

Towards Digital Pathology: Monitoring Color Calibration in Monitors

Jerry J. Lou^{1,2}; Sherwin Kuo^{2,3}; William H. Yong^{1,2}; Ryan O'Connell^{1,2}

¹Department of Pathology, University of California, Irvine Medical Center, CA, USA

²School of Medicine, University of California, Irvine, CA, USA

³Department of Medicine, University of California Irvine Medical Center, CA, USA

Background: Digital pathology relies heavily on computer monitors. Monitors present imaged slides to the pathologist for review but shift colors in the process. Variation in monitor chromaticity can alter the original colors of scanned slides, potentially influencing interpretation. We examine the hypothesis that monitor chromaticity in a standard pathology practice varies sufficiently that can alter visible colors on digital slides, which has not been previously investigated.

Methods: Chromaticity coordinates on the 1931 CIE XY chromaticity space provide a simple method for measuring variation in the color output of monitors. The XY coordinate of blue is approximately (0.174, 0.010); red is (0.736, 0.261); green (0.114, 0.824); white (0.3127, 0.329). Colorimetry from a total of 7 monitors including 2 attending desktops, 2 resident desktops, 1 personal laptop, and 2 public desktops were measured. The XY chromaticity coordinates were obtained for each monitor. Variation in color was measured by the standard deviation of the x and y coordinates, respectively.

Results: Among 7 monitors in our pathology practice, the standard deviation of X chromaticity coordinates was 0.00662 and of Y chromaticity coordinates was 0.00844 (Figure 1). The range of X coordinates was 0.0190 and of Y coordinates was 0.0278. According to the MacAdam chromaticity ellipses study, a deviation of approximately 0.003 near white light produces a grossly noticeable difference in color. Therefore, the standard deviation and range of XY chromaticity coordinates we measured produce a noticeable variation in the red-green-blue color space.

Conclusions: Monitor colorimetry varies in a standard pathology practice. This variation is sufficient to alter visible colors on digital slides. A move towards digital pathology necessitates standardization of monitor colorimetry to ensure uniform appearance of digital slides across pathology. Similar to other laboratory tests in the clinical pathology setting, monitors should be considered diagnostic instruments to be validated and maintained.

Figure 1: Chromaticity coordinates of 7 monitors

