Effects of HMD Image Luminance in Low-Light Augmented Reality Applications

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ABSTRACT

Previous work with low-light augmented reality helmet mounted display (HMD) applications examined the degree to which dark state LCD luminance bleed-through can obscure real-world objects viewed through the display. In this follow-on work, we investigate the degree to which relatively low-luminance ($\leq$25cd/m^2) monochrome HMD images can obscure real-world objects displayed in a simulated low-light formation flight scenario. These HMD images are intended to simulate augmented-reality camera images (night vision goggle, etc.) which are present in several HMDs used in military aviation and flight simulation. Observer performance was evaluated at several different luminance levels for tasks that require locating an aircraft with active navigation lights under starlight illumination. Adaptation time between relatively high and low HMD luminance conditions was also characterized. In this paper we summarize the previous work pertaining to LCD bleed-through and extend the psychometric threshold measurements to higher luminance levels due to augmented reality camera images. Human performance was estimated for each luminance condition using the Psi psychometric threshold estimation algorithm. These methods can be used to accurately calibrate training simulations in which highly realistic representations of low-light see-through HMD operations are a critical requirement for effective training.

BIO

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Dr. Eleanor O'Keefe is a research scientist in the Science and Space Business Unit of KBRwyle. She works in the Operational Based Vision Assessment laboratory at the United States Air Force School of Aerospace Medicine at Wright-Patterson AFB, Ohio. She assists with multiple projects including efforts with F-35 and KC-46 vision research. Eleanor received her PhD in Experimental Psychology, specializing in vision and hearing sciences, from the University of Louisville in 2017 and her BS in Biopsychology from the University of California, Santa Barbara in 2010, with a minor in Applied Psychology. She began working in experimental psychology laboratories in 2008, and has training in behavioral, cognitive, and attentional psychology as well as her main focus, visual psychophysics. Her experience includes experimental design, data collection, data analysis, and working with specific experimental hardware including virtual reality, EEG and fMRI.