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A Mobile Application for Detecting Skin Cancer Using Convolutional Neural Networks and Random Forest Algorithm

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Abstract: As Skin is the largest part of body, skin Cancer is the most hazardous disease in the human body. Skin cancer occurs, when malignant tumors form on the skin and it gives protection to the body from heat, Ultraviolet rays and injury for internal organs. The Skin has many layers; the two main layers are epidermis and dermis. The epidermis is the place where malignant cells will beappearing. Melanocytes make melanin and appear in epidermis. Skin cancer diagnosis includes: full skin examination, a biopsy which includes shave biopsy, punch biopsy and excision biopsy. These tests take longer time, while the malignant cells will spread to nearby cells. Advance diagnosis of melanoma is very vital in saving a patient's lives. Although melanoma is a Hazardous disease of skin cancer, it can be treated only if it diagnosed in advance. To address the need for a diagnostic tool that is rapid, accurate, and cost-effective, this study explores the use of automated computer-based methods for skin cancer assessment. In the proposed approach, image pre-processing is applied to the input data to reduce noise and eliminate unwanted visual artifacts. A Convolutional Neural Network (CNN) model is then used to enhance the system's ability to classify and detect skin lesions.Region-based CNN (R-CNN) techniques have demonstrated strong performance in handling large image datasets, achieving reported accuracies in the mid-80% range in prior research. Their precision and consistency make them suitable for assisting with skin cancer identification and lesion categorization. Random Forest (RF) is a widely used ensemble learning algorithm designed for classification and regression tasks. It was introduced as an extension of decision tree algorithms to improve prediction accuracy, reduce over-fitting, and increase robustness. Because of its ability to handle high-dimensional data and noisy features, the algorithm has been extensively applied in medical diagnosis, bioinformatics, image analysis, and other domains requiring reliable predictive performance. Building on these methods, our solution incorporates a cloud-supported mobile application that captures images of suspicious lesions and provides an indication of whether the tumour is likely benign or malignant.
Keywords: Deep Learning, Machine Learning, CNN, Skin Cancer,Transfer Learning

OBJECTIVE

This study aimed to propose a mobile-based application for detecting skin cancer using convolutional Neural Networks and Random Forest algorithms, to help physicians'in diagnosis. If skin cancer is diagnose and treated in an early stage, the survival rate of the patient will be more.Therefore, there must be an application that can make the fastest, most accurate and cheapest diagnosis. Computerized diagnosis can diagnose cancer more effectively and focus on the symptoms of the disease. Our solutions will create a mobile application based on cloud computing application that will take photos of the affected tumor and sends the indication of whether it is malignant or benign. [4]. To develop an accurate and reliable automated system for skin cancer detection by integrating Convolutional Neural Networks (CNNs) for feature extraction and Random Forest (RF) for classification.

This helps us to integrate CNN feature learning with RF decision-making for improved diagnostic accuracy over standalone models.To assess the performance of the hybrid CNN–RF model in detecting malignant vs. benign skin lesions using standard metrics and to develop an efficient and potentially clinically deployable system for early skin cancer detection.

1. INTRODUCTION

In a human body, the largest organ is skin and it is one of the most incurable diseases globally. Skin cancer occurs in skin cells when skin grows abnormally while exposed to the sun. Cancer can affect people of all ages and can be fatal if not treated early. It has the highest mortality rate and the fastest rising and most alarming public health threat. Generally saying, among the three types of skin cancer, melanoma is the worst type of skin cancer occurs in melanocytes, which produce melanin, the coloring agent for skin. The reports show that from a past one decade, the increase in new melanoma cases are 65% high. If skin cancer diagnosed at an advanced stage, the survival rate is less than 13 percentile. The possibility of survival is 99% when we detect cancer in an earlier stage. This scenario urges to find method for the early detection of skin cancer. Few common ways of the first sign of skin cancers can appear include: A lump or patch which is not healing after many days, increasing or changing growth on the skin. Sometimes it looks like a rough or scaly red patch or sore that developed in an old scar. In general, a dermatologist may perform a variety of tests such as a physical examination of the suspicious area, followed by dermoscopy, and finally a blood test. This will take time and patients may progress to later stages. Reports show that even the best dermatologists have a less than 85 percentage accuracy rate in diagnosing skin cancer. Not only are we facing these problems, but there is also a worldwide lack of dermatologists in public health services.

To diagnose skin cancer as early as possible, computer image analysis algorithms can provide the best solutions to the above skin cancer problems. Speed of skin cancer diagnosis can be increased by introducing computer based diagnose. This need will be filled by Artificial Intelligence in Medical field and it plays a vital role. Automated Artificial Intelligence based systems can be developed by Machine Learning and Deep Learning algorithms. Numerous researches investigated about skin cancer analysis using various machine-learning methods. Many classifier skills were used in this machine learning algorithms. A considerable quantity of computational time will be required for precise analysis. This study is about the diagnosis of skin cancer, which can help us find its type and better carry out the necessary prevention work for people's lives. Convolutional Neural Networks can learn directly from the data and it can be used for image recognition and classification. This algorithm is very much helpful in analyzing images. Computer vision is a rapidly evolving field within artificial intelligence (AI) that aims to enable machines to interpret, analyze, and understand visual information in a manner comparable to human perception. Recent advances in deep learning, particularly convolutional neural networks (CNNs) and vision transformers (ViTs), have significantly enhanced the accuracy and scalability of visual recognition systems. This section provides a concise overview of the foundations, methods, and applications of contemporary computer vision. Computer vision focuses on developing computational techniques that allow machines to extract meaningful information from images and videos. By mimicking certain aspects of human visual processing, computer vision systems can recognize objects, detect patterns, and interpret complex scenes. With the exponential growth of visual data and computational power, computer vision has transitioned from rule-based methodologies to data-driven, learning-based frameworks that offer superior performance and generalization capabilities. Random Forest (RF) is a widely used ensemble learning algorithm designed for classification and regression tasks. It was introduced as an extension of decision tree algorithms to improve prediction accuracy, reduce overfitting, and increase robustness. Because of its ability to handle high-dimensional data and noisy features, the algorithm has been extensively applied in medical diagnosis, bioinformatics, image analysis, and other domains requiring reliable predictive performance.

2. LITERATURE REVIEW

In recent years, imaging has become increasing useful in skin cancer diagnostic studies. Many different and specific methods have been tried to diagnose skin cancer. ISIC is also says that the server less mobile application has to be used to detect cancer easily. Researchers are trying to get better the accurateness of skin cancer diagnosis by using various classification algorithms and techniques. With Fukushima and subsequent Le-Cunn's introduction of neural network (CNN) architecture, image classification reached new frontiers.

Alaa Haddad, Shihab, A.Hameed suggested to detect skin diseases by eliminating noise or unnecessary factors. The results of the analysis can encourage doctors to help with an initial diagnosis and understand the type of disease using low-cost diagnostic tests.

Huang et al. [13] suggested a model that is a densely connected convolution network where, each layer was connected to each other layer. All the features of previous layers were utilized as input for another layer. Afta et al. A three-stage in-depth study of the skin lesion is planned. They use transformational learning in their research to obtain learning properties and maps. Sultana et al. advice of CNN-based optimization has improved efficiency of graphics recommendation systems. As per authors, CNN will help in significant developments in copy dispensation. The writers were comparing CNN with other dimensionality reduction techniques, and found that CNN performs well with these approaches. De Angelo et al., suggested a model to filter the region of interest (ROI) of lesions using Deep learning approaches. This work is based on segmenting the lesions border by applying Conditional Random Fields (CRF) algorithm as processing method to improve the segmentation.

Computer vision has evolved from early geometry-based approaches into a core area of artificial intelligence driven primarily by deep learning. The field aims to enable machines to extract, interpret, and act upon visual information in ways that approximate human perception. This literature review synthesizes developments from traditional image-processing methods to modern deep learning architectures, highlighting key models, datasets, and application domains. Random Forest combines a large number of decision trees to form an ensemble model. Instead of relying on a single tree which often overfits RF builds multiple trees and aggregates their predictions through majority voting (for classification) or averaging (for regression).

3. RESEARCH METHODOLOGY AND SYSTEM ARCHITECTURE

3.1 SYSTEM- ARCHITECTURE

The system consists of the following key modules:

3.1.1 Image Acquisition

- Users capture images of skin lesions using the Smartphone camera.
- Images can be either dermoscopic or standard clinical photos.
- The system ensures quality by automatically checking resolution, lighting, and focus.

3.1.2 Image Pre-processing

- Hair Removal: Removes occluding hair using morphological filters.
- Noise Reduction: Eliminates background noise to highlight lesion features.
- Normalization & Resizing: Standardizes images for CNN input.
- Data Augmentation: Enhances training robustness through rotations, flips, brightness adjustments, and scaling.

3.1.3 Feature Extraction Using CNN

- A pretrained CNN (e.g., ResNet50, EfficientNet) extracts hierarchical features from the images.
- Low-level features (edges, textures) and high-level features (lesion patterns, shapes) are learned automatically.
- Intermediate feature maps are flattened to form feature vectors for classification.

3.1.4 Classification Using Random Forest

- The extracted CNN features are input to a Random Forest classifier.
- RF aggregates predictions from multiple decision trees, improving accuracy, generalization, and resistance to overfitting.
- The classifier outputs either:
  - Binary classification: benign vs. malignant
  - Multi-class classification: various types of skin lesions
- Feature importance scores from RF can enhance interpretability by showing which visual features most influenced predictions.

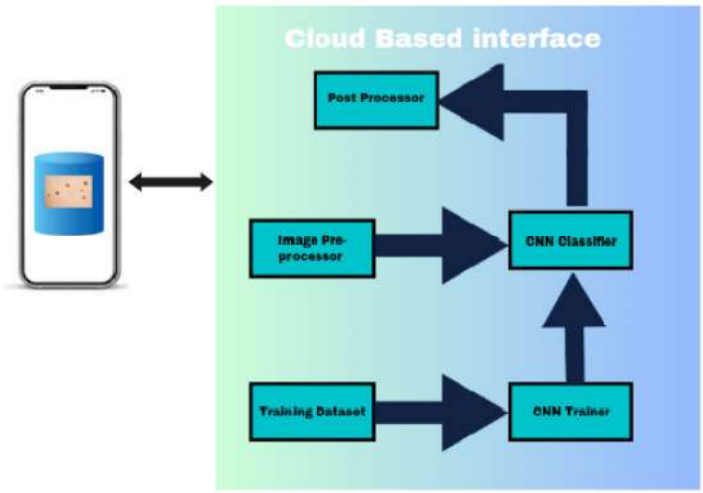

Fig.1 System Architecture

Cloud based Mobile Application system: -

- Users will be registered immediately when they log in first.
- When the photo of skin is uploaded to mobile application, the image will be sent for classification and analysis.
- After the data is loaded, the user must click on the “Classify” option for the CNN classification process.
- Detailed information will be produced after CNN’s distribution.
- These reports will be stored in file as background information that users can view and can help doctors perform analysis.
- Users can also Email the doctors for a second opinion.

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3.1 (b) PROPOSED METHODOLOGY:

Mobile Application consists of a simplified front-end which will be handled by users to enter their information. Skin images can be captured by the mobile camera and these images can be uploaded to the Cloud platform for analysis. The uploaded image has to be not blurred and low quality, otherwise the result will not be accurate.

Mobile Application Integration

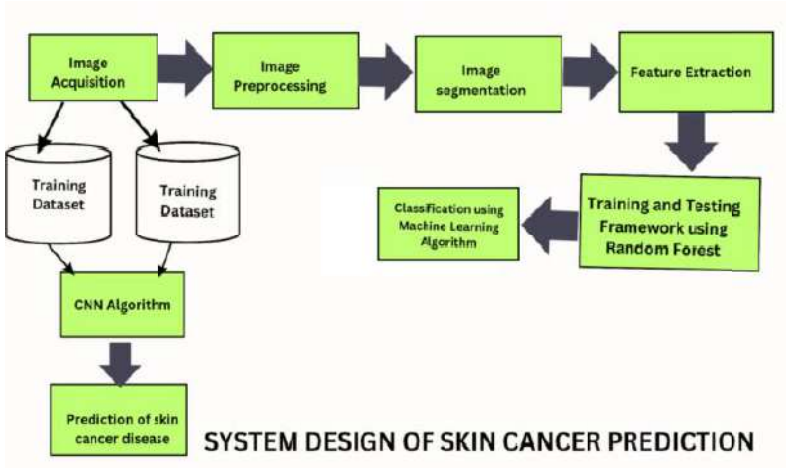
The app provides:

- Image capture or upload functionality.
- Instant predictions with confidence scores.
- Educational resources and guidance for medical consultation.
- Optional cloud processing for large images or model updates while ensuring user privacy.

SYSTEM WORKFLOW

1. User captures lesion image via the mobile app.
2. Preprocessing module cleans and standardizes the image.
3. CNN extracts deep features from the processed image.
4. Random Forest classifier predicts the lesion type.
5. Prediction and guidance are displayed to the user, including confidence level and recommended next steps.

Image classification involves assigning a label to an entire image. Deep CNNs have achieved remarkable success by learning hierarchical feature representations. Object detection extends classificationby simultaneously identifying and localizing multiple objects within a scene. State-of-the-art detectors enable real-time or near real-time deployment in practical environments. Segmentation provides pixel-level understanding and is commonly divided into semantic segmentation (classifying each pixel) and instance segmentation (differentiating individual object instances). In Image pre-processing stage, a Cloud-based Python program is used to standardize the images for finding the type of skin cancer. Sampling stage selects a high quality image from the images given by the user and gives the result immediately and helps us for better accuracy. Transformation stage influences unprocessed data to turn out a particular input. In a de-noising stage, extracts the background noise to identify that selected part of an image alone is being used. Imputation, which synthesizes statically relevant data for missing values. Feature extraction, which segregates a relevant feature subset that is significant in a particular subset that is significant in a particular context. This process has to be repeated for all the images and it keeps on repeating until all the images are fully ready to be processed. The user will get the diagnosis report whether the image is Malignant or Benign. This application will email the results to a doctor, is an added advantage to this mobile application. The cloud-based service uses CNN classifier, Image Net datasets to classify images. The CNN model will be trained using images of benign and malignant tumors retrieved from a reliable open source repository. Depending on the type of skin cancer, individual images will be transferred to the folder. The images then need to be resized so the machine can understand them; this creates a folder containing the resized images in the directory. The cloud-based service uses a model learned by a CNN trainer to classify incoming images as good or bad. Find the mean of all distribution scores based on the total probability with the standard deviation of the parameters.[4]



SYSTEM DESIGN OF SKIN CANCER PREDICTION

3.2. (a) DEEP LEARNING:

Deep learning is a category of machine learning that is essentially a three or multi-tier neural network. A Deep Neural Network consists of multiple layers of switching nodes, where each layer builds on the previous layer to improve and refine the prediction or insight. This calculation process performed by the network is called forward propagation. The process of input and output in deep neural network is called the visualization process. The input layer gives the data processing the deep learning model, and the output layer is the layer where the final prediction or classification is made.

- Deep learning has made great progress in many fields, including image recognition, speech recognition, word processing and word recognition. Some of deep learning methods are Convolutional Neural Networks, Recurrent Neural Networks and Deep Belief Networks.

- Training deep neural networks necessitate more data and resources. However, the ease of use of cloud computing and advances in dedicated hardware such as GPUs have made training deep neural networks less powerful.

3.2 (b) CONVOLUTION NEURAL NETWORK (CNN):

Convolutional neural network (CNN) is used in image recognition and computer vision. Computer-vision is a field of expertise that enables computers and systems to extract valuable information from digital images, videos, and other visual and processing sources and operate on those ideas. CNN algorithm is an algorithm that can classify objects without further extraction because the algorithm already has a learning process. Images obtained from the internet will be used as input, and the process of finding various features and patterns from the input image will continue. This different feature can be seen from the network. CNN captures the difference between space and time. These features are used to distinguish groups of images. VGG16 and LeNet used for image classification. Classification is a type of data analysis that provides models to describe distributions or groups of data. In classification, a classifier or model is created to predict the names of classes. The truth is the matrix that evaluates the results of the distribution model.

3.2.(b).1 STRENGTHS OF CONVOLUTION NEURAL NETWORK (CNN):

Automatic Feature Extraction

Unlike traditional methods requiring handcrafted features, CNNs automatically learn relevant visual features from data.

Hierarchical Learning

CNNs learn progressively from simple patterns (edges, textures) to complex concepts (lesion patterns, tumor shapes).

High Accuracy in Image Classification

CNNs outperform traditional algorithms in tasks like skin cancer detection, face recognition, and object recognition.

Scalability and Transfer Learning

Pretrained CNN models (e.g., VGG, ResNet, MobileNet, EfficientNet) can be fine-tuned for specialized applications such as medical imaging, even with limited datasets.

3.2. (c) TRANSFER LEARNING

Transfer learning of convolutional networks (CNN) has created a field called computer vision by reprocessing pre-trained models of new tasks. The impact of this process on learning from big data is very strong. This will help model training quickly and accurately using some level of registration information. Using CNN pre-training as elimination and fine-tuning network based on specific data. Transformative learning reduces the need for extensive learning time and computing resources. This project explores the concepts, applications, ideas, and implications of transfer learning using CNNs for a variety of computing tasks. The benefit of adaptive learning is that CNNs are trained on large datasets that learn general features relevant to many vision tasks. Instead of using CNN from scratch on new data, instead of learning based on the previously trained CNN and updating it in new data. CNN is pre-trained as a specialized tool to capture high-visibility presentations. These features are then transformed into layers designed for occult work. While the new set is developed, the previously trained set remains unchanged throughout the refinement process.[1]

3.2.(d) RANDOM-FOREST:

The popularity of the Random-forest algorithm is due to its user-friendliness and flexibility, which allows it to solve classification and recovery problems. The success of the algorithm based on its capability to process complex data and minimize over fitting; this makes it essential for many prognostic tasks in machine learning. The main features of the random forest algorithm are that it can process data that changes categorically during the classification process.

3.2.(d).1 STRENGTHS OF RANDOM FOREST

High Accuracy and Robustness

RF typically provides strong baseline performance across many datasets, even when hyperparameters are not heavily tuned.

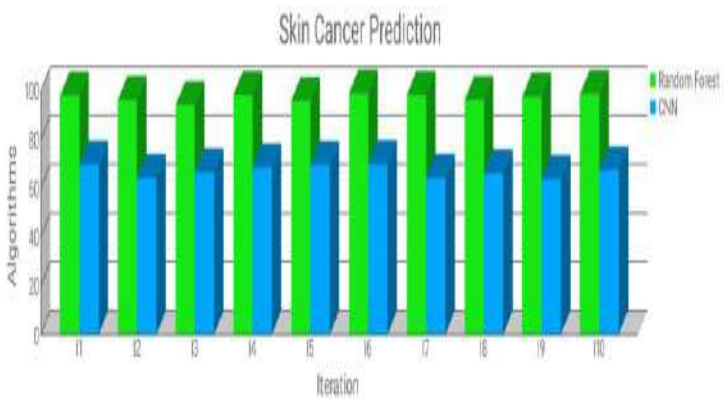
Resistance to Over-fitting

The combination of bagging and feature randomness prevents over-fitting more effectively than a single decision tree.

Handles High-Dimensional and Noisy Data

RF performs well even when the number of features is very large or when irrelevant features exist.

4. RESULTS AND DISCUSSION



In this study, a new CNN based technique is suggested to diagnose skin cancer using the given images. It is clear that this method can achieve the characteristics of skin cancer by using cross-linking to exploit the characteristics of cancer cells in the skin. The figure fig.3 shows the results of CNN and Random Forest Algorithm.

5. CONCLUSION

The development of a mobile application for skin cancer detection using Convolutional Neural Networks (CNNs) and Random Forest (RF) presents an effective, accessible, and practical solution for early diagnosis outside clinical settings. CNNs provide powerful feature extraction capabilities by learning complex visual patterns from dermoscopic or smartphone images, enabling accurate identification of suspicious lesions. When combined with the Random Forest classifier, which offers strong generalization and robustness, the hybrid system achieves enhanced performance compared to using either model independently. Implementing this hybrid approach in a mobile application significantly expands its usefulness. Mobile devices allow real-time, on-the-go screening, making early detection more accessible to individuals in remote areas, underserved communities, or situations where dermatological experts are not readily available. The proposed system aids users in recognizing potentially malignant lesions at an early stage, thus encouraging timely medical consultation and improving the likelihood of successful treatment. This article describes a computer vision basedmodel to detect skin cancer. Here two deep learning models used, LeNet and VGG16 to prepare an automated system. We used approaches like Convolutional neural networks, with Random Forest. The result shows that Random Forest algorithm gives more accuracy than Convolutional Neural Network. This article describes image classification, data analysis, and training to detect cancer cells. In the future, classification of cancer images may be further improved by adding algorithms that will make the results more efficient and effective.

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