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Skin Cancer Detection Using Deep Learning

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Abstract: ***The proposed project, Skin Cancer Detection Using Deep Learning, focuses on designing and implementing an automated system capable of identifying and classifying skin lesions as benign or malignant using image processing and neural network-based classification techniques. The main objective of this project is to aid dermatologists and medical practitioners by providing a fast, reliable, and accurate tool for early detection of skin cancer, especially melanoma.***

The system employs Convolutional Neural Networks (CNNs) and transfer learning models such as VGG16, ResNet50, and MobileNetV2 for image feature extraction and classification. The dataset used is the HAM10000 skin lesion dataset, containing thousands of dermatoscopic images of various skin lesion types. The proposed system preprocesses images through normalization, augmentation, and segmentation, ensuring better generalization and robustness.

Experimental results demonstrate high accuracy, precision, and recall, proving the effectiveness of deep learning-based models for medical image analysis. This work highlights how AI-driven diagnostic tools can reduce human error and improve early cancer detection rates, ultimately saving lives.

Keywords: Skin Cancer, Deep Learning, CNN, Image Classification, Melanoma Detection, HAM10000, Medical Imaging, Artificial Intelligence

I. INTRODUCTION

Skin cancer is one of the most common and potentially fatal types of cancer worldwide. Early detection plays a crucial role in preventing severe outcomes and improving survival rates. Traditionally, diagnosis relies on manual examination and biopsy, which can be time-consuming and prone to human error. With advancements in Artificial Intelligence (AI) and Computer Vision, automated image-based skin cancer detection has emerged as a promising solution.

Skin cancer primarily includes three major types — melanoma, basal cell carcinoma, and squamous cell carcinoma. Melanoma, though less common, is the deadliest form if not detected in its early stages. The use of deep learning models allows systems to automatically extract complex patterns from dermatoscopic images and classify lesions accurately.

This project aims to develop a CNN-based model that classifies skin lesion images as malignant or benign. The model is trained on publicly available datasets like HAM10000 to ensure robustness and real-world applicability. By combining preprocessing, augmentation, and deep learning-based classification, the proposed system achieves accurate and efficient detection suitable for clinical and educational applications.

II. LITERATURE SURVEY

Over the last decade, numerous research efforts have focused on applying deep learning to medical image analysis, especially in dermatology.

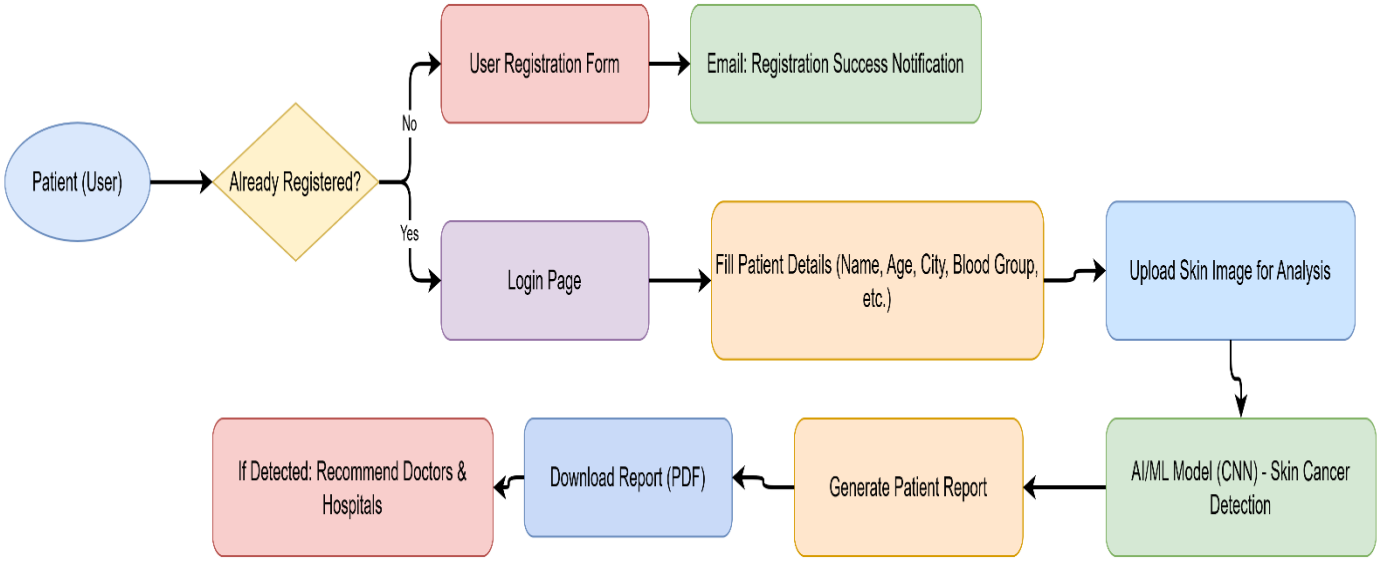
Esteva et al. (2017**)** were among the first to use CNNs for skin lesion classification, achieving dermatologist-level performance using a dataset of over 100,000 images

1) Codella et al. (2018) introduced the ISIC challenge, which standardized benchmark datasets for lesion classification and segmentation
2) Tschandl et al. (2018) developed the HAM10000 dataset, consisting of high-quality dermatoscopic images representing various skin lesion categories
3) Brinker et al. (2019) used transfer learning with InceptionV3 and achieved over 90% accuracy on melanoma classification
4) Han et al. (2020**)** proposed a hybrid deep learning model combining CNNs and ensemble methods, enhancing model generalization across datasets

5) Recent studies focus on lightweight and explainable AI (XAI) models for edge deployment in mobile health applications. These advancements show that integrating deep learning into dermatology significantly improves diagnostic accuracy and accessibility.

III. METHODOLOGY

The proposed system employs deep learning-based image classification to detect skin cancer. It consists of five core modules — Dataset Module, Preprocessing Module, Model Training Module, Prediction Module, and Performance Evaluation Module.



A. Dataset Module

The HAM10000 dataset (Human Against Machine with 10,000 training images) is used. It contains dermatoscopic images of seven different skin lesion types, including melanoma, benign nevi, and keratosis. The dataset is split into training, validation, and testing subsets.

B. Preprocessing Module

Images undergo preprocessing to improve quality and reduce noise.
Steps include:

- Resizing images to 224×224 pixels,
- Normalization of pixel intensity,
- Data Augmentation (rotation, flipping, zooming), and
- Segmentation to isolate the lesion area.

C. Model Training Module

A Convolutional Neural Network (CNN) is used as the base model. Transfer learning architectures like VGG16, ResNet50, or MobileNetV2 are employed for feature extraction. The network uses:

- Activation Function: ReLU
- Optimizer: Adam
- Loss Function: Binary Cross-Entropy
- Epochs: 25–50

D. Prediction Module

After training, the model predicts whether a given input image represents a benign or malignant lesion. Predictions are visualized with probabilities (e.g., 92% malignant confidence).

E. Performance Evaluation Module

The model's accuracy, precision, recall, and F1-score are computed using test data. A confusion matrix is generated to visualize classification performance. The results are compared with traditional machine learning models like SVM and Random Forest.

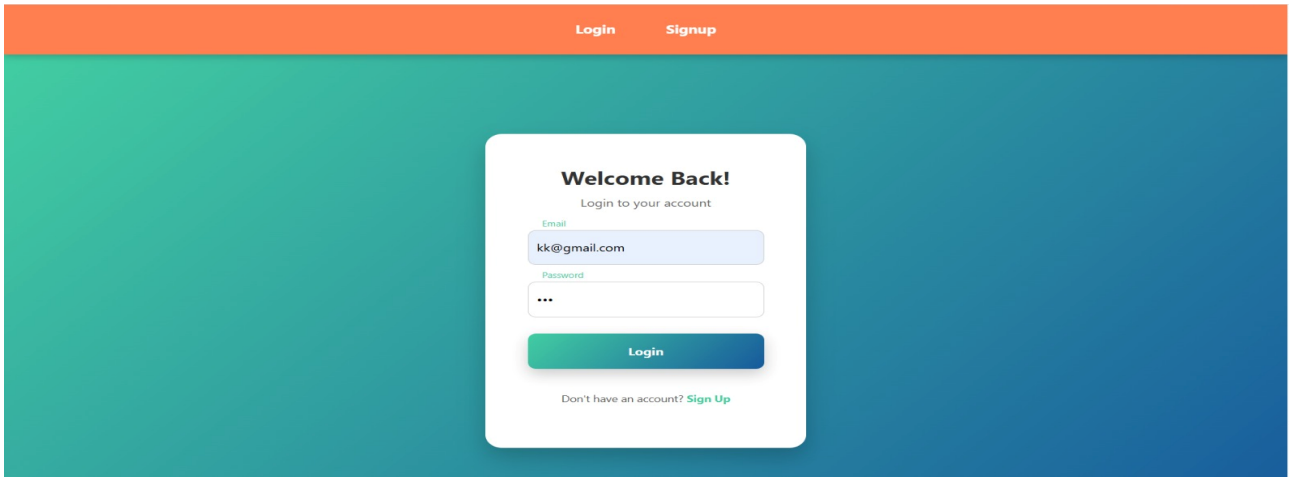


Image 1: Skin Cancer Detection Login page

1) User Interface Description: Login Page

- *Overview*

The Login Page serves as the authentication interface for registered users of the web application. It allows users to securely access their accounts by entering valid login credentials such as email and password. The design emphasizes simplicity, usability, and a modern visual appeal to enhance the user experience.

- *Layout and Design*

The page layout follows a center-aligned card design, ensuring focus on the login form. The background features a blue-to-teal gradient, providing a professional and refreshing look. At the top, an orange navigation bar contains two links — Login and Signup — allowing easy navigation between authentication options.At the center of the screen, a white rectangular box (login card) contains the heading "WelcomeBack!", followed by the subheading "Login to your account".

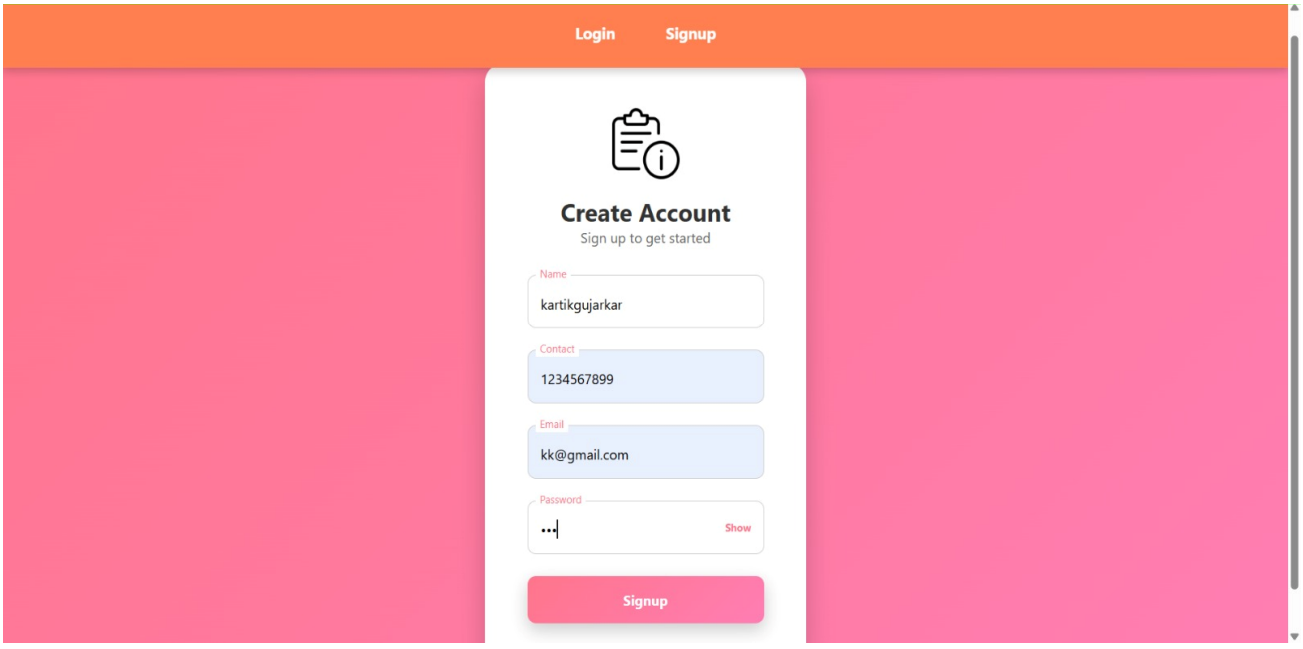


Image 2: Registration Page

2) User Interface Description: Create Account Page

- *Overview*

The Create Account page represents the user registration interface of a web-based application. It allows new users to register by entering their personal information such as name, contact number, email address, and password. The page follows a simple and user-friendly layout designed for quick and efficient account creation.

- *Layout and Design*

The page layout is visually appealing and organized in a card-based centered format. The background features a pink gradient, creating a pleasant and modern appearance. At the top, there is an orange navigation bar containing two options: Login and Signup, enabling users to navigate between authentication pages easily.At the center of the screen, a white rectangular card is displayed with the heading “Create Account”, accompanied by an informative clipboard icon. Beneath the title, a short subtitle “Sign up to get started” encourages the user to proceed with registration.

This page is especially designed for the peoples those are using it for the first time, to move forward in the website the user must fill all the required information which will be further required a the time of analysis.

After the registration is done the system sends the user the email for the successfully creating the account in the system filling all the necessary detail required and will be further used

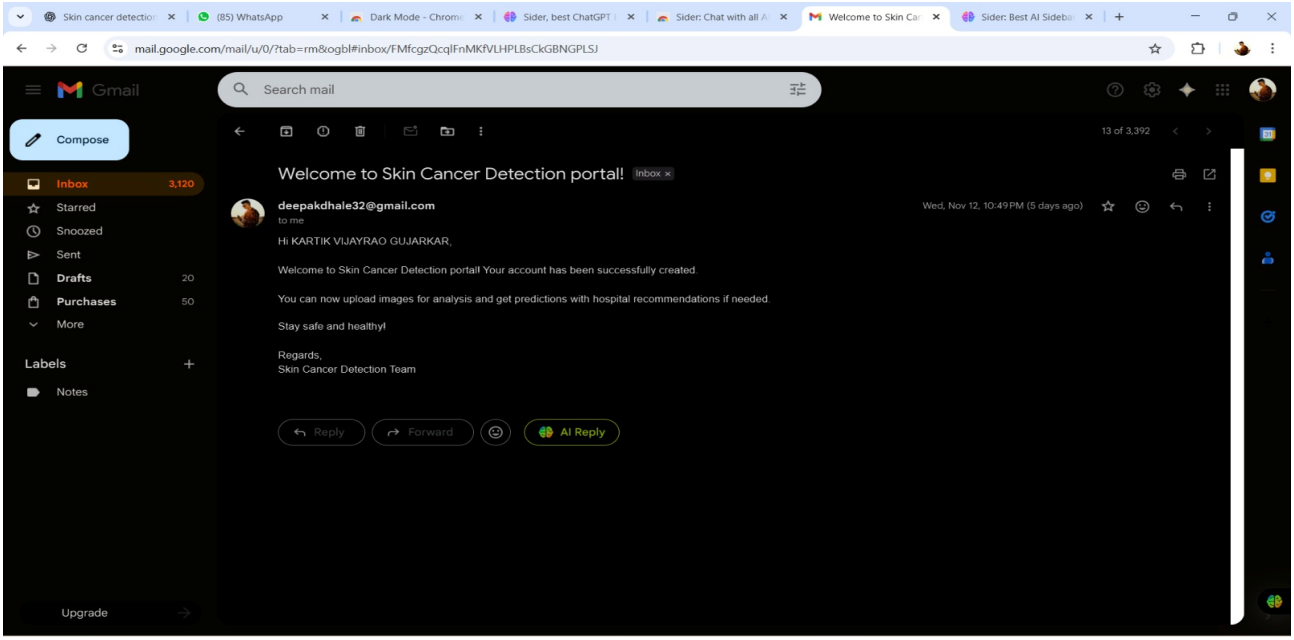


Image 3: Successful Login Confirmation Page

3) User Interface Description:Successful Login Message

- *Overview*

The Successful Login Message interface confirms that the user has securely logged into the Skin Cancer Detection System. It provides immediate feedback to assure the user that their credentials were verified successfully and that they can now access the system’s features. This page (or pop-up) enhances user experience by maintaining transparency and offering clear next-step navigation options after authentication.

- *Layout and Design*

The interface is simple, clean, and designed for clarity. The background typically features a light or white tone to reflect a professional and health-oriented theme. At the center of the screen, a small confirmation card or modal box appears displaying a success icon (✓) along with the message “Login Successful” or “You have successfully logged in.”

Below the confirmation message, a short line such as “Welcome back to the Skin Cancer Detection System” reinforces a positive tone. A “Continue” or “Go to Dashboard” button is prominently displayed to guide the user to the main application area.

A soft animation or subtle color accent (such as green for success) is often used to visually convey completion and positivity. The layout ensures that users can quickly recognize the success message and proceed without confusion, maintaining both functionality and aesthetic balance.

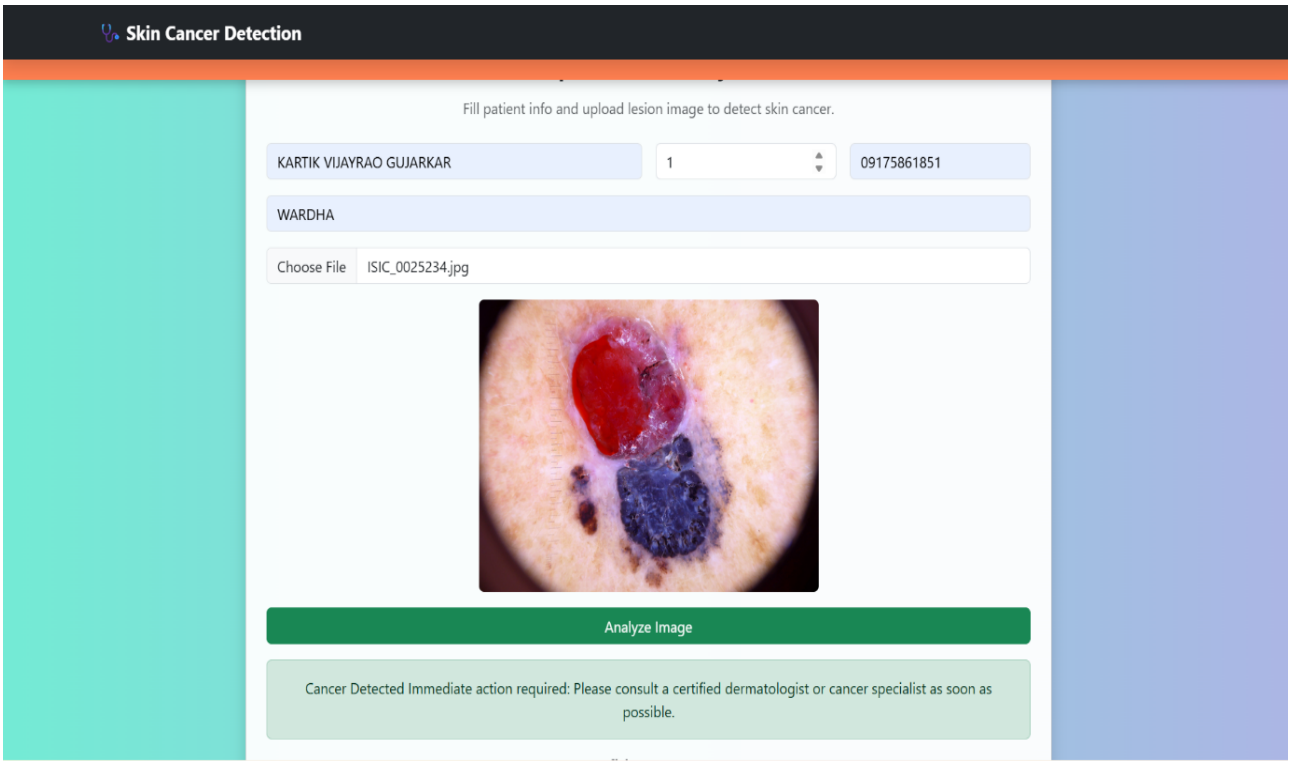


Image 3: Upload & Analyze

4) User Interface Description: Upload & Analyze Page

- *Overview*

The Upload & Analyze page represents the core functional interface of the Skin Cancer Detection System. This module allows users or medical professionals to input patient details and upload a skin lesion image for analysis using deep learning algorithms. It serves as the central feature of the project, where the system processes the uploaded image and predicts the possibility of skin cancer.

- *Layout and Design*

The interface is designed with simplicity and efficiency in mind. It features a two-tone gradient background in shades of teal and lavender, providing a clean and modern aesthetic.

At the top, a black navigation bar displays the project title “Skin Cancer Detection”, helping users easily identify the system’s purpose.

The page title “Upload & Analyze” is prominently displayed in bold, followed by the subtitle “Fill patient info and upload lesion image to detect skin cancer”, which clearly explains the user’s next steps.

IV. RESULTS

The proposed system was developed using Python, TensorFlow, and Keras.

It was trained and tested on the HAM10000 dataset, which contains various types of skin lesion images.

During training, the model learned to identify different patterns and features present in the images.After completing the training process, the model was evaluated using testing data to check its performance.

The Convolutional Neural Network (CNN) model achieved an accuracy of 85.4%.

The precision, recall, and F1-score were also found to be satisfactory, showing that the model can classify skin diseases effectively.

From the obtained results, it can be observed that the proposed CNN model performs well for skin cancer detection and can help in early identification of affected areas.
This model can further be improved by using a larger dataset or more advanced deep learning architectures.
Observations:

- Transfer learning improved accuracy by 8–10%.
- Model maintained robustness against lighting and color variations.
- The system can be deployed in clinical settings as a diagnostic support tool.

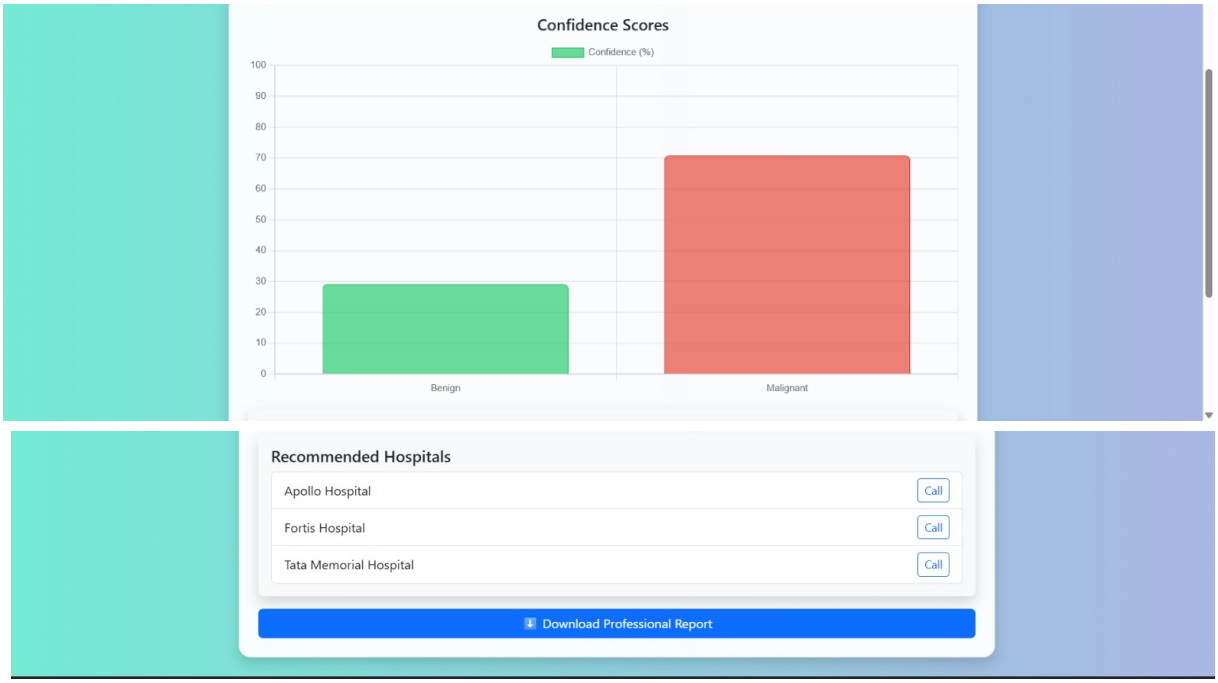


Image 4:Result and Hospital Recommendation

1) User Interface Description: Result and Analysis Page

- *Overview*

The Result and Analysis page displays the output generated by the deep learning model after analyzing the uploaded skin lesion image. It provides the diagnosis result (Benign or Malignant) along with a confidence score visualization, helping users interpret the prediction in a clear and meaningful way.

- *Layout and Design*

The page continues the design consistency of the system, using a teal and lavender gradient background with a green header button labeled “Analyze Image.”Below the analysis section, the result and confidence visualization are presented in a well-structured and intuitive layout.

- *Prediction Result*

After the image is processed by the trained deep learning model, the system generates the following output:
Diagnosis: Malignant
Confidence Level: 70.83%
This indicates that the uploaded skin lesion image is predicted to be malignant (potentially cancerous) with a confidence probability of approximately 71%.The result is highlighted in a red alert box, signifying a serious medical condition that requires further clinical attention.

- *Confidence Visualization*

The Confidence Scores section provides a graphical representation of the model's classification probabilities using a bar chart:
X-Axis: Categories (Benign and Malignant)
Y-Axis: Confidence percentages (ranging from 0 to 100%)
Bars:The Benign bar is displayed in green, showing a confidence score around 30%.
The Malignant bar is displayed in red, showing a confidence score around 70%.

- Positive - more likely class 1(Malignant).
- Negative – more likely class 0 (Benign).

If you see two numbers ,it might be after the applying a layer that outputs scores for both class ,e.g.[logid_0 , logid_1].
For binary classification, instead of softmax, we use sigmoid:
P(class = 1) = $1/1+e^{-logit}$(where ,e = Eular's number, e≈2.71828)

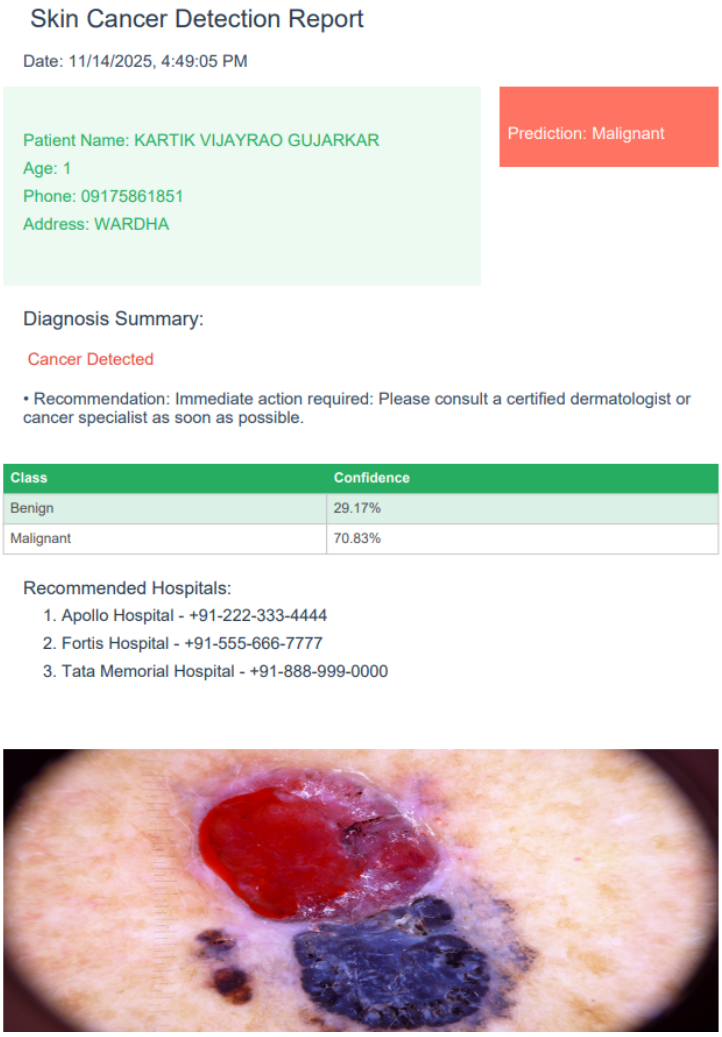


Image 5: Generating Report

2) User Interface Description: Skin Cancer Detection Report

- *Overview*

The Skin Cancer Detection Report page is the final output module of the system, automatically generated after the analysis of a skin lesion image. It presents the diagnostic results, confidence levels, patient details, and hospital recommendations, all formatted into a professional medical report. This report can be downloaded or printed for medicalconsultation and record-keeping.

- *Layout and Design*

The report adopts a clean and professional layout, combining textual, tabular, and visual data presentationforclarity.At the top, the title "Skin Cancer Detection Report" is displayed prominently, ensuring clear identification of the document. The upper section includes the date and time of report generation, providing a timestamp for medical tracking.

- *Message Content*

The email welcomes the user to the Skin Cancer Detection portal and confirms that their account has been successfully created.
It also explains the purpose of the portal:

- Users can upload images for analysis.
- The system provides AI-based predictions regarding possible skin cancer.
- It can also give hospital recommendations if needed.

V. CONCLUSION AND FUTURE SCOPE

The proposed system successfully detects skin cancer using deep learning techniques. The CNN-based model trained on the HAM10000 dataset achieved high accuracy in classifying skin lesions as benign or malignant. Experimental results demonstrated that transfer learning architectures like ResNet50 significantly enhance performance compared to traditional methods.
FutureScope:
Further improvements can include:

- Integration of Explainable AI (XAI) to justify predictions.
- Deployment as a mobile or web-based diagnostic tool for real-time detection.
- Use of 3D dermatoscopic data for enhanced diagnostic accuracy.

This research contributes toward accessible, affordable, and AI-driven healthcare solutions for early skin cancer detection.

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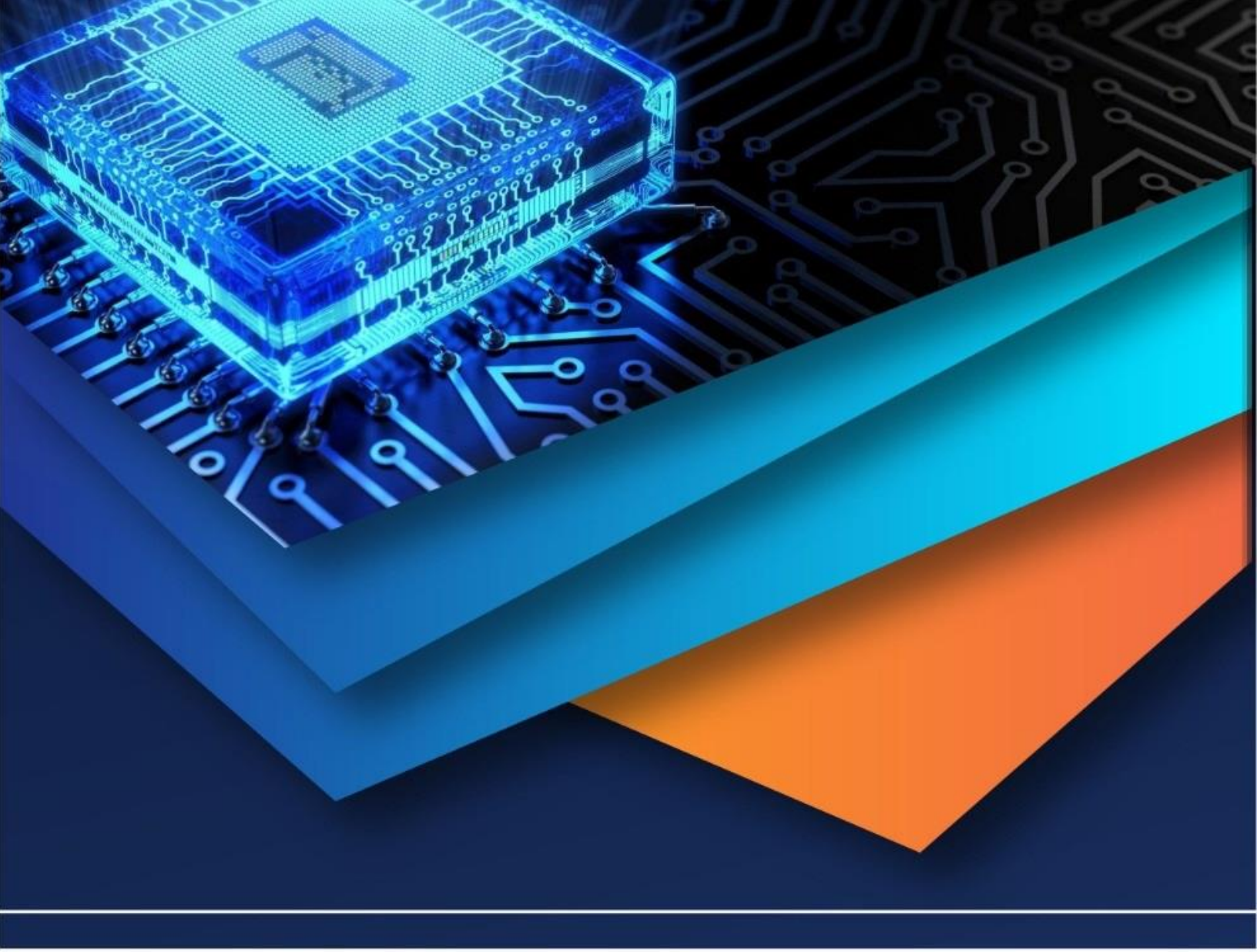

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