Software Requirements Specification (SRS)

Mobile App for Real-Time Skin Cancer Detection

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1 Introduction

1.1 Purpose

The purpose of this document is to define the requirements for a mobile application designed to assist in the real-time detection and prevention of skin cancer using machine learning technology. The SRS provides a shared understanding between the development team, the faculty advisor, and potential end-users. It specifies functional and non-functional requirements, external interfaces, constraints, and system characteristics in sufficient detail to guide design, development, and testing.

This application is intended to empower individuals by giving them accessible tools for preliminary skin health monitoring. While the app will not replace professional medical consultation, it will serve as a preventive tool, encouraging users to seek early medical advice when suspicious lesions are detected. This aligns with broader public health objectives of increasing awareness, encouraging preventive care, and reducing healthcare disparities in underserved regions.

Skin cancer is one of the most common cancers worldwide, with millions of new cases reported each year. Many cases could be treated successfully if detected early, but barriers such as limited access to dermatologists, high costs, and geographic distance often delay diagnosis. By offering an easily accessible mobile solution, this project addresses a pressing healthcare need while also contributing to the academic study of AI in healthcare.

1.2 Scope

The product is a cross-platform mobile app developed with Flutter and powered by TensorFlow Lite models trained on dermatological image datasets. The application will:

- Allow users to capture or upload images of skin lesions. This feature is critical for usability since some users will prefer real-time capture, while others may wish to analyze older photographs.
- Provide real-time, on-device AI predictions classifying lesions as benign or malignant risk. On-device inference avoids delays caused by slow internet connections and protects sensitive health data.
- Display prediction confidence levels to ensure transparency. Users can interpret results better when they know the system's certainty, which reduces overreliance on any single output.

- Offer medical disclaimers and preventive resources to promote responsible usage. This ensures ethical boundaries are respected and directs users toward professional care when necessary.
- Protect user privacy by keeping all data processing local to the device. By not sending data to external servers, the app increases user trust and aligns with modern privacy regulations.

The app will not:

- Provide formal medical diagnoses. All results are advisory in nature.
- Store user images in cloud servers, reducing risks of leaks or misuse.
- Replace professional medical evaluation or dermatologist visits, which remain essential for treatment decisions.

1.3 Definitions, Acronyms, and Abbreviations

- AI: Artificial Intelligence – algorithms capable of performing tasks that typically require human intelligence.
- CNN: Convolutional Neural Network – a deep learning model particularly effective in image classification.
- ISIC Dataset: International Skin Imaging Collaboration dataset for dermatological image analysis.
- TFLite: TensorFlow Lite – a lightweight ML framework for mobile devices.
- UI/UX: User Interface / User Experience – design considerations for usability.
- Benign lesion: A non-cancerous skin abnormality.
- Malignant lesion: A skin lesion at risk of being cancerous.

1.4 References

- IEEE Std 830-1998 (Software Requirements Specifications Recommended Practice).
- ISIC Dataset Documentation.
- Team Project Plan and Presentation documents.
- Research publications on skin lesion classification with CNNs.

1.5 Overview

The remainder of this document is structured as follows:

- Section 2 provides an overall description of the system.
- Section 3 specifies detailed functional and non-functional requirements.
- Section 4 includes supporting information such as appendices, references, and risk assessments.

2 Overall Description

2.1 Product Perspective

The system is a standalone mobile application that does not require constant internet connectivity. Unlike many existing health applications that upload images to cloud servers, this app performs all inference locally using TensorFlow Lite.

This design choice prioritizes user privacy and ensures that even users in low-connectivity environments can access the app's features. By relying on efficient CNN models deployed on-device, the app achieves a balance between performance, accessibility, and trust. This approach is part of a larger trend in healthcare technology, where lightweight machine learning models are increasingly being deployed directly on smartphones, wearables, and IoT devices.

2.2 Product Functions

The mobile application provides several core functions that together enable its role as a preventive health tool. Each function has been carefully designed to balance usability, technical feasibility, and ethical responsibility.

- **Image capture and upload with framing overlays to improve quality.** The app allows users to either capture new images of skin lesions using their smartphone camera or upload existing photos from their device gallery. To support consistent data quality, framing overlays will be displayed on-screen during capture. These overlays guide the user to properly center the lesion, avoid cutting off edges, and maintain consistent distance from the camera. By standardizing the way images are captured, the application reduces noise and variation in input data, which in turn improves the accuracy of AI predictions.

- **Image preprocessing (resize, normalize, crop) for consistency.** Before analysis, all uploaded or captured images will undergo preprocessing. This includes resizing images to the input dimensions required by the CNN, normalizing brightness and contrast to handle different lighting conditions, and cropping to ensure the lesion is the focus of the image. These preprocessing steps are critical in preparing diverse real-world images for consistent AI interpretation. Without such steps, differences in lighting, background clutter, or resolution could lead to inaccurate results.

- **CNN-based risk prediction with confidence display.** At the core of the application is a Convolutional Neural Network (CNN) model trained on dermatological image datasets. When an image is processed, the CNN outputs a classification result indicating whether the lesion appears benign or carries malignant risk. Importantly, the prediction is accompanied by a confidence score (e.g., "Malignant risk – 82% confidence"). Providing confidence levels ensures transparency and helps users interpret the result responsibly rather than relying on a binary outcome.

- **Presentation of disclaimers and referral guidance to encourage follow-up.** To ensure ethical and responsible use, every prediction is displayed alongside disclaimers that clarify the app is not a medical diagnostic tool. Instead, it is an advisory system to encourage awareness. In the case of high-risk predictions, referral guidance will be provided, such as links to local dermatologists, online consultation services, or educational resources. This ensures that the app does not exist in isolation but directs users toward appropriate medical care.

- **Access to preventive educational materials, such as warning signs of skin cancer.** Beyond predictions, the app will also serve as a resource hub. It will include educational content such as the ABCDE guidelines for evaluating moles (Asymmetry, Border, Color, Diameter, Evolving), information on common risk factors, and tips for skin protection. By integrating these materials, the app not only analyzes lesions but also fosters preventive behaviors, ultimately reducing the likelihood of delayed diagnoses.

2.3 User Characteristics

The application is intended for use by non-specialist individuals who may be concerned about their skin health but lack access to professional dermatology resources. The user base has been profiled based on three main characteristics: demographics, technical skills, and motivation.

- **Demographics:** The primary audience consists of adults from a wide range of age groups who are concerned about skin abnormalities or at risk for skin cancer. This includes users in both urban and rural communities. In rural or underserved regions, where access to dermatologists may be limited, the application offers an important tool for preliminary self-checks. In urban settings, it can supplement access to healthcare by providing quick reassurance or prompting earlier medical consultation.

- **Technical skills:** The app is designed with the assumption that users possess only basic smartphone literacy. Tasks such as opening an application, using the camera, or selecting an image from the gallery are sufficient. No advanced technical expertise, such as familiarity with machine learning, medical imaging, or detailed configuration settings, is expected. This ensures that the barrier to entry is minimal and that the app can be used by a broad audience, including those who are less familiar with advanced technology.

- **Motivation:** Users are primarily motivated by preventive care, personal awareness, and reassurance. Some may use the app proactively as part of routine skin monitoring, while others may turn to it after noticing an unusual mole or skin change. The app provides peace of mind when results are low-risk and encourages timely professional consultation when results suggest elevated risk. By supporting these motivational factors, the app positions itself as a tool that empowers individuals to take a more active role in their health.

2.4 Constraints

- **Hardware limitations:** Mobile devices, especially lower-end smartphones, have limited memory, processing power, and battery capacity compared to desktop or cloud-based systems. These limitations place restrictions on how large and complex the deployed machine learning models can be. For example, deploying a very deep CNN with hundreds of millions of parameters may be impractical due to long inference times and excessive battery drain. Therefore, the application must use lightweight models optimized for mobile hardware, balancing accuracy with efficiency. In addition, developers must test across a range of devices to ensure that performance is acceptable on both high-end and entry-level phones.

- **Regulatory:** Because this application deals with health-related predictions, it must comply with healthcare app ethics standards, informed consent guidelines, and transparency requirements. Predictions must never be presented as official medical diagnoses, since doing so could create legal liability and mislead users. Instead, results must be framed as advisory, accompanied by disclaimers urging users to seek professional medical consultation. Compliance is also necessary to meet institutional review board (IRB) standards and to satisfy app store approval processes, both of which scrutinize healthcare applications more closely than general-purpose apps.

- **Privacy:** User privacy is a core design priority. All image processing must remain strictly on-device, and no images or sensitive information should be transmitted to external servers. This not only protects users from potential breaches but also builds trust in the system. The design aligns with regulatory frameworks such as HIPAA in the United States and GDPR in the European Union, which both emphasize strict controls over personally identifiable health data. By ensuring local-only processing, the system avoids the risks associated with third-party data storage and demonstrates ethical responsibility in handling user health information.

- **Usability:** The application must be usable across a wide range of devices with different screen sizes, resolutions, and operating systems. For example, a feature that looks polished on a large high-resolution screen may not be usable on a smaller, lower-resolution display. Additionally, users may have varying levels of technical literacy, so the design must remain intuitive and simple, minimizing the number of steps required to complete core actions. The system must be compatible with both Android and iOS ecosystems, adapting to their different design guidelines without compromising the user experience. This usability constraint ensures the app can reach the broadest possible audience while maintaining accessibility and inclusiveness.

2.5 Assumptions and Dependencies

- **Users will have smartphones with functional cameras and basic technical skills.** The application assumes that end-users own modern smartphones capable of capturing high-quality images. While advanced technical expertise is not required, users should be familiar with simple tasks such as opening an app, taking a photo, and navigating a results screen. This dependency ensures the app remains accessible while still requiring a baseline level of digital literacy.

- **The ISIC dataset or similar resources will remain available for training.** Model accuracy depends on the continued availability of high-quality dermatological image datasets. If these datasets were removed or restricted, retraining and updating the AI model would become significantly more difficult. This assumption is important for long-term maintainability and scientific reproducibility.

- **Flutter and TensorFlow Lite frameworks will continue to be supported.** The app's cross-platform deployment strategy relies on frameworks such as Flutter for UI/UX and TensorFlow Lite for mobile inference. If either of these tools were deprecated, the development team would need to migrate to alternatives, which could require major architectural changes.
- **Adequate lighting and image quality will be available when capturing lesions.** Accurate AI predictions depend heavily on clear and well-lit images. Poor lighting, blurry photos, or partially obstructed lesions can lead to misclassification. This assumption reflects real-world constraints, acknowledging that image quality remains a critical dependency for reliable results.
- **Users will accept disclaimers acknowledging the app is not a diagnostic tool.** To mitigate misuse, the app presents clear disclaimers that predictions are advisory only. It is assumed that users will read, understand, and accept these disclaimers before use. This protects both the users (from misunderstanding) and the development team (from liability).

2.6 Apportioning of Requirements

Future versions of the application may include advanced features that go beyond the initial release:

- **Multi-language support to increase accessibility globally.** In its first version, the app may default to English, but global accessibility requires localization into multiple languages. This will allow broader adoption across regions where skin cancer prevalence is high but English literacy is low.
- **Dermatologist integration to provide professional consultation links.** While the current system only offers static medical resources, future iterations may allow users to book virtual consultations or directly share anonymized images with certified dermatologists. This would transform the app from a preventive tool into a more integrated healthcare companion.
- **Lesion-tracking dashboards for longitudinal health monitoring.** A planned enhancement is to allow users to save and track changes in skin lesions over time. By maintaining a visual record, users can observe trends and present them to healthcare providers, improving long-term monitoring and early detection efforts.

3 Specific Requirements

3.1 Functional Requirements (FRs)

Each FR includes rationale, explanation, and where possible, an example use.

FR1: Capture images using the smartphone camera. *Rationale*: Enables real-time lesion monitoring. *Example*: A user can photograph a mole on their arm under natural light.

FR2: Upload images from the gallery. *Rationale*: Allows retrospective checks. *Explanation*: Users can compare a lesion across different dates.

FR3: Provide framing overlays. *Rationale*: Ensures consistent image quality. *Example*: A circular guide overlay helps the user center the lesion.

FR4: Preprocess images (resize, normalize). *Rationale*: Standardizes input. *Explanation*: Ensures all photos are analyzed under the same scale and brightness.

FR5: Classify lesions as benign or malignant. *Rationale*: Delivers the app's core function. *Example*: Output may say "Malignant Risk, 82% confidence."

FR6: Display confidence percentage. *Rationale*: Promotes transparency. *Example*: "The system is 92% confident this lesion is benign."

FR7: Present disclaimers. *Rationale*: Ensures ethical compliance. *Explanation*: Prevents misinterpretation of the results as a diagnosis.

FR8: Provide links to medical resources. *Rationale*: Encourages follow-up. *Example*: Provide links to dermatologist directories or telehealth services.

FR9: Operate offline. *Rationale*: Increases accessibility. *Example*: Farmers in rural areas can still use the app without internet.

FR10: Store no images externally. *Rationale*: Guarantees privacy.

FR11: Allow image retakes. *Rationale*: Improves accuracy. *Example*: If a photo is blurry, the user can retry.

FR12: Provide educational tips. *Rationale*: Raises awareness. *Example*: Tips on checking asymmetry, border irregularity, and color variation.

FR13: Log anonymized usage data. *Rationale*: Supports evaluation. *Explanation*: Helps improve future app iterations.

FR14: Display loading, analyzing, and result states. *Rationale*: Improves UX by setting expectations.

FR15: Deploy on Android and iOS. *Rationale*: Maximizes reach.

3.2 Non-Functional Requirements (NFRs)

NFR1: Predictions within 5 seconds. *Explanation*: Long delays reduce usability.

NFR2: Processing must remain local. *Explanation*: Increases trust and protects privacy.

NFR3: Handle corrupted/irrelevant images gracefully. *Example*: If a user uploads a selfie instead of a lesion photo, the app should provide feedback.

NFR4: Interface intuitive for first-time users. *Explanation*: Usability testing will ensure this.

NFR5: App must run on Android/iOS. *Explanation*: Ensures broad adoption.

NFR6: Must not expose sensitive data. *Explanation*: No logs should reveal health data.

NFR7: Support large fonts/high contrast. *Explanation*: Supports accessibility for older users.

NFR8: Modular architecture. *Explanation*: Facilitates maintenance and upgrades.

NFR9: Support future datasets/models. *Explanation*: Keeps the app adaptable.

NFR10: Follow healthcare ethics standards. *Explanation*: Aligns with regulatory guidelines.

3.3 Use Case Scenarios

- **UC1: Capture New Image** – *Precondition*: App installed, camera permission granted. *Steps*: Open app → Tap "Capture" → Center lesion in overlay → Capture → System preprocesses and analyzes → Result displayed with disclaimer. *Postcondition*: User receives a confidence rating and advisory message.
- **UC2: Upload Existing Image** – *Precondition*: User has an existing photo. *Steps*: Open app → Select "Upload" → Browse gallery → Image selected → Processed and analyzed → Result displayed. *Postcondition*: User sees result and education tips.
- **UC3: High-Risk Result** – *Precondition*: User provides image with malignant characteristics. *Steps*: Upload or capture → System classifies lesion as malignant risk (>80% confidence) → Warning screen displayed with referral links. *Postcondition*: User is encouraged to seek immediate medical consultation.

4 Supporting Information

4.1 Table of contents and index

The table of contents and index are critical navigation aids. The TOC lists sections and subsections, while the index includes technical terms, acronyms, and requirement identifiers.

4.2 Appendices

Appendices supplement requirements with supporting information:

- Appendix A: Milestones and Deliverables – Expanded timeline and evaluation points.
- Appendix B: Task Matrix – Clear breakdown of responsibilities.
- Appendix C: Risk Assessment – Dataset imbalance, ethical concerns, and mitigation.
- Appendix D: Future Enhancements – Potential integrations and multi-language support.

4.3 References to supporting documents

- IEEE Std 830-1998.
- ISIC Dataset Documentation.
- Team project plan and presentation.