# Dermaphone: Using Photogrammetry-based Data Driven Vibrotactile Texture Rendering to Simulate Skin Lesions for Dermatology Students using a Smartphone

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**Abstract.** The Dermaphone is an educational tool for medical students learning dermatology. Within the application, consultants can use photogrammetry to create 3D models of skin lesions. These are presented to students with texture rendered through vibration by the iPhone's taptic engine. The application is designed to give medical students exposure to dermatology and act as a study resource to fill gaps from their limited opportunities for practical experience. A framework for crowdsourcing a skin lesion library of 3D models and associated texture data is also provided, built as more educators contribute scans from real life cases.

**Keywords:** Surface haptics · Texture rendering · Medical haptics.

## 1 Introduction

In 2025, the UK General Medical Council will introduce the Medical Licensing Assessment for final-year medical students, which places far more emphasis on dermatology than the existing curriculum [1]. Worldwide, the dermatology medical specialism reports low figures regarding the number of medical students choosing to specialise in it after medical school, specifically due to students' feelings of a lack of exposure and experience in the specialism [2].

Medical students are currently exposed to dermatology through a 1-2 week clinical placement, often observing experienced clinicians rather than examining patients themselves. The placements are short, highly variable in quality, and do not guarantee that the students will gain sufficient experience with different skin conditions. This highlights the importance of independent study resources such as the DermNet website [3], supplemented by textbooks and, occasionally, 3D skin lesion models.

Existing approaches to rendering skin lesions through haptics generally work by creating a 3D reconstruction of a skin lesion, of which the texture is rendered by force-feedback. Current methods of creating the 3D model are unreliable and expensive, such as using image gradients [4] or multi-view images [5] to generate the model.

To physically recreate the texture, most use research-grade haptic robots such as the 3D Systems Touch X [6]. In these expensive, research-grade systems, the user experiences the texture via force feedback through a probe rather than cutaneously through their fingertip - a substantial departure from clinical practice.

To produce a resource that can be made available to students, a software format which makes use of readily availablere will allow a larger number of students to benefit.

## 2 Data-driven texture rendering

The Dermaphone application has been designed to address this problem and works as a multi-sensory educational resource, combining the information included in textbooks with 3D models and the physical experience of examination that is missing from current dermatology teaching.
Photogrammetry is used to construct the 3D skin lesion model. A multi-angle video of the skin lesion is taken, frames extracted, and Apple RealityKit used to produce the model. An accurate 3D model is then presented in the Dermaphone application, and geometry and surface texture data is computed from a height map.
The application uses vibrotactile texture rendering to simulate the physical texture and bumps of skin lesions. It achieves this by generating vibrations from the phone that stimulate the fingertip, in the same way that a surface deformation would deform the finger pad during active touch [7]. Use of the iPhone's taptic engine removes the need for external hardware, ensuring that the application remains widely accessible. The vibration is generated in real-time from the height map in response to finger movement across the skin lesion's bumps and textured areas.

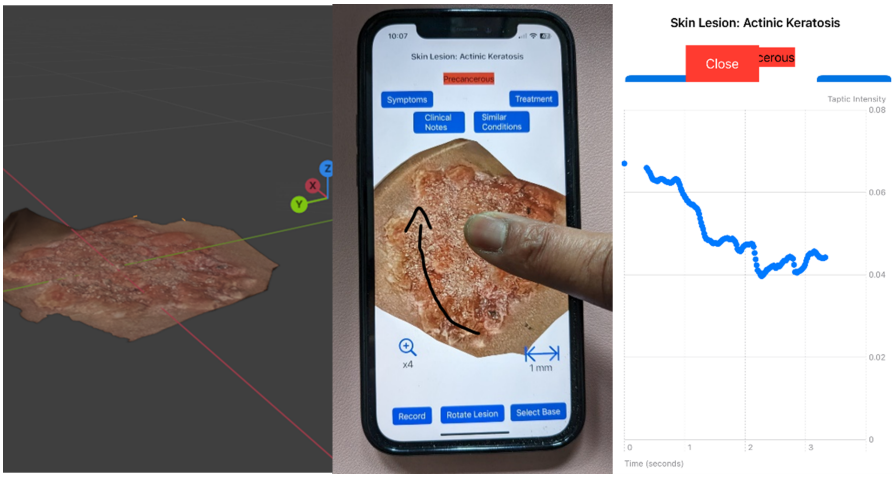


**Fig. 1.** 1: Rendered photogrammetric 3D skin lesion model (Actinic Keratosis), 2: Dermaphone being used by a student, 3: Texture profile of the finger path

## 3 Applications to dermatology training

The application is designed for two groups: trained consultants and medical students. The consultant creates the 3D skin lesion models by taking a multi-angle video of the condition. The texture of the created model is determined automatically, but it is also modifiable by the consultant manually. The consultant can add annotations to the skin lesion model, such as key feature descriptions, links to related skin lesions in the application library, and details for particular case studies (presenting symptoms, suggested

treatments, etc.). This full skin lesion package will then be added to a library of skin lesion packages. It is hoped that this will eventually result in a large, crowdsourced skin lesion library being built.
Students can load skin lesion packages from this library and inspect the 3D models, touch them to feel a simulation of their texture and roughness and read the clinical notes provided by consultants. They can also add their own notes and annotations for later reference.

## 4 Summary and Continuing Work

The Dermaphone app is an educational resource that provides an improved solution to medical students' limited dermatology experience and exposure. Photogrammetry is used for the creation of high quality models, and vibration renders texture sensations. Its low cost, combined with the wide availability of smartphones, ensures access for all.
In future, additional multi-sensory cues will be added to enhance the users' perception of the tactile effect. Such cues, such as a visual deformation to represent palpation, or auditory effects, for example a rubbing sound to represent an increased level of friction, are expected to enhance the user's experience and contribute to their perception of the skin lesion's texture. The effect of these cues will be investigated scientifically to determine their influence on a user's perception of texture.
The application will be evaluated in two parts. The first part will examine the effectiveness of the tactile representation. The second will examine the usefulness of the application within an educational context. The project's links with the Chelsea and Westminster and West Middlesex Hospitals' dermatology and burns units will facilitate user studies with expert dermatologists and medical students.

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