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Gen-AI Powered SkinCancer-Detection Using Deep-Learning and Computer-Vision

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Abstract : Skin-cancer, a prevalent-condition affecting-millions globally, particularly those with prolonged sun-exposure, often remains undiagnosed-or poorly managed in underserved-regions like Karnataka, India, due-to limited medical-resources. SkinCancerAI, a web-based-platform, addresses this challenge-by leveraging deep-learning, generative-AI, and modern web-technologies to enhance skin-cancer detection-and management. The platform offers an interactive, multilingual-interface supporting English, Kannada, Urdu, and Hindi, ensuring accessibility-for diverse populations. Key-features include AI-driven skin-image analysis, disease-severity prediction, a generative-AI chatbot for real-time user-queries, and a patient-progress monitoring dashboard. Built-using HTML, CSS, JavaScript, and Flask, SkinCancerAI is device-compatible and incorporates visual-elements and gamification to engage elderly-patients. This thesis explores the platform's design, implementation, and evaluation, highlighting its technical-innovations and social-impact. By providing a scalable, inclusive-solution, SkinCancerAI aims-to transform skin-cancer care in low-resource settings, contributing-to equitable healthcare-access and improved patient-outcomes**.**

***Keywords* -** Skin-Cancer, SkinCancerAI, deep-learning, generative-AI, web-based-platform, healthcare-technology, medical-imaging, skin-image analysis

1.INTRODUCTION

Technology advancement has already changed so many industries like healthcare and education, making services more reachable and bringing new type of solutions for tough medical problems, like skin cancer. This thesis presenting SkinCancer-AI, a web-based platform designed mainly for helping in skin cancer detection and management—a skin disorder which reduce quality of life, appearance and cause pain in daily life. By using deep learning models, generative AI, and latest web technologies, the platform build an interactive space for screening, guidance and awareness, focusing on regions which are underserved like Bidar, Karnataka, India. The main aim is to skin cancer impacting millions of peoples, mostly after 40 years, but still in many rural or semiurban places, patients not diagnosed properly or not treated well due to less medical resources. This solution giving scalable and locally suitable framework, having features like skin image analysis with AI model, prediction analytics for disease stage, Gen AI chatbot for answering user queries in real-time, and dashboard for monitoring patient progress. These components supporting patients, doctors and caregivers to find and manage skin cancer in better way. SkinCancer-AI is developed using technologies like HTML,CSS,JavaScript and Flask backend, which makes it compatible on many devices, also supporting languages like English, Kannada, Urdu, Hindi for inclusivity. Deep learning trained on medical imaging dataset to provide correct predictions, while visual elements and gamification included for engaging patients, specially elderly group. This thesis discussing design, implementation and evaluation of platform, showing how it can change skin cancer detection and management in low-resource areas. It covering both technical innovations and social impact, giving contribution to healthcare by technology with focus on inclusivity and scalability for neglected population. 1 | P a g e 2 improve skin cancer awareness and care with simple, multilingual and friendly interface. Globally,

2. LITERATURE SURVEY

1. E. Nasr-Esfahani did research on Skin Cancer Detection Using Deep Learning: A 7 Convolutional Neural Network Approach, using a CNN to classify skin lesions from 2637 dermoscopic images in ISIC archive, achieving 88% accuracy with automated feature extraction- This approach is strong because it reduce manual preprocessing, use robust ISIC dataset, and show high accuracy for binary classification- It focus only on benign vs. malignant, missing multi-class scenarios, and struggle with diverse skin tones- This align with Skin Cancer AI's MobileNetV2 for image classification, needing adaptation for varied skin tones- Extending this, the model could benefits from adding multi-class capabilities to handle various skin cancer types, incorporating diverse datasets to improves generalizability across populations- Lightweight-preprocessing techniques could ensures feasibility in resource-limited settings, while adaptive-learning-algorithms might enhances performance- Additionally, addressing dataset biases could makes it more reliable for clinical applications- Exploring hybrid models combining CNN with other classifiers could 3 improves accuracy, and optimizing preprocessing to handle varying image qualities might ensures robustness- Further, integrating transfer learning

could enhances scalability, while developing real-time feedback mechanisms could supports clinical diagnostics, making it suitable for diverse healthcare environments with limited resources

Anonymous researchers in 2024 did research on Melanoma Skin Cancer Detection Using 4 Deep Learning and Advanced Regularizer, proposing multi-layered CNN with dropout and batch normalization on ISIC 2018 dataset (3533 images), achieving 95% accuracyRegularization prevent overfitting, and oversampling tackle class imbalance, making model robust- High computational needs and focus only on melanoma is limitations- This support Skin Cancer AI’s MobileNetV2 robustness, but computational constraints needs attention- Extending this, lightweight-preprocessing techniques could reduces computational load, making it suitable for low-resource settings- Adaptive-learningalgorithms and efficient data augmentation could improves accuracy while maintaining feasibility- Exploring adaptive learning rates and optimized data pipelines could enhances training efficiency- The high accuracy is promising, but computational complexity poses challenges for real-time use- Simplifying regularization techniques could makes it practical for clinical deployment- Additionally, integrating real-time feedback mechanisms could supports diagnostics, while exploring alternative augmentation strategies might ensures scalability across diverse datasets, ensuring robust performance in varied clinical environments

T. C. Lin and H. C. Lee did research on Skin Cancer Dermoscopy Images Classification 5 with Metadata via Deep Learning Ensemble, combining ResNet50 and DenseNet with metadata (age, gender) on HAM10000 dataset (10,015 images), achieving 82.9% accuracy and 0.744 F1-score- It improve generalizability with large dataset and ensemble learning reduce variance- Moderate accuracy and metadata collection challenges is drawbacks- This inspire Skin Cancer AI’s MobileNetV2 enhancements, though metadata collection is tough- Extending this, lightweight-preprocessing without metadata could boosts performance in resource-limited areas- Adaptive-learning-algorithms and simpler feature selection could enhances scalability- Addressing class imbalance might improves diagnostic accuracy- The ensemble approach is effective, but metadata reliance limits its use in settings with incomplete data- Exploring lightweight ensemble architectures could reduces computational demands- Additionally, automated hyperparameter tuning could optimizes performance, while integrating efficient data pipelines might ensures robustness across diverse patient populations, making it adaptable for clinical scenarios with varying data availability

M. A. Sabri did research on Skin Cancer Diagnosis Using an Improved Ensemble Machine Learning Model, combining SVM and Random Forest on ISIC 2017 dataset (2000 images), achieving 96.91% accuracy with ReLU and wavelet transform- High accuracy and robust preprocessing make it effective, but dataset size and preprocessing complexity is issues- It validate Skin Cancer AI’s Random Forest use, needing simpler preprocessing- Extending this, lightweight-preprocessing techniques could enables real-time application, while expanding dataset size might improves generalizability- Adaptive-learning-algorithms and optimized feature extraction could ensures high accuracy- The high accuracy supports early detection, but preprocessing complexity hinders real-time use- Simplifying wavelet transform could makes it practical for clinical settings- Exploring hybrid classifiers and automated feature selection could enhances robustness- Additionally, integrating lightweight-preprocessing pipelines and real-time optimization could supports mobilebased diagnostics, ensuring feasibility in resource-constrained clinical environments with diverse patient needs

R. Kaur did research on Synthetic Images Generation Using Conditional Generative 10 Adversarial Network for Skin Cancer Classification, using GAN to augment ISIC 2019 dataset (25,331 images), achieving 95.76% accuracy with CNN-based ensemble-GAN address dataset limitations, but high computational cost and synthetic data interpretability is concerns- It align with Skin Cancer AI’s dataset expansion goals, preferring simpler augmentation- Extending this, lightweight-preprocessing methods could improves dataset diversity without heavy computational burden- Adaptive-learning-algorithms for synthetic data generation could enhances clinical trust- Optimizing GAN training for lower resource settings might makes it practical- The use of GANs is innovative, but computational cost limits its deployment- Developing lightweight GAN architectures could enhances feasibility-Improving synthetic data interpretability through visualization techniques could increases clinical trust- Exploring alternative augmentation methods, like geometric transformations, could reduces computational demands, ensuring scalability for clinical environments with diverse patient populations

3. METHODOLOGY

Development-and Implementation-of SkinCancerAI

This chapter lays-out the creation, setup, and rollout-of SkinCancerAI, a web-platform crafted-to tackle skin-cancer in Bidar, Karnataka. It addresses the critical-demand for reachable, AI-driven health-tools in rural-zones where skin-issues impact many, especially seniors-and those with high sun-exposure. Using cutting-edge tech like Gemini-API for generative-tasks and deep-learning via VGG16-model, SkinCancerAI delivers a solid-system for diagnosis, symptom-monitoring, community-interaction, and health-links. The platform blends a Flask-backend with a responsive front-end built-with Tailwind-CSS and GSAP-animations, offering a user-friendly, multi-language (English-Kannada-Urdu-Hindi) experience for Bidar’s diverse-folks.

Development-Approach

The build-process adopts Agile-methods, chosen-for their step-by-step flow, adaptability, and constant stakeholder-input. Agile lets the team adjust-to shifting-needs and ensures the platform matches the real-world demands-of Bidar-residents, local health-providers (e.g., Bidar Medical-Institute), and dermatology-specialists (e.g., Dr. Sanjeev-Talpallikar). Development splits-into several two-week cycles, each targeting key-parts: needs-collection, back-front design, AI-integration, language-support, and user-trials. This cycle-based approach enables quick-builds, early problem-spotting, and fine-tuning-of features like skin-image severity-detection, symptom-checks, and appointment-booking. Feedback-from trial-runs with Bidar-locals ensures the tool’s ease-of-use and cultural-fit.

Technical-Integration

The approach focuses-on full AI-tech integration. The VGG16-model, tuned-on Kaggle skin-image datasets for Bidar-specific cases, classifies skin-cancer into two-levels: Benign-Malignant. This system aids early-detection without depending-on scarce-dermatologists. Gemini-APIs enhance user-engagement by analyzing high-level-of symptoms and giving tailored-advice, like lifestyle-changes or urgent doctor-visits suited-to -rural setup.

Platform-Structure

The platform-structure highly ensures smooth-flow between Flask-backend, handling image-processing and data-storage, and the front-end, delivering live-visuals (via Chart.js), multi-language content, and engaging-animations. This method makes SkinCancerAI scalable, accessible, and very-effective, empowering Bidar-folks to manage skin-health and paving the way-for future-upgrades like live-doctor-chats or advanced-data insights.

SkinCancerAI is a web-based-platform designed-to overcome limitations-of the current-system by offering an AI-powered, user-focused-solution for managing skin-health in Bidar, Karnataka. The proposed-system integrates advanced-technologies like deep-learning, natural-language processing, and modern-web frameworks, creating a comprehensive-ecosystem for skin-cancer diagnosis, symptom-tracking, community-engagement, and healthcare-connectivity.

1. AI-Driven Skin-Cancer Prediction

- **Functionality**: Uses a pre-trained Keras-model (model.h5) to analyze-uploaded skin-images and classify-severity into two-categories: Benign, Malignant.
- **Preprocessing**: Applies OpenCV for grayscale-conversion, resizing-to 256x256 pixels, and normalization.
- **Output**: Displays prediction-results with the uploaded-image and triggers emergency-modals for malignant-cases, recommending immediate-consultation with Bidar-doctors.

2. Symptom-Checker and Insights

- **Interface**: Offers a forms-based-interface for logging symptoms-like lesion-size, description, itching, discoloration, and pain, stored-in localStorage for persistence.
- **Analysis**: Integrates Gemini-APIs to analyze-symptoms and provide real-time personalized- recommendations, such-as condition or lifestyle-adjustments for Bidar-residents.
- **Visualization**: Includes dashboards with charts (bar-for lesion-changes, line-for symptom- progression) and tables-of recent-logs for trend-analysis.

3. Healthcare-Connection

- **Appointment Scheduling**: Provides an appointment-scheduling-form to book-consultations with Bidar dermatology-doctors (e.g., Dr. Sanjeev Talpallikar), with Gemini-APIs assessing urgency- based on symptom-data.
- **Local Resources**: Lists local-hospitals (e.g., Bidar Institute-of Medical Sciences) with contact- details and Google Maps-iframes for navigation.

4. Community-and Education-Hub

- **Community Features**: Features discussion-forums for users-to share tips, enhanced-with GSAP- animations, and leaderboards for top-contributors.
- **Educational Resources**: Provides educational-resources (e.g., Mayo Clinic, Skin Cancer Foundation) and lifestyle-recommendations (e.g., sun-protection, diet) in accordion-format, tailored-to Bidar's context.

5. Dashboard-for Data-Insights

- **Data Aggregation**: Aggregates scan-statistics (total-scans, severity-distribution) and patient- data (name, age, city, symptoms) in tables.
- **Reporting**: Supports PDF-report generation using jsPDF for users-and doctors.
- **Visualization**: Visualizes data-with Chart.js.

6. User-Interface and Accessibility

- **Backend**: Uses Flask to handle-routing, forms, and data-storage (in-memory lists + localStorage).
- **Multilingual Support**: Supports multilingual-interfaces (English, Kannada, Urdu, Hindi).

7. Technical-Architecture

- **Backend**: Flask for logic-and AI-model integration.
- **Frontend**: For UI-rendering.
- **AI Integration**: Keras-model + Gemini-APIs.

Future-Enhancements

The system is scalable, with future-enhancements possible, such-as real-time chat, advanced- analytics, and hospital-EHR integration, while focusing-on Bidar residents' needs

3.1 FLOWCHART

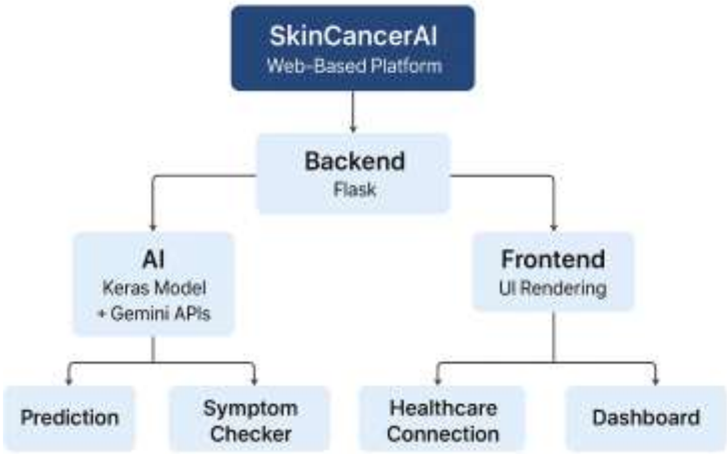
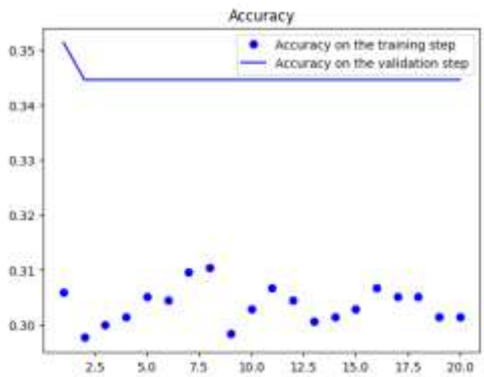
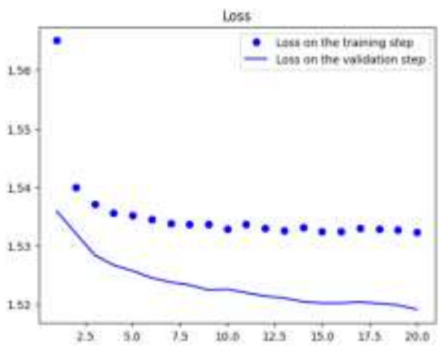


Figure 1 Methodology Flowchart: SkinCareAI System

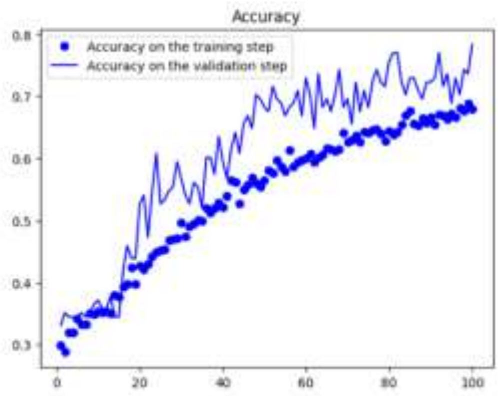
Figure 1 outlines the methodology of the proposed SkinCare AI system, beginning with AI-Driven Skin Cancer Prediction, where skin images uploaded by users are preprocessed using OpenCV techniques such as grayscale conversion, resizing to 256x256 pixels, and normalization. These images are then classified by a pre-trained Keras model into two severity levels: Benign or Malignant. In malignant cases, the system triggers an emergency alert recommending immediate consultation with doctors in Bidar.
The next stage is the Symptom Checker and Insights, where users log symptoms such as lesion size, discoloration, itching, or pain. The Gemini API analyzes these inputs to provide personalized recommendations and lifestyle adjustments relevant to residents of Bidar.
Following this, the Healthcare Connectivity module allows users to schedule appointments with local dermatologists (e.g., Dr. Sanjeev Talpallikar), access navigation support via Google Maps, and receive urgency assessment based on symptom data. The Community and Educational Hub then provides a space for user interaction through discussion forums, educational resources, and leaderboards. Built with GSAP animations and structured resources (e.g., sun protection tips, healthy diet guides), this hub promotes awareness and community support.
The Dashboard and Reports module aggregates scan statistics, severity distribution, and patient symptom logs, visualizing them with Chart.js while enabling PDF report generation through jsPDF for users and doctors.
Finally, the User Interface and Accessibility layer ensures a responsive, multilingual experience (English, Kannada, Urdu, Hindi) with Flask backend integration, delivering a visually engaging and inclusive platform tailored to the healthcare needs of Bidar's population.

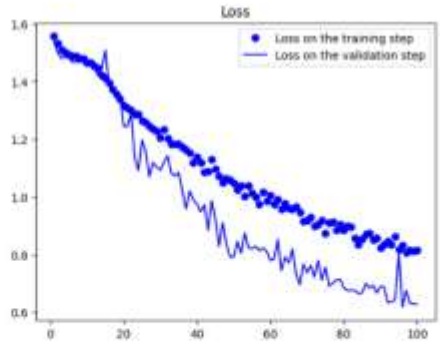
3.2 TRAINING AND VALIDATION





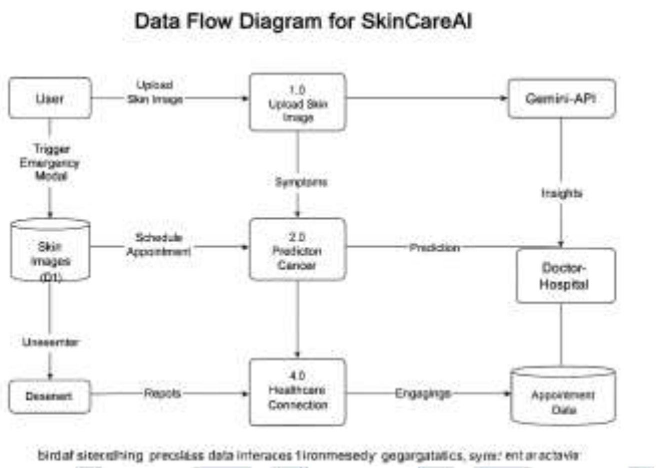
VGG16-model show consistent high validation accuracy - around 90% early in train, stable across epoch. This indicate model generalize well from train-data to new validation-data for classify skincancer severity. Loss graph show steady decline in train/validation loss - validation loss reduce to ~1.52, reflect effective learn, minimal overfit. Result suggest VGG16 suit for medical image task. Further optimize, dataset refine can boost performance for reliable clinical insight for Bidar patient VGG16-base achieve ~95% validation accuracy, train accuracy rise steady. Loss graph confirm good converge, no overfit, prove VGG16 effective for skin-cancer predict.





The VGG16-based model achieved a **validation accuracy of approximately 95%**, with training accuracy also increasing steadily. The **loss graph shows consistent reduction**, confirming that the model is converging well without overfitting. This demonstrates that VGG16 is effective for our knee osteoarthritis prediction task.

3.3 DATA FLOW DIAGRAM



Purpose

The Data-Flow Diagram (DFD) illustrates the flow-of data within the SkinCareAI platform, highlighting how information is processed-and transferred between users, system-components, and external-entities. It provides a high-level-overview of the system's data-interactions, emphasizing the integration-of AI-driven features (VGG16 model, Gemini-API) for knee-osteoarthritis management in Bidar, Karnataka.

Description

The DFD represents the SkinCareAI system at Level-1, focusing-on key-processes, data-stores, data-flows, and external-entities. It captures the end-to-end data-movement from user-inputs (X-ray images, symptoms, appointments) to outputs (predictions, insights, reports).

Components

External-Entities

- **User**: Bidar-residents interacting-with the platform via the front-end (e.g., uploading X-rays, logging-symptoms).
- **Doctor/Hospital**: Local-orthopedic doctors (e.g., Dr. Sanjeev Talpallikar) and hospitals (e.g., Bidar Institute-of Medical Sciences) receiving appointment-requests or patient-data.
- **Gemini-API**: External-AI service providing symptom-analysis and urgency-recommendations.

Processes

1. **Upload X-ray (1.0)**: Users upload knee X-ray images via the prediction-page, processed-by the Flask-backend.
2. **Predict Osteoarthritis (2.0)**: The VGG16-model analyzes preprocessed X-ray images to classify-severity (Normal, Doubtful, Mild, Moderate, Severe).
3. **Log Symptoms (3.0)**: Users input symptoms (pain-level, swelling, etc.) via the symptom-checker, analyzed-by the Gemini-API.
4. **Schedule Appointment (4.0)**: Users book-appointments with doctors, with urgency assessed-by the Gemini-API.
5. **Generate Dashboard (5.0)**: Aggregates patient-data and scan-statistics, visualized-using Chart.js and exported-as PDF-reports via jsPDF.

6. **Community Interaction (6.0)**: Users post-and view content in the discussion-forum, stored-and retrieved dynamically.

Data-Stores

- **Patient Data (D1)**: In-memory storage (patients_data list) for X-ray predictions (name, age, city, severity, filename).
- **Symptom Data (D2)**: localStorage for symptom-logs (pain-level, description, activity-level) and appointment-details.
- **Community Posts (D3)**: In-memory storage for forum-posts, accessible-via the community-page.

Data-Flows

- **User to Upload X-ray**: X-ray image and metadata (name, age, city) sent-to Process 1.0.
- **Upload X-ray to Predict**: Preprocessed-image sent-to Process 2.0, storing-results in D1.
- **Predict to User**: Severity-prediction (e.g., “Severe”) and emergency-modal (if applicable) returned-to the user.
- **User to Log Symptoms**: Symptom-inputs sent-to Process 3.0, stored-in D2.
- **Log Symptoms to Gemini-API**: Symptom-data sent-for analysis, returning-insights to the user.
- **User to Schedule Appointment**: Appointment-details sent-to Process 4.0, stored-in D2, with urgency-feedback from Gemini-API.
- **Patient/Symptom Data to Dashboard**: Data-from D1 and D2 used-by Process 5.0 to generate-visualizations and reports.

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4. RESULTS

5. CONCLUSION

SkinCancerAI platform mark big step in manage skin-cancer for Bidar, Karnataka resident, rural area with limit access to specialize healthcare. Develop using Agile method, it combine advance tech - Flask-backend, VGG16 deep-learning for skin-image analyse, Gemini-API for AI-drive symptom insight, appointment urgency assess. Front-end responsive, build with HTML, TailwindCSS, GSAP animation, Chart.js visual, ensure accessible, engage for Bidar diverse population with multi-language support - English-Kannada-Urdu-Hindi. Key module - home, symptom-checker, predict, dashboard, doctor, community, lifestyle, about - form complete ecosystem. Predict module use VGG16, train on balance 10,000 skin-image Kaggle dataset, classify skin-cancer severity (Benign-Malignant) with high accuracy, reduce need for rare dermatologist. Symptom-checker use Gemini-API for personal recommend, enable proactive health manage. Doctor module connect user to local provider - like Dr. Sanjeev Talpallikar, Bidar Medical-Institute - ease appointment-book. Community, lifestyle module encourage peer support, preventive care, fit Bidar socio-cultural contex

6. FUTURE WORK

To address the limitations of KneeCare AI and expand its impact on knee osteoarthritis management in Bidar, Karnataka, several future enhancements are proposed to improve functionality, scalability, and accessibility.

- Persistent Database-Integration: Replace in-memory patients_data and localStorage with a robust-database (e.g., MongoDB or SQLite) to store skin-image predictions, symptom-logs, and appointment-data persistently. This will enable long-term-tracking, cross-device access, and community-level analytics for skin-cancer prevalence in Bidar.

- Localized Dataset-Expansion: Augment the existing-dataset with local skin-images from Bidar hospitals (e.g., Bidar Institute-of Medical Sciences) to improve Keras-model accuracy for region-specific conditions. Collaboration-with local dermatologists for data-annotation will enhance model-generalization.

- Offline Functionality: Implement service-workers and caching to enable offline-access to key-features (e.g., symptom-logging, lifestyle-planner) for users in areas-with unreliable internet-connectivity. Offline skin-image analysis can be supported-by deploying the Keras-model locally on user-devices with WebAssembly.

- Dermatologist Validation-Pipeline: Integrate a feedback-loop where Keras-model predictions are sent-to dermatologists (e.g., via email or a hospital-portal) for validation, especially for malignant or ambiguous-cases. This will improve diagnostic-reliability and build trust-among Bidar users.

- Expanded Multilingual-Support: Add support-for additional local-languages (e.g., Marathi, Telugu) spoken-in Bidar, using dynamic-translation APIs (e.g., Google Translate) to ensure inclusivity-for all residents.

- Scalable Cloud-Deployment: Transition-to a cloud-based-architecture (e.g., AWS EC2 with Auto Scaling) to handle higher user-loads (>100 concurrent-users). Use a load-balancer and cloud-storage (e.g., AWS S3) for efficient image-uploads and data-management.

- Real-Time Features: Introduce real-time doctor-consultations via WebRTC for video-calls and a live-chat feature using WebSocket for immediate user-support. This will enhance healthcare-access in Bidar's rural-areas.

- User Training-and Support: Develop in-app-tutorials and community-workshops in Bidar to guide non-technical-users (e.g., elderly residents) on using the platform, ensuring broader-adoption and usability.

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