# ENGR 490 Multidisciplinary Capstone Design Project

# Pocket DermAssist

## Team 2


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“We certify that this submission is the original work of members of the group and meets the Faculty's Expectations of Originality”

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## Objectives

The objective of *Pocket DermAssist* is to design and develop a mobile AI tool that leverages computer vision and embedded systems to assist in the early detection of skin conditions. The project aims to provide users with a portable, accessible, and reliable solution that can analyze skin images and flag potential issues for further medical consultation, thereby supporting preventive healthcare and improving access to early diagnosis.

## Potential application areas & customers

The primary application area of the Pocket DermAssist device is early detection and screening of skin cancers, with a particular focus on basal cell carcinoma, squamous cell carcinoma, melanoma, and Merkel cell carcinoma. Our target users include individuals who are health-conscious or at higher risk due to sun exposure, skin type, or family history. The device is designed to empower these users to monitor suspicious skin lesions from home using AI-assisted image analysis. Another key customer segment includes people living in remote or underserved areas with limited access to dermatologists. In these cases, our device can serve as a first-line screening tool, potentially integrated with telemedicine platforms for remote diagnosis. Public health organizations and NGOs (Non-Governmental Organizations) focused on cancer prevention may also benefit from deploying our device in outreach programs, especially in regions with limited diagnostic infrastructure. By targeting users specifically concerned about skin cancer, Pocket DermAssist aims to fill a critical gap in accessible and early-stage cancer detection.

## Current or potential competitors

The main competitors we'll be experiencing come from various backgrounds. Established manufacturers such as **DermLite** offer high-quality dermatoscopes that attach to smartphone cameras. Their devices are trusted in dermatology for professional imaging, strong optics, and lighting control, though they generally do not integrate real-time on-device AI analysis to assess lesions. For example, the DermLite DL4 offers high field-of-view optics, PigmentBoost lighting, and strong build quality designed for clinical use [1]. Meanwhile, **MetaOptima's MoleScope** provides a clip-on dermatoscope and companion app for imaging, archiving, and teledermatology. MoleScope supports both patient and medical professional use, offering features such as magnification, specialized lighting, skin lesion tracking, and secure image sync through the DermEngine platform [2].

On the software and hybrid front, mobile applications like **SkinVision** pose significant competition. SkinVision has been validated in multiple studies, including a large prospective multicenter diagnostic accuracy study, demonstrating sensitivities of ~87 % for premalignant/malignant lesions and ~92.1 % for melanoma, with specificity around 80.1 % depending on lesion type and severity [3]. Such apps allow users to detect risk via image analysis and track lesion changes longitudinally without requiring specialized hardware. There is also a risk, however, that app performance drops under real-world conditions or with image input variations.

Pocket DermAssist differentiates itself by offering a low-cost, portable alternative that combines specialized hardware with on-device AI analysis. By integrating RGB and UV imaging, embedded TinyML inference, and local data storage, our device provides diagnostic support capabilities that are typically limited to more expensive solutions. This positions our project as a more accessible option for both consumers and healthcare providers who may not have the resources to invest in premium medical equipment.

## Product main features/specifications

A dermatoscope has important requirements that are crucial in any design. The hardware requirements of the device are lighting, magnification, and charging. All these requirements have strict guidelines to ensure that the image is captured with consistent accuracy. There are important software requirements to consider as well, since the device will use AI for skin cancer detection. These software requirements are image processing (computer vision), criteria parameters for skin cancer, storing the appropriate data for tracking, and GUI display. For software, there will be two main categories: Front end and Back end. All these requirements will address the most important needs of our customer/stakeholder base, and each will be explained in more detail.

**Hardware:**

Important lighting parameters are used to quantify the quality of illumination used. An example is correlated colour temperature (CTT), which measures the amount of yellow or blue colour the light is producing, in Kelvin [4]. This range of ultra bright white light is used often in dermatoscopes, as it controls the lighting environment by making it independent from outside light sources [5]. The natural colours of the skin are also more easily seen in this CCT range. Another important lighting parameter is the colour rendering index (CRI), which measures how various colours look on a certain light source in reference to the sun [6]. The scale is on 100, meaning that the closer to 100 the light source is, the more accurate the colour will be. The importance of these parameters in lighting is crucial, and our dermatoscope lighting (using LEDs) must illuminate the skin lesion area and provide a clear, precise view. The dermatoscope lighting should provide a CCT in the range of 4200K - 6175K, and a colour rendering index (CRI) of 90 or greater [7]. High end market dermatoscopes were measured for CCT and CRI, all in the ranges mentioned [7]. To meet these conditions, the dermatoscope measurements should be taken indoors, with adequate external lighting that is not brighter than the ranges mentioned. Verifying these parameters accurately with a small tolerance is difficult, though a light meter will be used to test the CCT and LED light spectrum.

To have accurate images of skin lesions that are zoomed in, a macro lens should be used. A macro lens usually has a magnification ratio of up to 1:1, meaning that the size of the image captured is the actual size of the object being photographed [8]. Being close to the skin lesion with a macro lens will allow for a more precise image, since a small image can be seen up close in detail. Therefore, the dermatoscope must have a macro lens that allows a close up, detailed image that fills the camera frame [8]. Most if not all dermatoscopes have a macro lens, and since skin lesions are required to be detailed and up close, this specification of 1:1 is justifiable. To meet these conditions, the lens must be cleaned thoroughly, and should get close enough to the legion without touching the skin. Verifying this will be done with multiple smartphone cameras and lens attached, to ensure that the image taken up close is detailed (not blurry).

Charging the device is done with a rechargeable battery (preferably lithium ion). For the scope to be used multiple times before charging, a minimum operating time of 100 minutes is required. The battery should therefore have a charge capacity greater than or equal to 2000mAh. To derive this, a simple battery life calculation is used:

$$Battery\ life\ (minutes) = Battery\ capacity\ (mAh)\ /\ Total\ current\ draw\ from\ the\ load$$

The total current draw is roughly estimated based on datasheet specifications. More thorough testing will need to be done with a working prototype. There are two main sources in our circuit that will draw current: the microcontroller (ESP32 WROOM) and the LEDs. According to the ESP32 datasheets, the operating current is around 80mA [9]. However, Wifi capabilities will also be used, and currents can peak at a typical value of 240mA (at a 50% duty cycle) [10]. The total current the microcontroller draws at a time could therefore be up to 320mA, but I would give a safety margin and say 350mA to be safe. As for the LEDs, after researching some options with the lighting specification parameters in mind, the draw current is usually around 50-70mA. One part number: BXEN-50S-11L-3C-00-0-0, has promising specs, with a draw current at 60mA [11]. The current plan is to use 8-10 LEDs in a ring formation. Given the voltage limitation of the battery, the LEDs will be all in parallel (one-by-one). Therefore, the current draw from the LEDs would be 600mA. The total current draw and battery life in minutes is:

$$Battery\ life\ (minutes)\ =\ 2000mAh\ /\ (320mA\ +\ 600mA)\ =\ 2.174hours\ *\ 60min/hour\ =\ 130.43$$

The conditions for this estimate to be feasible is that the environment temperature must be around room temperature. Once the prototype is built, these numbers can be verified in more detail by measurement with a multimeter. As well, the battery can be fully charged and connected to the circuit, and a timer will be set to determine the total time it takes to discharge the battery.

**Front end:**

The system must provide an intuitive, user-friendly mobile interface that allows users to capture skin images, view analysis results, and access guidance with minimal effort. To meet this requirement, the application shall feature a responsive front-end interface with camera integration for capturing or uploading images, real-time display of AI analysis results, and a clear navigation flow with minimal steps, ensuring accessibility for users across different age groups and backgrounds. This requirement was translated into specifications such as simplified layouts, large buttons, guided prompts, and integration with device-native camera functions to ensure that non-technical users can operate the app easily.

The specification is expected to hold under standard smartphone environments (Android/iOS), assuming the presence of a functional camera, internet connectivity for AI analysis. The performance will be measured by average task completion time, compatibility with Android and iOS, interface response time and getting the right data. Verification will be conducted through usability testing with representative users, performance benchmarking on supported devices, and conformance testing against UI/UX standards.

**Back end:**

The system must provide reliable and efficient processing of captured skin images through AI-based computer vision models to deliver accurate early detection of skin conditions. To meet this requirement, the backend shall include a secure image processing pipeline, integration of trained machine learning models for classification, and proper management of user data with strict adherence to privacy and confidentiality standards. This requirement was translated into specifications such as implementing optimized inference models for mobile or cloud execution, ensuring encrypted data transmission, and establishing databases that securely handle image data, analysis results, and user history.

The specification is expected to hold under conditions of stable internet connectivity for cloud processing or sufficient device computational power for on-device inference. The performance will be measured by analysis accuracy, system reliability, and compliance with privacy standards. Verification will be conducted through functional testing of the AI pipeline, validation against dermatological datasets, load testing for concurrent users, and security audits to ensure safe handling and storage of sensitive medical data.

## Validation & Demo plan

Since the Pocket DermAssist will be used to assess if a patient has a form of skin cancer, it is crucial that the project meets a certain standard of efficiency. The goal is to reduce the number of inconsistent results (ex: false negative) as much as possible. For this reason, we are aiming to have 75% correctly identified suspicious lesions while including people with multiple skin tones in our sample. For our device to be convenient and portable, it should fall under 250g while being able to connect to both Android and iOS all while providing results in an easy to comprehend manner.  In order to validate our device, we will be building a full-scale fully functional prototype while using commercially available components to accelerate development while maintaining a low cost under 400$. Our tests would be made on simulated data as well as volunteers to make sure we meet our standards.

## Design methodology

For the development of the Pocket DermAssist we will follow the agile philosophy using the scrum framework. We chose this development process because we strongly believe that continuous development, iterative improvement in sprints, and adaptability is crucial for a project like this. The foundation of scrum is a workflow of intense collaboration, and in our case a collaboration between the hardware and software team. The software and hardware teams will have consistently scheduled meetings to keep everyone up to date on what they worked on. This will allow everyone to have a hand at helping another team member to make sure the project does not have any prolonged delays.

At the end of each sprint, we will have retrospectives to have a recap on what we need to improve in the next sprint for a more seamless and successful sprint. Using this work flow allows us to have great flexibility in the project. Every few weeks our priorities may shift, therefore following this philosophy, the team will be able to adapt quickly and not prioritize something the stakeholder, customers, or even us as a team do find as pertinent.

Due to this, the hardware and software development team needs to work together to deliver a working product every sprint. This will be the best workflow to verify that everyone on the team has knowledge on the whole project rather than just what an individual worked on. With this in mind, we believe this offers us the best balance to bring PocketDerm to fruition.

## Main risks

Pocket DermAssist faces some technical risks that could affect both its reliability and its performance. The AI system that we may want to implement may struggle with false negatives or false positives, particularly if the training dataset we want to provide to it lacks diversity in its data. Diversity in data as in different skin tones, lesion types, age groups, etc. Another would be the conditions of the real world such as the user's lighting, camera angles, lens contamination that could make the accuracy much worse. Then on the hardware side there's several other issues that could arise such as making sure the lighting is consistent over time, changes to the AI models over time that may affect the precision of the tool over time and camera degradation. The TinyML system may also be an issue due to it being constrained by its processing power hence limiting the complexity of the AI mode and affecting its precision during diagnosis.

There are also regulatory and clinical risks that may occur. Medical devices would need to get proper Health Canada or the FDA which is both a very lengthy and resource intensive procedure with knowledge that delays could occur at any moment. Also if the data we collected from clinical or live trials with non-diverse groups of patients could undermine the capabilities of the device. Also if the data has misclassifications of cancerous lesions that could raise both ethical and liability concerns, due to giving false positives or false negatives.

Another issue would be related to market and user adoption, specifically trust. Users may misinterpret the results leading to false positives/negatives that may affect users psychologically, especially without proper disclaimers. There are also strong competitions with something like SkinVision which is software that does scanning exclusively or DermLite which is a hardware specific tool that does exactly the same, with both having strong market presences already and who may introduce their own AI features closing the distance to our tool. Data Privacy and security also pose significant questions regarding trust worthiness, specifically in regards to handling sensitive health images or if encryption is too weak which could cause reputational harm and regulatory punishments.

Finally there are operational, financial and ethical risks that need to be carefully managed. Manufacturing risks such as sourcing for high quality lenses and LED’s while keeping prices down while not affecting the scalability. Ethical issues may also arise which could include potential bias in detection accuracy across skin tones and the dangers of users overrelying on the tool instead of consulting with dermatologists despite being asked to explicitly. Together these risks emphasize the importance of rigorous testing, proper data refinement to remove biases and strategic planning for Pocket DermAssist to have a chance at success.


Pocket DermAssist
October 2025
November 2025
December 2025
January 2026
February 2026
March 2026
April 2026
Whole Team
Formal project proposal
Progress Update 1
Progress Update 2
Progress Update 3
Finalize Device Formfactor
Research Customer Needs
Meet with Supervisor
Research & Finalize Microcontroller
Integration Planning (Hw+Sw Comms)
Meet with Supervisor
Meet with Supervisor
Documentation
Meet with Supervisor
Meet with Supervisor
Detailed Design Report
Integration Implementation
Final Demo
Two Weeks Sprint Starts
Software Team
Research & Finalize Framework for App
Research Datasets for testing and training
Research UI/UX standards
Research AI/Computer Vision Implementation
Research Data Privacy standards
Design Mockups
Finalize Data Storage
Detailed System Flow
Application Development
Application Testing
Hardware Team
PCB Rsearch
Research Lighting Hardware
Research Camera Solution
Research Battery Solution
Finalize Lighting Hardware
Finalize Camera Solution
Finalize Battery Solution
PCB Modeling
Modeling Device Case
PCB Design & Iterations
Hardware Assembly / Protyping
Hardware Testing

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