Efffects of HMD Backlight Bleed-Through in Low-Light Augmented Reality Applications

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ABSTRACT

Many liquid crystal displays (LCD) operate by acting as a light valve to selectively block or transmit light emitted from a backlight. Due to the imperfect nature of the LCD light valve, when the LCD pixel is in the "off" state it is not perfectly opaque, and some small portion of the backlight bleeds through. This imperfect dark state, or black level, is a well-known drawback of LCD displays. In low-light augmented reality helmet mounted display (HMD) applications this bleed through can significantly obscure real world objects viewed through the display. In this work, we investigate the performance impact of an elevated dark state in simulated low-light formation flight scenarios using a monochrome green HMD. Observer performance was evaluated at several different dark state luminance levels for tasks that require locating or tracking an aircraft with active navigation lights under starlight illumination. Adaptation time between relatively high and low dark state conditions was also characterized. In this paper we focus on the challenges associated with implementing the operational scenario, including calibration of both the simulation and HMD, with discussion of the human performance under varying brightness conditions. 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. Logan Williams is a senior research engineer at the United States Air Force School of Aerospace Medicine at Wright-Patterson AFB, Ohio, and currently leads technology development for the Operationally Based Vision Assessment laboratory. Previously, he has led multiple lines of research in various fields such as human effectiveness, vison assessment, immersive environment & visual display system design, holographic metrology, and distributed simulation for aircrew training. He has previously served as the lead systems engineer for F-16, A-10, and KC-135 aircrew training systems and has over two decades of experience in analog and digital circuit design, networked control systems, optical & electro-optical system design, and physics-based modeling. He has earned a PhD in Electro-Optics, ME and BS degrees in Electrical Engineering, as well as a BS in Physics.