

Deep Learning–Based Skin Cancer Detection Using VGG and Inception-V3 with a Web-Based Diagnostic System

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Abstract

Skin cancer is one of the most common and dangerous diseases around the world, and catching it early is very important for helping people survive and making treatment easier. This study introduces a skin cancer detection and diagnosis system that uses deep learning and works online to help identify skin lesions in their early stages. The method uses convolutional neural networks with an Inception structure and transfer learning to automatically find key visual features from images of skin lesions and sort them into malignant or benign categories. The system uses publicly available datasets like ISIC and HAM10000 for training and testing, and data preprocessing and enhancement are used to make the model more reliable. Training the model is done using cloud-based GPU resources to make the process faster and more scalable. The trained model is part of a secure web app that allows users to log in, upload images, see predictions visually, manage their history of results, and get advice on what to do next. The goal of the system is to connect advanced medical diagnosis with easy access to healthcare by offering a dependable, user-friendly, and scalable tool for initial skin cancer screening

Keywords: Skin Cancer Detection, Deep Learning, Convolutional Neural Networks, Inception Models, Transfer Learning, Medical Image Analysis, Web-Based Diagnostic Systems, Artificial Intelligence in Healthcare

1. Introduction

Skin cancer has become a big problem around the world because it's happening more and more often, and if it's not found early, it can lead to serious issues. This happens when skin cells start growing in an unhealthy way, usually because of long-term exposure to the sun's harmful rays or other environmental factors. Even though skin cancer can be seen on the outside, it's often not noticed at first because people may not know enough about it, might confuse its signs with something else, or there may not be enough good doctors to check for it, especially in places that are not well developed or in rural areas. Skin cancer is generally split into two main groups: melanoma and non-melanoma.

Melanoma is the worst type and causes most of the deaths from skin cancer. Non-melanoma types like basal cell carcinoma and squamous cell carcinoma are more common, but they can still cause serious damage if not treated. Finding skin cancer early and making the right diagnosis is very important, as it affects how well a person can be treated and how long they might live.

Doctors usually look at skin lesions with the naked eye, use special tools called dermoscopes, or take small tissue samples for testing.

While taking a tissue sample can tell for sure if there's cancer, it's not very convenient because it's painful, expensive, and takes time. Also, the way doctors make a diagnosis can vary depending on their experience. These challenges show why there's a need for better, easier tools that can help with early checks.

New technologies in artificial intelligence and deep learning are helping in medical image analysis. These models, especially convolutional neural networks, are good at understanding complex patterns in images like skin lesions. In the field of skin cancer, these AI models have shown good accuracy that's almost as good as human doctors, which suggests they could be very useful in helping to diagnose skin cancer. This study is about making a complete system for detecting skin cancer that uses deep learning and a web application.

By using Inception-based models and transfer learning, the system can classify skin images effectively without needing a lot of training data. The web app makes it easy for people to upload images and get automatic results along with helpful advice. This system is meant to help with early detection and raise awareness, but it's not meant to replace professional medical care. It aims to help in preventing skin cancer through easy-to-use, smart technology.

REVIEW OF LITERATURE

Recent improvements in artificial intelligence have had a major impact on medical image analysis, especially in detecting skin cancer. Early studies showed that convolutional neural networks (CNNs) are very good at learning complex visual patterns from images of skin lesions. These studies found that CNN-based models can detect important characteristics like color changes, irregular borders, and texture, which are key signs of cancerous skin growths. These results showed that deep learning could be a strong alternative to older, manual ways of diagnosing skin conditions.

Later research tried to solve the problem of not having enough labeled medical data by using transfer learning.

Models like Inception, VGG, and ResNet, which were first trained on large image datasets, were then adapted for skin cancer classification. This approach helped improve performance and cut down on training time. Researchers noted that transfer learning helps models learn better by using knowledge from big image databases, which is especially useful in real medical settings where data is often limited. Many studies used public datasets like ISIC and HAM10000 to test how well models could classify different types of skin cancer. Although these models achieved high accuracy, they also faced issues such as uneven distribution of data and possible biases in the datasets. To handle these problems, methods like data augmentation, balanced sampling, and ensemble learning were introduced. These techniques helped make the models more reliable and better at handling a wide range of skin lesions.

Newer research highlights the need to use AI models in web-based diagnostic tools to make skin cancer detection more widely available. These online systems let users upload images and get automated results without needing special equipment. However, many current systems don't have strong security measures, clear explanations of how they work, or easy-to-use interfaces. This lack of practical implementation drives the development of a complete, secure, and user-friendly deep learning system for skin cancer detection, as suggested in this study.

METHODOLOGY

The proposed skin cancer detection system uses a clear method that combines deep learning for image classification with a web-based diagnostic tool. This method is designed to ensure accurate analysis of skin lesions, efficient model training, and practical use in real healthcare settings.

1. Data Collection

Skin lesion images are collected from publicly available and widely accepted medical datasets like ISIC and HAM10000.

These datasets include labeled images of various skin conditions such as melanoma, basal cell carcinoma, and benign lesions. The use of expert-annotated data ensures reliability and is suitable for training deep learning models.

2. Data Preprocessing

To improve model performance and consistency, all images go through preprocessing steps.

Images are resized to fit the input requirements of the deep learning models. Pixel values are normalized to make training more stable, and noise reduction is used to make images clearer. Techniques like rotation, flipping, zooming, and adjusting brightness are also used to increase dataset diversity and reduce overfitting.

3. Deep Learning Model Selection

The system uses two strong convolutional neural network models: VGG and Inception-V3.

VGG is chosen for its deep and uniform structure, which helps capture detailed features like texture and edges in skin lesions. Inception-V3 is selected because it can extract features at different scales using parallel filters, making it good for lesions of various shapes and sizes.

4. Transfer Learning Strategy

Transfer learning is applied by starting with pre-trained ImageNet weights for both VGG and Inception-V3.

The initial layers are kept fixed to maintain general visual features, while the higher layers are adjusted using the skin cancer dataset. This helps reduce training time and improves accuracy, especially when there is limited medical data available.

5. Model Training

Model training takes place using Google Colab, which uses cloud-based GPU power.

The dataset is split into training, validation, and testing groups. The Adam optimizer is used for efficient weight updates, and categorical cross-entropy is the loss function. Techniques like early stopping and learning rate scheduling are used to avoid overfitting and ensure stable model performance.

6. Model Evaluation

The models are tested on new data to check their performance. Accuracy, precision, recall, F1-score, and confusion matrices are used to evaluate results. Comparing VGG and Inception-V3 helps find the best model for skin cancer classification.

7. Web Application Integration

The best model is integrated into a web app built on Flask. Users can upload skin lesion images, which are processed and analyzed by the trained model. The backend handles image processing, prediction, and result generation, while the frontend shows the classification results in an easy-to-understand way.

8. Result Presentation and Guidance

The system provides prediction results, along with confidence scores and suggestions for next steps. These results help users understand the seriousness of the condition and encourage them to seek medical advice if needed.

OBJECTIVES & APPLICATION

The main goal of this proposed skin cancer detection system is to create an automatic and dependable method for early skin cancer detection using advanced deep learning methods. The system is designed to correctly identify different types of skin lesions, such as melanoma, basal cell carcinoma, and benign spots, which can be hard to tell apart just by looking. By using deep learning techniques like VGG and Inception-V3, the system aims to reduce mistakes made by humans in diagnosis and give consistent, accurate results, helping doctors and medical staff make better decisions. The system also focuses on making the model training and optimization process efficient, so it can achieve high accuracy even when working with small medical data sets.

Another key goal is to build a practical and easy-to-use web-based platform that lets users upload images of skin lesions for quick analysis.

This platform is designed to give detailed predictions, along with confidence scores and advice on what to do next, making it useful for both medical professionals and regular people. By combining the trained deep learning models with an easy-to-navigate web interface, the system allows for real-time image processing and predictions, so users get immediate feedback about the possible seriousness of their skin issues. This goal highlights the focus on making the technology user-friendly and accessible, connecting powerful AI tools with everyday healthcare needs.

The system has many useful applications that make a real difference, especially in early detection and management of skin cancer.

It can help dermatologists quickly examine and classify skin lesions more accurately. The system also offers a self-check feature for individuals, allowing them to keep track of their skin health and spot unusual changes early on. It can be used for large-scale screening in areas where there are not enough dermatologists. Additionally, the system has value in medical research and teaching, offering a reliable way to study skin lesion patterns and train healthcare workers. Its integration into telemedicine services also makes it possible to offer remote consultations and diagnoses, making dermatological care more widely available to people in underserved areas.

TECHNICAL CAPABILITIES

i. TECHNOLOGICAL ADVANCEMENT

Recent progress in deep learning, computer vision, and web development has greatly changed how medical images are analyzed, especially in detecting skin cancer. Modern models like VGG and Inception-V3 use convolutional neural networks to automatically recognize complicated visual details

such as color differences, texture, shape, and uneven borders in images of skin lesions. These models do better than older machine learning methods because they can learn complex patterns directly from images, which improves how accurately and reliably skin cancer can be diagnosed.

Another big improvement is the use of transfer learning, which lets pre-trained models be adjusted for medical tasks even when there isn't a huge amount of data.

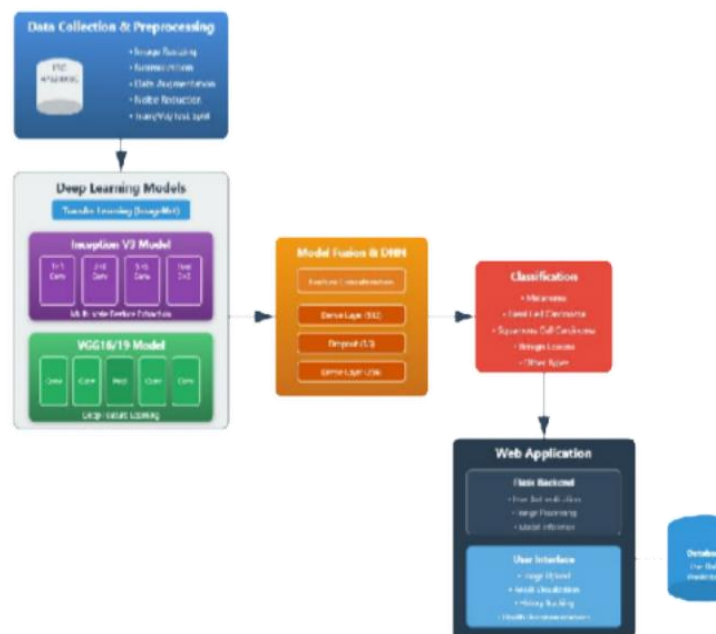
This helps cut down on training time, costs, and the need for large datasets while still keeping the models effective. Also, using cloud-based tools like Google Colab with GPU power has made it easier and more efficient to train large models at scale.

When it comes to putting these models into use, combining them with web frameworks like Flask makes it possible to offer real-time diagnosis through simple, user-friendly websites. Features like secure login, managing data safely, and using responsive design also make these systems more usable and protect sensitive information. Together, these advances help create healthcare systems that are efficient, easy to use, and capable of supporting early skin cancer detection and prevention.

ii. FUNCTIONALITY

The proposed skin cancer detection system is an intelligent, web-based tool that helps with diagnosing skin conditions. It uses deep learning combined with an easy-to-use interface. Users can sign up and log in securely before uploading images of skin lesions through the website. Once an image is uploaded, it goes through some steps like resizing, adjusting brightness, and improving quality to make sure it works well with the deep learning models.

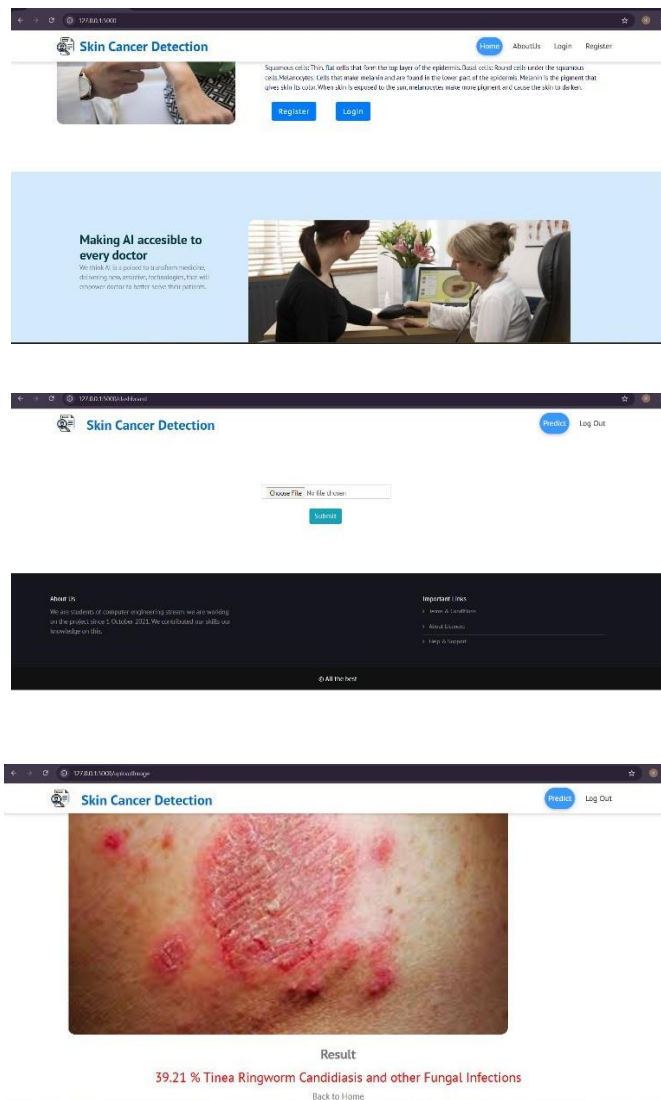
The image is then analyzed using deep learning models called VGG and Inception V3.



These models look for important visual features like color, texture, shape, and irregular borders. Based on these features, the system determines whether the image shows signs of skin cancer or a non-cancerous condition. The results, along with how confident the system is in its findings, are clearly shown to the user. The system also keeps a record of all the images and predictions users have made, so they can refer back to them later. It also gives users advice on how to take care of their skin and when to see a doctor. The main goals of the system are to be accurate, easy to use, secure, and helpful. It's meant to be a useful first step in checking for skin cancer.

iii. USER INTERFACE & EXPERIENCE

The interface of the skin cancer detection system is made simple, easy to use, and accessible for people with different levels of knowledge about technology and medicine. The design has a clean and not too busy look, which helps users move through the steps easily. It has clearly marked buttons for signing up, logging in, uploading images, and viewing results. The system walks users through each part of the process, making it easier to follow and less likely they will make mistakes. The design uses consistent visuals, easy-to-read fonts, and colors that are pleasant to look at, which is especially important for health-related tools.



From the user's point of view, the system is built to be fast, clear, and trustworthy. Uploading images and getting results is done quickly so users don't have to wait long. The results are shown in a clear way, including what kind of skin condition was found, how confident the system is about it, and some tips for taking care. If something goes wrong, like uploading an image that is not suitable, the system gives helpful messages to let users know what's wrong. As a whole, the system is made to be dependable, easy to use, and helpful, so users feel comfortable using it and understand that it is just a first step in checking for skin issues, not a substitute for seeing a doctor.

POTENTIAL CONSTRAINTS

i. CHALLENGES

Creating a skin cancer detection system using deep learning faces several technical and real-world issues. One big problem is that the data sets used are often unbalanced. These sets usually have more pictures of non-cancerous skin spots than cancerous ones. This can make the system less accurate at identifying the more serious cases. To fix this, special steps must be taken to prepare and improve the data.

Another issue is the difference in image quality. Skin lesion images can vary a lot in how bright they are, how clear they are, and even the background they're taken on. These differences can make it harder for the system to work well and predict accurately in all situations.

To handle this, strong techniques are needed to clean and standardize the images before they're used. The system can also become too focused on the training data, which is a problem called overfitting. This happens when there's not enough labeled medical data to train the system properly. Even with methods like transfer learning and regularization, it's still difficult to get the system to work well on new, unseen data. Training these models also uses a lot of computer power, so using powerful cloud-based systems with graphics processing units (GPUs) is often needed.

Lastly, there are important privacy and ethical issues. Medical images include personal and sensitive information, so it's crucial to keep them secure and follow strict privacy rules. Also, users might misunderstand the system's predictions, so it's important to make it clear that the tool is meant for initial screening and not for replacing professional medical advice.

ii. LIMITATIONS

Even though the deep learning-based skin cancer detection system works well, there are some important things to consider. The system's performance depends a lot on the quality of the images used. If the images are not well-lit, blurry, have shadows, or are out of focus, the system might not give accurate results. Because users upload their own photos taken with different devices, it's hard to keep the image quality consistent across all cases.

Another issue is that the deep learning models, like VGG and Inception V3, are trained on public datasets.

These datasets might not cover all the different skin types, tones, and rare conditions that exist in the real world. This can limit how well the model works when it's used on people who aren't in the training data. While the system can give accurate predictions, it can't take the place of professional medical exams or procedures like biopsies. The results should be seen as a starting point, not a final diagnosis.

Also, deep learning models are often hard to understand, which is called the "black-box" problem. This makes it difficult for users and doctors to know why the model makes certain predictions. That can reduce trust and slow down the use of the system in real medical settings. If the system is used on a large scale, there might also be problems with the computer resources needed, especially if the system isn't properly set up to handle a lot of users at once.

Result And Discussion

The proposed deep learning-based system for detecting skin cancer works well in sorting images of skin lesions into groups of harmful and harmless types using VGG and Inception-V3 models. During testing, both models were good at learning key visual details like color changes, texture problems, and the edges of the lesions. Inception-V3 performed better in correctly identifying the lesions and adapting to new

cases because it can look at features at different sizes. VGG, on the other hand, gave steady and dependable results because it has a simpler design. Using transfer learning helped speed up the training process and made the models reach good performance faster, even when there wasn't a large amount of data available. The results from the experiments show that this system can help in early detection of skin cancer by offering trustworthy predictions through a web interface. The system uses steps to clean and improve images, which makes it more reliable when dealing with different image qualities and lighting situations. From a practical point of view, the web app allows users to easily upload images, get quick results, and see the outcomes.

FUTURE SCOPE

The proposed skin cancer detection system can be improved in several useful ways to boost its accuracy, ease of use, and impact in real-life situations. One key step is to include bigger and more varied datasets that include different skin tones, ages, and areas from around the world. This will help make the system less biased and more effective at working with a wide range of people. Also, using better data enhancement and methods to balance different types of cancer in the data can help the system perform better, especially for less common and serious cancer types.

Another important area for improvement is using explainable AI techniques like Grad-CAM and heatmaps. These tools can show which parts of a skin image are important for the system's decision, making it more transparent and trustworthy for doctors and users. The system could also use a mix of different models, such as VGG and Inception V3, to make it more accurate and reliable. From a practical point of view, the system could be made into a mobile app, letting users take pictures directly with their phone cameras for quick analysis. Connecting the system with telemedicine services would allow patients to get advice from dermatologists based on the system's findings. Also, adding features that let the model learn from new data over time would help it stay up-to-date and useful in both clinical and everyday healthcare settings.

CONCLUSION

This study introduced a skin cancer detection system that uses deep learning combined with a web-based platform to help identify and raise awareness about skin cancer early on. The system uses advanced neural network designs like VGG and Inception V3, which allow it to learn detailed visual characteristics from images of skin lesions, such as different colors, texture patterns, and irregular shapes. Transfer learning was used, which made the model easier to train and improved its ability to classify skin conditions, even when there wasn't a large amount of medical data available.

The trained models were then included in an easy-to-use web application, making the research more practical and useful. Users can upload their skin images securely and get quick, automatic predictions along with some general advice on what to do next. This method makes early screening more accessible, especially for people in areas that don't have easy access to dermatologists. It's important to note that this system isn't meant to replace professional medical diagnosis, but rather to support doctors and help people be more aware of skin cancer. The results show how combining deep learning with web technology can help improve preventive healthcare. Overall, the study shows how effective and useful AI can be in skin cancer detection, and sets a solid base for more advanced medical diagnostic systems in the future.

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