# Simulation Pipeline for Virtual Clinical Trials of Dermatology Images

*V. Vasudev,[a,c] B. Piepers,[a] A. Maidment,[b] T. Kimpe,[a] L. Platisa,[c] W. Philips,[c] and P. Bakic[b]*
*[a]Barco Healthcare, Kortrijk, Belgium, [b]Dept. of Radiology, University of Pennsylvania, Philadelphia, PA 19104, USA, [c]imec-IPI, Ghent University, Belgium*

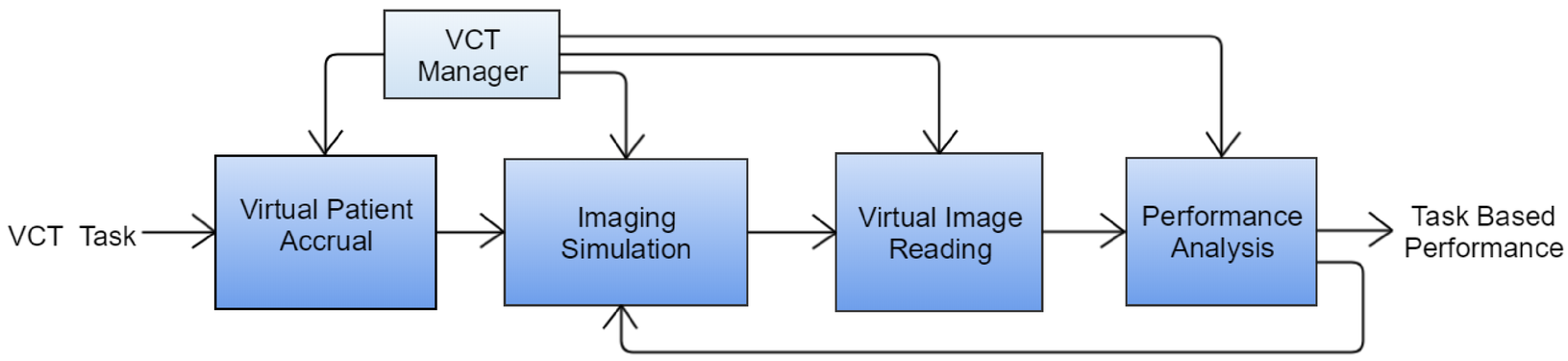
## INTRODUCTION

- Skin cancer is one of the most common cancers in Western countries, with an estimated 96,480 new cases of melanoma to be diagnosed in the US in 2019.
- Dermatoscopes, the standard equipment of dermatologists, are mostly analogue devices, though recent advances have seen the arrival of digital dermatoscopes, allowing for a more comprehensice analysis of skin lesions.

- Optimization and validation of novel medical devices is highly challenging and costly. Moreover, bringing new devices into the market requires clinical trials with a large number of patients imaged repeatedly to benchmark their performance to existing systems.
- Our work proposes an efficient alternative for the optimization and validation, in the form of Virtual Clinical Trials (VCTs) of dermatology imaging. The model has been developed in Blender, a 3D modelling tool most commonly used for game engines.

## METHODS

The proposed dermatoscopy pipeline is based on a breast imaging VCT open source pipeline[1,2] and the Medical Virtual Imaging Chain (MeVIC)[3].



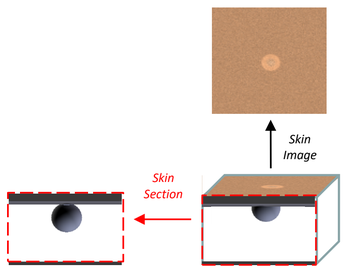

- *Virtual Patient* Module – Patient data, skin volume of interest, the thickness of the skin layers, flat or irregular borders between skin layers, subcutaneous tissue[4], as well as number of lesions, lesion parameters (stage, type, size, shape).
- *Imaging Simulation* Module - Light propagation model, with device specifications.
- *Virtual Image Reading* Module – Display, and Reader models.
- *Performance Analysis* Module - Task-based criteria tests, computing corresponding figures of merit.
- *VCT Manager* Module – Controls all other modules.

For the simulation of skin anatomy, we have used the open source software Blender. We simulated skin as composed of two layers: epidermis and dermis. Lesions were modeled as oblate spheroids. Optical properties of the skin and lesions were selected based upon the reports in literature[4]. Simulated images were generated using a linear camera model available in Blender renderer LuxCore[5], which is based on physically based rendering (pbrt). We have also assumed ambient white lighting to best approximate the normal lighting under which a dermatologist would examine a patient.

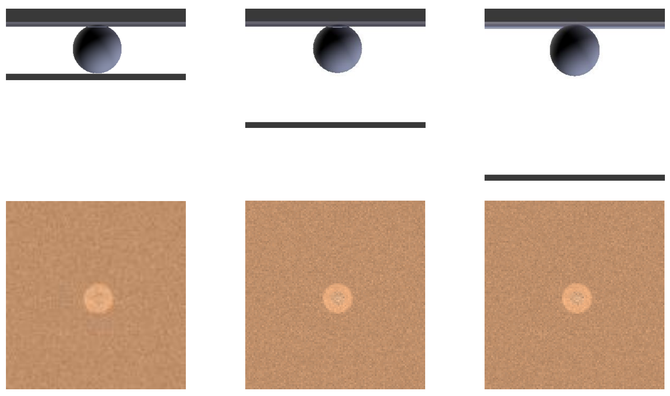
## RESULTS

The images below depict simulated skin sections* (top) and corresponding rendered images (bottom) of the skin model. A lesion size of 1mm, and a dermis size of 3mm is used unless stated otherwise. We observe that the simulated images produce visually plausible appearance.

The simulated skin sections represent the side view of the skin model, while the rendered images are the top view of the model, as would be seen by a dermatologist.

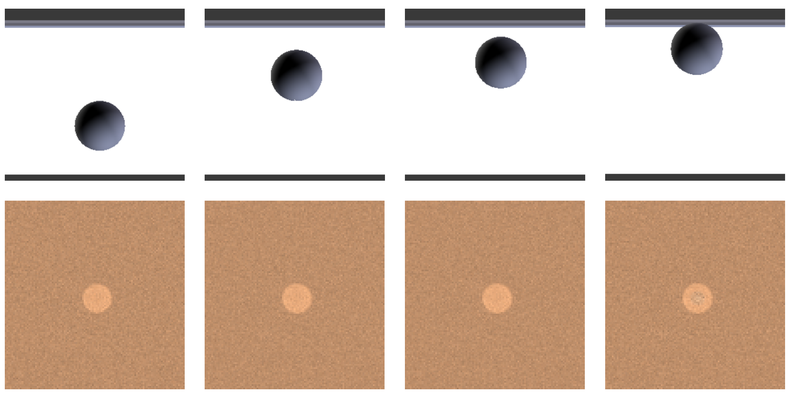



**Varying Dermis Size**



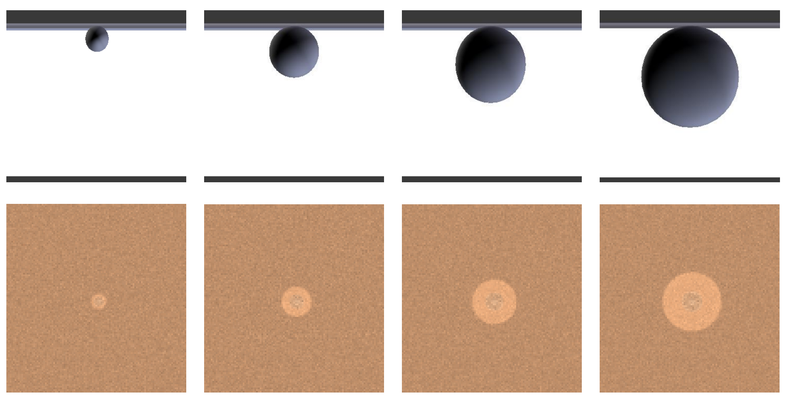
(a) 1mm (b) 2mm (c) 3mm

**Varying Lesion Position**



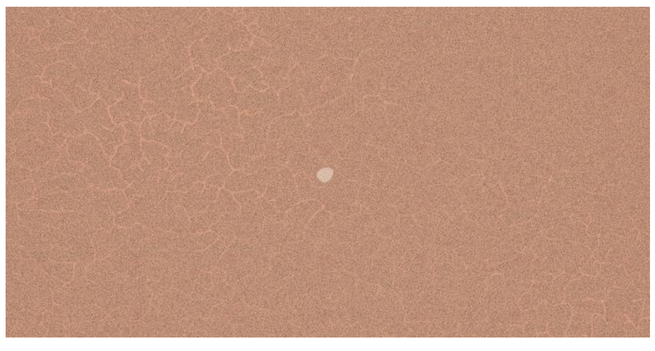
(a) 1.75mm (b) 0.5mm (c) 0.25mm (d) 0mm

**Varying Lesion Size**



(a) 0.5mm (b) 1.0mm (c) 1.5mm (d) 2.0mm

***Future work*** will include surface skin grooves, septated border between skin layers, blood networks and other possibe skin structures / lesion shape (work in progress can be seen below).



** The Epidermis is denoted by the narrow grey band above the lesion, while the dermis is denoted by the white band. The Black bands above the epidermis and below the dermis are not part of the model, and hence should not be considered*

## CONCLUSIONS

The proposed VCT pipeline will not only accelerate the process of clinical trials, but also provide the freedom to opimise parameters that may be useful to a dermatologist in classifying lesions. This will help provide a more tailored and informative experience to dermatologists, something yet to be seen.

## ACKNOWLEDGEMENT

This project is supported by Agentschap Innoveren & Ondernemen of the Flemnish Government (HBC.2017.0583), and the Burroughs-Wellcome Fund (IRSA 1016451).

## REFERENCES

1. Maidment A., “Virtual Clinical Trials for the Assessment of Novel Breast Screening Modalities,” [Breast Imaging], H. Fujita, T. Hara, C. Muramatsu, Eds., Springer, 1–8 (2014)
2. Bakic, P., Barufaldi, B., Higginbotham, D., Weinstein, S., Avanaki, A., Espig, K., Xthona, A., Kimpe, T., Maidment, A., “Virtual clinical trial of lesion detection in digital mammography and digital breast tomosynthesis,” Med. Imaging 2018, SPIE 10573, 1057306 (2018).
3. Marchessoux, C., Kimpe, T. and Bert, T., “A Virtual Image Chain for Perceived and Clinical Image Quality of Medical Display,” J. Disp. Technol. 4(4), 356–368 (2008)
4. Meglinsky, I. V. and Matcher, S. J., “Modelling the sampling volume for skin blood oxygenation measurements,” Med. Biol. Eng. Comput. 39(1), 44–50 (2001)
5. “LuxCoreRender – Open Source Physically Based Renderer.”

## CONTACT

Email: varun.vasudev@barco.com