# Effects of Smartphone Sensor Characteristics on Dermatoscopic Images, a Simulation Study.

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## MOTIVATION

- In today's mostly virtual world, smartphones are being utilised more and more as replacement dermatoscopes[1].
- Diagnosing a lesion requires the overall analysis of the lesion and any/all of its dermatoscopic features[2] that may be present (globules, blue white veil, blood vessels etc,.).
- Different smartphone sensors will result in differing images that will affect diagnosis.
- We examine possible effects a smartphone sensor may have on dermatoscopic images, and how it would stack up when compared to a modern digital dermatoscope sensor.

## BACKGROUND

- Smartphones are being leveraged to capture images of skin lesions in situations where the patient is unable to visit a dermatologist or is in need of a quick diagnosis.
- There are even smartphone attachments[1] that help alleviate some of the negative aspects (for e.g., magnification) of utilising a smartphone as a replacement dermatoscope.
- The sensors have been analysed with the help of the dermatoscope module that is part of the virtual simulation pipeline for dermatology, VCT-Derma[3].

## METHODS

- We have simulated two smartphone sensors (sensors X and Y), and one reference device; the acquisition parameters of all devices can be seen in Table 1.
- Polarization is not considered so the subject has been adapted to prevent specular reflection.
- Smartphone-specific image processing is also not considered as this information is proprietary.
- Simulations were run in Blender[4], with the help of a CAD model of a dermatoscope, to act as reference, and two test subjects: a skin model part of VCT-Derma[3], and an image of a ColorGauge Nano chart[5] (both of which can be seen in Figure 1 alongside).
- The tests employ a simple setup consisting of a camera (dermatoscope model), a uniformly distributed light source, and the test subject. The first test involving the skin model uses an ambient light source, the default "Sun" light source, that is available in Blender[4]. The second test with the chart employs strategically placed white leds as the light source.
- The camera model parameters have been modified based on those mentioned in Table 1 for the respective sensors.

*Table 1 - Smartphone Sensor Characteristics*

| Name | Sensor Spatial Resolution | Sensor Size | Pixel Size | Chroma | f-stop | Focal Length | Crop Factor |
|---|---|---|---|---|---|---|---|
| Reference device | 3864 x 2202 8.51MP | 7.20mm (1/2.5") | 1.62µm | RGB | f/3.7 | 57.6mm | 6.0 |
| X | 4032 x 3024 12.2MP | 6.15mm (1/2.93") | 1.22µm | RGB | f/2.2 | 29mm | 7.2 |
| Y | 4032 x 3024 12.2MP | 7.06mm (1/2.55") | 1.4µm | RGB | f/1.7 | 26mm | 6.1 |

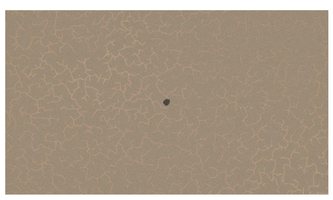
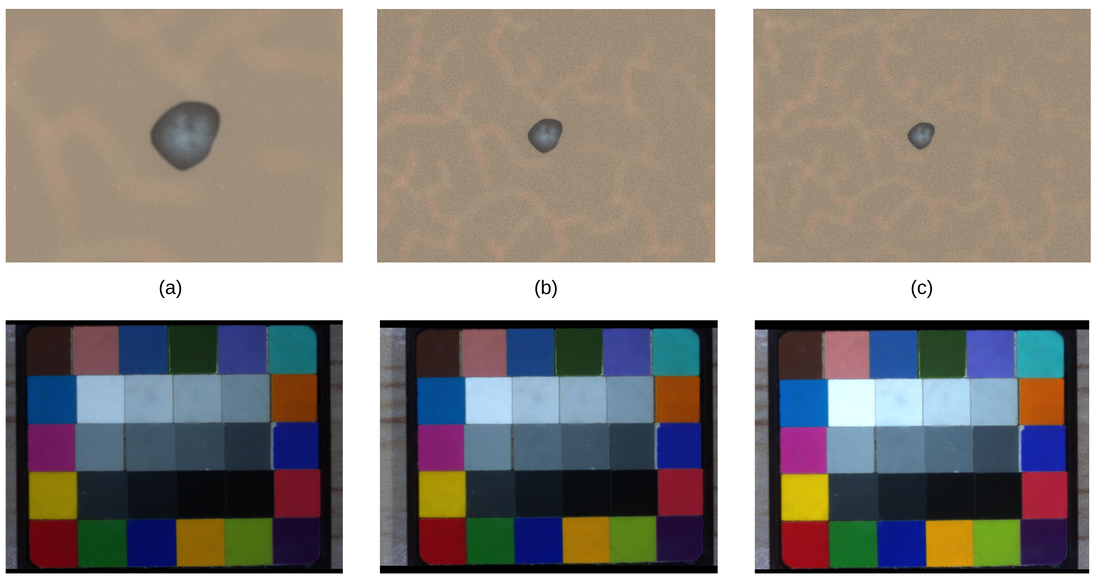


*Figure 1 - Test Subjects: VCT-Derma Skin Model[3] (left), and ColorGauge Nano Chart[5] (right)*

## RESULTS AND DISCUSSION



(a) (b) (c)

*Figure 2 – The skin model as seen from (a) Reference Device, (b) Sensor X, and (c) Sensor Y*

*Figure 3 – The ColorGauge Chart as seen from (a) Reference Device, (b) Sensor X, and (c) Sensor Y*

- Figure 2 shows the result of the first test involving the skin model. A blue white veil[6] has been inserted into the image[7] to help show the difference in the optics of the sensors.
  - There is improved clarity and magnification in the.reference device image as compared to images from sensors x and y.
  - The increased magnification allows for a better analysis of dermatoscopic features[2] that may be present, allowing for a more accurate diagnosis.
- Figure 3 shows the results of the second test involving the ColorGauge chart.
  - The differing sensor characteristics (Table 1) results in differing results with respect to color. Some colors appear to be oversaturated in images from Sensors X and Y as compared to the reference device.
- Results of imaging the ColorGauge chart show average ΔE2000 values of ~12.5 across all color patches for the reference device, and smartphone sensors (more details can be found in the accompanying manuscript)

## CONCLUSIONS

- We have demonstrated that the same lesion appears differently when imaged by different smartphones.
- Differences in image feature clarity, and color, are observed from our tests, with the skin model and chart.
- Some colors were notably more saturated with the smartphone sensors than the reference device, leading to potential loss of information, which can be of clinical significance in dermatological applications.
- Future work includes studying the effect of multispectral illumination on smartphone sensors.

## ACKNOWLEDGEMENT

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