Preliminary experiments on quantification of skin condition

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1. Introduction

Skin conditions vary widely among individuals.

- Fineness of the skin
- Amount of moisture
- Presence of skin disease etc…

Sample of skin

Many people care a lot about skin conditions.
→ The market of cosmetics or drugs is expanding.

Current state of diagnosis of skin conditions

Judged by him/herself or diagnosed by dermatologist.
→ They are often subjective.

➡ **Development of objective evaluation criteria for skin conditions has been called.**

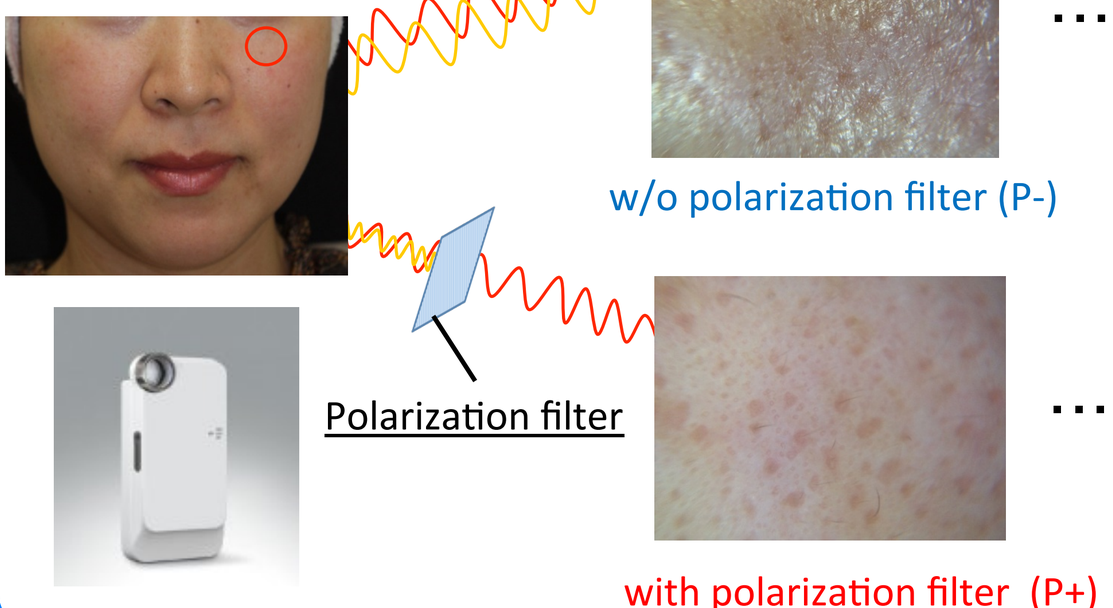
Purpose of the study

Development of the convenient and **objective evaluation method of skin conditions with only image analysis.**

2. Materials

We used a total of 136 facial skin images captured from 68 face spots (1cm below from bottom lid and mandibular regions) from 11 volunteer subjects aged between 30s and 60s by Pocket Micro® device.

About images



3. Method and Results

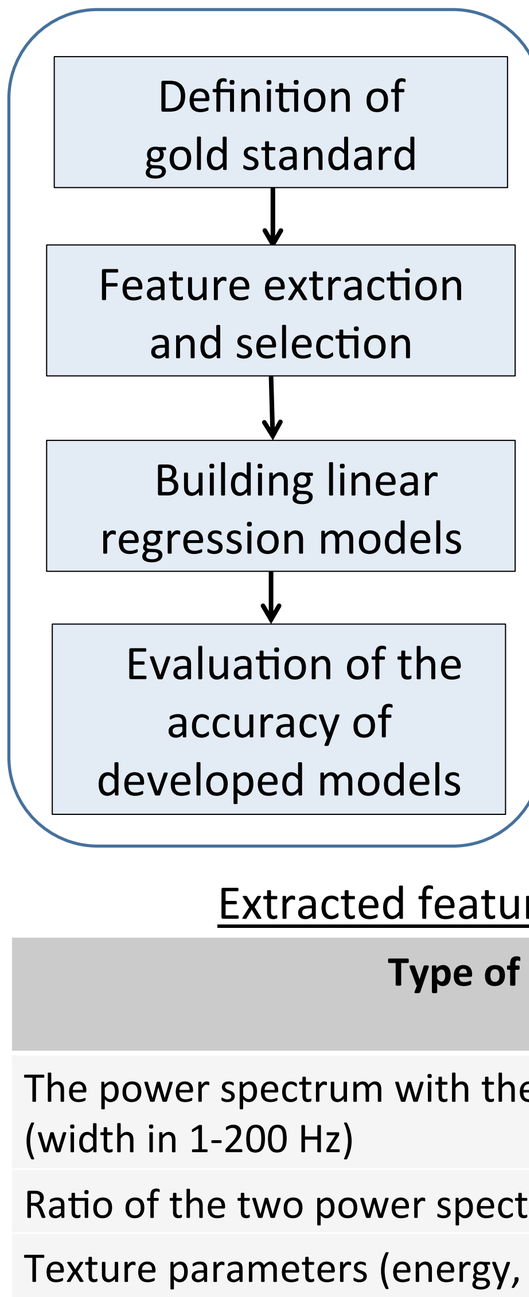
- Investigating the relationship between skin conditions (**skin fineness** and **moisture-retaining property**) and objectively defined image parameters with linear regression models.
- The gold standard for each criterion is obtained as follows:

Gold standard ①: Skin fineness (tentative assessment)

Subjective score of skin fineness in 5-point scale
(good) 5 ← ← 3 → → 1 (bad)

Gold standard ②: moisture-retaining property

The absolute skin moisture measured with the moisture meter



- (The mean and SD of skin fineness in 136 images) = 3.46 ± 1.17
- (The mean and SD of the amount of moisture in 136 images) = 35.15 ± 3.22

- Feature extraction from each image
- Selecting only efficient features with the stepwise input selection method

- Use of multiple linear regression analysis

- Evaluation with the mean absolute error (MAE) under the leave-one-out cross validation strategy

Extracted features (total of 107)

Type of features	Sub total
The power spectrum with the step of 10 Hz band (width in 1-200 Hz)	20
Ratio of the two power spectra	48
Texture parameters (energy, moment, entropy, correlation)	28
High-dimensional moment parameters (Hu moment)	7
Skin luminance (mean and SD)	2
Skin color in blue (mean and SD)	2

In the following divided data sets(1)-(3), we built linear regression models after selecting efficient features with stepwise way.
(1) Images captured **w/o polarization filter** (total of 107 features)
(2) Images captured **with polarization filter** (total of 107 features)
(3) both (1) and (2) (total of 107 × 2 = 214 features)

Developed estimation model for (A)fineness of skin and (B) moisture-retaining under the leave-one-out cross validation

Developed model for (A)

Images	#p	Correlation	MAE
P-	3	0.785	0.557
P+	6	0.737	0.669
P- & P+	7	**0.888**	**0.507**

Developed model for (B)

Images	#p	Correlation	MAE
P-	5	0.690	1.931
P+	3	0.534	2.245
P- & P+	6	**0.715**	**1.924**

#p : The number of selected parameters using stepwise method

4. Conclusion and challenges for the future

Conclusion

- Estimation of the skin fineness and its moisture-retaining property can be estimated appropriately by means of only the captured skin image.
- These simple image analyses had a potential to quantize the skin conditions without the use of expensive device.

Challenges for the future

- Improving estimation performance by redefining image features with larger dataset
- Redefining gold standard