

Fast Determination of Melanin based on Skin Hyperspectral Reflectance

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A decorative graphic consisting of four horizontal bars of varying lengths and colors (light blue, dark blue, dark blue, red) stacked vertically.

Context and Objectives


A decorative graphic consisting of four horizontal bars of varying lengths and colors (light blue, dark blue, dark blue, red) stacked vertically.

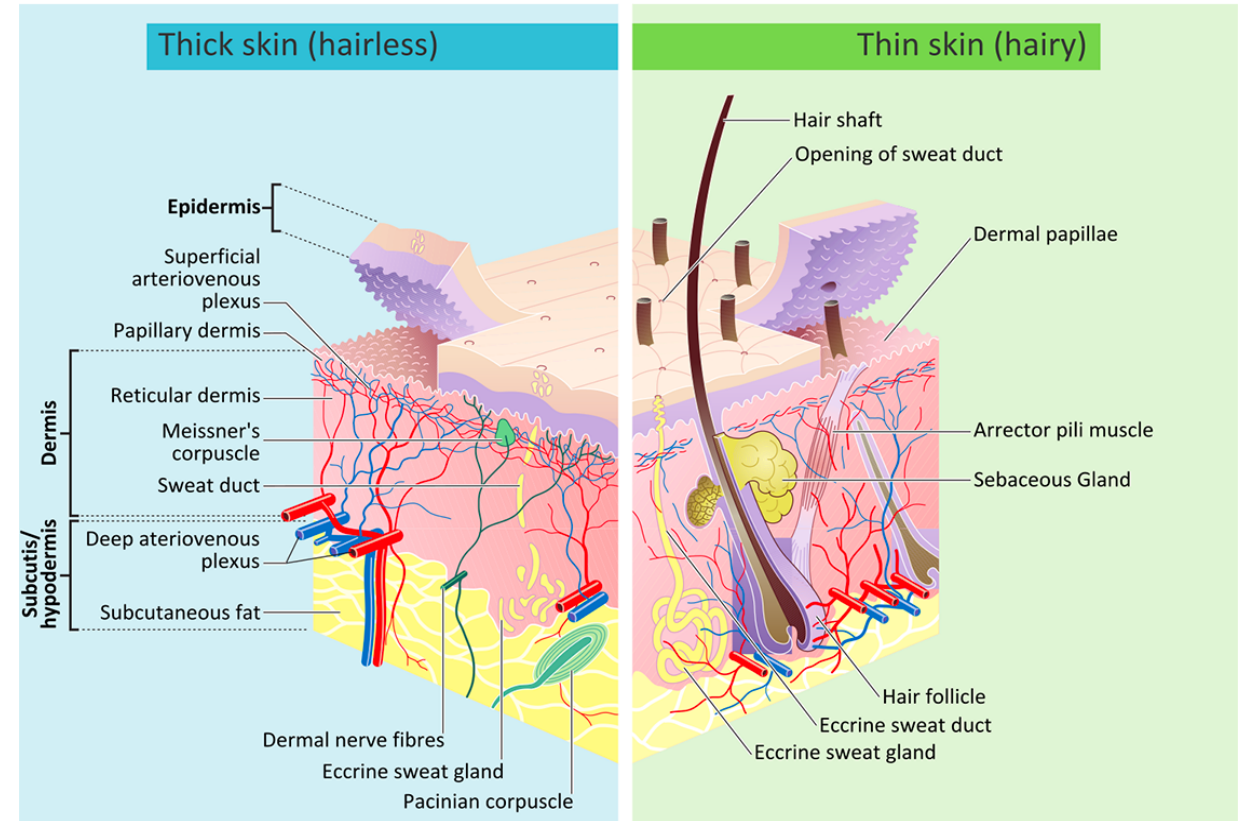
Research Results

A decorative graphic consisting of four horizontal bars of varying lengths and colors (light blue, dark blue, dark blue, red) stacked vertically.

Future work

■ Skin properties:

- The largest organ of human body
- Multi-layered translucent tissue
- Skin appearance  Skin diseases

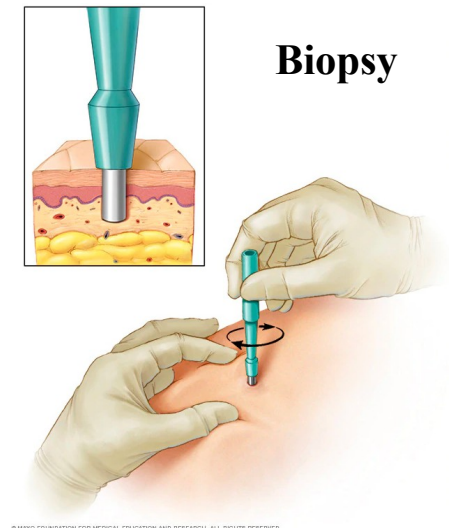


Hyperspectral Imaging Technique:

- **High resolution: 1~10 nm interval**
- **Ability to extract the inner information from biological materials**
- **Widely used in agriculture, chemical imaging, etc.**

Applications:

- **Non-invasively Determination of Skin components: melanin, blood concentration**
- **Skin and Non-Skin Detection**
- **Quantification and diagnosis of skin diseases**



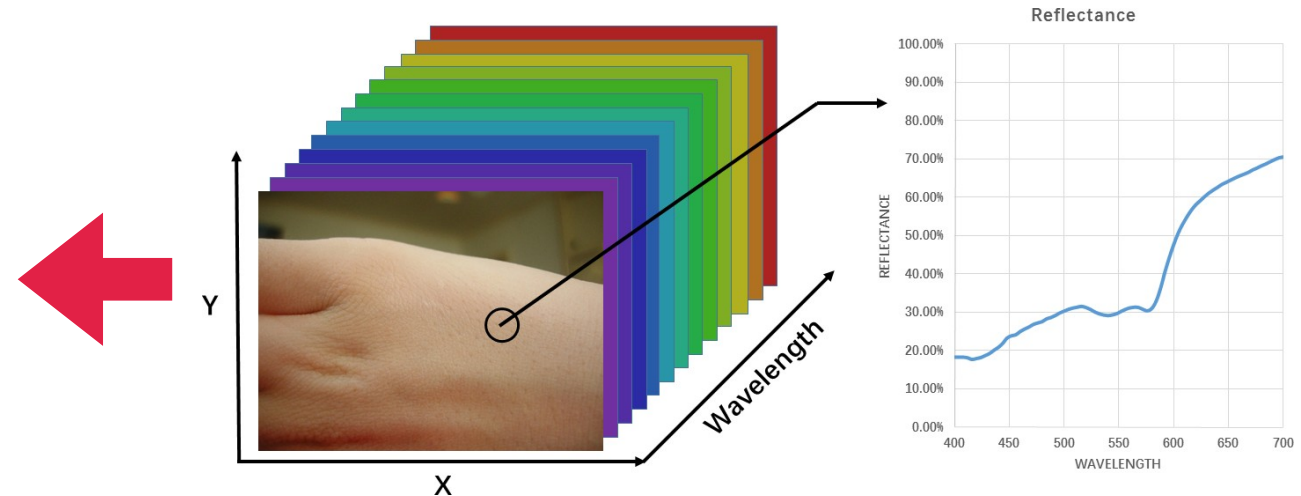
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Extraction of Skin Components based on Hyperspectral Reflectance:

TABLE I

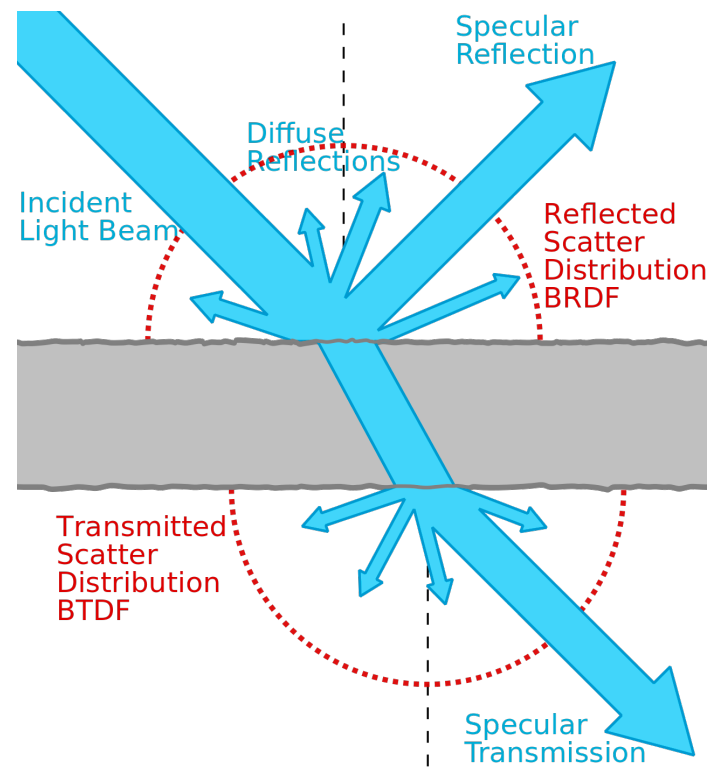
DEFINITION AND RANGE OF SKIN BIOLOGICAL PARAMETERS

Layers	Biological parameters	Range
Epidermis	P_1 : melanin volume fraction	1.3-43%
	P_2 : water volume fraction	10-20%
	P_3 : melanin blend	4.9-36%
	th_1 : thickness	0.027-0.15mm
Dermis	P_4 : blood volume fraction	0.2-7%
	P_5 : oxygen saturation	50-95%
	P_6 : water volume fraction	40-90%
	th_2 : thickness	0.6-3mm
Subcutis	P_7 : fat volume fraction	40-70%
	P_8 : blood volume fraction	5-20%
	P_9 : water volume fraction	40-90%
	P_5 : oxygen saturation	50-95%
	th_3 : thickness	1-5mm



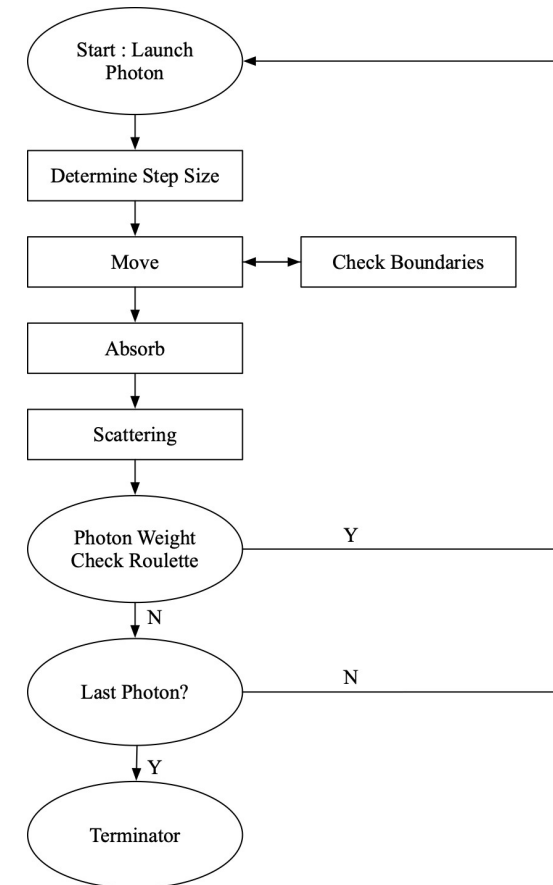
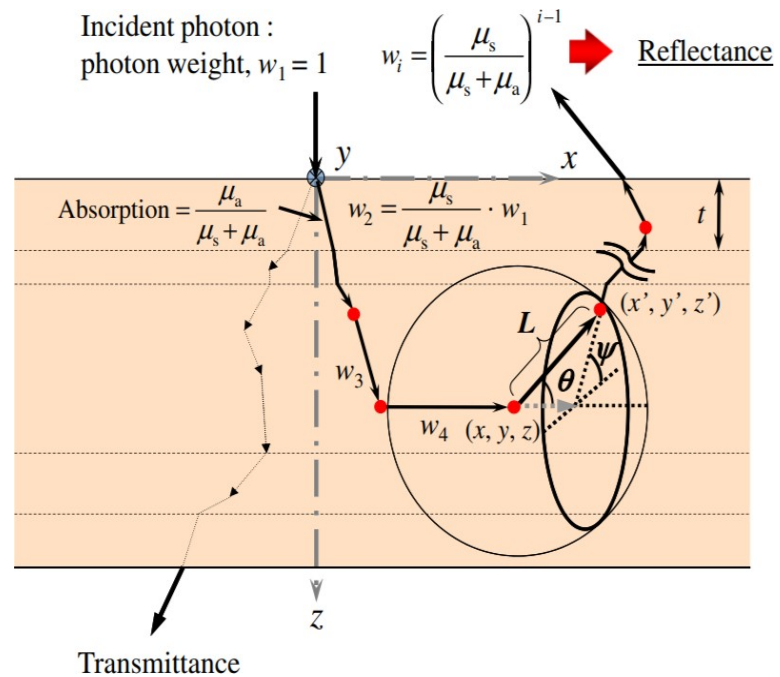
Extraction of Skin Components based on Hyperspectral Reflectance:

- **Light-Skin interaction: Monte Carlo (Gold Standard Method), Diffusion Approximation, Kubelka-Munk Theory, etc.**



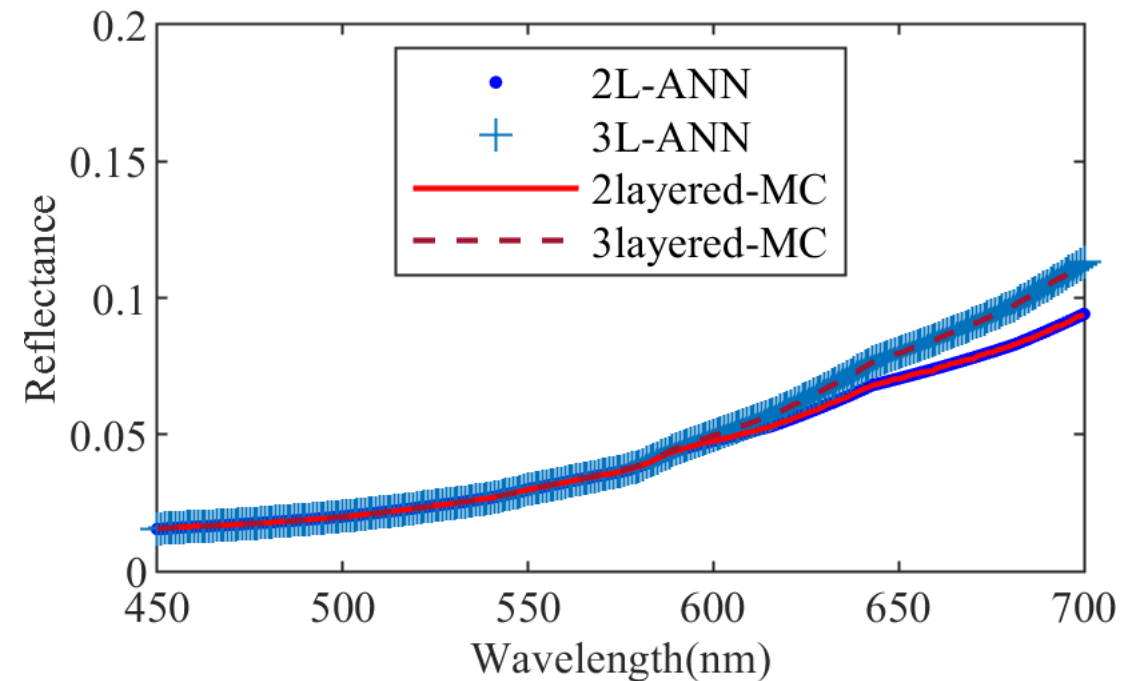
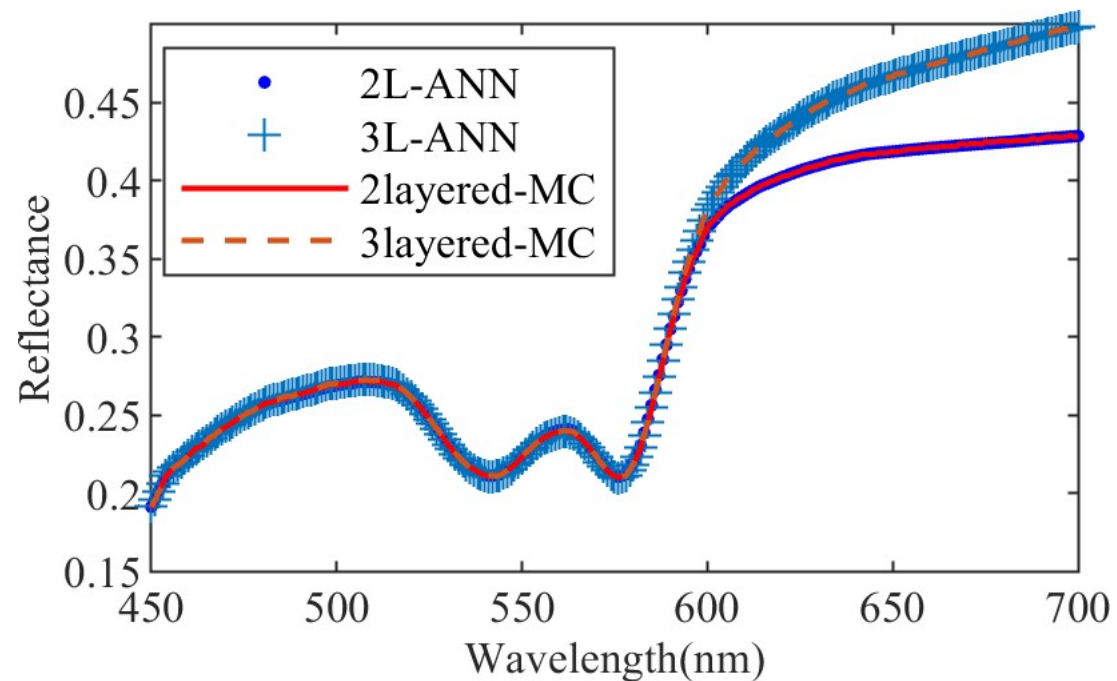
Extraction of Skin Components based on Hyperspectral Reflectance:

Method-Monte Carlo



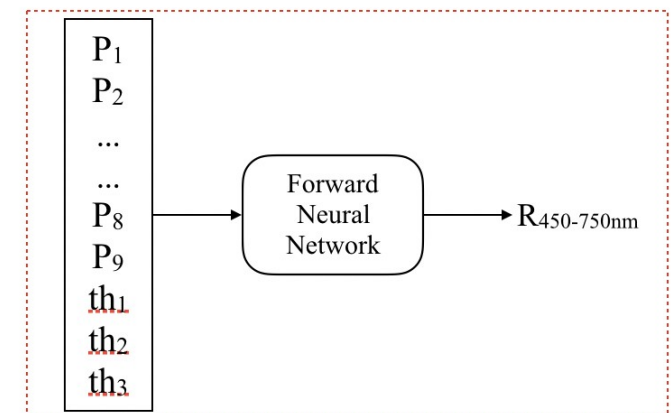
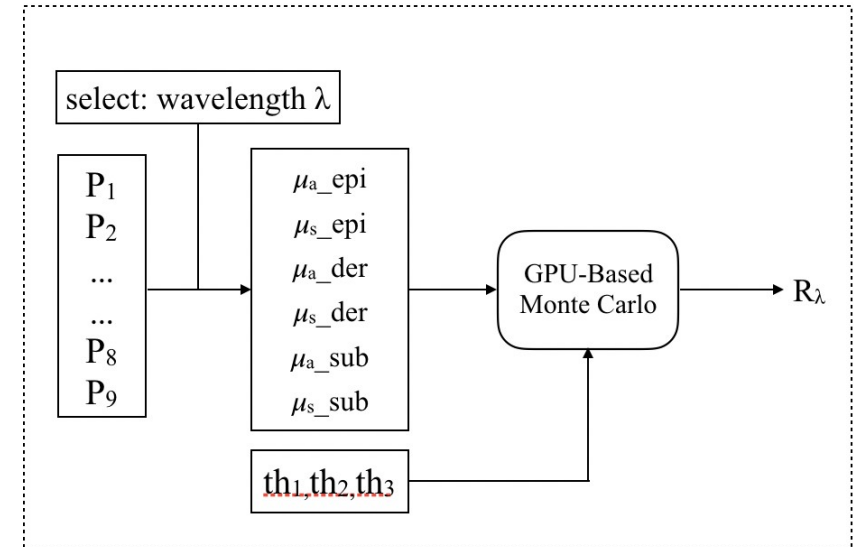
Extraction of Skin Components based on Hyperspectral Reflectance:

- Modeling using both 2-layered skin and 3-layered skin model with neural networks



Fast Determination of Melanin based on Skin Hyperspectral Reflectance Analysis

- Melanin is the most important pigment within skin
- 3-layered skin model
- Inverse neural network to speed up



Fast Determination of Melanin based on Skin Hyperspectral Reflectance Analysis

- **Lightly pigmented skin**

TABLE II
MELANIN[%] DETERMINATION RESULTS OF OUR DIRECT METHODS FOR LIGHTLY PIGMENTED SKIN TYPE

Samples	no.1	no.2	no.3	no.4	no.5	no.6	no.7	no.8	no.9	no.10
Target	2.51	2.02	1.76	1.85	2.26	1.74	1.96	1.88	2.79	1.47
RF	1.98	2.08	1.63	2.33	1.65	1.04	2.65	1.31	3.11	1.63
INN	2.30	1.78	2.13	1.88	2.41	1.67	1.66	1.30	3.24	1.32
SVR	4.93	7.40	7.85	3.91	6.40	5.97	6.17	7.83	5.87	6.54

Fast Determination of Melanin based on Skin Hyperspectral Reflectance Analysis

- **Moderately pigmented skin**

TABLE III

MELANIN[%] DETERMINATION RESULTS OF OUR DIRECT METHODS FOR MODERATELY PIGMENTED SKIN TYPE

Samples	no.11	no.12	no.13	no.14	no.15	no.16	no.17	no.18	no.19	no.20
Target	15.63	12.44	12.18	13.01	13.82	13.48	11.24	14.28	14.45	11.43
RF	15.94	11.56	12.92	12.49	12.77	14.93	13.32	14.24	13.61	12.80
INN	15.72	12.59	12.28	12.60	13.77	13.64	12.10	13.89	14.05	11.98
SVR	15.45	12.76	12.30	11.77	12.86	13.30	12.35	15.96	13.66	9.82

Fast Determination of Melanin based on Skin Hyperspectral Reflectance Analysis

- Darkly pigmented skin

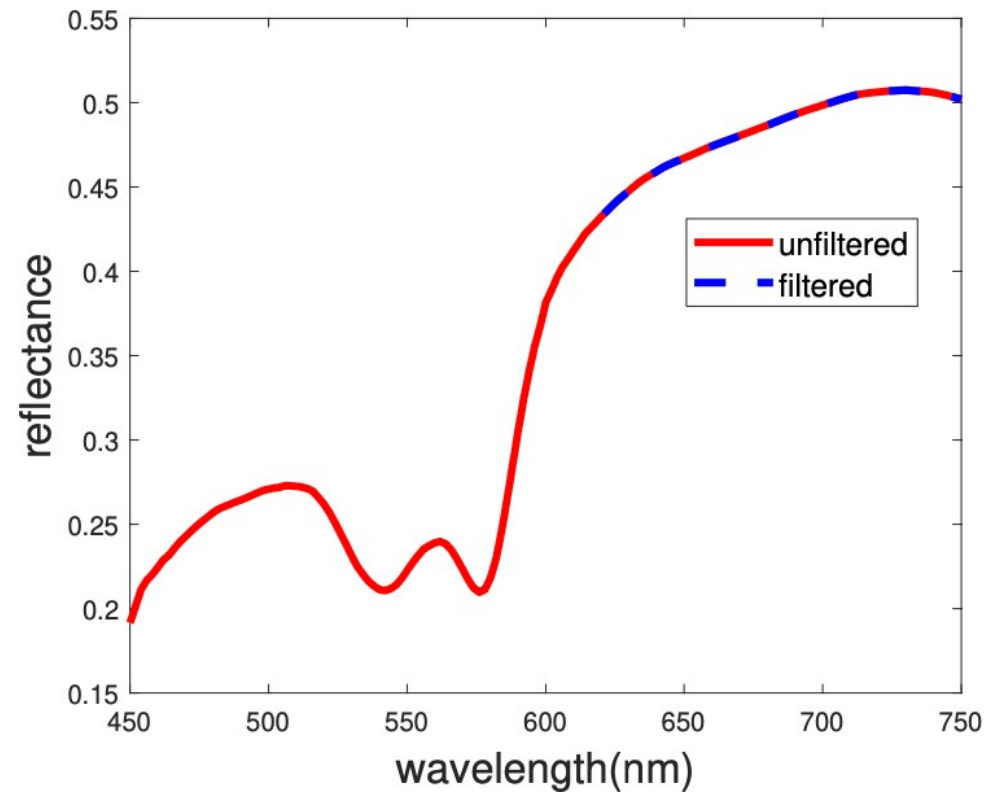
TABLE IV

MELANIN[%] DETERMINATION RESULTS OF OUR DIRECT METHODS FOR DARKLY PIGMENTED SKIN TYPE

Samples	no.21	no.22	no.23	no.24	no.25	no.26	no.27	no.28	no.29	no.30
Target	28.65	24.49	30.97	19.79	36.19	39.78	27.24	28.35	22.17	37.46
RF	28.86	24.67	30.70	19.50	35.68	28.33	27.64	32.53	23.00	38.62
INN	28.64	24.01	30.73	19.28	36.14	33.88	27.02	30.42	22.02	37.83
SVR	27.37	24.73	30.98	19.36	36.48	33.20	28.43	32.11	22.02	38.24

Fast Determination of Melanin based on Skin Hyperspectral Reflectance Analysis

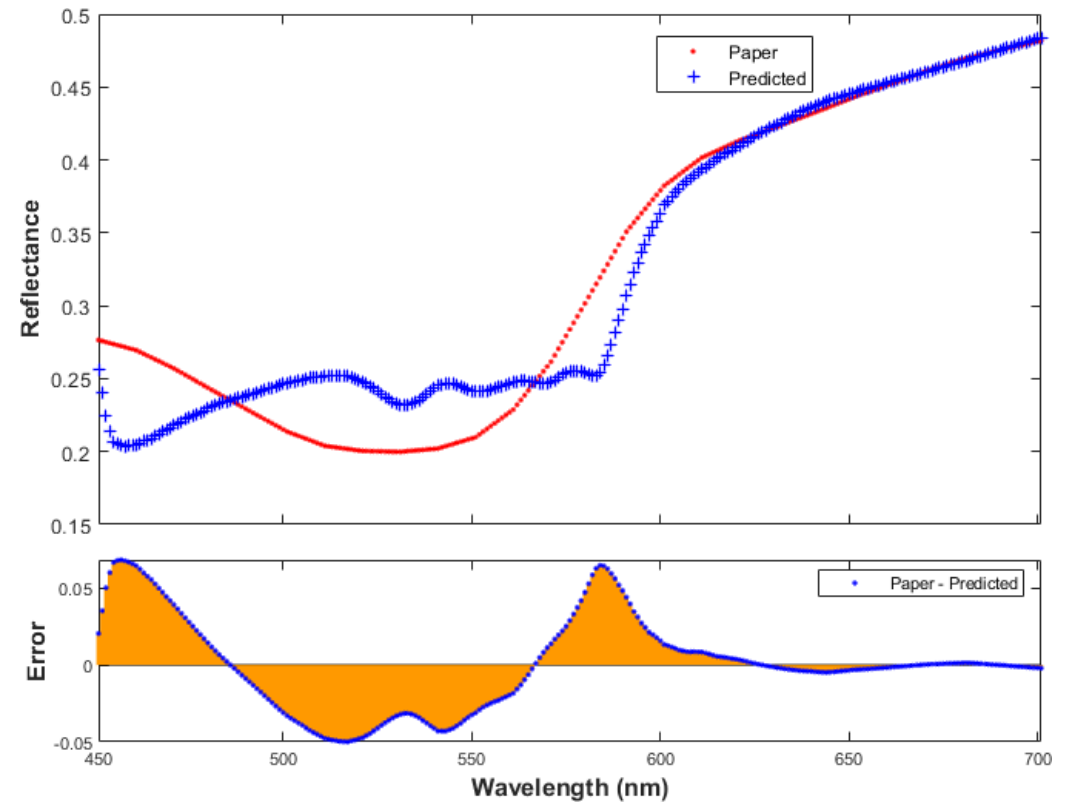
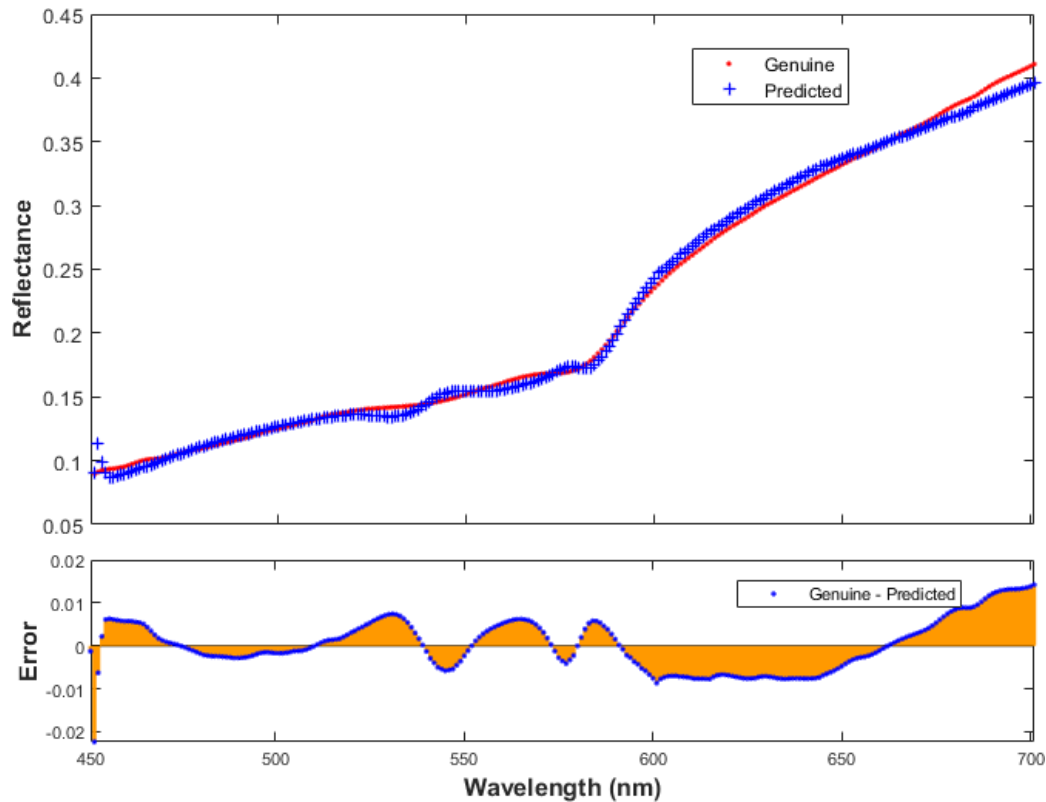
- **Dimensionality reduction:
Low Variance Filter**



Research steps

- Collecting hyperspectral skin images: there is no public hyperspectral skin images database so far
- Applying our skin detection method to more hyperspectral skin images
- Implementation of our fast melanin determination with the help of hyperspectral images reconstruction from RGB images

Curve fitting results from Skin (left) and Paper (right)



Skin Detection using Images from CAVE

