SRS Report for Undergraduate Major Project: CanScan

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Domain Introduction: Healthcare IT for Skin Cancer Detection

Skin cancer is one of the most prevalent forms of cancer worldwide, with millions of new cases diagnosed each year. Early detection is crucial for improving treatment outcomes and survival rates. However, identifying skin cancer in its initial stages remains challenging for many individuals due to limited access to dermatological expertise, subjective diagnosis methods, and lack of awareness about risk factors and warning signs.

The Healthcare IT domain aims to address these challenges by leveraging advanced technologies, including machine learning, artificial intelligence (AI), and mobile application development, to create innovative solutions that enhance the quality of care, improve diagnostic accuracy, and make health services more accessible to patients. Companies operating in this domain develop and distribute software tailored for healthcare providers, including hospitals, pharmacies, and medical practices. Emerging technologies are transforming various aspects of healthcare, enhancing patient care and operational efficiency. The widespread adoption of health IT solutions not only improves cost management but also enhances medication administration and overall healthcare delivery.

In the context of skin cancer detection, Healthcare IT solutions offer significant advantages:

1. **Automated Detection Tools:** Advanced algorithms analyze images of skin lesions to differentiate between benign and malignant conditions, reducing dependency on specialist consultations.

2. **Accessibility and Convenience:** Mobile applications equipped with diagnostic features provide users with on-the-go access to self-screening tools, empowering them to monitor their skin health regularly.

3. **AI-Driven Risk Assessment:** By integrating machine learning models trained on large datasets of skin images, applications can provide personalized risk evaluations based on factors such as lesion shape, color, and texture.

4. **Enhanced Healthcare Integration:** Systems that seamlessly communicate with healthcare providers enable efficient referral processes, data sharing, and remote consultation, improving overall patient management.

This project focuses on developing an innovative mobile application for skin cancer detection, utilizing AI-driven image analysis to provide users with real-time risk assessments and actionable recommendations. The application will also promote skin health awareness, educate users about preventive measures, and encourage timely medical consultations for suspicious skin lesions. By combining cutting-edge technology with healthcare accessibility, the project aims to contribute to the fight against skin cancer and improve patient outcomes on a global scale.

Existing systems

1. **Dermatologist AI-Based Skin Cancer Detection Systems**

   These systems utilize machine learning and deep learning algorithms trained on large datasets of skin lesion images to detect skin cancer. Notable tools include:

   - **SkinVision**: A mobile application that analyzes skin spots and moles using machine learning to assess skin cancer risk. Users capture photos of their skin, and the app provides a risk assessment within 30 seconds.
   - **MoleScope**: A smartphone-based dermatoscope that magnifies skin lesions for detailed imaging. It works with a companion app that helps track changes in moles and provides analysis to support early skin cancer detection.

2. **Computer-Aided Diagnosis (CAD) Systems for Dermoscopy**

   - **Dermoscopy CAD Systems**: These are specialized tools used by dermatologists to enhance the visual analysis of skin lesions. The system combines high-resolution dermoscopic imaging with AI to differentiate between benign and malignant growths.
   - **MedGadget DermLite AI**: Integrates dermoscopy with artificial intelligence to offer real-time skin cancer risk assessments. It assists dermatologists by providing an additional diagnostic layer to manual examination.

3. **Cloud-Based AI Skin Cancer Screening Platforms**

   - **SkinIO**: A cloud-powered skin cancer detection platform that uses AI for comprehensive skin mapping and lesion monitoring. It supports regular scans, image comparisons, and dermatologist referrals.
   - **SkinCheck AI**: A web-based AI system that allows users to upload skin lesion images for automated analysis. It provides immediate feedback on potential skin abnormalities, guiding users to seek professional care if necessary.

4. **Standalone AI-Powered Diagnostic Devices**

   - **Nevisense**: A non-invasive diagnostic tool that uses Electrical Impedance Spectroscopy (EIS) to differentiate between benign and malignant lesions. It measures skin tissue properties to aid in melanoma detection.

5. **Wearable and IoT-Integrated Skin Monitoring Systems**

   - **Miiskin**: A wearable-based monitoring system that integrates with smartphone apps to track changes in moles and lesions over time. It provides notifications for checkups based on image comparisons.

These systems represent a diverse range of technologies aimed at improving skin cancer detection, enhancing accessibility, and supporting early intervention. Each has unique strengths, from real-time risk assessment to long-term monitoring and clinical-grade diagnostic support.

Limitations Of Existing Systems

1. Limited Accuracy and False Positives/Negatives
Many AI-based systems still face challenges in providing consistent and highly accurate results. False positives (indicating cancer when it is not present) and false negatives (failing to detect cancer) can lead to unnecessary anxiety or missed diagnoses.

2. Dependence on Image Quality
The effectiveness of most mobile and AI-based applications depends heavily on the quality and resolution of the images captured by users. Poor lighting, improper angles, or blurry images can significantly reduce diagnostic accuracy.

3. Limited Coverage of Rare Skin Conditions
Most systems are trained primarily on common skin cancer types such as melanoma, basal cell carcinoma, and squamous cell carcinoma. They may not effectively recognize or differentiate rare or atypical skin conditions.

4. Lack of Comprehensive Clinical Validation
While some systems have undergone clinical testing, many are not yet fully validated for widespread clinical use. Limited peer-reviewed studies and a lack of large-scale trials reduce trust in their reliability.

5. Over-Reliance on AI without Expert Consultation
Some systems provide diagnostic feedback without adequate guidance to consult healthcare professionals, which could delay necessary medical intervention or create overconfidence in self-diagnosis.

6. Data Privacy and Security Concerns
Applications that store or process patient images and personal data may have vulnerabilities related to data privacy and security. Ensuring compliance with healthcare regulations like HIPAA and GDPR is a critical challenge.

7. Limited Integration with Healthcare Systems
Many skin cancer detection applications do not seamlessly integrate with electronic health records (EHR) or provide direct communication with dermatologists, limiting their utility in ongoing patient management.

8. High Cost of Advanced Devices
Specialized diagnostic devices like Nevisense can be prohibitively expensive for widespread adoption by individuals or smaller healthcare practices, limiting access to advanced diagnostic tools.

Addressing these limitations is critical to improving the effectiveness, reliability, and adoption of next-generation skin cancer detection systems.

Project Proposal: CanScan

Introduction

Skin cancer is one of the most common and preventable types of cancer, with early detection playing a vital role in improving patient outcomes. Despite advancements in healthcare technology, access to dermatological expertise remains limited for many individuals. CanScan aims to bridge this gap by providing a user-friendly, AI-powered mobile application that empowers individuals to monitor their skin health and detect early signs of skin cancer from the convenience of their smartphones.

Project Objectives

- Develop a mobile application that allows users to self-examine their skin for potential cancerous lesions using smartphone cameras.
- Utilize advanced machine learning models to analyse skin lesion images based on established dermatological criteria (ABCDE: Asymmetry, Border irregularity, Colour variation, Diameter, Evolving).
- Provide personalized health recommendations and risk assessments, categorized as low, moderate, or high, to guide users toward appropriate medical action.
- Promote awareness of skin cancer prevention, encourage proactive healthcare habits, and support early diagnosis for improved health outcomes.

Scope of Work

1. **Machine Learning Model Development**
    - Develop and train custom machine-learning algorithms on a comprehensive dataset of skin lesion images to detect melanoma and other skin cancers.
    - Implement the ABCDE rule-based analysis for feature extraction and risk classification.
2. **Mobile Application Development**
    - Build a robust, intuitive, and secure mobile interface for image capture, analysis, and risk reporting.
    - Incorporate image comparison functionality to track lesion changes over time.
3. **Risk Assessment and Recommendation Engine**
    - Develop a risk scoring system to classify lesions into low, moderate, or high-risk categories.
    - Provide actionable recommendations, including when to seek professional dermatological advice.
4. **Privacy and Security**
    - Ensure compliance with healthcare data privacy regulations (e.g., HIPAA, GDPR).
    - Implement secure data storage, image processing, and user authentication mechanisms.

Key Features

- **Image Analysis with AI**: Detect potential skin cancer using smartphone-captured images.
- **ABCD Criteria-Based Evaluation**: Assess asymmetry, border irregularities, colour variations, and lesion size.
- **Historical Tracking**: Monitor changes in skin lesions over time for better health insights.
- **Personalized Health Guidance**: Tailored recommendations for preventive care and medical consultation.
- **Data Privacy and Security**: Ensure strict adherence to data protection regulations.

Expected Outcomes

- Empower users with an easy-to-use, technology-driven tool for proactive skin health monitoring.
- Improve awareness of skin cancer and preventive care measures.
- Facilitate timely medical intervention, potentially reducing mortality and morbidity rates associated with skin cancer.

Conclusion

CanScan offers an innovative, accessible solution to a significant healthcare challenge. By leveraging mobile technology and AI, this project aims to promote early skin cancer detection and foster healthier lifestyles through proactive self-examination and personalized healthcare guidance.

Functionalities

1. Image Capture and Analysis

Description:
CanScan allows users to capture high-resolution images of skin lesions or moles using their smartphone cameras. The application guides users with prompts to ensure proper lighting, focus, and framing to optimize image quality.

Detailed Process:

- Users take a picture of the lesion or select a previously saved image.
- The app applies pre-processing filters to enhance clarity and remove noise.
- The machine learning model analyzes the image, extracting key features based on the ABCD criteria:
    - **Asymmetry**: Compares one half of the lesion to the other.
    - **Border Irregularity**: Identifies uneven, blurred, or jagged lesion edges.
    - **Colour Variation**: Detects multiple shades within the lesion.
    - **Diameter**: Measures the lesion size to identify if it exceeds a risk threshold.

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2. Risk Assessment and Recommendation Engine

Description:
The application classifies lesions into risk categories: **Low, Moderate, or High**. A personalized health path recommendation follows, advising users on next steps.

Detailed Process:

- Low risk: Suggests monitoring with periodic image capture.
- Moderate risk: Encourages users to consult a dermatologist for a professional opinion.
- High risk: Advises immediate medical attention.
- The system explains the reasoning behind risk scores and provides educational content on skin cancer prevention.

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3. Historical Tracking of Lesions

Description:
Users can save and track the evolution of skin lesions over time.

Detailed Process:

- The app stores images and risk scores for each lesion in a user's personal history.
- A timeline view shows how lesions have changed with time-stamped records.
- Automated reminders prompt users to retake pictures based on personalized schedules.

4. User-Friendly Interface

Description:
The interface is designed for ease of use with clear instructions and a clean layout.

Key Features:

- **Guided Image Capture**: Step-by-step prompts for capturing quality images.
- **Dashboard Overview**: Displays risk scores, lesion history, and recommended actions.
- **Educational Resources**: Interactive content on skin cancer prevention and self-examination techniques.

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5. Blockchain-Based Data Storage

Description:
Blockchain technology provides secure, decentralized data storage for users' medical data and images.

Detailed Process:

- **Decentralized Storage**: User data (images, risk assessments, and history) is stored on a blockchain ledger, ensuring data integrity and preventing unauthorized modifications.
- **Privacy and Security**: Data is encrypted, and access is restricted through private keys controlled by the user.
- **Transparency and Ownership**: Users maintain ownership of their data and control permissions for sharing with healthcare providers.
- **Immutability**: Blockchain ensures that data cannot be altered retroactively, reinforcing trust in diagnostic history and recommendations.

Implementation Strategy:

- Use a **permissioned blockchain** like Hyperledger or **Ethereum smart contracts** for managing user data.
- Employ **IPFS (Interplanetary File System)** for efficient image storage, linking hashes to the blockchain to reduce on-chain data size.
- Create **smart contracts** for access control, enabling secure sharing with dermatologists or healthcare professionals.

These functionalities together make CanScan a comprehensive, secure, and user-centric solution for proactive skin cancer monitoring. The integration of blockchain technology strengthens data privacy, enhances user control, and builds trust, setting CanScan apart as a future-forward healthcare application.

Advantages Of Proposed Idea

1. Early Detection and Timely Intervention

Early detection of skin cancer significantly improves treatment outcomes. CanScan empowers users to monitor their skin health regularly, identifying suspicious lesions before they become advanced.

- **Advantage**: Increases the likelihood of early diagnosis and reduces mortality and morbidity rates associated with late-stage skin cancer.
- **Benefit to Users**: Encourages proactive health management, especially for individuals at high risk or with limited access to dermatological care.

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2. Accessibility and Convenience

The mobile-based approach makes skin cancer detection tools accessible to a wide audience without requiring specialized equipment or frequent dermatology visits.

- **Advantage**: Users can self-examine from the comfort of their homes using a smartphone camera.
- **Benefit to Users**: Saves time and costs associated with medical consultations for non-critical concerns.

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3. Personalized Health Guidance

CanScan provides tailored recommendations based on the risk level of detected lesions, helping users understand appropriate next steps.

- **Advantage**: Reduces uncertainty by offering actionable insights and evidence-based advice.
- **Benefit to Users**: Builds awareness and encourages better skin health practices through customized health paths.

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4. Historical Tracking for Long-Term Monitoring

Users can store images and track lesion changes over time, identifying growth patterns or evolving characteristics that may indicate increased risk.

- **Advantage**: Enables comprehensive monitoring and visualization of skin health trends.
- **Benefit to Users**: Facilitates earlier detection of progressive changes that might warrant medical evaluation.

5. Blockchain-Based Data Privacy and Security

CanScan incorporates blockchain for secure, decentralized storage of user data, ensuring privacy, security, and user ownership of personal information.

- **Advantage**: Prevents unauthorized data access and tampering, fostering trust in the platform.
- **Benefit to Users**: Users retain full control of their data and can securely share records with healthcare providers if needed.

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6. Cost-Effectiveness

Compared to regular dermatology consultations and specialized diagnostic tools, CanScan provides an affordable alternative for routine skin health monitoring.

- **Advantage**: Reduces healthcare expenses for non-urgent issues.
- **Benefit to Users**: Offers a low-cost, technology-driven preventive care solution, making it accessible to a larger population.

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7. Global Reach and Scalability

The app's mobile nature makes it adaptable for users worldwide, with potential multilingual support and localization features.

- **Advantage**: Scalable across regions, making advanced skin cancer detection tools more accessible globally.
- **Benefit to Users**: Offers inclusive healthcare solutions regardless of geographic or economic constraints.

Technical Stack for CanScan

1. **Front-End Development**

   - **Language/Framework**: Flutter / Dart
   - **UI/UX Design Tools**: Figma for wireframing and prototyping
   - **Libraries and Tools**:
     - **CameraX** for camera functionality
     - **Glide/Fresco** for image loading and processing

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2. **Back-End Development**

   - **Language**: Python
   - **AI/ML Libraries**:
     - **TensorFlow/Keras** for model training and inference
     - **OpenCV** for image processing
   - **Database**:
     - **Firebase** for structured data storage
     - **IPFS** for decentralized image storage (linked to blockchain)

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3. **Machine Learning and Image Processing**

   - **Model**: Custom convolutional neural network (CNN) for lesion classification
   - **Criteria-Based Analysis**:
     - ABCDE rule-based feature extraction
   - **Libraries and Tools**:
     - **scikit-learn** for data analysis
     - **Pandas/NumPy** for data manipulation

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4. **Blockchain Integration**

   - **Blockchain Platform**:
     - **Ethereum** (smart contracts with Solidity)
   - **Data Storage**:
     - **IPFS** for storing images and metadata
   - **Access Control**:
     - **Smart Contracts** for managing user permissions

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5. **APIs and External Services**

   - **Google Cloud Vision** (optional, for advanced image processing)
   - **FastAPI** To make & attend calls to/from the python server.