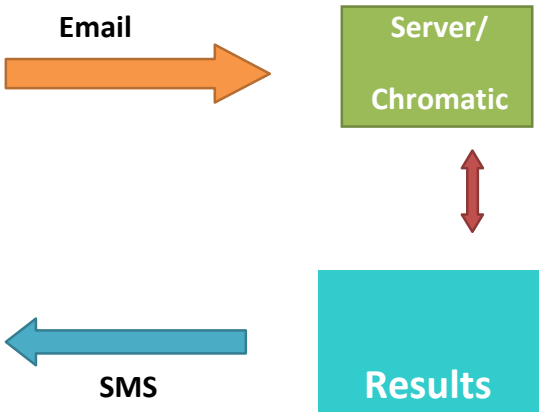
‘clikJaundice’- Technology



The chromatic monitoring (Jones et al 2008) of optical signals produced by the skin tissue of a neonate is based upon addressing the complicated spectrum of polychromatic light reflected and scattered by the tissue using three sensors (R, G, B) having overlapping wavelength responses. Typical optical spectra of normal and jaundiced tissues are shown on figure 1 along with the responses of three processors R, G, B superimposed. The B processor addresses the short wavelength range, G the medium wavelengths and R the longer wavelengths. The outputs from the three sensors are transformed as in colour science into signal features defining parameters such as, for example, the signal strength (L) and the relative magnitudes of the short, medium and long wavelength components (Z, Y, X) (Jones et al 2008).

$$L = (R + G + B)/3 \quad (1)$$

$$X = R/3L; \;\; Y = G/3L; \;\; Z = B/3L \quad (2)$$

This enables features of complicated spectra to be defined and quantified in terms of a limited number of parameters whilst remaining sensitive to the growth of unexpected spectral features and events. Sensor responses and chromatic parameters may be selected for highlighting required information as illustrated by the monitoring of high voltage transformer oil (Elzagzoug et al 2014, Lo et al 2017), alcoholic liquors (Jones et al 2009a), urine samples (Deakin et al 2014).

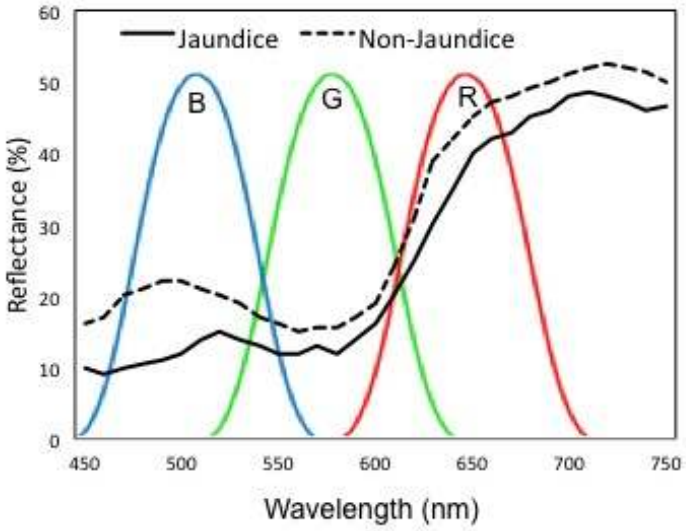


Figure 1. Optical spectra of neonate's forehead tissue with Jaundice & Non-Jaundice and wavelength responses of a typical electronic camera

The chromatic parameters X, Y, Z may be represented on a two dimensional chromatic map which in the present work is chosen as a graph of Y against Z and which emphasises variations at short / medium wavelengths, but with X also represented by virtue of

$$X + Y + Z = 1$$

References

1. Bertini G, Pratesi S, Cosenza E, Dani C. (2008) "Transcutaneous bilirubin measurement: evaluation of Bili test", Neonatology 93,101-105
2. Biliscan, n.d., A Portable non-invasive transcutaneous bilirubin analysis instrument, Löwenstein Medical. Available from: https://hul.de/en/produkt/biliscan/?ref=en.hul.de [13 October 2017]
3. Bosschaart N, Mentink R, Kok j H, van Leeuwen T G, Aalders M C G. (2011) Optical properties of neonatal skin measured in vivo as a function of age and skin pigmentation, *J. of Biomedical Optics* 16(9), 097003
4. Bosschaart N, Kok H K, Newsum A M, Ouweneel D M, Mentink R, van Leeuwen T G, Aalders C G (2012) Limitations and Opportunities of Transcutaneous Bilirubin Measurements, *Pediatrics* **129** (4) 689-694
5. Deakin A G, Jones G R, Spencer J W, Bongard E J, Gal M, Sufian A T, Butler C C. (2014) A portable system for identifying urinary tract infection in primary care using a PC-based chromatic technique, *Physiol. Meas.* **35** 793-805
6. De Greef L, Goel M, Seo M J, Larson E C, Stout J W, Taylor J A, Patel S N. 2014. "Bilicam: using mobile phones to monitor newborn jaundice', In *Proceedings of the 2014 ACM International Joint Conference on Pervasive and Ubiquitous Computing*. ACM, New York, NY, USA, 331-342. DOI: https://doi.org/10.1145/2632048.2632076
7. De Luca D, Zecca E, Corsello M, Tiberi E, Semeraro C, Romagnoli C. (2008) "Attempt to improve transcutaneous bilirubinometry: a double blinded study Medick BiliMed versus Respironics BiliCheck", Archives of Disease in Childhood–Fetal and Neonatal edition 93,135-139

8. Elzagzoug E, Jones G R, Deakin A G, Spencer J W (2014) Condition monitoring of high voltage transformer oils using optical chromaticity *Meas. Sci. Technol.* **25** 065205
9. Jones G R, Deakin A G, Brookes R J, and Spencer J W (2009a) A portable liquor monitoring system using a PC-based chromatic technique, *Meas. Sci. Technol.* **20** 075305
10. Jones G R, Deakin A G, and Spencer JW(ed), 2008 *Chromatic Monitoring of Complex Conditions* (Boca Raton, FL: CRC Press) ISBN: 9781584889885
11. KJ-8000, n.d., A portable instrument that measures transcutaneous bilirubin value relating to serum bilirubin value of new-borns and infants, Kejian Hi-tech. Available from: http://www.kejianmed.com/bilirubin-meter-Jaundice-meter.htm [13 October 2017]
12. *Lo C K, Loo H, M, Sufian, A T, Jones G R, Spencer J W. (2017). Transformer Oil Degradation Monitoring Analyzed by Optcal Fluorescence. Proceeding of the International Conference on Imaging, Signal Processing and Communication (ICISPC), Penang, Malaysia.* ACM, New York, NY, USA
13. Namba F, Kitajima H, 2007 Utility of a new transcutaneous jaundice device with two optical paths in premature infants *Pediatrics International* **49** 497-501
14. Petersen J R, Okorodudu A O, Mohammad A A, Fernando A, Shattuck K E. (2005) “Association of transcutaneous bilirubin testing in hospital with decreased readmission rate for hyperbilirubinemia”,Clinical Chemistry 51,510-544
15. Pratesi S, Boni L, Tofani L, Berti E, Sollai S, Dani C (2015) Comparison of the transcutaneous bilirubinometers Bilicare and Minolta JM-103 in late preterm and term neonates, *J. of maternal-fetal and Neonatal Medicine* Taylor and Francis. DOI: 10.3109/ 14767058.2015.1113521
16. Rubaltelli F F, Gourley G R, Loskamp N, Modi N, Kleiner M R, Sender A, Vert P. (2001) “Transcutaneous bilirubin measurement: amulti center evaluation of a new device”, Pediatrics107, 1264-1271(2001)
17. Shabeer H M, Jones G R, Spencer J W, Sufian A T, Elzagzoug E Y, Smith D H, Viju T S, Zhra F, 2016 Chromatic Mobile Phone Accessory, Government of India Patent Office, Certificate of Design Registration No. 288654.
18. Tayaba R, Gribetz D, Gribetz I, Holzmann I R. (1998) “Noninvasive estimation of serum bilirubin”, Pediatrics 102,e28(1998)
19. Yamanouchi, Y. Yamauchi, I. Igarashi. (1980) “Transcutaneous Bilirubinometry: Preliminary Studies of Non invasive Transcutaneous Bilirubin Meter in the Okayama National Hospital”, Pediatrics 65,195- 202(1980)
20. Yasuda S, Itoh S, Isobe K, Yonetani M, Nakamura H , Nakamura M, Yamauchi Y, Yamanishi A. (2013) “New transcutaneous jaundice device with two optical paths”, Journal of Perinatal Medicine 31, 81-88