Skin colour measurement and reproduction

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ICC MIWG Meeting, FDA

Outline

- Introduction
- Skin colour measurement
- Skin colour database
- Skin colour reproduction

Introduction

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Automated rapid manufacture of facial soft tissue prostheses

The University Of Sheffield.

2010-2013

fripp design ltd

Measuring and reproducing the 3D appearance of human facial skin under varying illumination condition:

A 3D Imaging System for Human Facial Skin

2013.10 - 2016.9

EPSRC
Engineering and Physical Sciences Research Council

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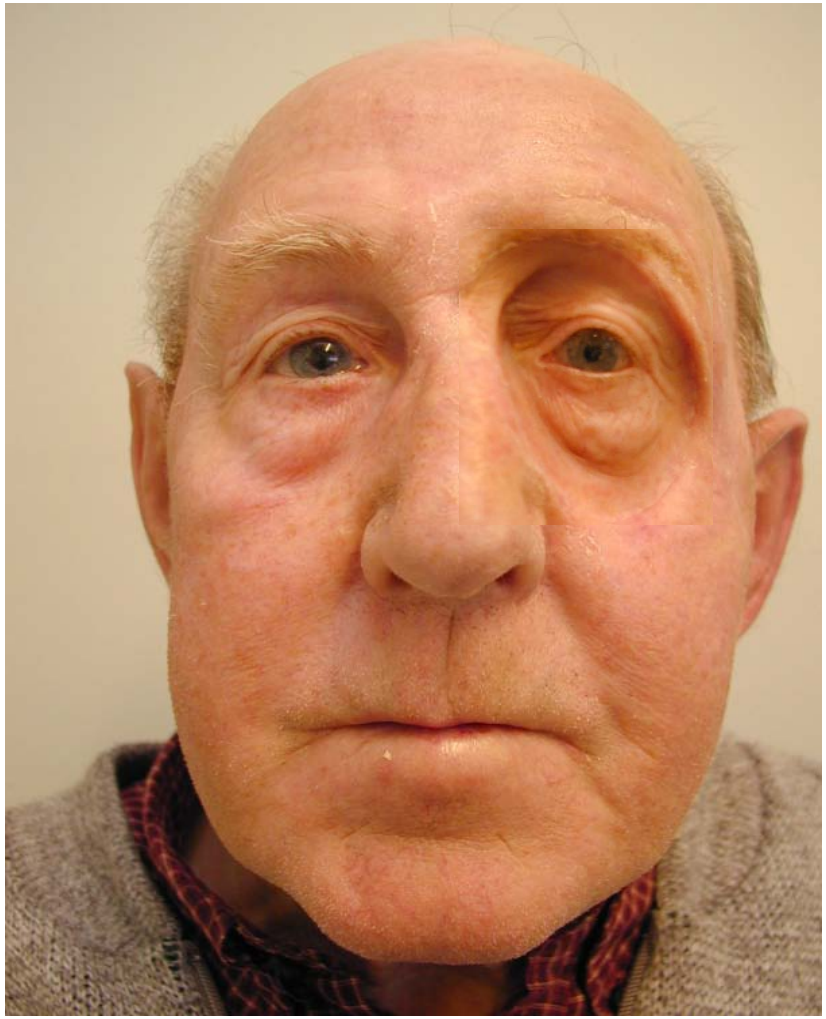
MANCHESTER 1824
The University of Manchester

ROYAL ACADEMY OF ENGINEERING

Introduction



Soft Tissue Prostheses

Automated additive manufacture of facial soft tissue prostheses

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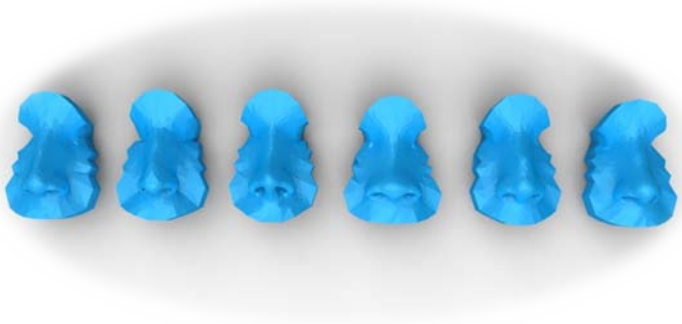
Conventional methods of facial prostheses

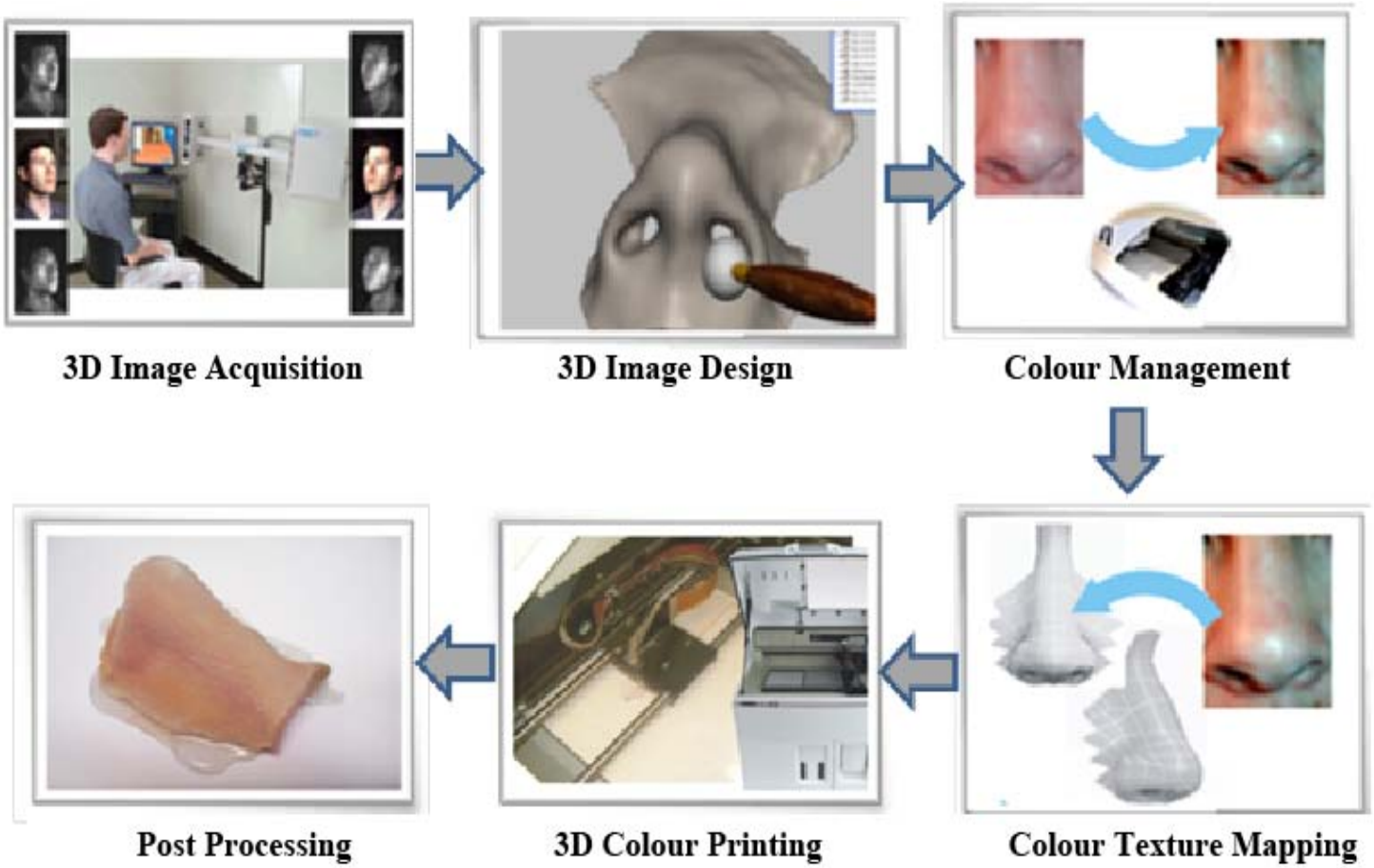
- Impression technique and Impression materials
- High technical skill
- High cost and long processing time
- No assess in world wide

Advanced Methods of Facial Prostheses

- Non-contact measurement
- Additive manufacturing (3D Printing)
- Automatic processing
- Accurate skin colour reproduction
- Saving time and cost



Frame work



Advanced Method of Facial Prostheses

Application of Skin Colour Database

Research Fields	Applications	Data Format
Computer Graphic	colour reproduction	LAB, Reflectance
Cosmetic	Colour Foundation	LAB, Reflectance
Medical	Facial Prosthesis	LAB, Reflectance
Medical	Plastic Surgery	LAB, Reflectance
Medical	Skin Disease Diagnose	Melanin and Erythema index
Computer Vision	Face Detection	Ycbcr
Lighting	Colour rendering	LAB, Reflectance

Skin colour database

- Skin colour database are required for multi-disciplinary research.
- Skin colour variation for individuals is know to be significant.
- None of the presently available skin colour databases is comprehensive.
- Existing skin colour databases are not comparable.

CIE TC1.92 Skin colour database

- **Year Established:** 2013

- **Terms of Reference:**

1. To investigate the uncertainty in skin color measurement and to recommend protocols for good measurement practice.

2. To tabulate skin color measurements that accord with these protocols covering different ethnicity, gender, age and body location.

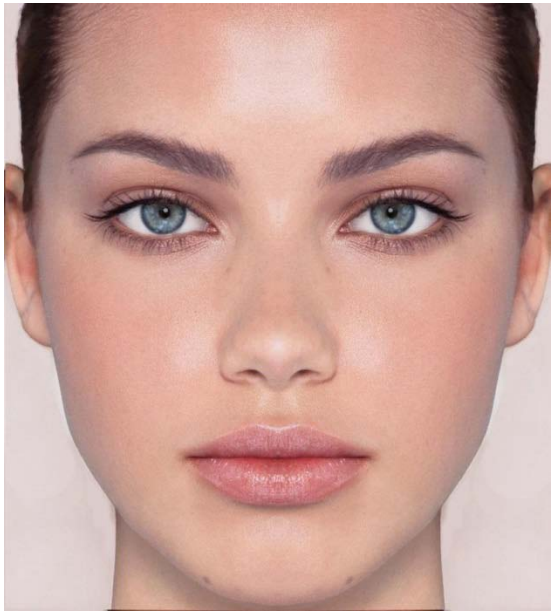
Skin colour data

Spectral reflectance

Skin measurement methods

- Spectrophotometer measurement
- Spectroradiometer measurement
- Digital camera measurement

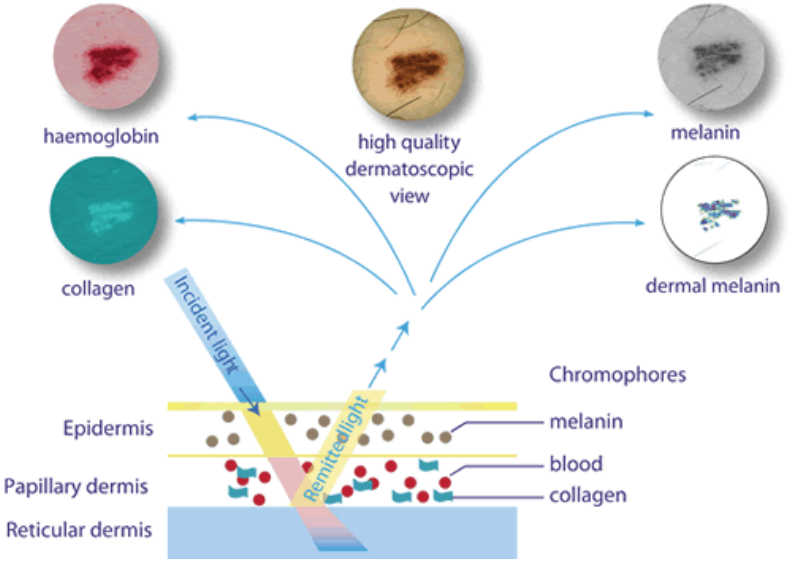
Human Skin Colour



Small Colour Gamut

Similar shape of colour spectrum

Complicated structure



Non-uniform

Non-flat

Un-stable

Spectrophotometer Measurement

The spectral reflectance can be measured directly using an instrument with a built in light source.

Konia Minolta CM-700d

- Easy to handle
- Built in illumination
- Easy to control measurement angle

Uncertainty:

Effect of measurement pressure
Effect of measurement size

Applications:

Medicine, Dentistry, Cosmetic

Spectroradiometer Measurement

The spectral power distribution (SPD) of skin under a defined lighting system is measured. The spectral reflectance of skin is calculated based on the SPD of the light source and that of the skin sample.

Photoresearch PR 650

ChromaSphere by L'Oreal

Non-contact measurement
Measurement under light source applied

Uncertainty:

- Smoothness of lighting system
- Effect of measurement size
- Effect of measurement angle (Shadow effect)

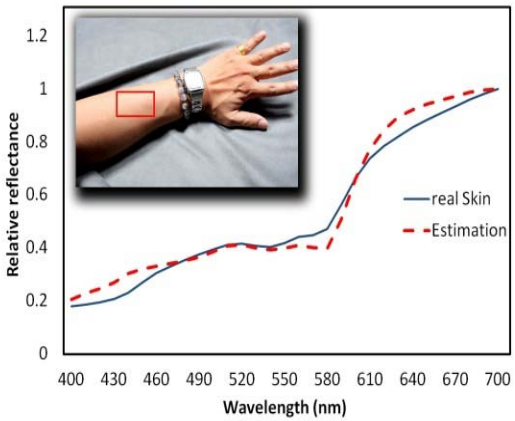
Application:

Computer Graphic, Lighting, Cosmetic

Camera Measurement

Camera RGB of skin under a defined lighting system is obtained and transformed to skin reflectance using reflectance re-construction algorithm.

Non-contact measurement
Measurement under light source applied
Fine detail of skin image



Uncertainty:

- Smoothness of lighting system
- Accuracy of colour transform algorithm

Application:

Computer Graphic

Advantages of camera measurement

- Small measurement size
- Calibration for lighting and measurement angle
- Easy to evaluate system accuracy
- Low cost

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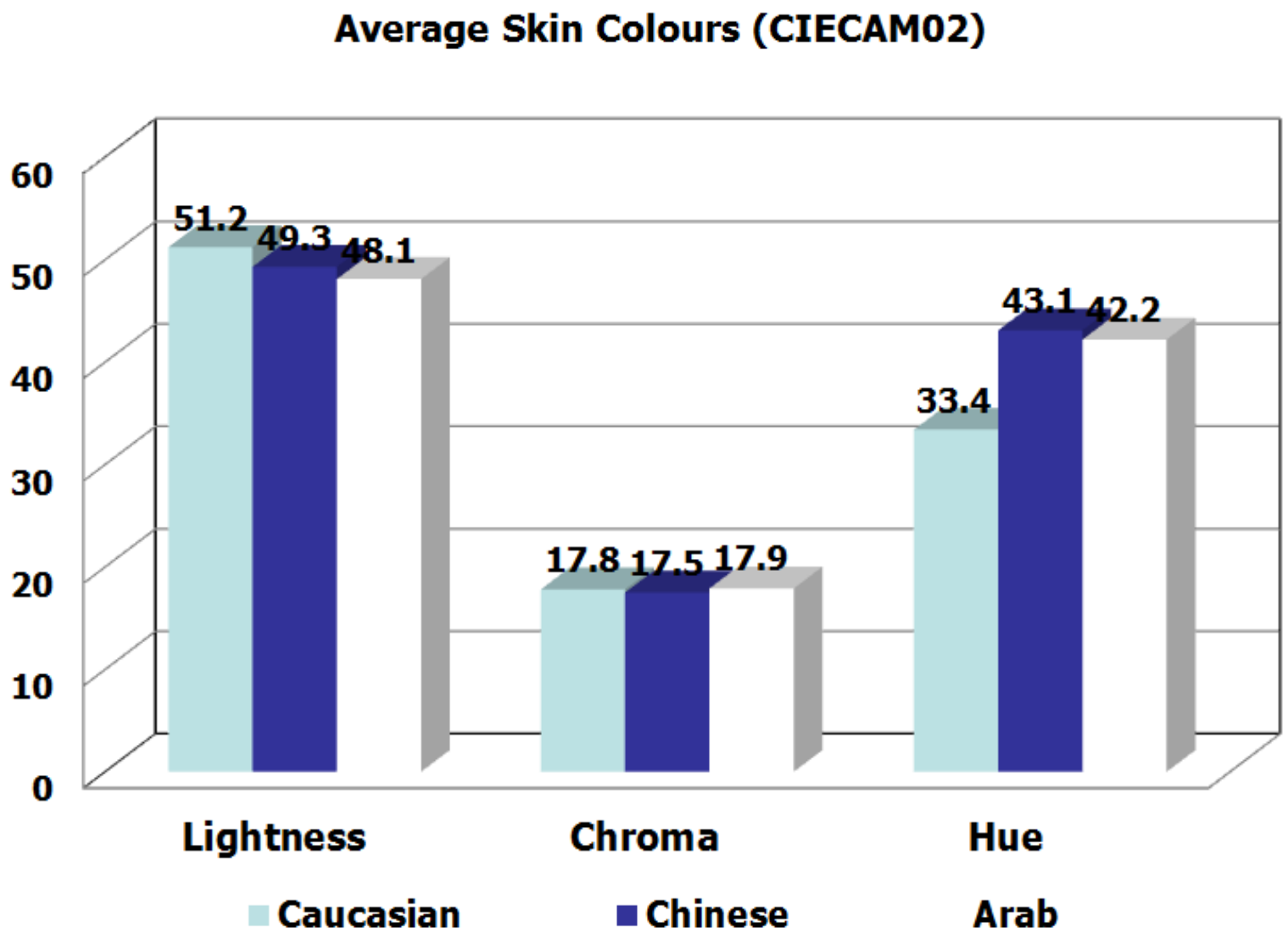
634 Subjects in 9 body areas

Caucasians	Chinese	Arabs	Asians	Africans
173	234	161	34	32

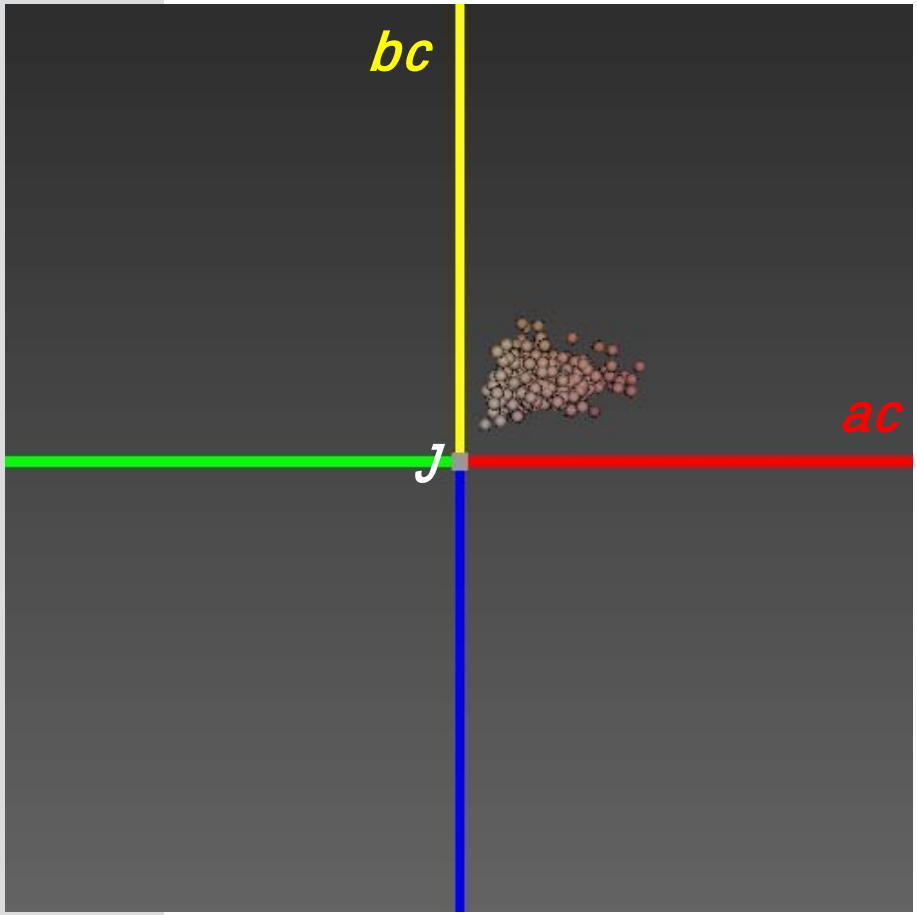
Data: CIELAB values and Spectral Reflectance

Location: UK, China, Iraq, Thailand

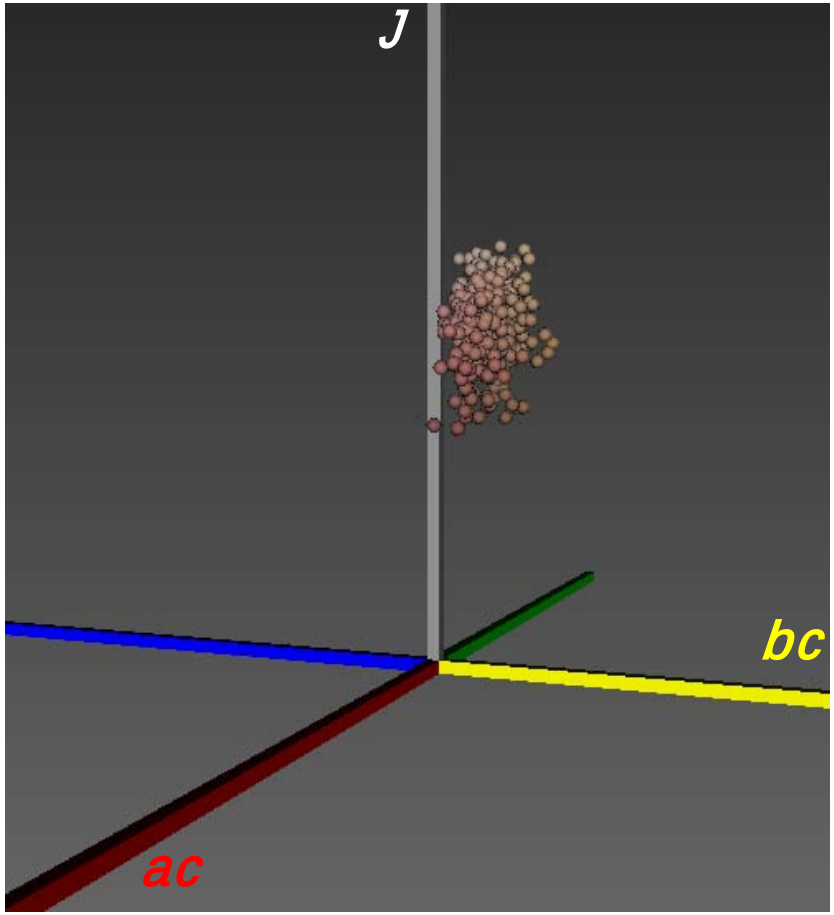
Difference in Ethnic Groups



Caucasian skin gamut

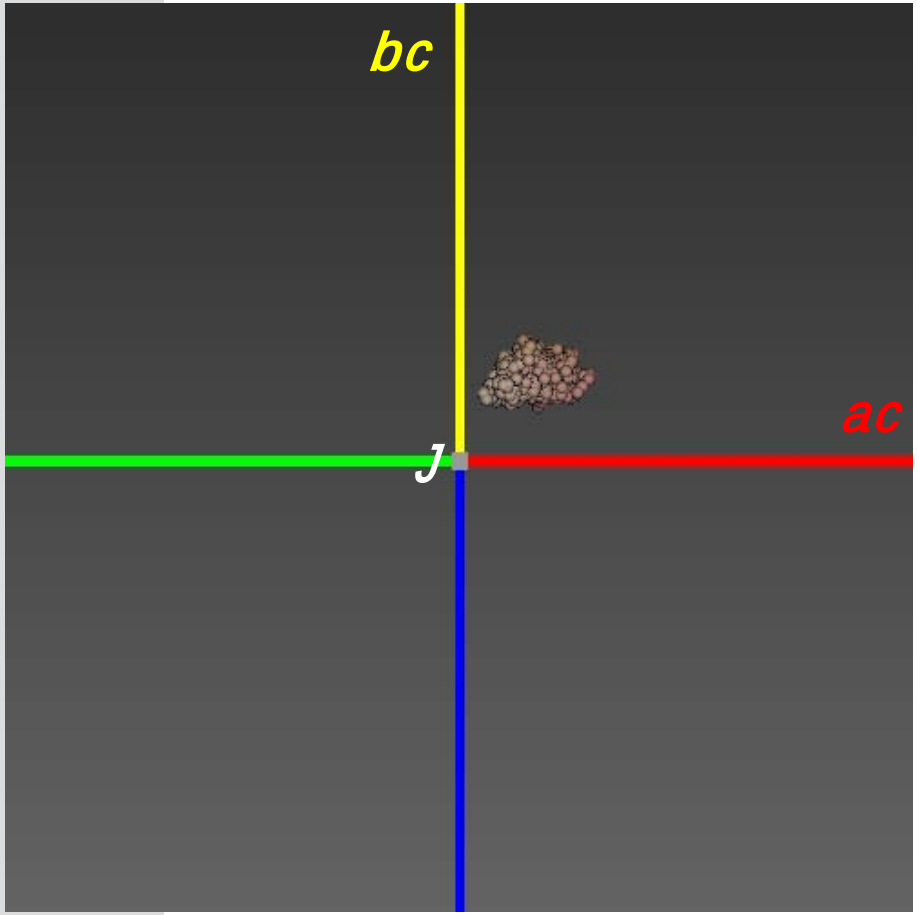


CIECAM02 -Top View



CIECAM02- Side View

Chinese skin gamut



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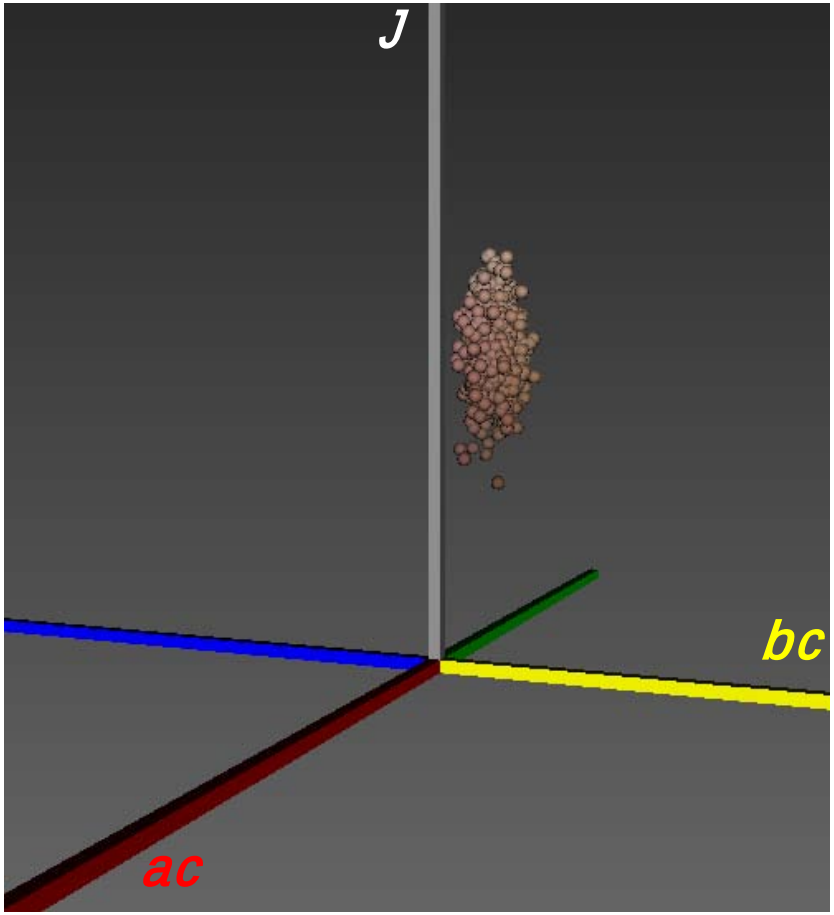
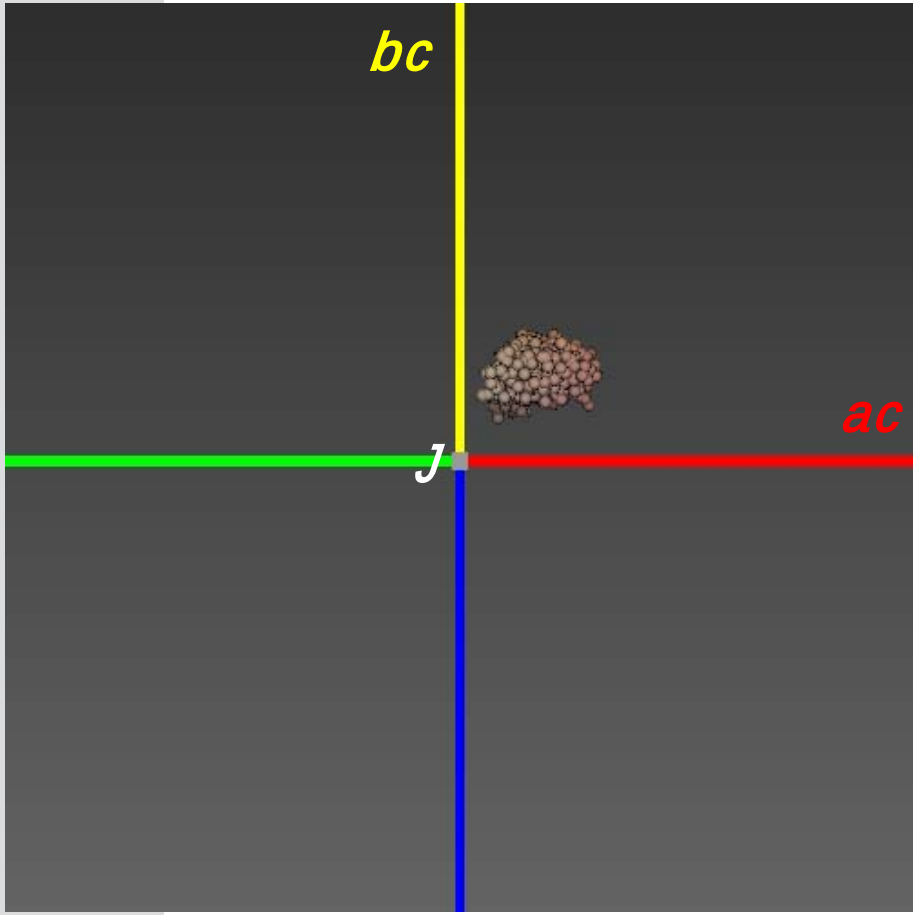
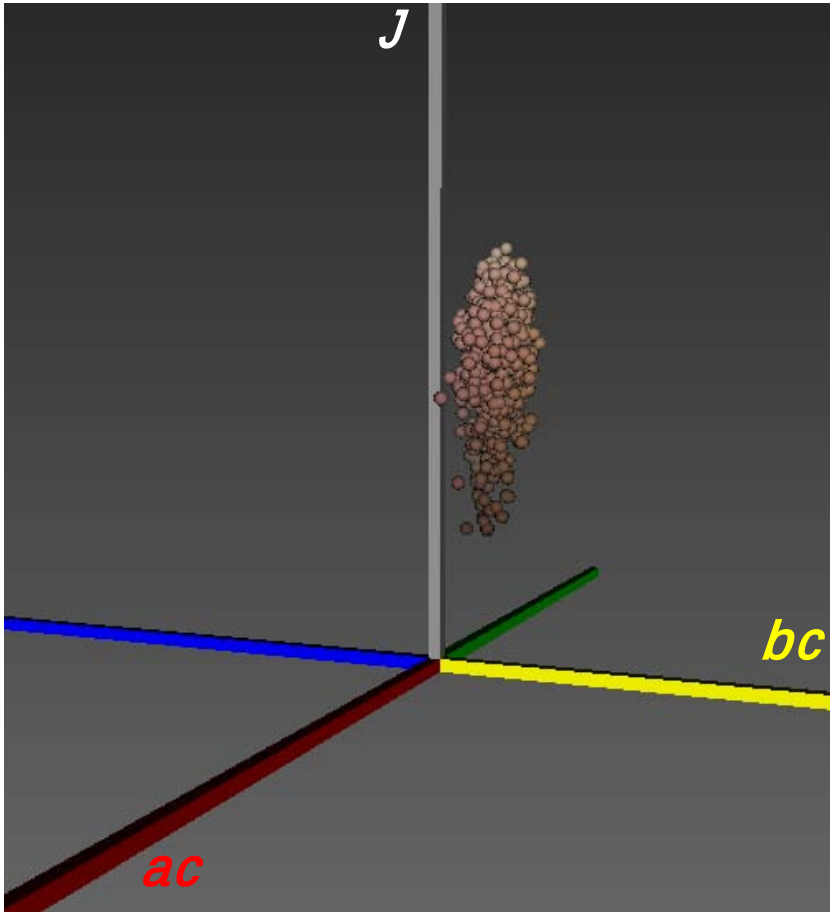


CIECAM02- Side View

Arabs (Iraqi) skin gamut

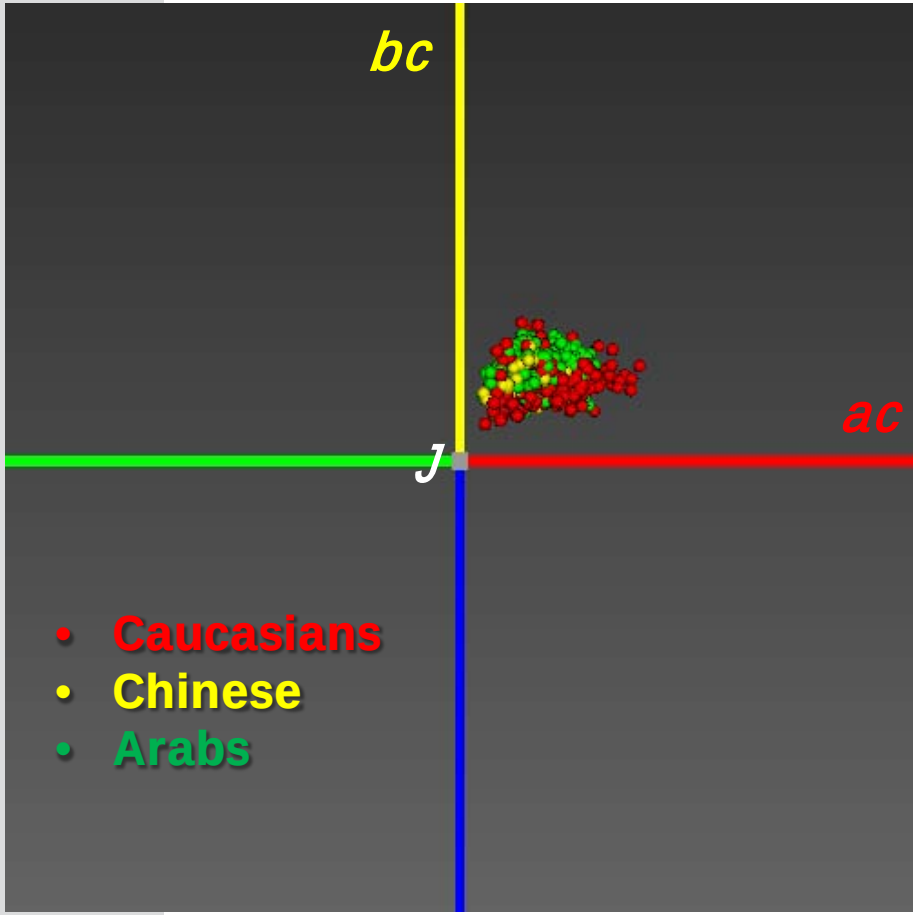


CIECAM02 -Top View

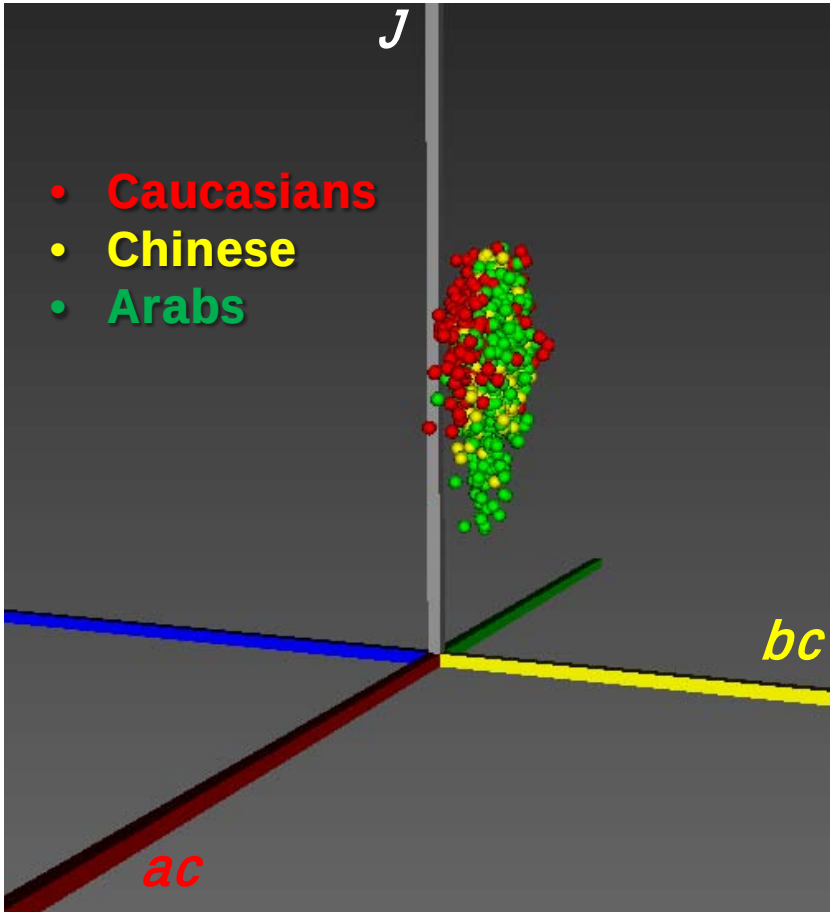


CIECAM02- Side View

All skin colour gamut

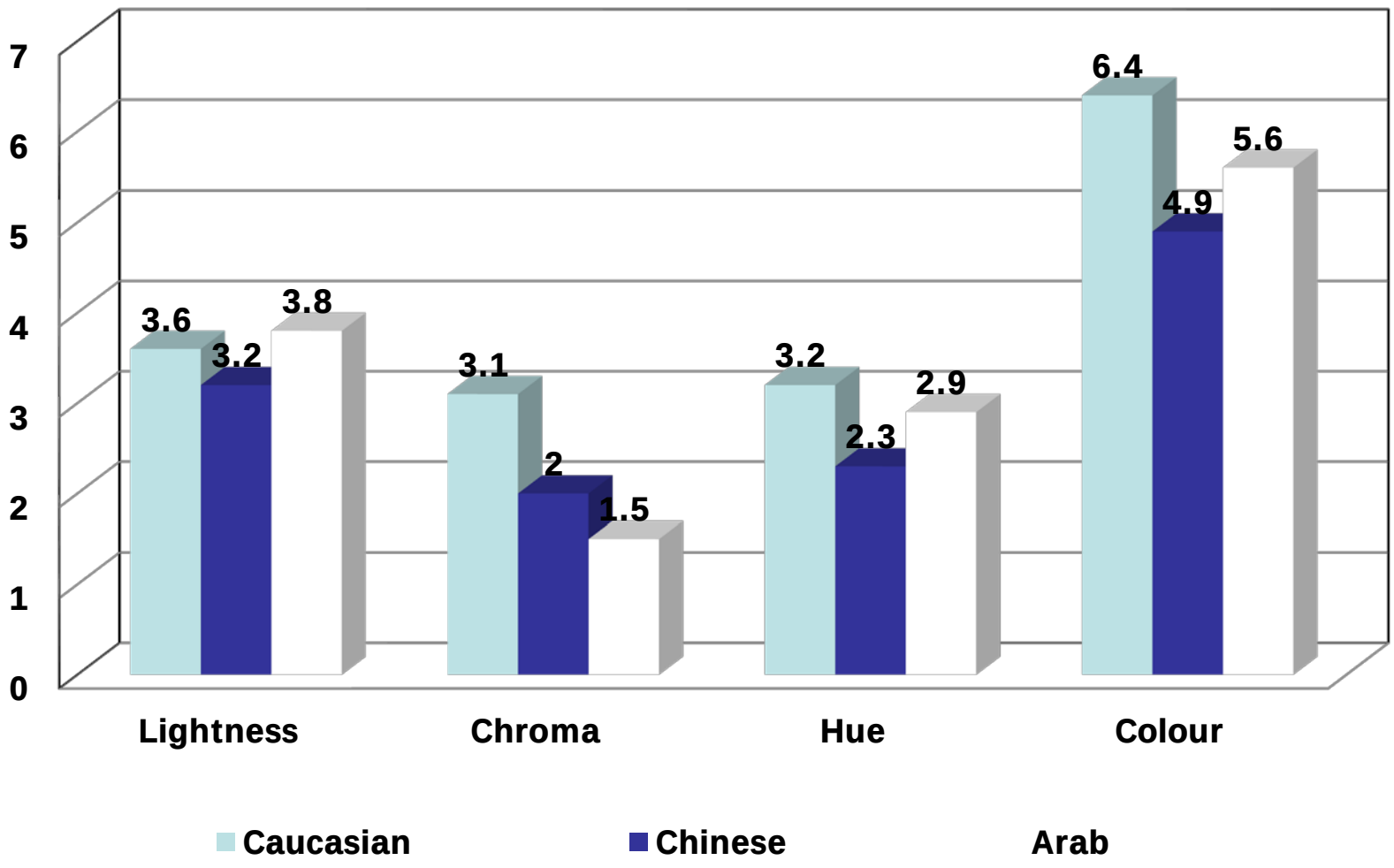


CIECAM02 -Top View



CIECAM02- Side View

Skin colour variation



Application of Skin Colour Database

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❑ Colour Reproduction

Skin colour chart

❑ Spectral Reproduction

To develop skin reflectance reconstruction algorithm for camera

❑ Skin image analysis

To predict Melanin, Haemoglobin, Shade etc.

based on both CIELAB and skin reflectance

Subjective method

- Visual assessment and match
- Skin colour chart

Objective method

- Spectrophotometer
- Spectroradiometer
- Camera

Skin colour chart

- Based on skin measurement
- Either Printed or painted colour
- Paper material
- Valid with reference illumination

Skin colour reproduction

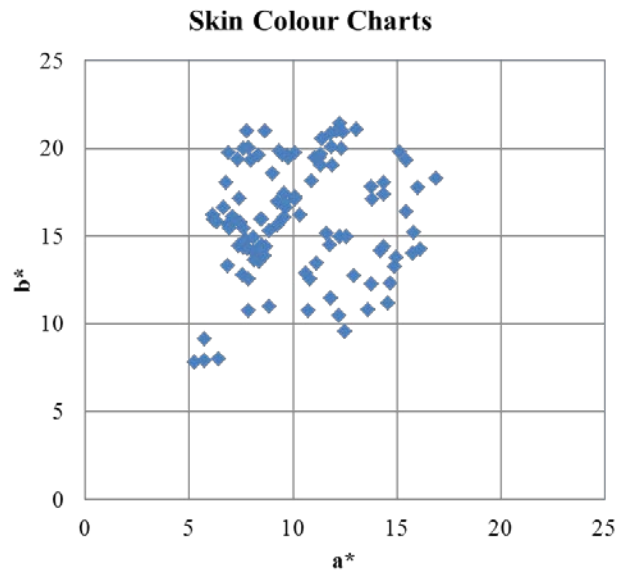
Applications:

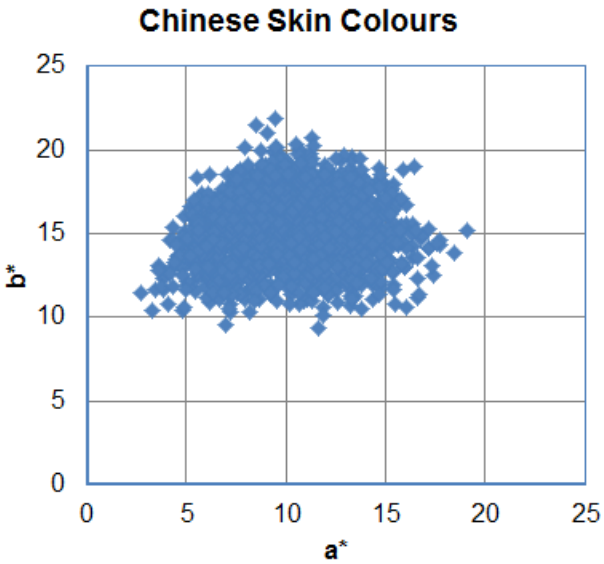
- ❑ Skin colour reproduction
- ❑ Skin image capture (reference chart)

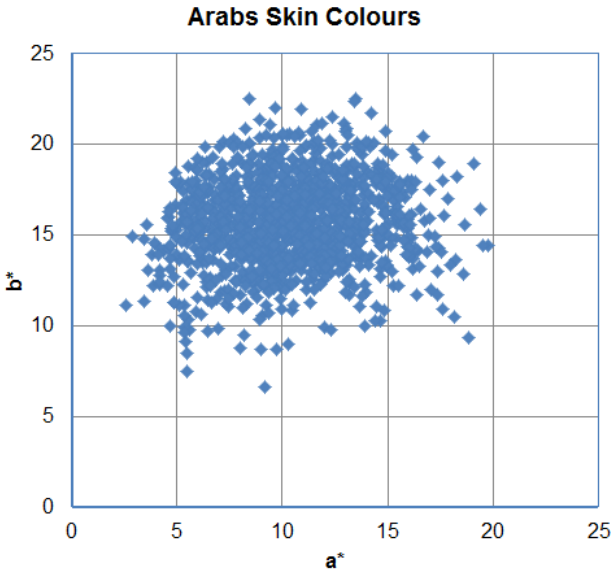
Evaluation of skin colour charts

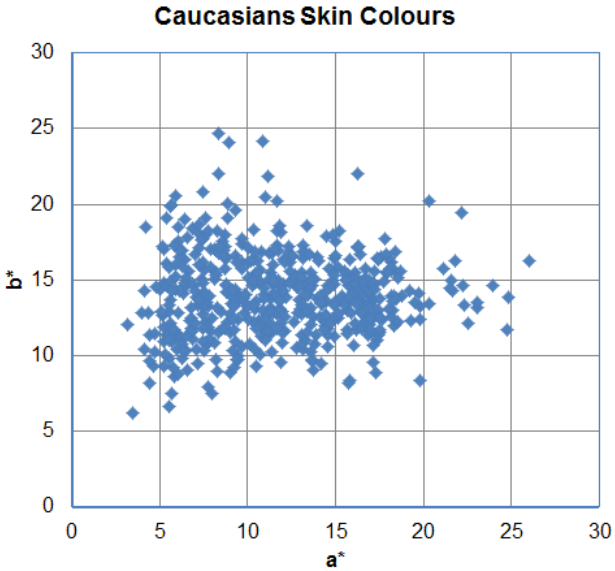
- ❑ Spectrophotometer Measurement
- ❑ CIELAB values
- ❑ D65 reference white

Skin colour charts

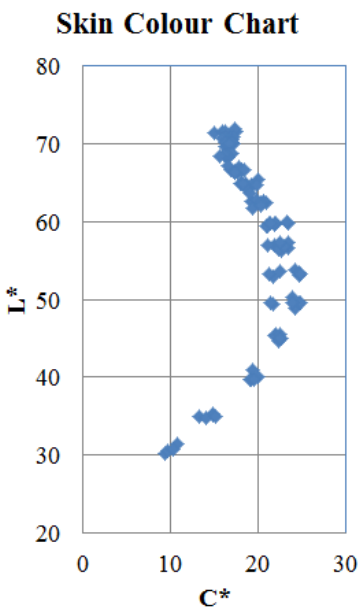


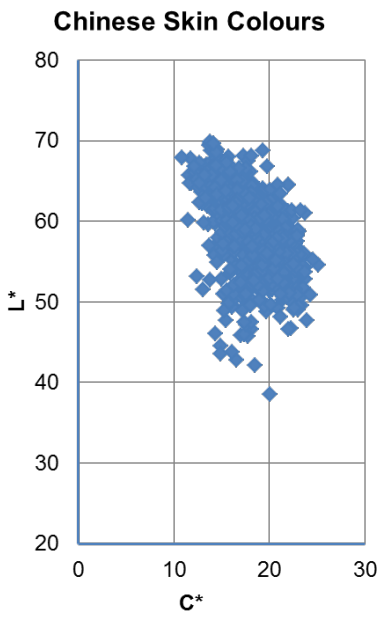


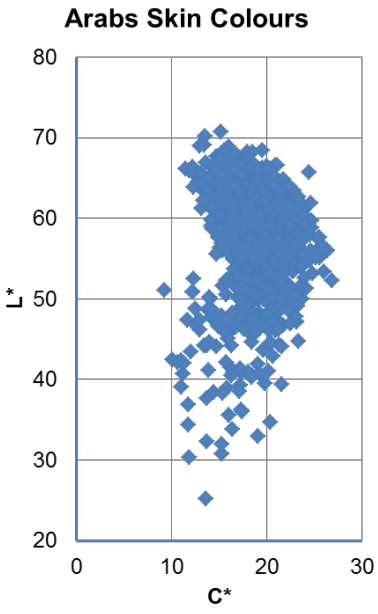


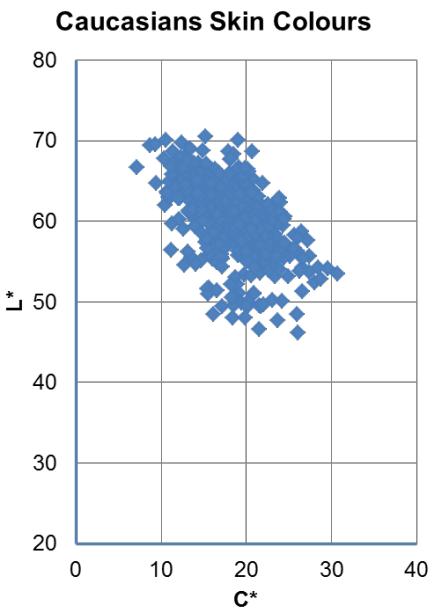


Skin colour chart

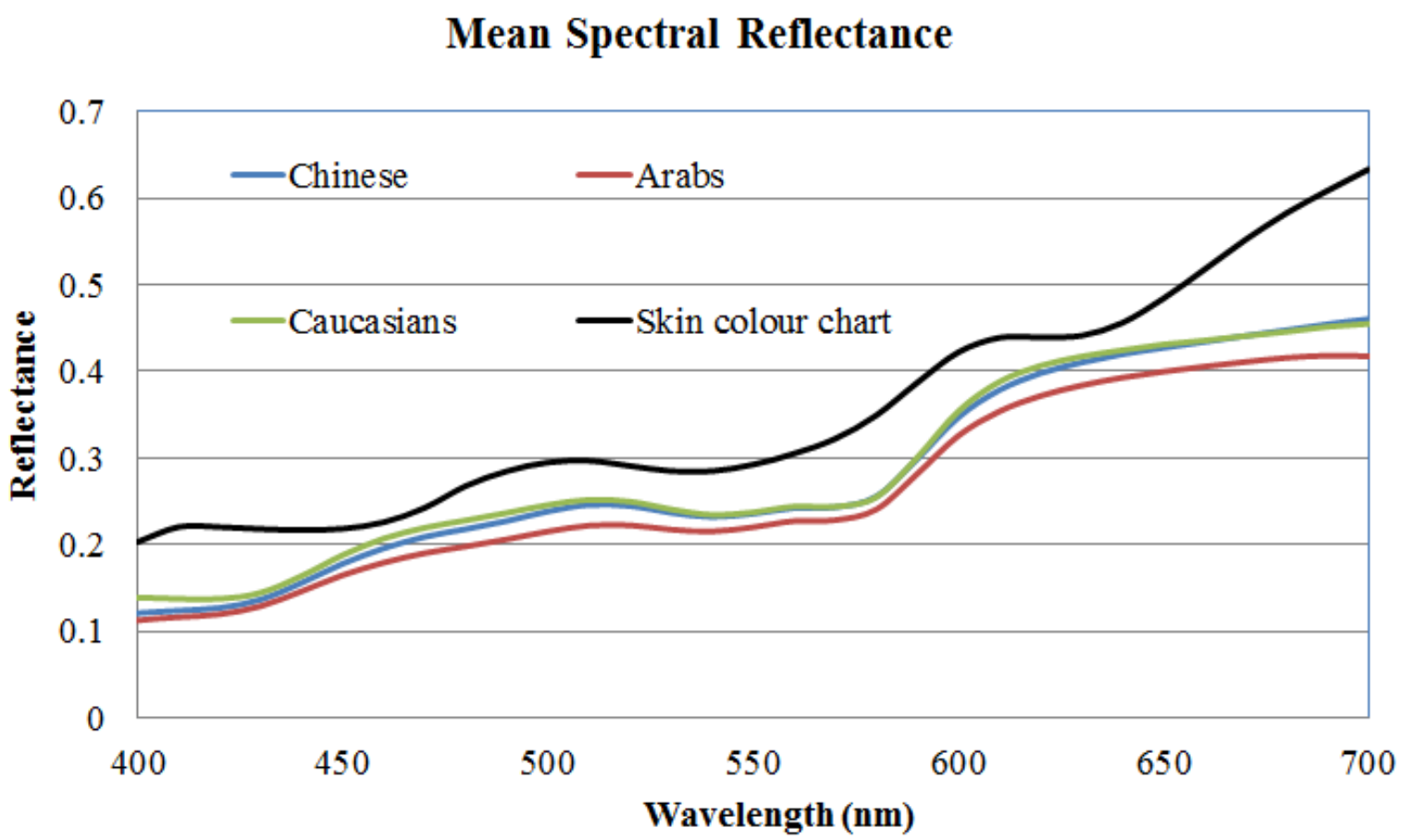








Skin colour chart



Skin colour chart for skin image capture

- A large skin colour gamut
- Different skin ethnic groups
- Accurate skin reflectance
- Trade off between colour number and accuracy

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Skin image capture

- Lighting design
- Protocol of measurement

Skin image colour management

- Skin colour chart
- Calibration procedure
- Colour transform and spectral reflectance reconstruction

Skin colour measurement and reproduction in university of Liverpool

- Spectrophotometer
- Spectroradiometer
- Camera
- 3D camera
- Multi-angle camera
- 400 subjects

Thanks

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