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Letter to Editor

Response to Rojo and Bueno: "Analysis of the impact of high resolution monitors in digital pathology"

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We thank Rojo and Bueno for their thoughtful commentary on our study of the effect of display resolution on diagnostic speed. Display resolution is a critical factor in digital pathology efficiency. Our design decisions are described in detail elsewhere,[1,2] but were deliberately based on what is known about microscopy (the space-bandwidth product of a typical diagnostic microscope is 5–50 megapixels, and the angular field of view is approximately 50–70°) and human physiology (the angular resolution of the eye is approximately 0.5–1 arc-minute per pixel at the fovea). The three screen system in this work was designed to mimic these parameters as closely as possible with the displays available to us at the time.

Rojo and Bueno raise the question of whether the particular NVIDIA Quadro graphics cards used would enable optimal performance but do not state what they mean by "optimal." In our view, the most important factor is that a graphics card is capable of driving the displays at their native resolution and refresh rate, and this was the case for the graphics card/displays combination used in our study. The maximum refresh rates quoted for both displays are for analog inputs. In our study, we used digital inputs for both displays. In both cases, the maximum refresh rate is 60 Hz for digital inputs. NVIDIA Quadro graphics cards are designed with GPU intensive three-dimensional CAD-type applications in mind and are not stressed by two-dimensional applications such as ours. One must be careful when comparing the contrast ratio of different displays. There is no industry standard test for measuring contrast ratios of displays and the figures are often manipulated for marketing purposes and may not be directly comparable. The environment in which the display is located can also affect the contrast ratio. The input images used eight bits per channel (16.7 million colors), so no advantage would have been gained of the extra colors available on the Dell display.

Rojo and Bueno also raise the question of the level of experience of the pathologists who participated in the study. Experience is an important issue, and unfortunately we do not have access to data regarding our participants' years of experience. However, the use of a crossover design, with all participants reviewing slides in each condition, protects against the variation in participants' level of experience introducing bias.

Rojo and Bueno reflect on the increasing popularity of high-resolution displays in digital pathology. In our most recent work,[2] we combined two high-resolution medical grade screens, a Barco 6.7 megapixel Coronis Fusion and a 3.1 megapixel Nio screen, to provide an almost 10 megapixel display [Figure 1]. The slide is viewed in detail on the 6.7 megapixel screen, although the 3.1 megapixel screen provides an overview of the slide currently being viewed as well as an overview of all slides in the case. This removed any problems caused by bezels or users focusing on the central screen. Using this set up, combined with a unique design that enables real-time rendering of slides, although providing a quick and intuitive means of navigation via the slide overviews, we were able to show no significant difference in time to diagnosis between digital and glass slides.

Finally, we would like to clarify a point about our methodology. All participants reviewed the same slides, with the slide set used in each condition counterbalanced. This means that, while there were 81 trials, only nine slides were used, not 81.

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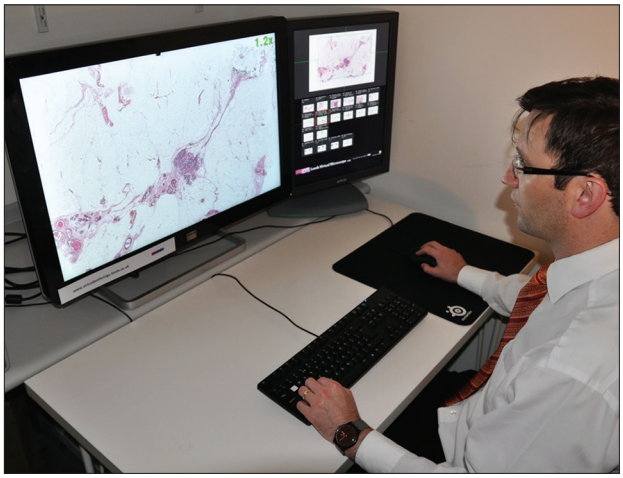

Figure 1: The Leeds virtual microscope

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Conflicts of Interest

There are no conflicts of interest.

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