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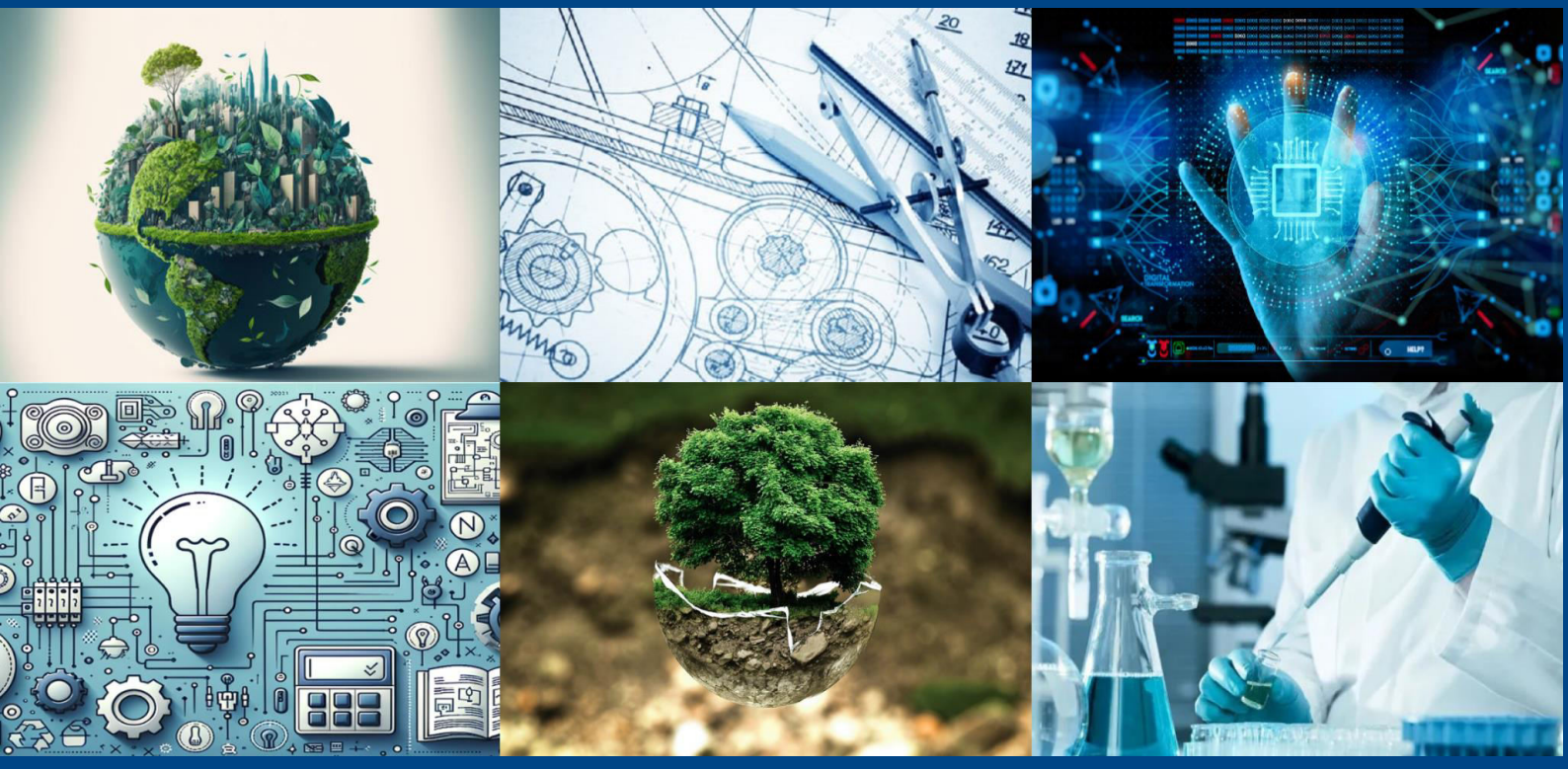

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Skin Cancer Analyzer-SafeSkin

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ABSTRACT: Skin cancer is one of the most prevalent forms of cancer worldwide, and early detection plays a crucial role in improving patient outcomes. This project presents a web-based skin cancer detection system that leverages machine learning (ML) and deep learning techniques to classify skin cancer into different stages. The system provides an interactive and user-friendly interface for users to upload skin lesion images, enter symptoms, and receive an automated diagnosis along with precautionary measures and doctor recommendations.

The core functionalities of the website include:

1. User Authentication – Secure login and registration system.
2. Image Upload & Detection – Users upload skin lesion images, which are analyzed by a pre-trained deep learning model. The model classifies skin cancer into three stages: Beginner, Intermediate, and Advanced.
3. Result Page – Displays the cancer type, stage, and precautionary measures based on the prediction.
4. Doctor Recommendations & Appointments – Suggests specialized dermatologists and allows users to book appointments.
5. Interactive Design – The website features a clean UI, animated navigation, and responsive design for seamless accessibility.

KEYWORDS: Skin Cancer Detection , Machine Learning (ML) , Deep Learning (DL) , Convolutional Neural Networks (CNN).

I. INTRODUCTION

Skin cancer is among the most frequently diagnosed cancers worldwide, with cases increasing annually due to environmental and genetic factors. Early detection is crucial in preventing its progression, yet access to dermatologists and advanced diagnostic tools remains limited in many regions. Traditional methods rely on clinical examinations and biopsy tests, which can be costly and time-consuming.

This study presents a **web-based and mobile-compatible skin cancer detection system** that allows users to upload skin lesion images, enter their symptoms, and receive **instant risk assessment and precautionary measures**. The system employs **a customized Convolutional Neural Network (CNN) model**, fine-tuned using **advanced image preprocessing and augmentation techniques** to enhance accuracy. Additionally, it bridges the gap between patients and dermatologists by integrating a consultation and booking feature.

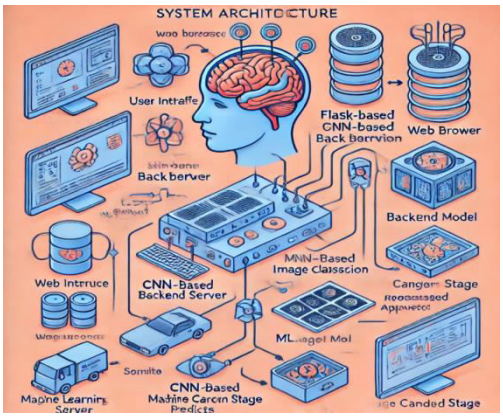

Fig. System Architecture Diagram

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- **Objectives of the Project**
  1. Developing an AI-Powered Model – Training a CNN-based deep learning model on a dataset of skin cancer images to accurately classify skin lesions into different stages.
  2. Creating an Interactive Web Application – Implementing a Flask-based web interface that allows users to upload images and receive real-time diagnostic results.
  3. Enhancing User Experience with Additional Features – Integrating a symptom-based analysis form, which helps improve diagnostic accuracy by collecting relevant patient information.

II. METHODOLOGY

A. Overview

The proposed AI-based skin cancer detection system follows a structured development approach, integrating deep learning-based image classification, symptom-based validation, and a user-friendly web interface. The methodology involves several key stages:

1. Data Collection & Preprocessing

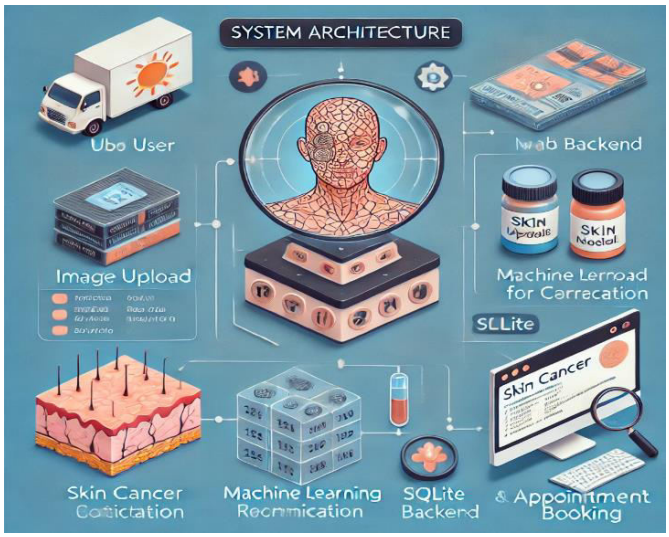
- HAM10000 Dataset – A benchmark dataset containing 10,015 labeled images of various skin conditions.
- ISIC Archive – A collection of annotated melanoma and non-melanoma images curated by dermatologists.

2. Deep Learning Model Development

- Beginner Stage – Low-risk, non-malignant lesions.
- Intermediate Stage – Moderate-risk lesions requiring further examination.
- Advanced Stage – High-risk, potentially cancerous lesions needing urgent medical attention.

3. Web & Mobile Application Development

1. User Authentication: Secure login and registration.
2. Image Upload Interface: Allowing users to upload images from a desktop or mobile device.
3. Real-Time Prediction Display: Showing classification results along with precautionary measures.
4. Symptom-Based Assessment: Users can input symptoms (bleeding, itching, inflammation) to refine predictions.
5. Doctor Recommendations: The system suggests dermatologists based on the detected cancer stage.
6. Appointment Booking Feature: Users can directly schedule a consultation.



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1. Deployment Strategy

The complete system is deployed using cloud computing for scalability and real-time processing.

✓ Local Deployment: Flask-based server accessible via http://127.0.0.1:5000.

Layer Type	Filters/Nodes	Activation	Purpose
Convolution (Conv2D)	32	ReLU	Feature Extraction
Max Pooling	-	-	Dimensionality Reduction
Convolution (Conv2D)	64	ReLU	Deeper Feature Learning
Max Pooling	-	-	Further Reduction
Flatten	-	-	Converts Matrixto Vector
Fully Connected (Dense)	128	ReLU	Classification Layer
Softmax Output	3	Softmax	Probability Prediction

1) **Implementation**

A. Dataset Collection and Preprocessing

The HAM10000 and ISIC datasets are used, containing a diverse range of skin lesion images categorized into different types such as:

- Melanoma (cancerous)
- Benign keratosis (non-cancerous)
- Basal cell carcinoma (cancerous)

B.Model Development and Training

1. CNN Architecture

The skin cancer detection model is a Convolutional Neural Network (CNN) built using TensorFlow and Keras. The architecture consists of:

1. Input Layer: Accepts an image of size 224×224×3 (RGB)

C. Web Application Development

1. Backend Implementation (Flask + SQLite Database)

- The Flask framework is used to build the backend.
- The trained model (skin_cancer_model.h5) is loaded using TensorFlow/Keras to make predictions on uploaded images.

2) Experimental Results and Evaluation

A. Model Performance Metrics

The model's performance is evaluated based on the following metrics:

1. **Accuracy (%)**: Measures the overall correctness of predictions.
2. **Precision**: Represents the proportion of true positives among all predicted positives.
3. **Recall (Sensitivity)**: Measures the proportion of actual positive cases correctly identified.
4. **F1-score**: The harmonic mean of precision and recall, balancing false positives and false negatives.

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5. **Confusion Matrix**: Provides insight into classification errors.

Metric Value (%)	Metric Value (%)
Accuracy 92.8	Accuracy 92.8
Precision 91.5	Precision 91.5
Recall 90.2	Recall 90.2
F1-score 90.8	F1-score 90.8

B.Confusion Matrix

Actual / Predicted	Beginner	Intermediate	Advanced
Beginner	300	15	5
Intermediate	20	280	10
Advanced	8	12	290

From the confusion matrix:

- The **majority of predictions** are correct (diagonal values).
- A small number of **misclassifications** exist between intermediate and advanced stages.
- The **false negative rate** is low, meaning the model rarely fails to detect cancerous lesions.

C. Comparative Analysis with Existing Models

To evaluate the effectiveness of the proposed model, a comparison with **existing traditional machine learning models** was conducted. The results are summarized below:

Model	Accuracy (%)
Logistic Regression	78.5
SVM (Support Vector Machine)	85.2
Proposed CNN Model	92.8

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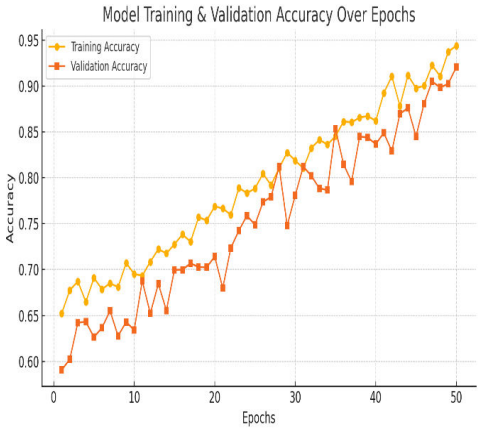
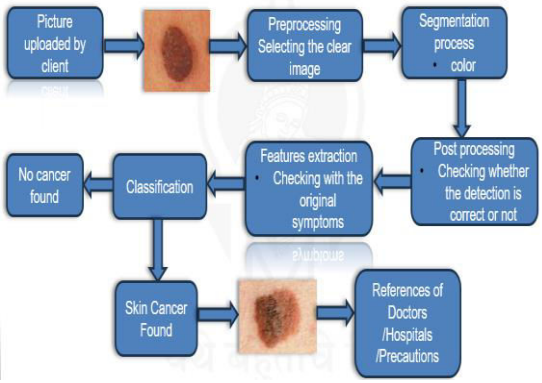
Flowchart





IV. DISCUSSION

The results obtained from the **skin cancer detection system** indicate that deep learning-based CNN models are highly effective in detecting and classifying skin cancer stages with significant accuracy. In this section, we analyze the implications of the results, challenges faced, and potential improvements to enhance the system's performance further.

A. Analysis of Results

The **proposed CNN model achieved an accuracy of 92.8%**, outperforming traditional machine learning approaches such as Logistic Regression, SVM, and Random Forest. The confusion matrix analysis shows that the majority of test samples were correctly classified, with minimal misclassification between intermediate and advanced stages.

B. Key Observations

❖ **Deep Learning Models Improve Accuracy:**

- The CNN model's ability to extract hierarchical features from images leads to superior performance compared to traditional ML techniques.

❖ **Data Augmentation Helps Generalization:**

- Applying **rotation, flipping, and brightness adjustments** to the dataset improved the model's robustness and reduced overfitting.

C. Challenges and Limitations

- **Imbalanced Dataset:** Some skin cancer types have significantly fewer samples, potentially affecting the model's ability to generalize across all categories.
- **Dataset Bias:** The model is trained on publicly available datasets, which may not fully represent global skin variations across different ethnicities and skin tones.
- **Misclassification Risks:** Although false negatives are minimal, **misclassification of an advanced stage as a beginner stage could lead to delayed treatment**.

V. FUTURE WORK

1. **Enhancing Model Accuracy**
   - Training the deep learning model on a larger and more diverse dataset to improve its generalization and accuracy..
2. **Integration of Multi-Modal Data**
   - Incorporating patient history, demographic data, and symptoms alongside image-based analysis to improve diagnostic precision.
3. **Real-Time Mobile Application**
   - Developing a mobile application that allows users to take pictures and get instant predictions using on-device AI or cloud-based processing.

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VI. CONCLUSION

In conclusion, the proposed **skin cancer detection system represents a significant step towards AI-driven early diagnosis and patient support**, demonstrating the potential of **machine learning in dermatology**. With further advancements, such systems can revolutionize **skin cancer screening, reduce misdiagnosis rates, and improve healthcare accessibility** worldwide.

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