

Skin Sight

Dermatology Triaging Platform Utilizing Multimodal AI Models

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Problem Statement

Approximately 1.9 billion people globally are affected by skin conditions, facing long wait times of 3-6 months to see a dermatologist and about 20.6 days to see a primary care provider (PCP)(1). Many non-skin cancer dermatological conditions can be diagnosed and treated by non-dermatologists. Currently, an excessive number of patients opt for expensive dermatologist consultations via telemedicine or in-person, despite the availability of other healthcare providers who could offer similar clinical outcomes online such as nurse practitioners and physicians assistants. This inefficiency highlights a critical need for a streamlined, cost-effective approach to dermatological care.

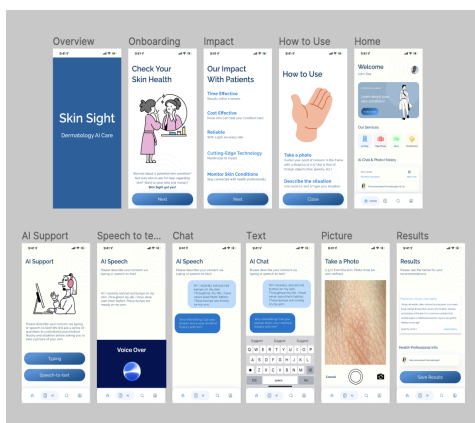
Overview of Prior Research

In the U.S., \$75 billion is spent annually on skin disease treatment(2). Concurrently, the number of nurse practitioners saw an 8.5% increase in 2022(3). Significant advancements in AI dermatology, particularly with the introduction of convolutional neural networks, have propelled AI models to achieve diagnostic accuracies comparable to human experts(4). Recent innovations include multimodal AI systems that analyze both clinical images and textual medical histories.

Findings & Review of Work to Date

Needfinding: Through various interviews, we learned that most conditions seen by PCPs can be effectively managed by nurse practitioners (NPs) or physician assistants (PAs). There is a growing demand for automated triaging systems as patients increasingly seek monitoring and quick answers to their health questions. Interviews with a PCP and a dermatologist revealed that current triaging is often handled by patients themselves or dermatologists. This highlights a need for better quality photos and improved access to care. Further insights from interviews with two patients indicated a desire for a monitoring tool to track changes in skin conditions. However, potential users have expressed concerns about trust with AI.

Prototype



Our app utilizes the AI multimodal model, providing users the opportunity to type or utilize speech-to-text to describe their skin condition problem and medical history. Patients have the ability to take photos of their skin for the AI model to detect what type of skin condition they have. Our app also provides an onboarding process to understand the user. The user will then receive results regarding the prediction of what their skin condition is and the triaging of which healthcare professional recommended to see.

The backend integrates an AI model capable of processing multimodal inputs—speech, images, or text—to detect skin conditions. It utilizes prompt engineering techniques to enhance the performance of language models. To guide the AI model, we developed over 25 well-designed questions approved by dermatologists to collect users' medical histories for specific diagnoses. Comprehensive documentation details various skin conditions and the appropriate healthcare professionals based on disease severity and expertise. Using this documentation, we crafted and optimized input prompts to ensure the AI model asks no more than five targeted questions to reach an accurate diagnosis. Subsequently, the system directs users to the appropriate healthcare professional, following the established guidelines. In the AI-powered dermatology app, prompt engineering ensures that user descriptions of skin conditions and medical history are clear, significantly enhancing the model's predictive accuracy and recommendation quality. The modular architecture of the app, with distinct routes for authentication, image processing, and predictions, promotes scalability. This structure facilitates easy updates and extensions of functionalities while ensuring a seamless user experience across different input modalities.

Proposed Business Model

Our value proposition is focused on transforming access to dermatological care through an innovative AI-driven platform. We target two primary customer segments: healthcare professionals who benefit from AI-enhanced triaging to streamline their clinical workflows, and insurance payors who require precise triaging for efficient and accurate payments. Our revenue generation strategy is dual-layered, featuring a subscription model for regular users desiring continual access, complemented by a pay-per-use model catering to occasional needs for specialized triaging.

The projected growth in the AI healthcare market, expected to reach \$148.4 billion by 2029 growing at a 48.1% CAGR, underscores the substantial market opportunity for our services. This growth is propelled by the increasing demand for technology solutions that enhance diagnostic accuracy and patient care efficiency, positioning us favorably within this expanding sector.

Financially, our service demands significant investment in cutting-edge AI development and ongoing maintenance to keep our solutions at the forefront of technological advancements. We are also committed to extensive marketing efforts aimed at increasing service adoption and sustained investment in research and development to keep our offerings competitive and innovative.

Strategic partnerships form the backbone of our operational strategy. Collaborations with leading technology providers ensure robust platform support, while partnerships with skincare companies allow for an integrated approach to dermatological care. Furthermore, engaging with healthcare professionals helps align our solutions with real-world clinical needs, ensuring they are both practical and beneficial.

To address the competitive landscape, where established players and innovative startups vie for market share, we differentiate ourselves through superior user experience for all types of skin conditions, proven clinical efficacy and accuracy, and seamless integration into existing healthcare workflows. Our service is accessible through an online platform and a mobile app, both designed for maximum ease of use and optimal user engagement, ensuring that healthcare professionals and patients alike can benefit from our advanced diagnostic tools wherever they are.

In summary, our business model not only captures the essence of innovation in healthcare technology but also strategically positions us to capitalize on the growing trend of digital health solutions. By continuously evolving and adapting to market needs, we aim to lead the wave of AI-driven advancements in dermatological care, making significant impacts on global health outcomes.

Impact of Research

Our research underscores the significant benefits of deploying lower-cost healthcare providers for non-critical care, revealing a substantial reduction in healthcare costs and the provision of immediate results through telehealth. This approach significantly shortens wait times and simplifies access to care, enhancing overall healthcare accessibility. The system's capacity to accommodate a wide range of ethnicities, skin colors, and medical histories contributes to its inclusivity. High user satisfaction is consistently reported, reflecting the system's effectiveness and ease of use. Moreover, strict adherence to clinical safety and privacy regulations is a priority, ensuring the reliability and security of the system.

Implications of Research

By utilizing our AI-driven platform to employ lower-cost healthcare providers, we decrease healthcare expenses, reduce wait times, and broaden access to dermatological care across diverse populations. Our app inclusively supports various skin conditions and patient demographics to address biases in dermatological AI apps. Positive user feedback emphasizes the app's potential to boost patient engagement and trust in telehealth technologies. Continuous enhancements in AI accuracy and reliability are crucial, particularly for diagnosing rare conditions.

Key Learnings

In comparing Gemini AI and ChatGPT-4, we evaluated the potential benefits of these emerging language models. Despite both being trained on vast amounts of data, Gemini AI is designed to avoid offering medical advice, understanding the potential dangers of doing so. In contrast, ChatGPT-4 demonstrated the ability to provide nearly accurate diagnoses in most cases, offering detailed explanations and exploring possibilities associated with the given symptoms or images. It also suggested initial steps for patients and indicated when professional medical intervention

was needed. While neither model is specifically tuned for disease diagnosis tasks, ChatGPT-4 shows significant potential in this area, delivering accurate and informative results.

Challenges & Successes

While we achieved success in obtaining accurate diagnoses for common skin symptoms such as rashes and moles, the extent of these models' knowledge remains uncertain. There is potential for misinterpretation when dealing with uncommon diseases or various types of cancer, as the models may not be sufficiently trained on such specific medical conditions. Furthermore, the true capabilities of these models cannot be fully understood without exposing them to these specialized tasks. It is crucial to recognize that AI models are trained on large datasets, but may lack the specificity required for complex medical conditions. The risk of misdiagnosis or incomplete advice highlights the importance of continuous evaluation and training with targeted medical data. By systematically exposing these models to a wider range of medical scenarios and incorporating feedback from healthcare professionals, we can enhance their diagnostic accuracy and reliability. This approach also involves developing validation protocols and ensuring that ethical guidelines are followed. While these AI models show promise in augmenting medical diagnostics, their integration into healthcare systems must be handled with caution, emphasizing the need for ongoing research and collaboration with medical experts to ensure patient safety.

Next Steps

Our next steps involve refining our AI model using RAG, user testing with healthcare professionals and patients to assess diagnostic accuracy, and expanding features. We aim to develop more sophisticated prompts to improve AI understanding and processing, thereby reducing misdiagnoses and enhancing user experience. We want to ensure the app's interface is responsive across various devices. We will continuously update our compliance with medical regulatory standards like HIPAA and implement data protection methods to ensure user privacy.

References

- (1) Appointment wait times drop for family physicians. Available: <https://www.medicaleconomics.com/view/appointment-wait-times-drop-for-family-physicians-indicating-shift-in-care>. Author: Unknown. Accessed: 05/30/24
- (2) Burden of Disease. Available: <https://www.aad.org/member/clinical-quality/clinical-care/bsd#:~:text=Skin%20disease%20cost%20the%20US,in%20caring%20for%20these%20patients>. Author: Unknown. Accessed: 05/30/24

(3) Nurse Practitioner Profession Grows 385,000 Strong. Available: <https://www.aanp.org/news-feed/nurse-practitioner-profession-grows-to-385-000-strong>. Author: Unknown. Accessed: 05/30/24

(4) Deep Learning Models Across the Range of Skin Disease. Nature. Venkatesh, K.P., Raza, M.M., Nickel, G. et al. Deep learning models across the range of skin disease. npj Digit. Med. 7, 32 (2024). <https://doi.org/10.1038/s41746-024-01033-8>