Determinants of system resolution for simulation training display systems

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ABSTRACT

This paper presents the results of analyses and measurements of the primary display system components that affect system resolution. These components include sampling rate (angular pixel pitch), anti-aliasing kernel width (sampling aperture), pixel point spread function, image re-mapping (warp), lens blur, projection screen, mirror, projector contrast, and scattered light. The paper goes on to illustrate and discuss the relative influence of each of these components on system performance.

An analysis of the CRT-based systems that were pervasive a decade ago indicate that system performance was significantly limited by components such as CRT spot size, video amplifier bandwidth, and lens blurring. The performance of these components was well described using the modulation transfer-based metrics and measurements adapted from the field of optical engineering for non-sampled display systems. Since these components were primary determinants of system resolution, these "projector-based" measurements were a useful correlate of user performance with these display systems.

In more recent years, digital display systems have come to dominate and existing CRT-based systems are being replaced at a rapid pace. With the newer digital display systems the traditional resolution limiters (spot size, amplifier bandwidth, and lens blur) have been reduced to levels where they are no longer primary determinants of system performance. Variables such as the presence of spatial sampling artifacts, anti-aliasing, and image warping have become relatively more influential. Additionally, the use of substantially higher pixel counts has pushed the performance of these new systems closer to "observer-limited" performance than the systems they replace.

To accommodate these fundamental changes in system design, the metrics and measurements used to evaluate system performance need to account for sampling characteristics if they are expected to remain good correlates of observer performance with training display systems. Additionally, these metrics and measurements need to account for the visual capability of the target population of observers who will use these systems.