Computational Inexpensive Two Step Auto White Balance Method

Sergio Goma, Milivoje Aleksic – ATI Technologies

6069-13/EI 2006

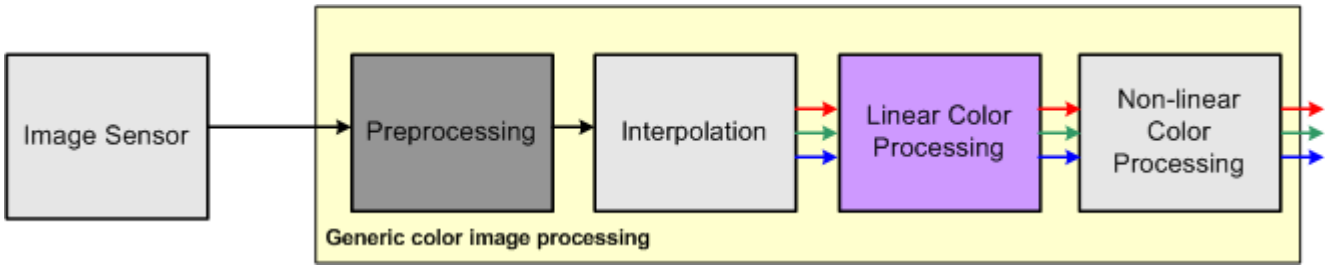


Outline

- Introduction
- Proposed algorithm
  - Implementation details
- Results
- Conclusions and remarks

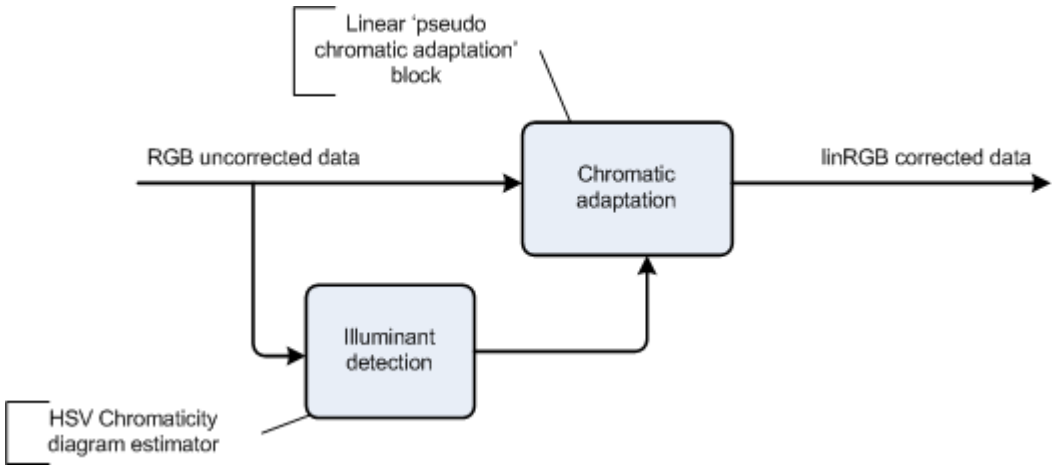
Generic Color Image Processing

- Hardware implementation of the image processing data path is usually a good choice for the mobile market.
- The constrains are:
  - Power
  - Cost
  - Performance (speed, color quality)
- The color processing part



Overall Methodology

- Color constancy vs. chromatic adaptation
- 2 step color correction:
  - White point estimation
  - Chromatic transformation



Proposed algorithm

- color correction is implemented using linear transformations:
  - ‘Pseudo White point’ estimation using a 2D projection of a constrained area in HSV space;
  - ‘Pseudo Chromatic adaptation’ using a chromatic transformation from estimated white point to a D65 white;

White Point Estimation Method

- Basic idea: a compressed form of the color information in the image is used to estimate color attributes.
- The compressed form is represented by a 2D projection (2DP) of a close to perceptual ‘linear’ color space.
- Basic assumption used in the white point estimation method: low saturated colors in the image contain useful illuminant information.
- Simplification used: an averaged low saturation constrained area of the 2DP is used to estimate the ‘white point’

Color space used

- Need a linear color space close to a perceptual one
- For ease of implementation a 2D projection is used:

$$X = R - \frac{B+G}{2}$$

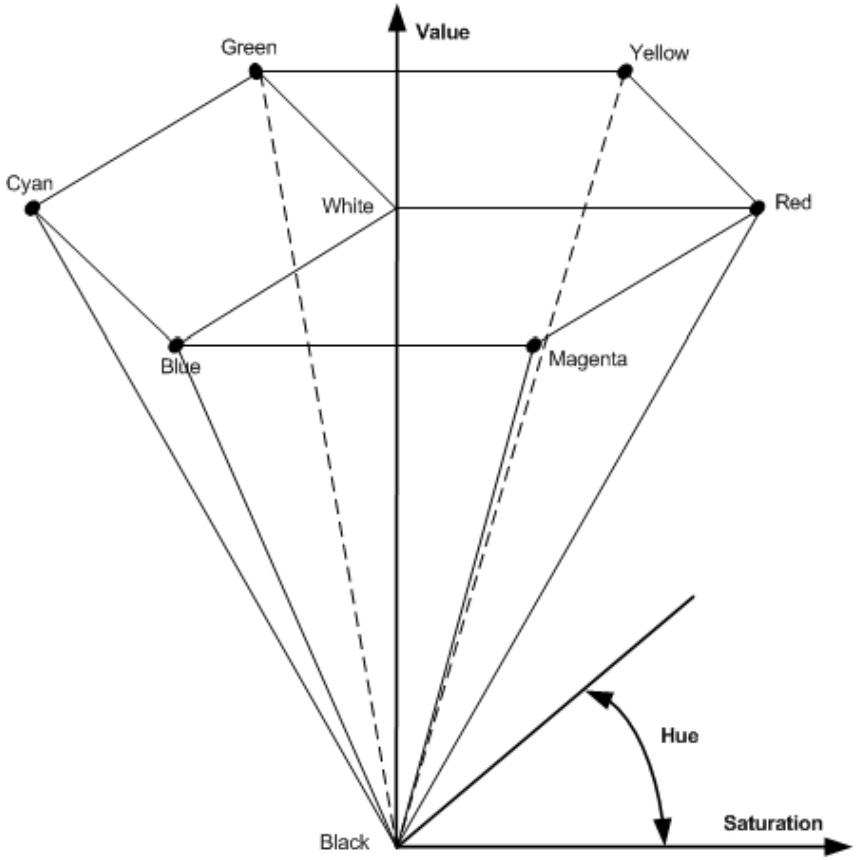
$$Y = 0.866 \cdot (G-B)$$

- Relation to HSV can be characterized by:

$$Sat = \sqrt{X^2 + Y^2}$$

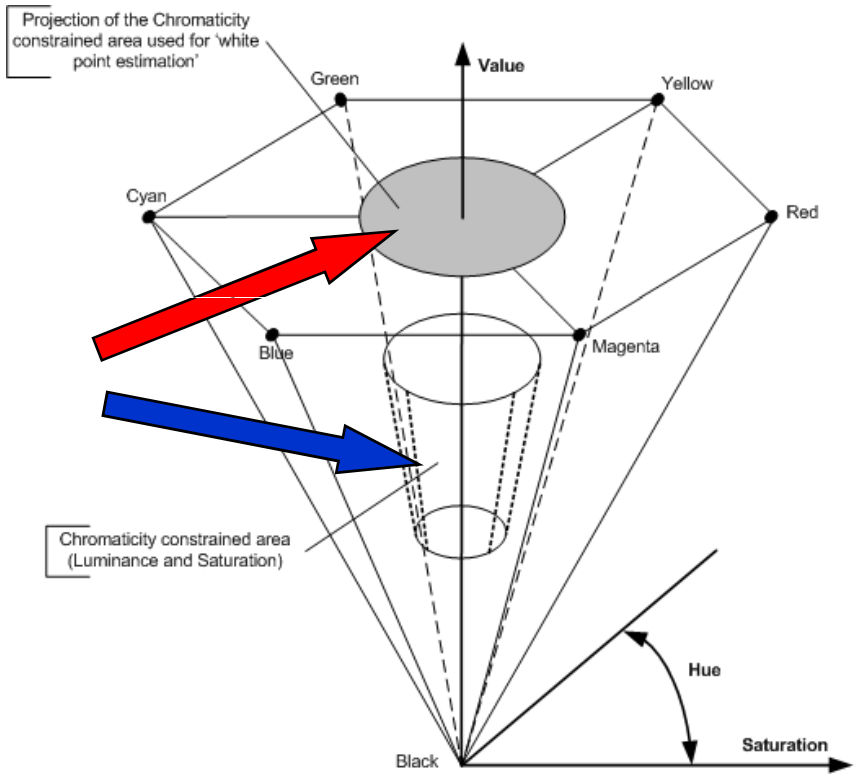
$$Hue = \frac{atg\left(\frac{X}{Y}\right)}{2 \cdot \pi}$$

$$Value = \left(\frac{R+G+B}{3}\right)$$



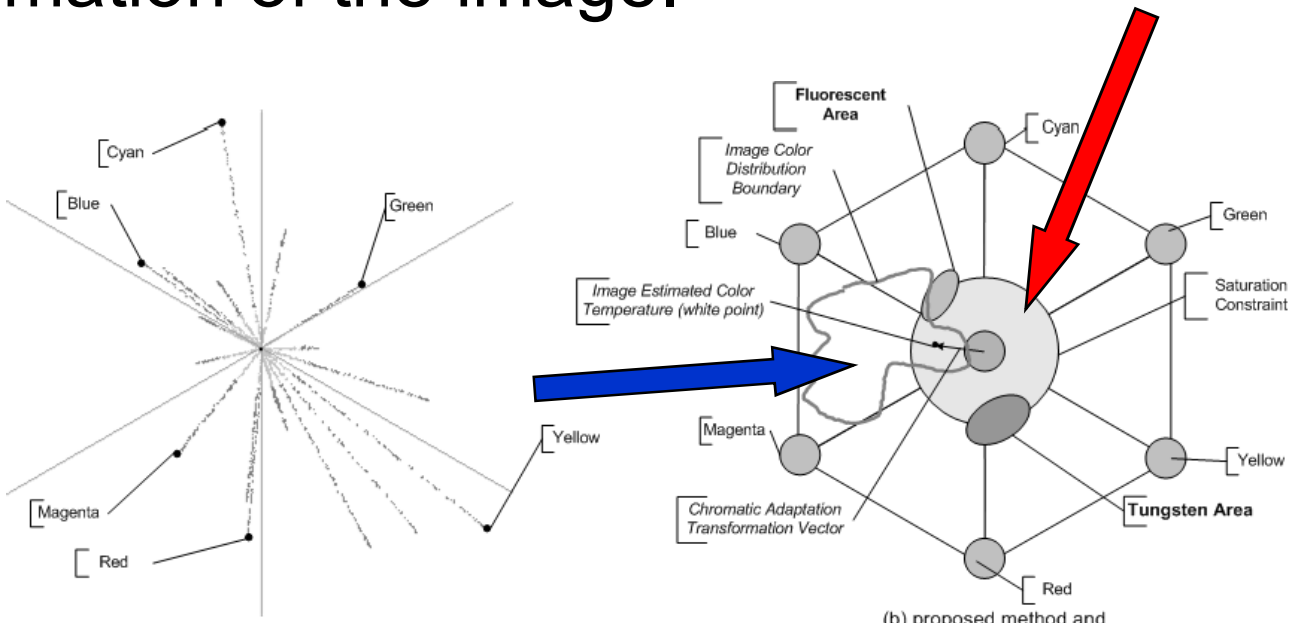
Implementation Detail: Statistics collection constraints

- Requirements:
  - Simple implementation
  - Linear processing
  - No memory
- Constrains:
  - Luminance (low and high)
  - Saturation (based on the assumption that low saturated colors preserve information related to color temperature of the image)



Implementation Detail: 2D chromaticity diagram

- The 2D chromaticity diagram offers a low-complexity solution to compress the color information of the image.

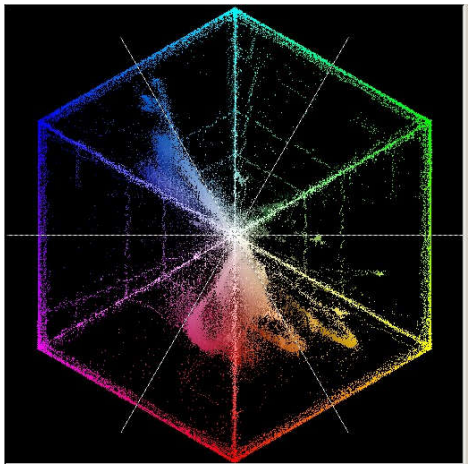


(a) chromaticity diagram of synthetic MacBeth chart

(b) proposed method and synthetic saturated colors

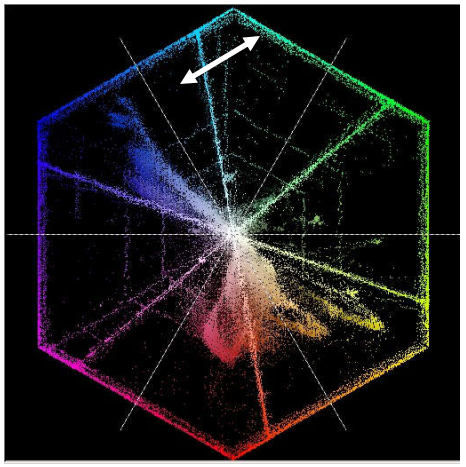
2D chromaticity diagram examples (Hue/Saturation)





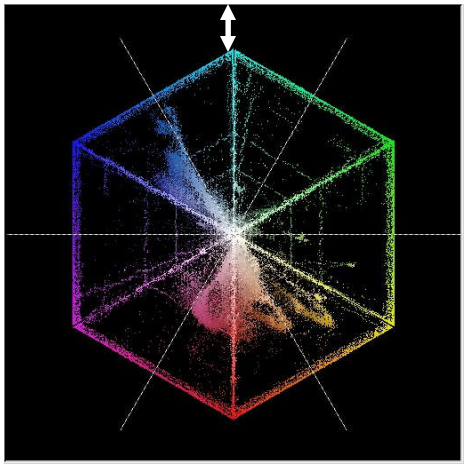
original





Hue error





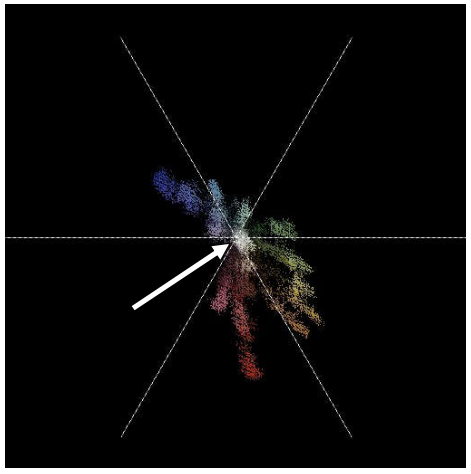
Saturation error

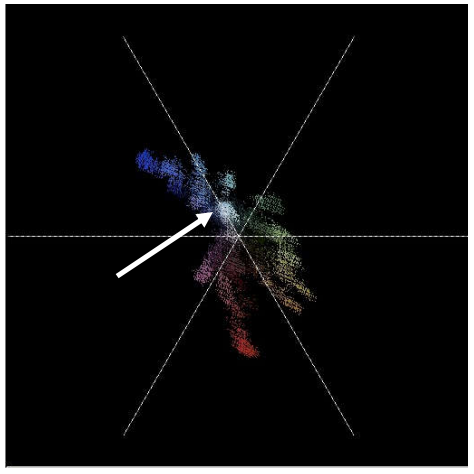
2D chromaticity diagram examples (White point)

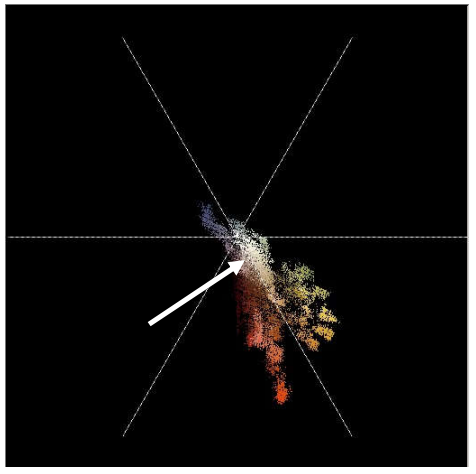












White balanced

High color temperature

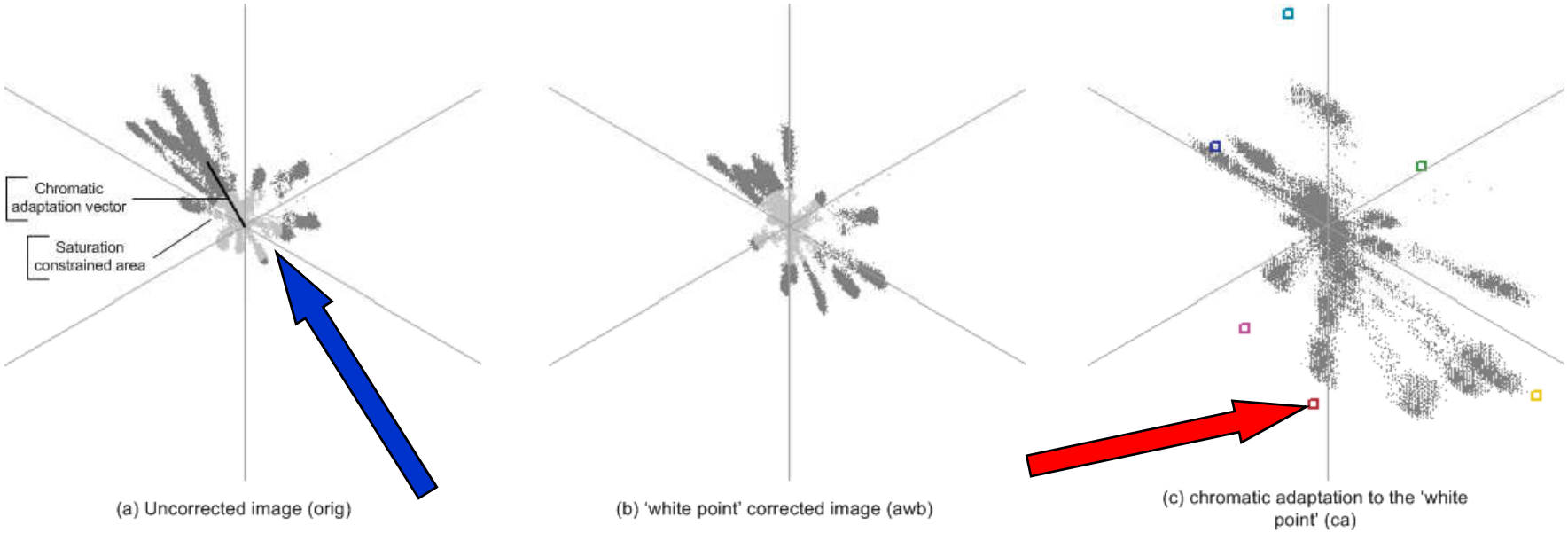
Low color temperature

Results

•4 Illuminants used with 4 color temperatures: 2300K, 2865K, 4100K and 7500K
•metrics used were: mean square error (MSE) and root mean square error (RMS) in a*b* plane of CIELAB color space (RMS error gives more weight to large errors)
•Scene used was a MacBeth color chart.
•Methods compared were: simple RGB scaling to white point (denoted awb) and chromatic adaptation in linear space (denoted ca).

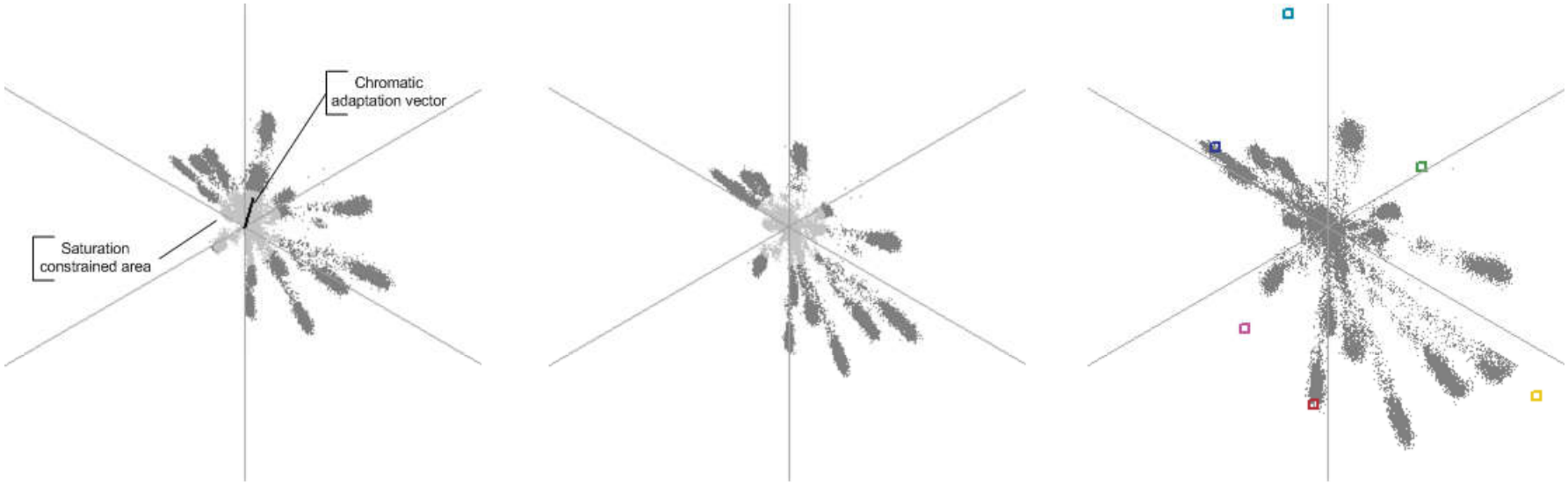
illuminant	**D75 (7500K)**			**F (4100K)**			**A (2865K)**			**HOR (2300K)**		
	orig	awb	ca	orig	awb	ca	orig	awb	ca	orig	awb	ca
MSEb	28.6	19.6	10.5	18.3	14.3	10.9	18.8	16.9	12.3	23.4	20.5	12.4
RMSSb	32.2	23.7	12.3	22	18.8	13.7	22.2	21.9	16.5	26.6	25.3	15.1

Results



- Illuminant D75(7500K) chromatic diagrams: uncorrected, 'white point' correction and chromatic adaptation

Results



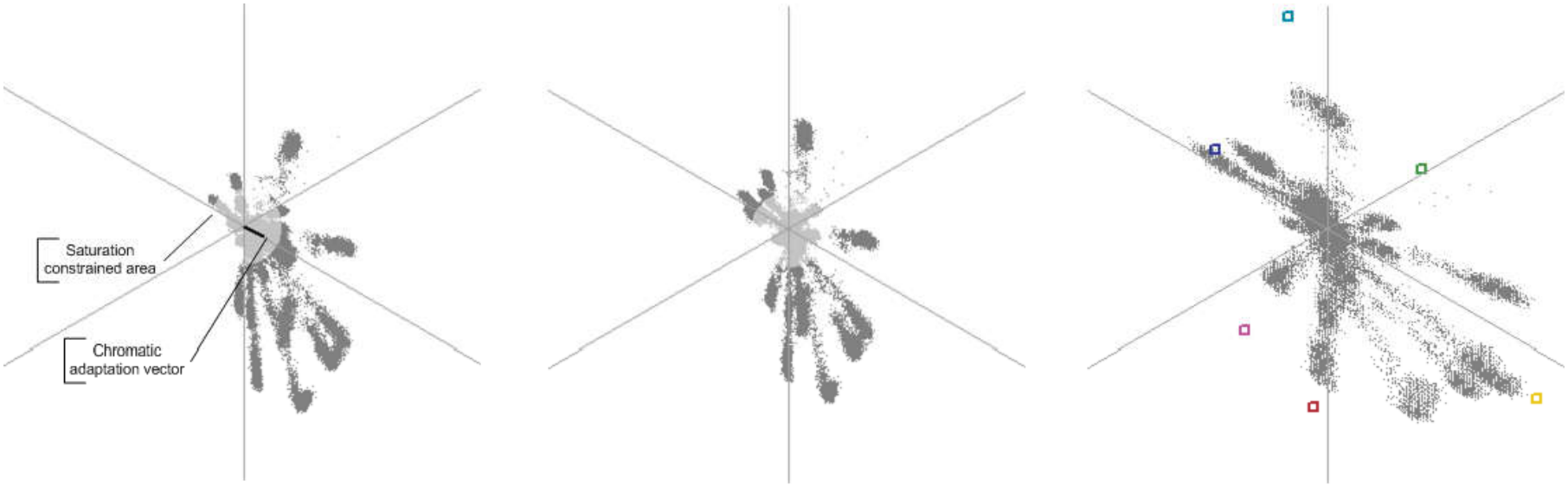
(a) Uncorrected image (orig)

(b) 'white point' corrected image (awb)

(c) chromatic adaptation to the 'white point' (ca)

- Illuminant F(4100K) chromatic diagrams: uncorrected, 'white point' correction and chromatic adaptation

Results



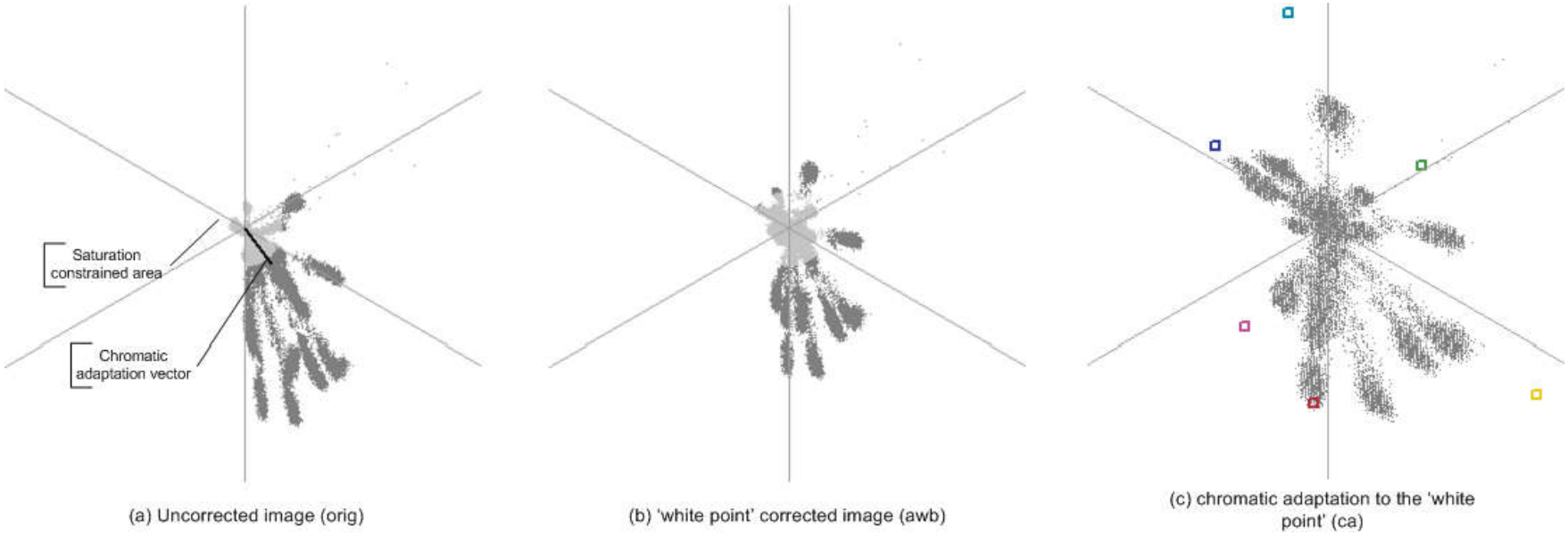
(a) Uncorrected image (orig)

(b) 'white point' corrected image (awb)

(c) chromatic adaptation to the 'white point' (ca)

- Illuminant A(2865K) chromatic diagrams: uncorrected, 'white point' correction and chromatic adaptation

Results



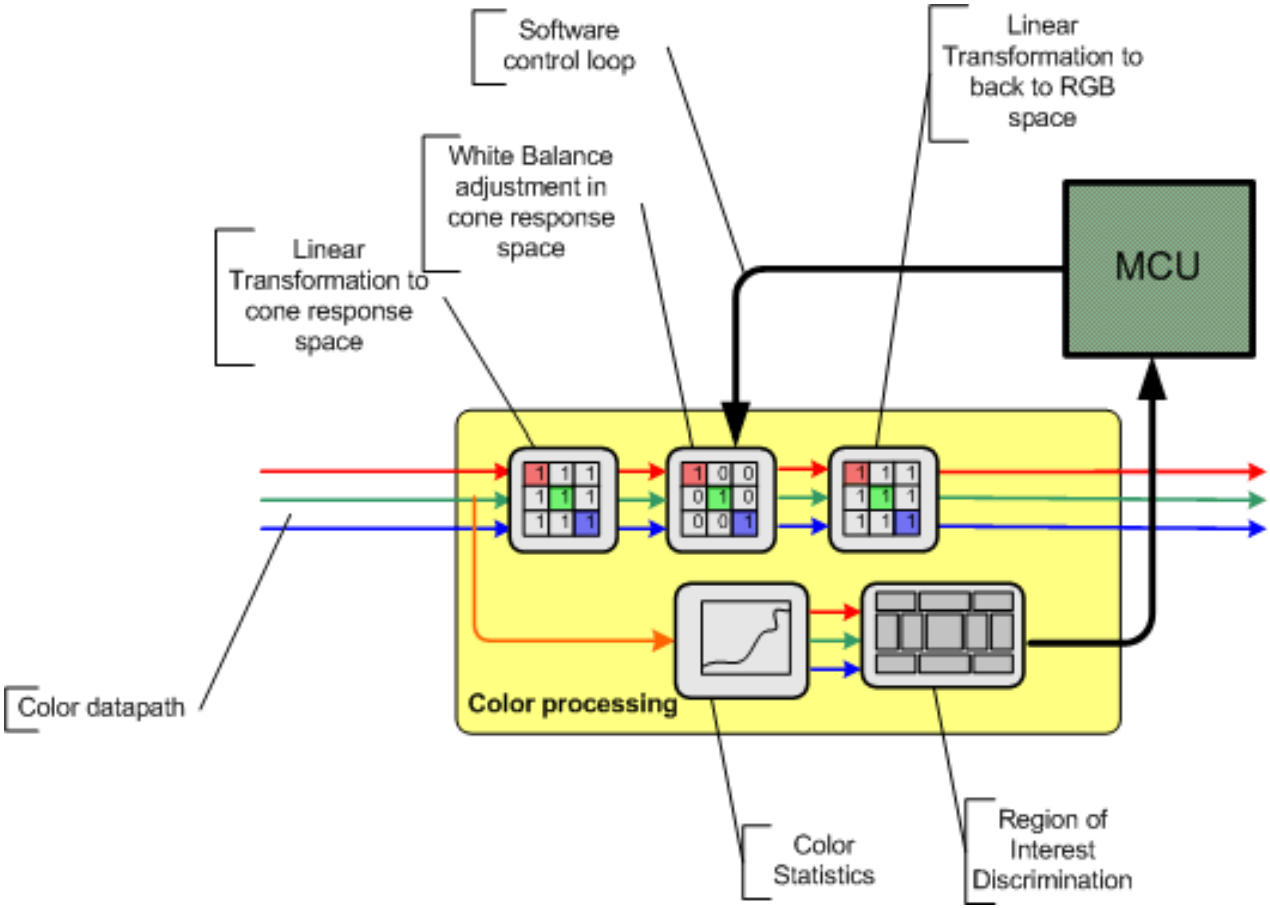
(a) Uncorrected image (orig)

(b) 'white point' corrected image (awb)

(c) chromatic adaptation to the 'white point' (ca)

- Illuminant HOR(2300K) chromatic diagrams: uncorrected, 'white point' correction and chromatic adaptation

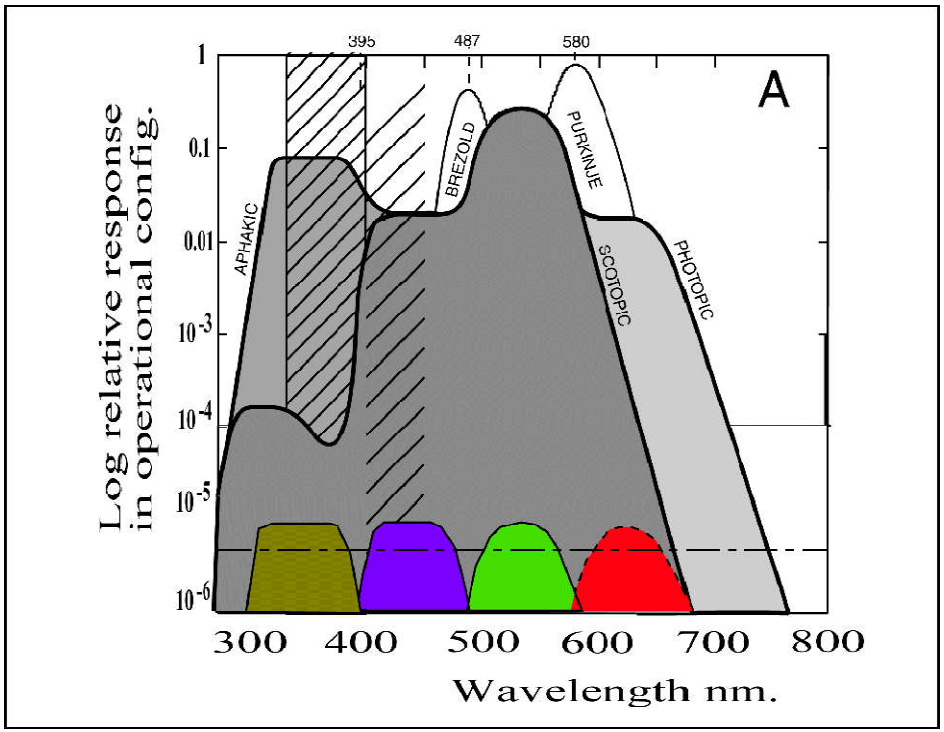
Implementation Example

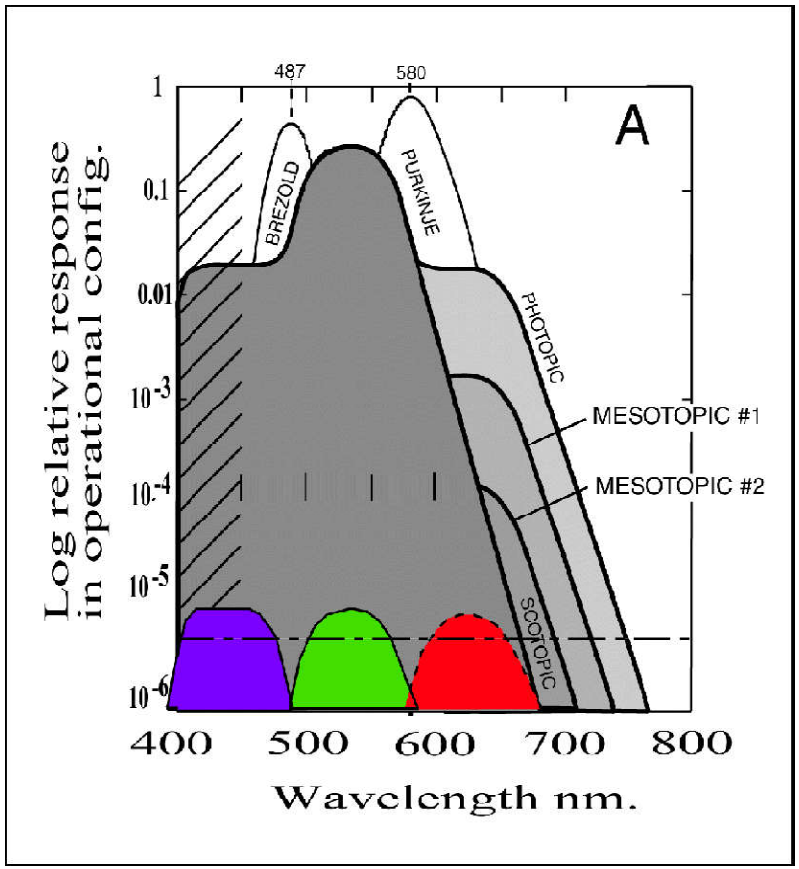


Conclusions

- White balance algorithm optimized for mobile devices;
- White point detection based on a 2D projection of a constrained area in HSV space;
- Chromatic adaptation using a linear transformation to move to D65 white;

Backup slide: Spectral Eye Response





REF: Processes in biological vision-J.T.Fulton