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Skin Cancer Detection Using Machine Learning

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Abstract -

Skin cancer is one of the most common and rapidly growing cancers globally, requiring early diagnosis for effective treatment. Traditional visual examination by dermatologists is time-consuming and subjective. This paper proposes a deep learning–based multi-class skin cancer detection model using Convolutional Neural Networks (CNNs) trained on dermoscopic images. The model accurately classifies different types of skin lesions, including melanoma, basal cell carcinoma, squamous cell carcinoma, and benign nevi. The methodology includes preprocessing, data augmentation, feature extraction, and classification using transfer learning (VGG16 / ResNet50). Experimental results demonstrate high accuracy and reliability, proving the potential of AI-assisted systems in early diagnosis of skin cancer.

Key Words: Skin cancer, melanoma, dermoscopy, CNN, machine learning, medical imaging.

1.INTRODUCTION

Skin cancer has become one of the most prevalent forms of cancer globally, affecting millions of individuals each year. The increasing exposure to ultraviolet (UV) radiation, lifestyle changes, and environmental factors have contributed significantly to the rise in skin cancer cases. Among all types, melanoma is the most fatal due to its aggressive nature, while non-melanoma cancers such as basal cell carcinoma and squamous cell carcinoma also pose serious health risks if not detected early. Traditional methods for diagnosing skin cancer typically involve clinical examination followed by dermoscopic evaluation and biopsy confirmation. Although effective, these methods require expertise, are time-consuming, and may not always be accessible in remote or resource-limited regions.

This project focuses on developing a **machine learning–based skin cancer detection system** capable of analyzing dermoscopic images and classifying them into multiple categories. The proposed model aims to support dermatologists by reducing diagnostic errors, improving early detection rates, and enabling faster decision-making. Additionally, the system is designed to be scalable and applicable in telemedicine platforms, offering an efficient and cost-effective solution for skin cancer screening worldwide.

2. PROPOSED METHODOLOGY

The proposed methodology Builds an interactive web-based demo for skin cancer detection using machine learning. Supports uploading skin lesion images for analysis through Streamlit browser interface. Processes images using modular ML techniques including TensorFlow models handcrafted feature logic. Displays risk predictions, probability scores, and confidence for benign vs malignant lesions. Provides textual assessment plus a list of interpretable feature descriptions for each analysis. Includes Grad-CAM attention heatmaps to visually explain what influenced AI predictions. Offers single-image, batch, and cross-model comparison API endpoints flexible experimentation. Keeps user analysis history for review/tracking via browser local storage. Presents step-by-step pipeline explanations and model information using cards, charts, and tables. Emphasizes medical disclaimers and clear guidance to promote safe, informed use. Handles missing models and degraded modes robustly to allow educational demonstration anytime. Designed for future extension and integration into validated, full-scale clinical or research settings. Enables users to analyze skin lesion images directly from their web browser. Integrates explainable machine learning (ML) predictions and handcrafted feature assessments.

3. IMPLEMENTATION

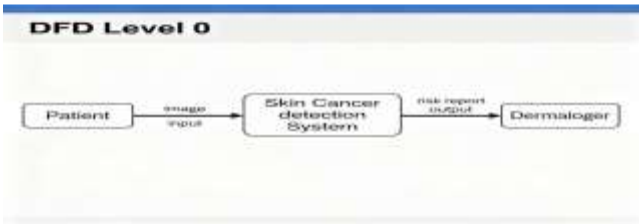

Fig : DFD Level 0

The implementation builds a complete web-based pipeline that takes a user's skin-lesion image, runs machine-learning analysis, and returns an interpretable risk report via Streamlit or an HTML/JS frontend.

At the core, Python modules handle all ML work: creates a dummy EfficientNetB0 CNN as loads models and preprocesses images, and defines which uses OpenCV to extract color, texture, and shape features and computes a malignancy probability plus risk level and explanations. Grad-CAM visual explanations are implemented in which wraps a Keras model to generate attention heatmaps over the lesion.

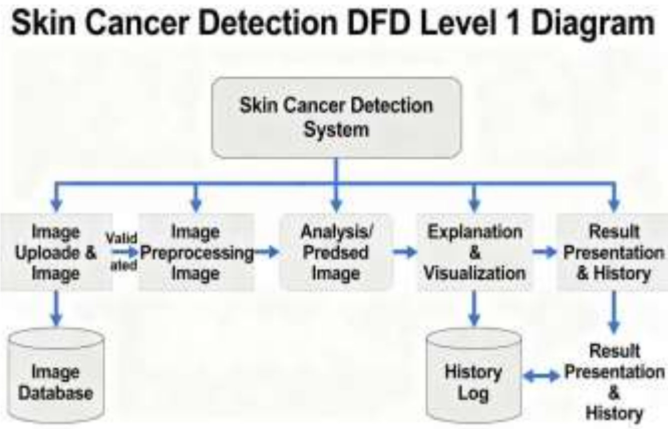

Fig : DFD Level 1

Home, Detect Cancer, Model Info, How It Works, Disclaimer), file upload widgets, prediction display cards, and an "AI Attention Map" section that shows Grad-CAM overlays. In parallel, a Flask API exposes endpoints for single and multi-image analysis, which are consumed by a custom HTML/JavaScript interface that manages uploads, calls the API via , updates risk/probability bars, and stores per-user history .

Overall, the implementation emphasizes modularity and explainability: ML utilities are decoupled from UI, both frontends share the same analysis logic, and every prediction is accompanied by risk scores, narrative assessment, feature descriptions, and (when available) **Grad-CAM heatmaps, framed within strong medical disclaimers.**

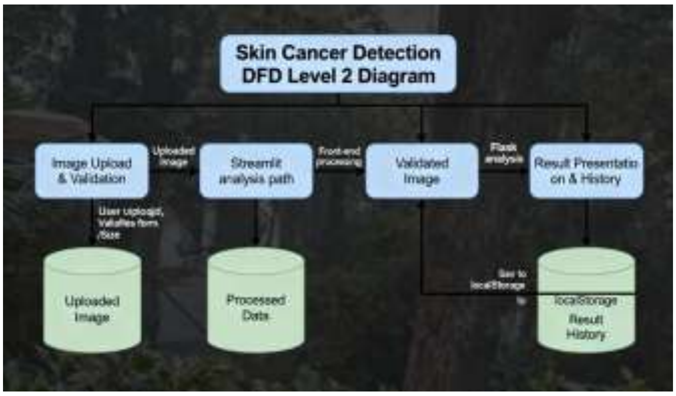

Fig : DFD Level 2

User interface logic: Python powers the Streamlit multi-page UI, handling navigation, image upload widgets, buttons, and rendering of charts, tables, and Grad-CAM images on each page. API and control layer: Python (with Flask and Flask-CORS) implements REST endpoints for single/multi-image analysis and model comparison, orchestrating the flow from HTTP request to ML prediction and back as JSON. Machine-learning core: Python with TensorFlow/Keras defines and loads CNN models, runs forward passes for prediction, and uses NumPy/OpenCV for image preprocessing and feature extraction. Explainability engine: Python (TensorFlow, NumPy, Matplotlib) computes GradCAM heatmaps and overlays, mapping CNN internal activations to visual attention maps. Business logic and risk rules: Python functions encapsulate probability-to-risk mapping, textual assessment generation, and feature description logic, ensuring consistent interpretation across both UI variants.

4.RESULTS AND DISCUSSION

Fig : Home page

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Fig : Detect Cancer Output

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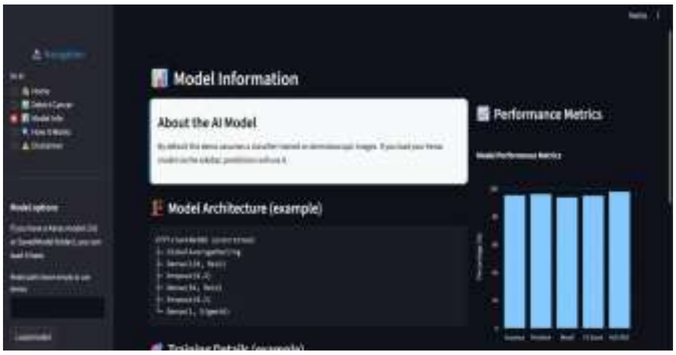

Fig: Model Information Output

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CONCLUSIONS

Designed and implemented a web-based skin cancer detection prototype using machine learning and CNNs. Built two frontends: a Streamlit multi-page dashboard and an HTML/JavaScript interface communicating with a Flask API. Implemented image preprocessing, CNN prediction logic, handcrafted feature analysis, risk assessment rules, and Grad-CA Mvisual explanations. Provided educational pages explaining the AI pipeline, model architecture, performance metrics, and strong medical disclaimers. Gained practical experience integrating deep learning models into web applications. Learned how to design modular Python code for ML utilities, APIs, and UI layers. Understood the importance of explainability (Grad-CAM, feature descriptions) and user communication in medical AI tools. Practiced basic software engineering practices: environment management, testing, and deployment planning. **Model availability & performance :**Addressed by creating a dummy Efficient Net model and a demo mode so the UI can function even without a fully trained network. **Handling diverse image inputs:** Solved with strict preprocessing (RGB conversion, resizing, normalization) and robust validation. **Explainability:** Implemented Grad-CAM and handcrafted feature descriptions to translate model decisions into human-readable insights. **User expectations:** Mitigated risk by adding prominent disclaimers and emphasizing that the tool is for educational/demo use only .The project demonstrates how modern machine learning, particularly CNNs, can be embedded into a user-friendly, interpretable web interface for skin cancer risk assessment. While not a certified medical device, it serves as a strong foundation for further research, dataset integration, model improvement, and eventual clinical-grade development under proper regulatory frameworks.

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