What Impacts Skin Color in Digital Photos?

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Outline

1. Statistical Framework:
Image-Mining
2. Impact on Skin Color
3. Skin Detection

Statistical Framework

Statistical Framework

Claudia Schiffer

Will Smith

George Clooney

Statistical Framework

Claudia Schiffer

Will Smith

George Clooney

% bright-ish skin tone pixels

Statistical Framework

sorted list	33	47	50	51	62	64	72	73	75	80	82	90
rank index	1	2	3	4	5	6	7	8	9	10	11	12
ranksum	$T = 1+2+4+6=13$											

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Mann-Whitney-Wilcoxon ranksum test

$$\mu_T = \frac{n_1(n_1 + n_2 + 1)}{2}$$

$$\sigma_T^2 = \frac{n_1 n_2 (n_1 + n_2 + 1)}{12}$$

$n_1 = 4$ cardinalities
 $n_2 = 8$ of both sets

$$z = \frac{T - \mu_T}{\sigma_T} = \frac{13 - 26}{5.88} \approx -2.21$$

[F. Wilcoxon, Individual comparisons by ranking methods, Biometrics Bulletin, 1(6):80–83, 1945]

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$z < 0 \rightarrow$ *Will Smith* has few bright skin tone pixels.

Statistical Framework

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rank index	1	2	3	4	5	6	7	8	9	10	11	12

ranksum $T = 1 + 2 + 4 + 6 = 13$

$T = 8 + 10 + 11 + 12 = 41$

Mann-Whitney-Wilcoxon ranksum test

Will Smith $z = \frac{T - \mu_T}{\sigma_T} = \frac{13 - 26}{5.88} \approx -2.21$

Claudia Schiffer $z = \frac{T - \mu_T}{\sigma_T} = \frac{41 - 26}{5.88} \approx 2.55$

Skin color distribution

Impact of Metadata

Databases

Flickr

- Geolocation: 6 x 12 grid cells on the globe, 68,795 images
- Cameratype: mainly *Canon* and *Nikon*, 25,585 images
- Flash: *On* or *Off*, 22,387 images

Google

- Keyword: *sunburn*, 美女, and 45 other keywords, 8,585 images
- PubFig: 140 different persons, 24,713 images

Geolocation

Geolocation

- Geolocation impacts skin colors.
- Photographer's origin might be just as important.

PubFig

Barack Obama

Claudia Schiffer

Barack Obama has a darker more saturated distribution than Claudia Schiffer.

Keywords

geisha

dark skinned

Geisha: Japanese women with very pale (almost white) make-up.

Cameratype

Canon

Nikon

Nikon cameras constrain skin colors more than *Canon* cameras, especially along the L axis.

Flash

No flash

Flash

Flash adds more reddish skin tones.

ΔE and Significance

Flash and cameratype

Geolocation

Keyword

PubFig

ΔE and Significance

Keyword

PubFig

- Keywords and persons have strongest impact.

Skin Detection

Ground Truth

- Keywords: *sunburn*, *paleness* and *beauty*.
- 50 images each.

Skin Detection

1. Significance map with z scores

2. Threshold τ

Detection Results

Keywords improve detection of skin regions.

Conclusions

- Statistical framework to link image metadata with image characteristics.
- Impact of metadata on skin colors.
- Keyword enhanced skin detection.
- Take home message:
Image-mining can save you from tedious work.

Thank You