Colour Vision - Weeds
the Open Sky
and
a Thermos

Hans Jørgen Andersen

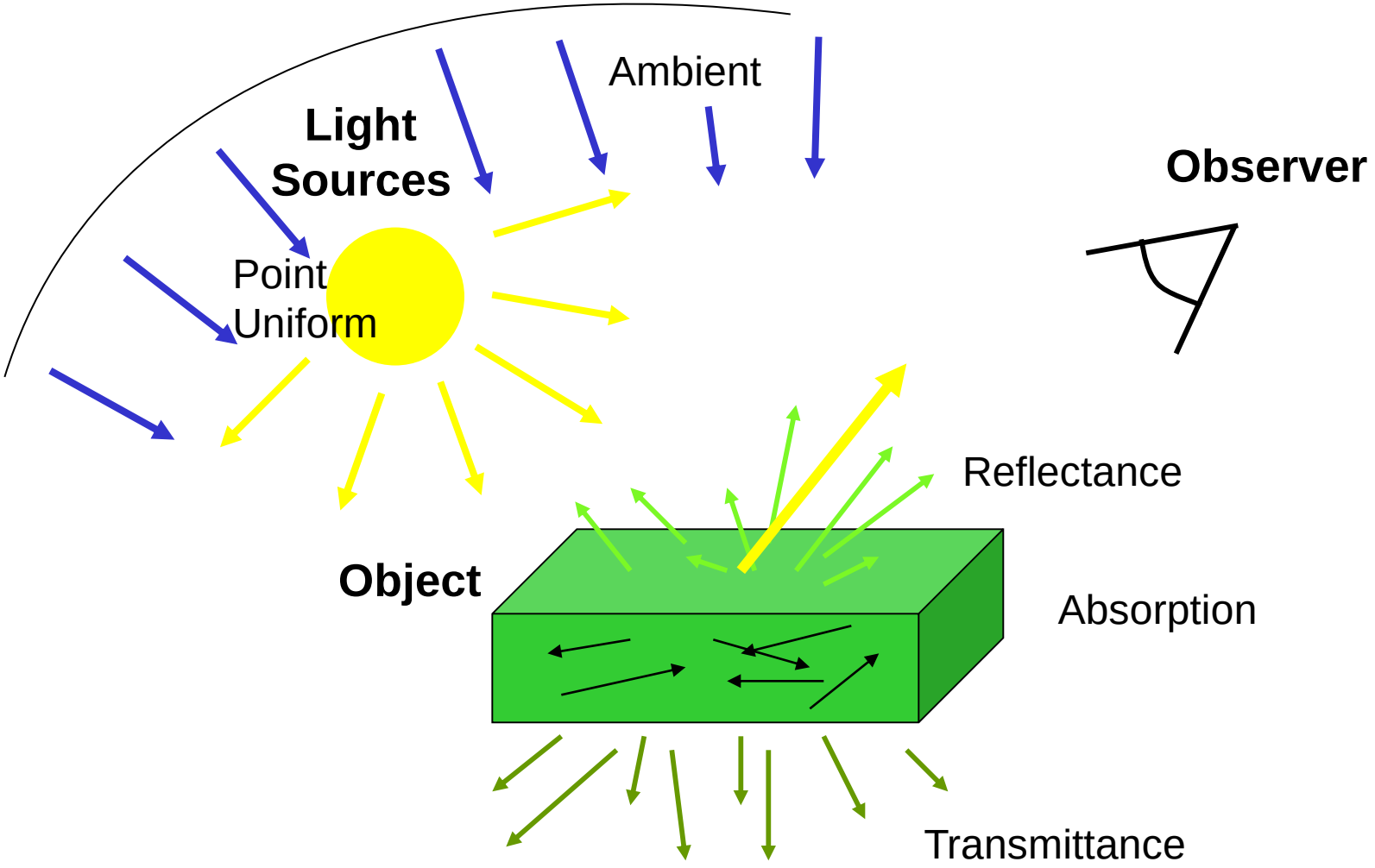
When then start

Telephone Call from Norway

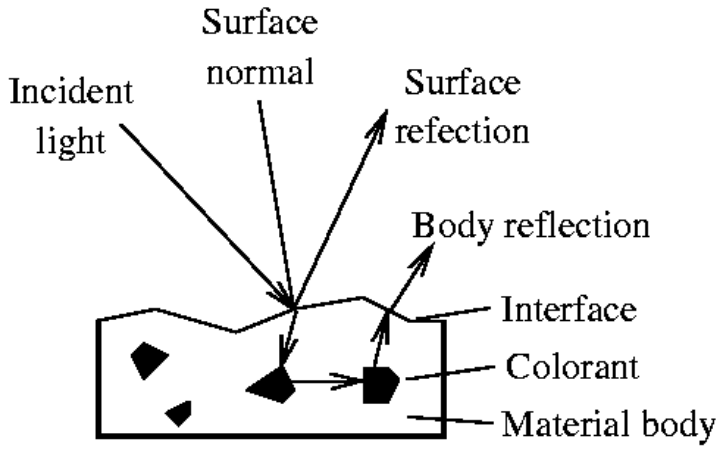
Reduced use of Pesticides and
other Input Factors

Computer Vision for Localization
and-or Monitoring of Plants

Outdoor Image Formation



Dichromatic Reflection Model



$$C(x,y) = m_B(\Theta)C_B(x,y) + m_S(\Theta)C_S(x,y)$$

Reflected Light | Body Reflection | Surface Reflection

Shafer S.A. 1985

Type I

Neutral Interface Reflection,
Objects with high oil, water content

Type II

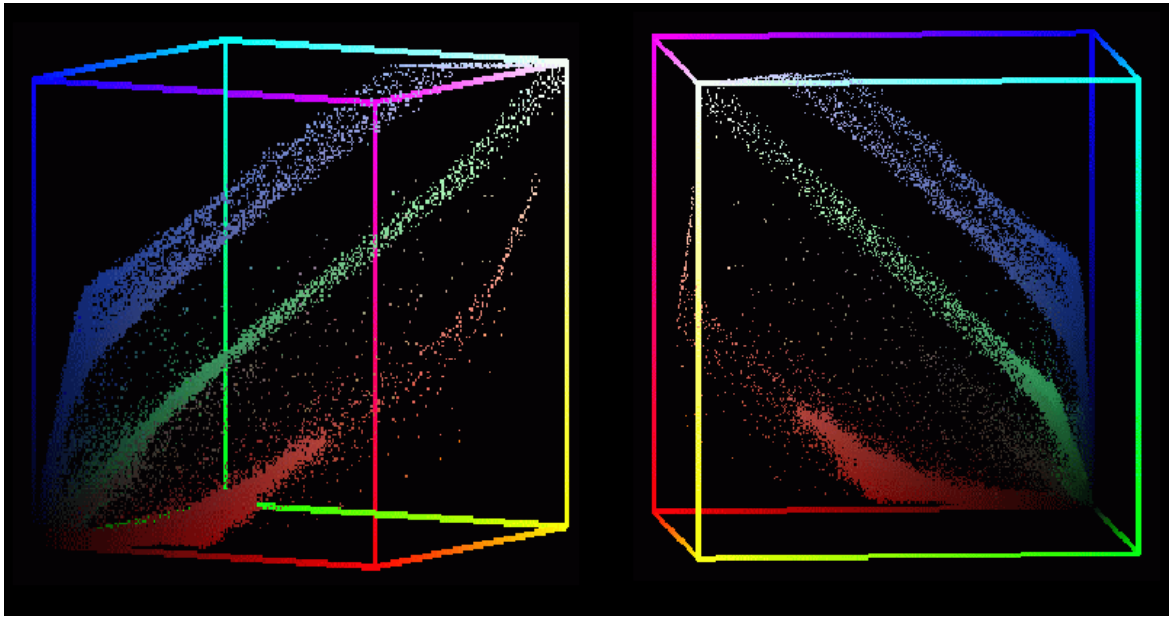
”Full” Dichromatic Reflection Model
Objects as silk, wool, coloured paper

Type III

Special Version of the Dichromatic Reflection Model
Adaptable for Metals

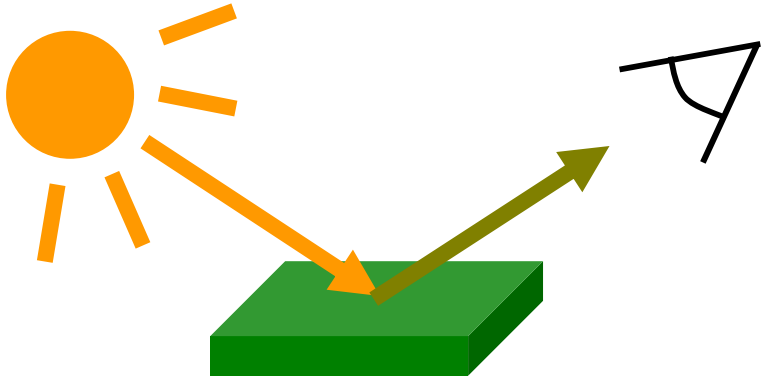
Tominaga, 1994

Dichromatic Reflection Model

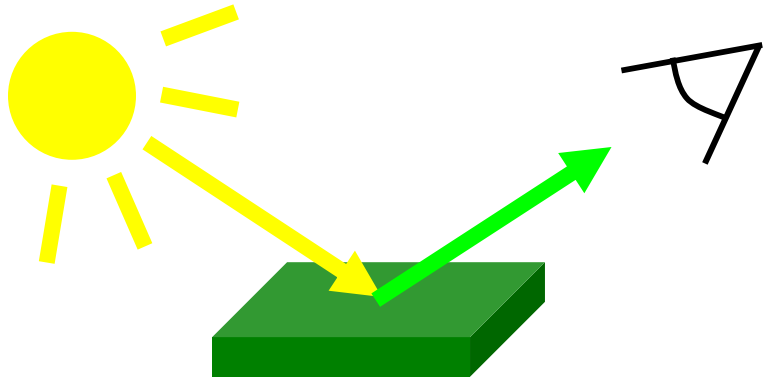


Spectral Variation of the Illumination

If Spectra of Light Source Changes

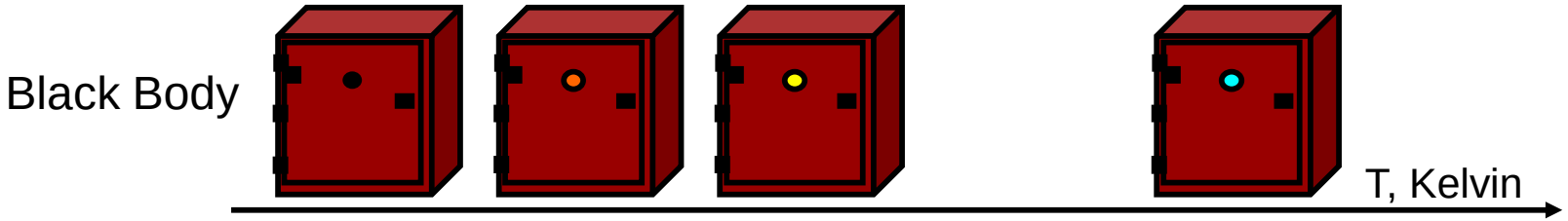


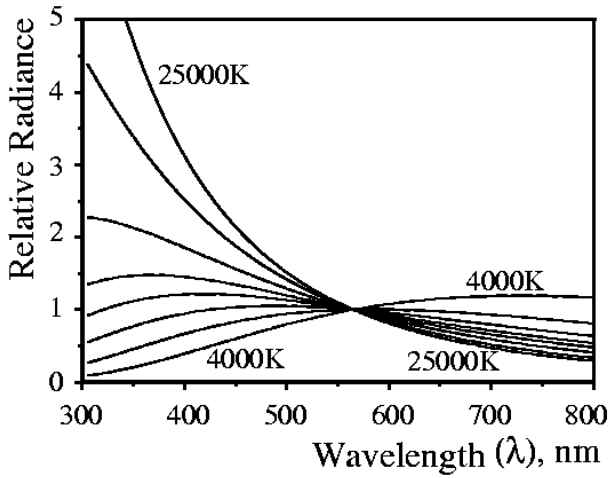
Spectra of Reflected Light Changes

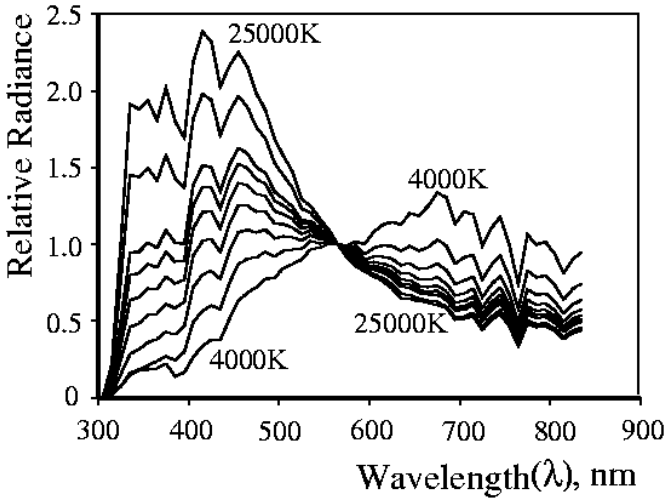


Modelling Daylight

Correlated Colour Temperature, CCT







Judd et al., 1964
CIE standard

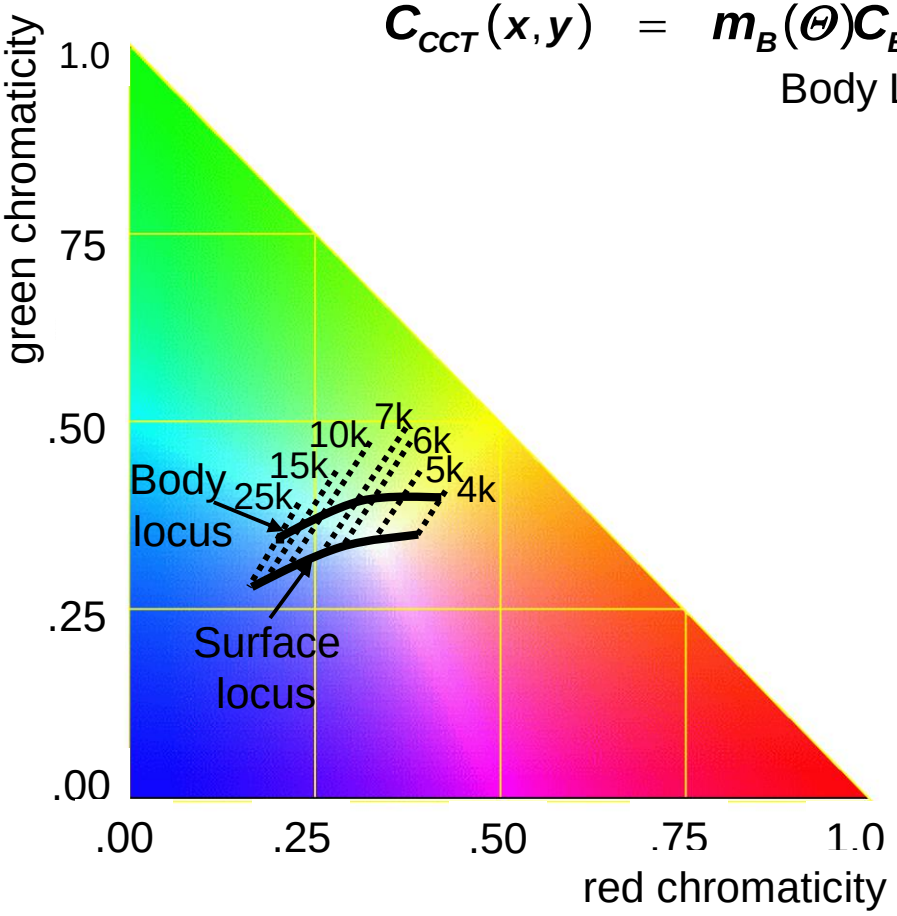
Range 4000 – 25000K

"Typical Daylight" 5700K

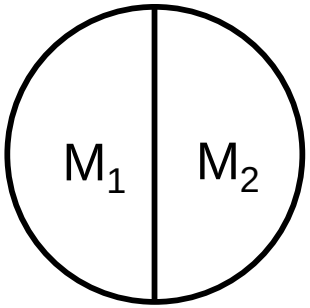
Modelling Daylight Changes

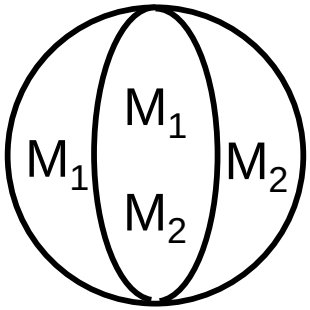
$$C_{CCT}(x,y) = m_B(\Theta)C_{B,CCT}(x,y) + m_S(\Theta)C_{S,CCT}(x,y)$$

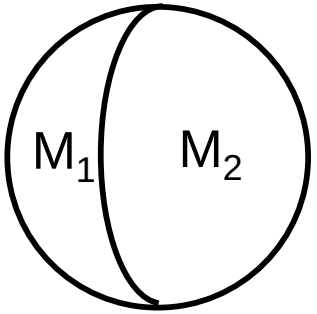
Body Locus Surface Locus

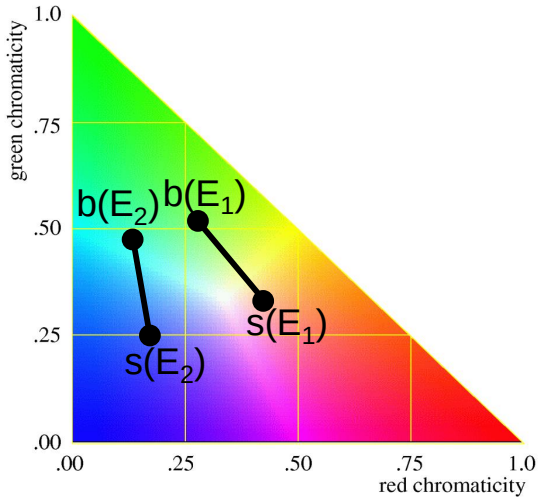


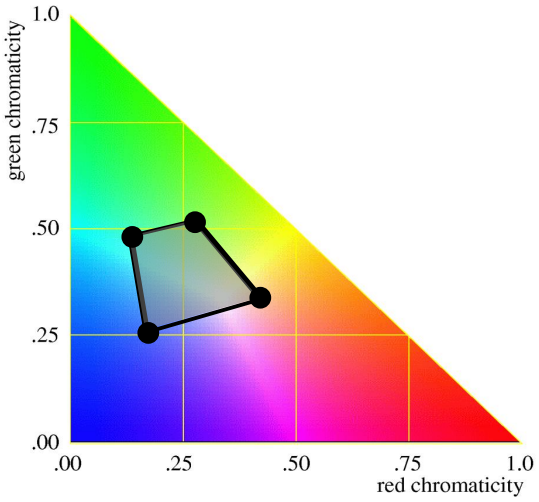
Assessment of Illumination Conditions

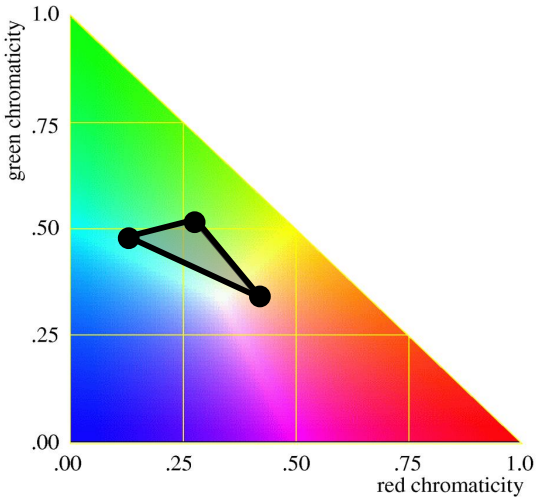












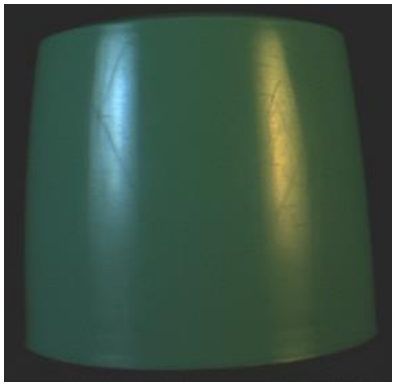
Assessment of Illumination Conditions

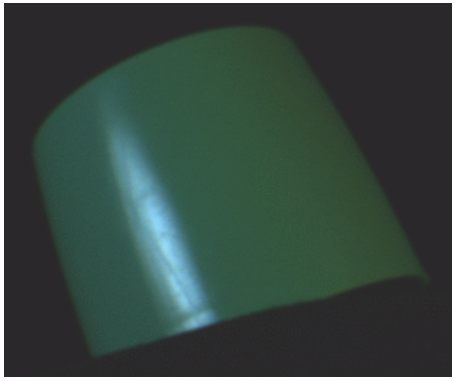
Pixel Point Distribution	Reflection due to Illumination Sources					
	E_1		E_2		$E = E_1 + E_2$	
	$b(E_1)$	$s(E_1)$	$b(E_1)$	$s(E_2)$	$b(E)$	$s(E)$
Tretragon	x	x	x	x		
Triangle	**x**	**x**	**x**			
Triangle	x		x	x		
Line	x		x			
Line					x	x
Point					**x**	

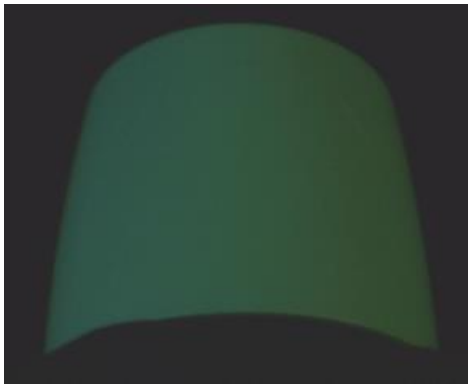
Sun and Skylight

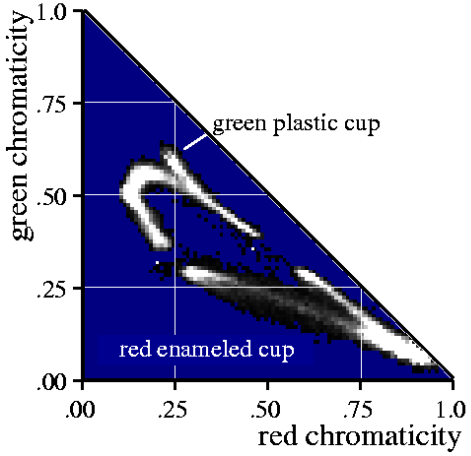
Skylight

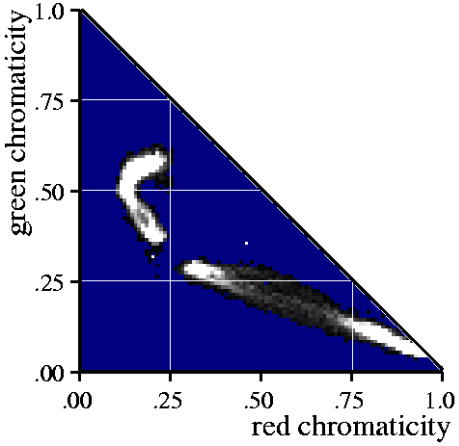
Assessment of Illumination Conditions

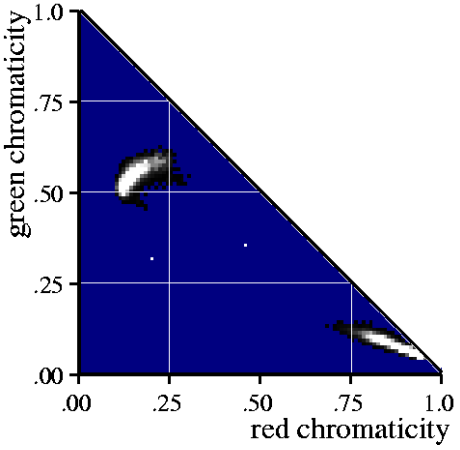








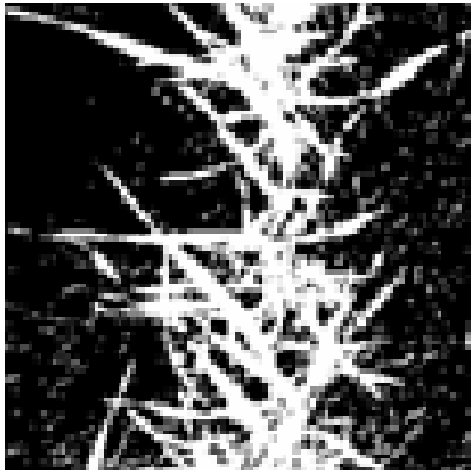
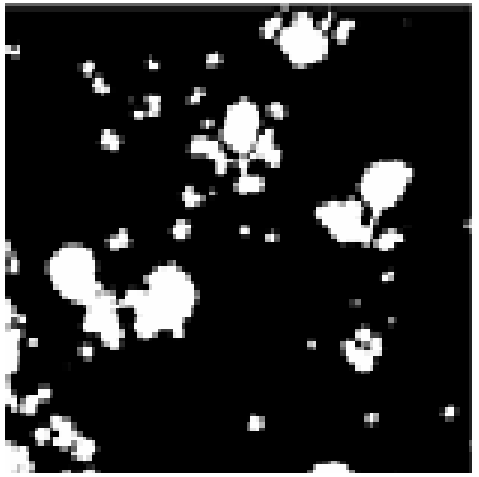




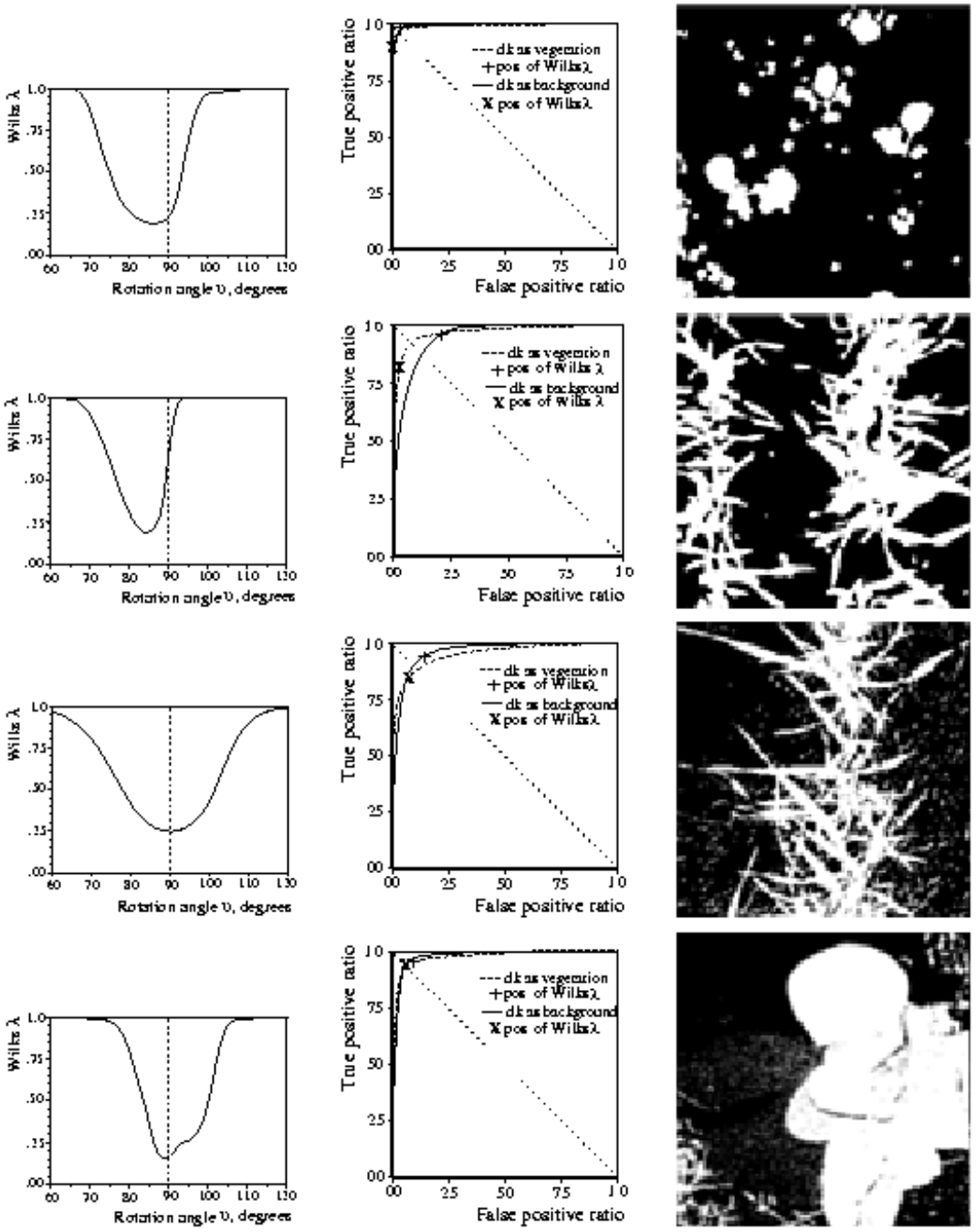
Segmentation





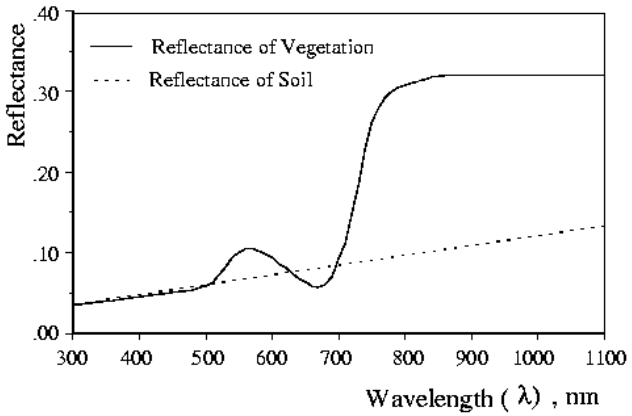
Results


Wilks λ
Rotation angle θ, degrees
True positive ratio
False positive ratio
dk as vegetation
pos of Wilks λ
dk as background
pos of Wilks λ

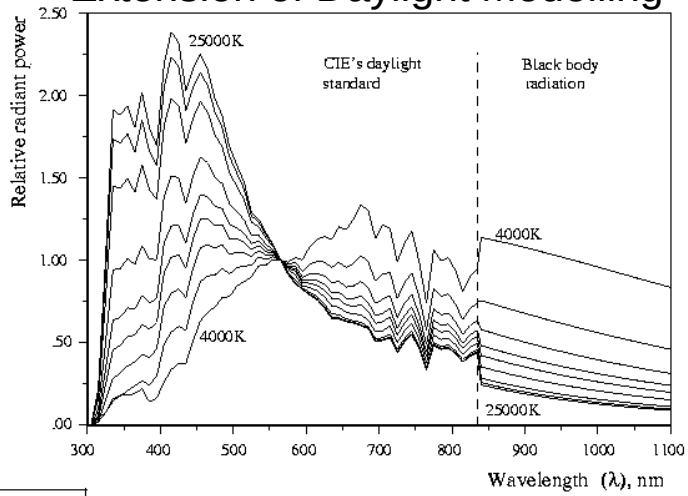
Dedicated Sensor

Design

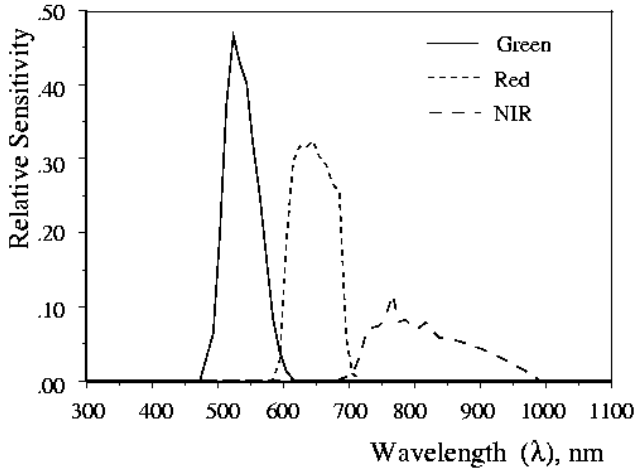
Reflectance of Vegetation and Soil



Extension of Daylight Modelling

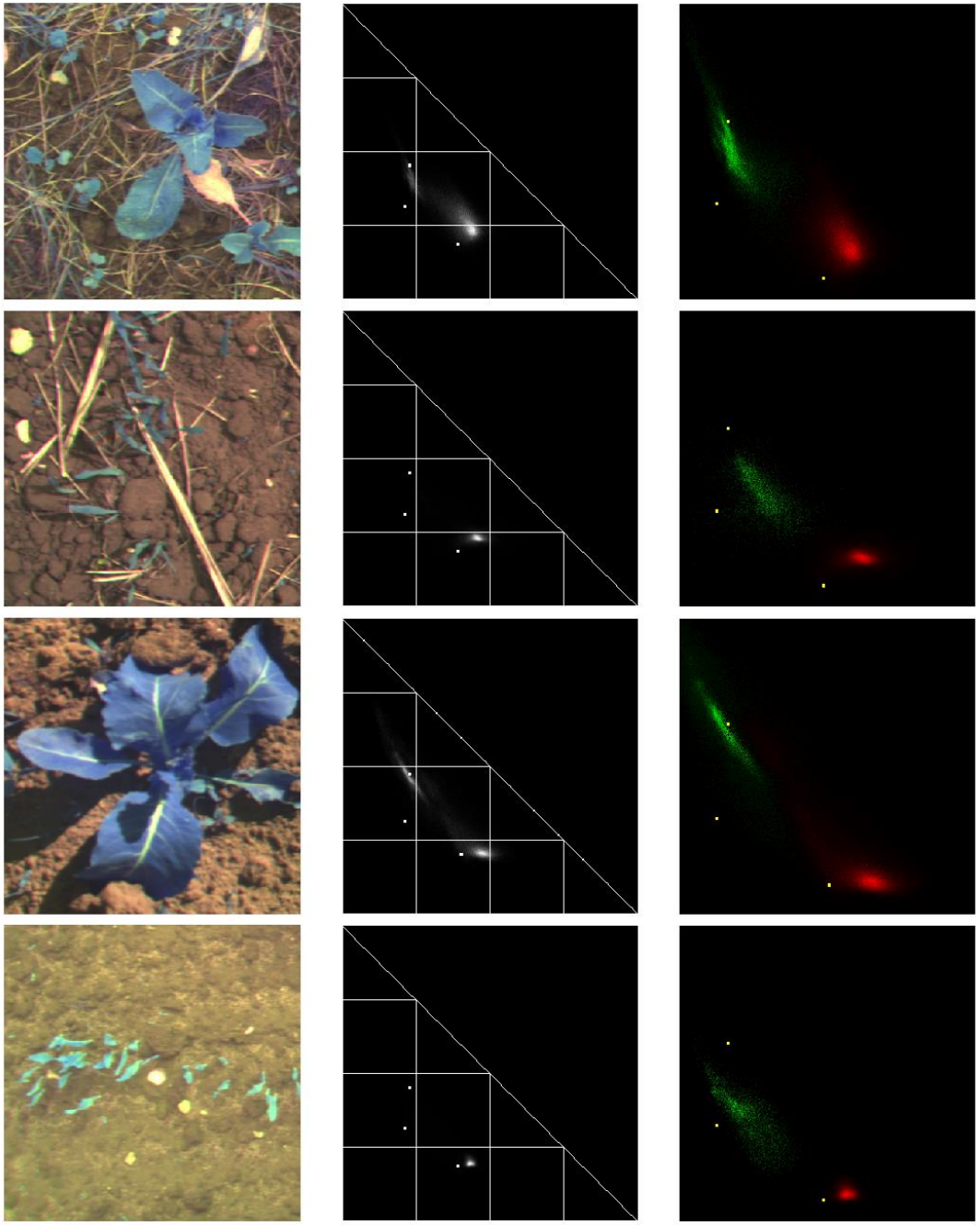


Characteristic of Sensor

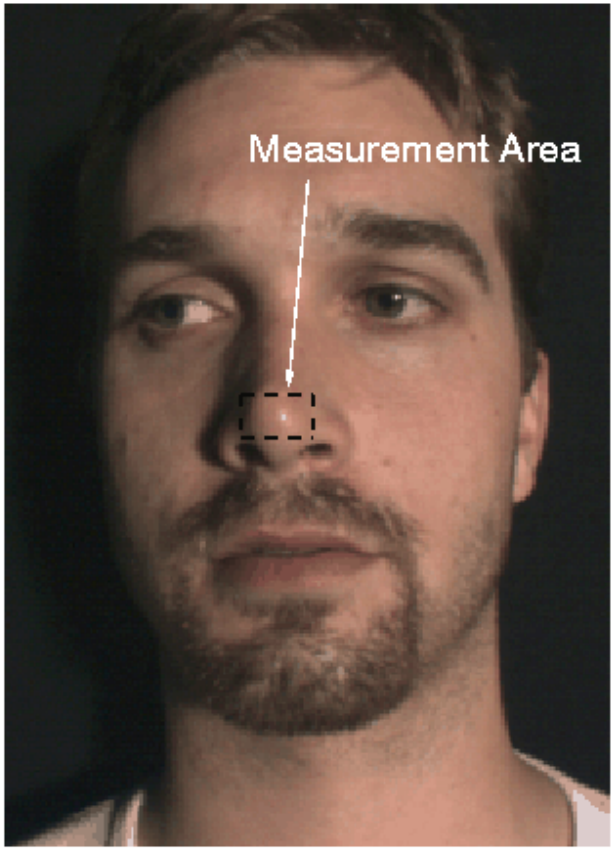


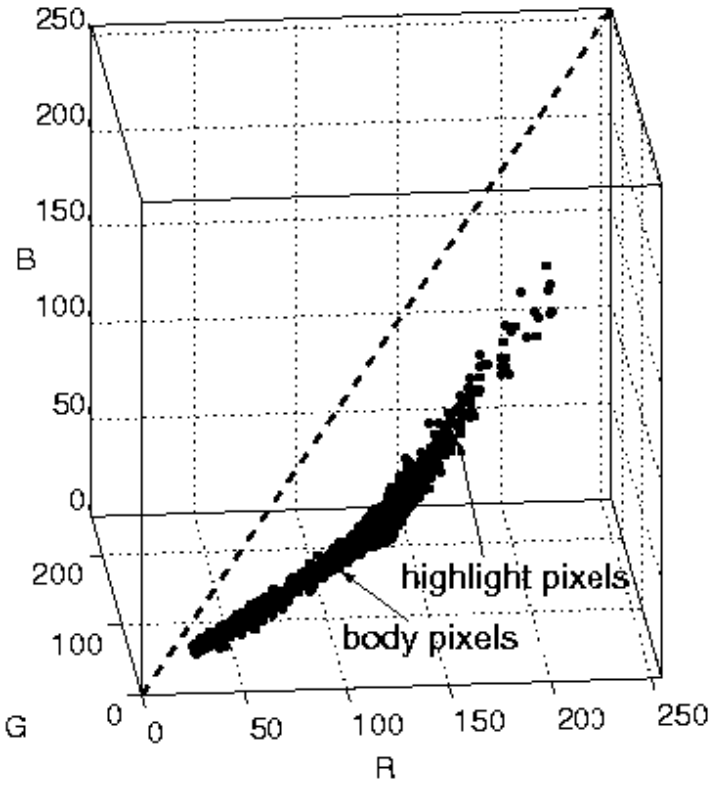
Cluster Shape

and Location



What did it lead to?





Colour Correction

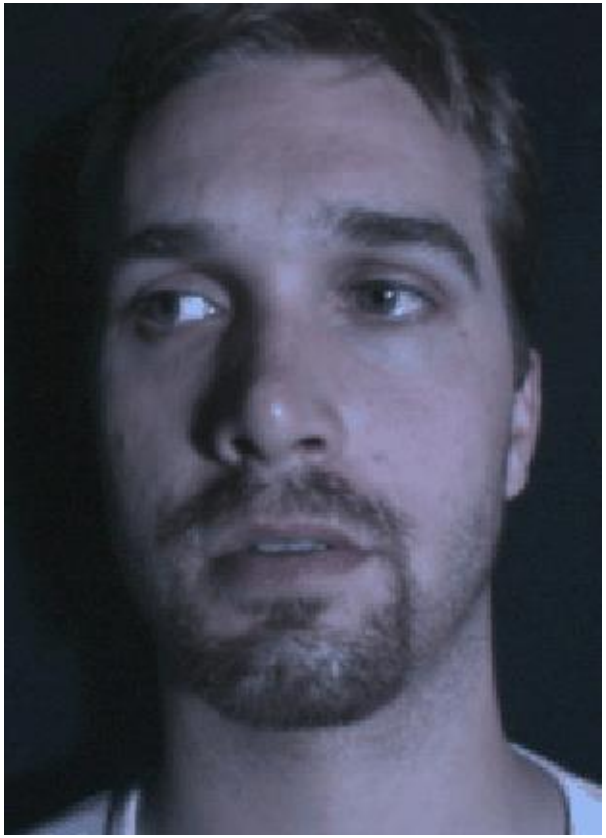
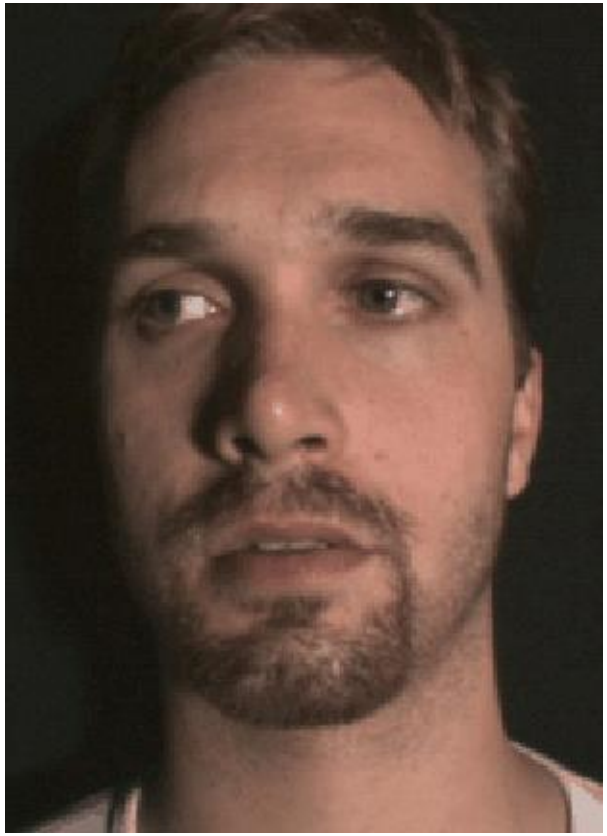
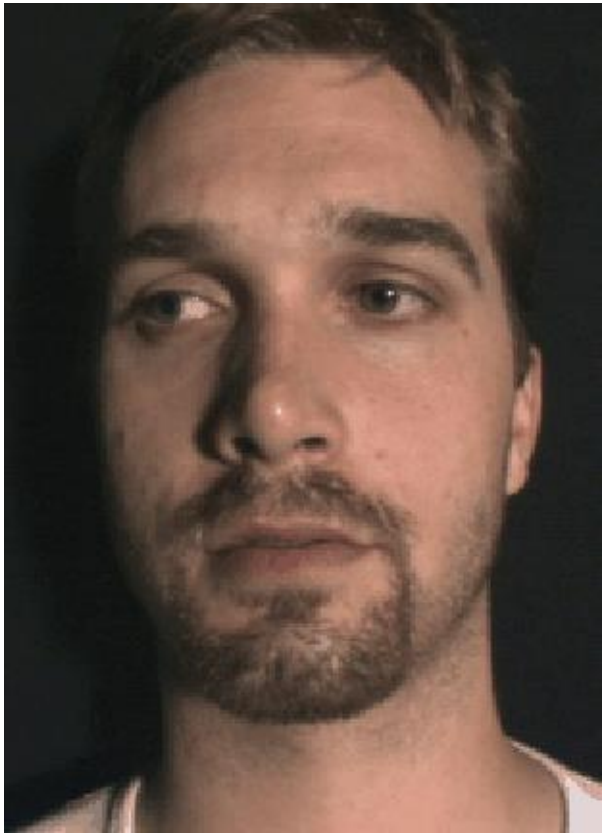


Image taken under
CCT = 4700K



Re-rendered image
to canonical cond.



Canonical image at
CCT = 3200K

What did it end up with?

A Company

- Historie:
- 1999, afslutter HJA sit PhD studie. HJA ansættes i det netop startede firma Eco-Dan ApS.
- 2000, Eco-Dan ApS lancerer det første komercielle rækkestyringstyringssystem baseret på computer vision teknologi.
- Firmaet vinder indtil flere priser for sit produkt, blandt andet EU grand IST prize på 200.000€
- 2007, opkøbes Eco-Dant af AgroCom der blandt andet ejer CLAES og er en af de største producenter af landbrugsmaskiner
- 2008, firmaet ligger stadig i Kvistgård og beskæftiger 10-15 personer med udvikling af computer vision soft- og hardware til landbrugssektoren