Wearable Sensing for Measuring Skin-Tone, Melanin, and Erythema

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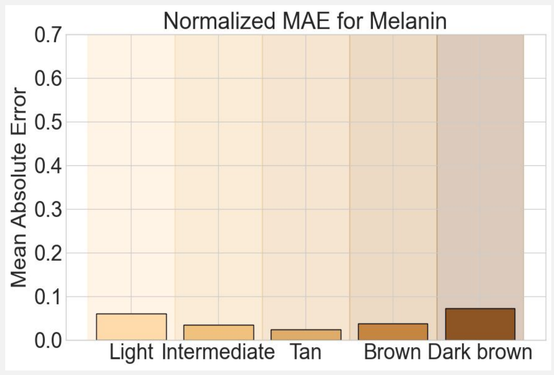
Research Overview

Developing quantitative measurement of skin-tone, melanin, and erythema in a wearable form-factor can:

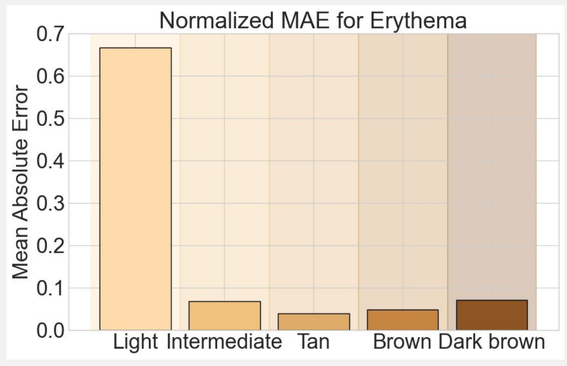
- Correct for inaccuracies in pulse oximeter measurements across skin-tones more directly.
- Allow for continuous monitoring of skin and associated dermatological conditions.

Results: Using Lumos as a colorimeter

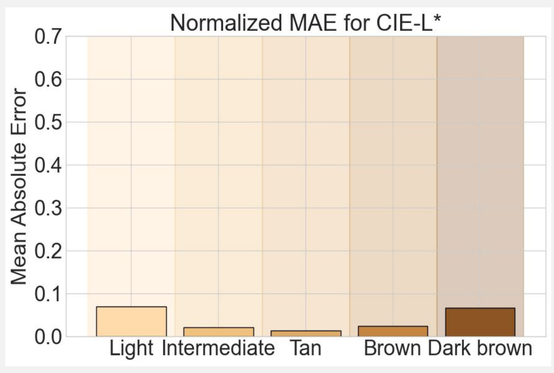
- Five-fold cross validated results, stratified per skin tone, to ensure equal class representation.
- Our model excels at measuring melanin (a) and skin undertones (c, e), but struggles with erythema (b) and redness (d) in lighter skin.
- We anticipate better predictions with more samples.



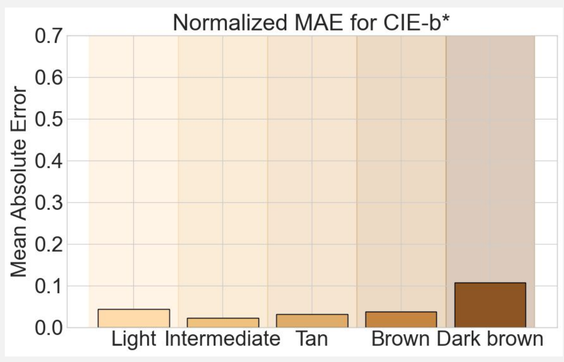
(a) Melanin



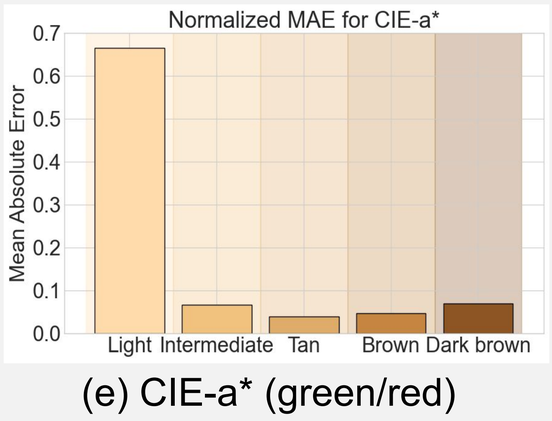
(b) Erythema



(c) CIE-L* (black/white)

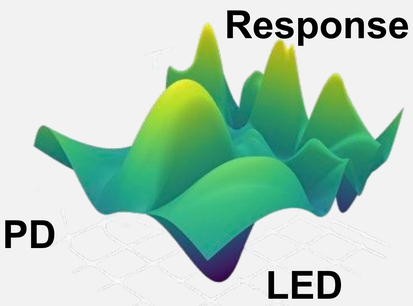


(d) CIE-b* (blue/yellow)



(e) CIE-a* (green/red)

Methodology

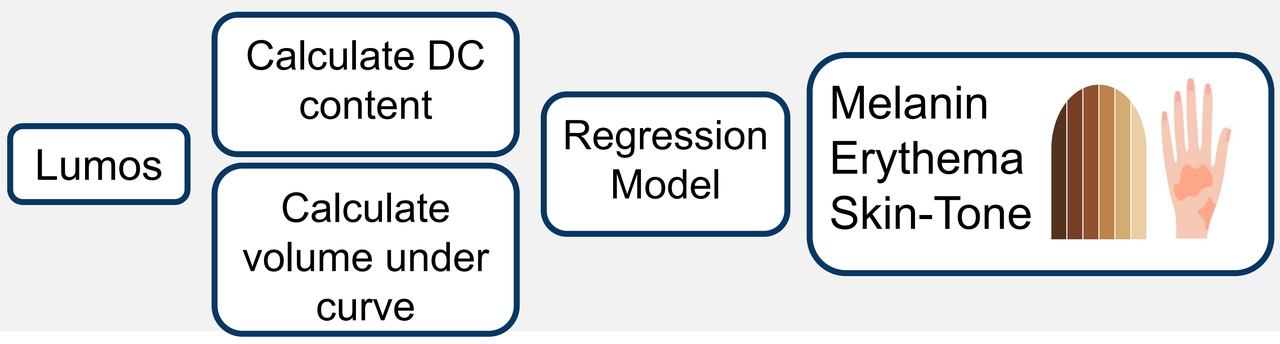


Wearable
Lumos

Colorimeter
Cortex DSM-4

3D Projection
SpectraVue

- Pilot study of n=10
- Measurements across 5 different body locations.
- LEDs and PDs spanning 400nm - 1000nm.
- 20 second recording per location.



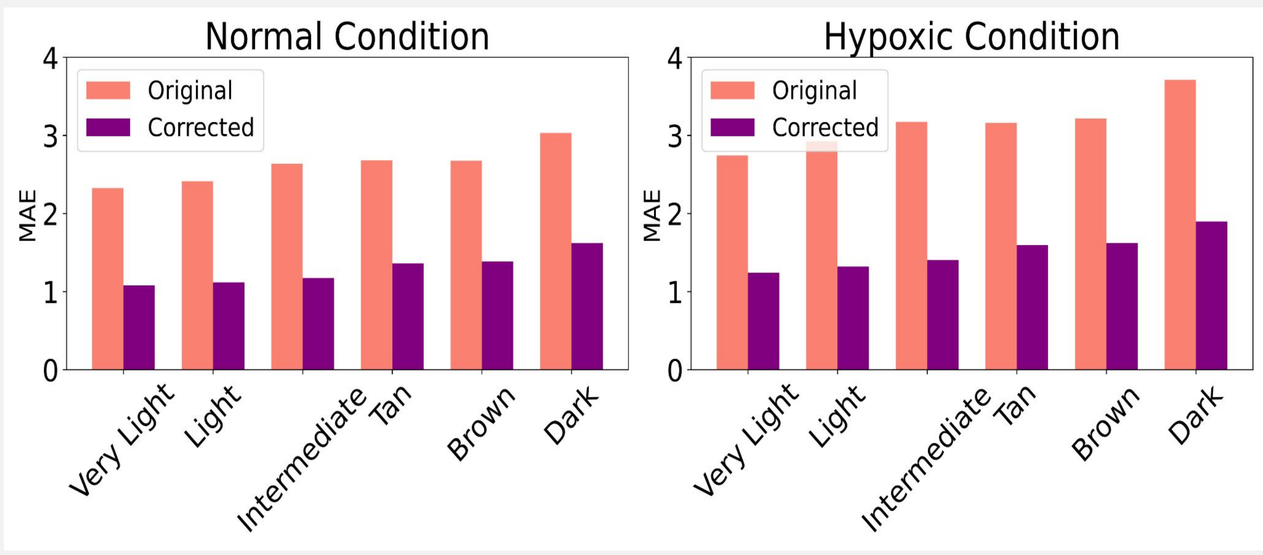
Results - Fixing Pulse Ox with Colorimeter

Using PhysioNet's Open Oximetry database:

- Normalize blood oxygen measurements with spectrophotometer measurements
- Predict true blood oxygen measurements using standardized measurements

Result: up to 50% reduction in mean absolute error (MAE) across skin-tones in normal and hypoxic conditions.

Most important feature: CIE-L* (black/white)



Applications and Future Work

Future Work

- **Standardize** correction for skin-tones in optical spectroscopy using commercial wearables.
- We are currently conducting a **larger trial** with greater representation across skin-tones to build out this PoC.

Applications

- Can be used to **remotely monitor potential skin conditions** continuously.
- Equal representation of skin-tones in **AI datasets**.
- **Integration** into commercial pulse oximeter technology.