin magnifier with polarized light (SMP).

Methods

Dermoscopy images acquired by SMP were processed by a first deep learning algorithm and sonified. Audio output was further analyzed by a different secondary DL. Study criteria outcomes of SMP were specificity and sensitivity, which were further processed by a F2-score, i.e. applying a twice extra weight to sensitivity over positive predictive values.

Findings

Patients (n = 73) fulfilling inclusion criteria were referred to biopsy. SMP analysis metrics resulted in a receiver operator characteristic curve AUC's of 0.814 (95% CI, 0.798–0.831). SMP achieved a F2-score sensitivity of 91.7%, specificity of 41.8% and positive predictive value of 57.3%. Diagnosing the same set of patients' lesions by an advanced dermoscope resulted in a F2-score sensitivity of 89.5%, specificity of 57.8% and a positive predictive value of 59.9% (P=NS).

Interpretation

DL processing of dermoscopic images followed by sonification results in an accurate diagnostic output for SMP, implying that the quality of the dermoscope is not the major factor influencing DL diagnosis of skin cancer. Present system might assist all healthcare providers as a feasible computer-assisted detection system.

Fund

Bostel Technologies.

Trial Registration clinicaltrials.gov Identifier: NCT03362138

Keywords

Skin cance,rDeep learning,Dermoscopy Sonification,MelanomaTelemedicine,Artificial intelligence.