Use of a live, virtual, constructive simulation approach to evaluate visual symbology on a helmet-mounted display for spatial disorientation mitigation.

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ABSTRACT

Spatial disorientation (SD) continues to be one of the most costly problems in military aviation, as measured by both life and equipment loss. The unique Helmet-Mounted Display (HMD) centric interface within 5th generation fighter/attack aircraft has the potential to be more supportive of operator orientation maintenance than display systems in previous similar role aircraft. However, the highly immersive nature of present generation HMDs may also give rise to potential loss of attitude awareness, especially during operations including prolonged off-axis viewing. This paper discusses an approach used to evaluate the addition of off-axis ownship attitude information within the HMD field-of-view when the operator looks away from the virtual Head-Up Display (HUD). A live, virtual, constructive (LVC) methodology was developed to create an environment within which participants can perform tasks representative of real-world operations. An HMD system was integrated into the rear seat of a two-seat single-engine jet aircraft for purposes of data collection. A safety pilot occupied the front seat but, while the physical aircraft was at a safe altitude, rear-seat participants (all qualified pilots) controlled the aircraft during simulated air-to-ground weapon delivery tasks. The outside visual world was occluded by shrouding the rear-seat canopy with a "hood". In our case, the virtual world depicted mountainous terrain and cultural features of a target area. In reality, the aircraft was flown above 10,000 feet in airspace in Iowa but visually the participants experienced low-level flight in a "threatening" virtual environment while controlling the aircraft in-the-loop and experiencing actual acceleration forces. The operational task included radio communication with a live confederate "actor" directing the aircraft to the virtual target area to perform simulated attacks. The virtual environment mixed with the physical "live" experience was designed to generate a very compelling and challenging task from an SD perspective. It was within this methodological framework that novel visual symbologies intended to aid orientation maintenance during off-axis HMD use were evaluated via quantitative performance, physiological response, and subjective feedback. The quantitative measures included compliance with assigned altitude blocks, head movement activity, and flight control entropy. This paper discusses the development and use of this methodology within the flight environment as well as its planned transition into a multi-axis centrifuge-based simulator called the Disorientation Research Device (DRD). The DRD is a U.S. Navy research asset that will provide a flexible and reconfigurable means for performing human-in-the-loop studies to investigate the interactive effects of visual, vestibular, and other sensory input. Utilization of the DRD is intended to supplement performance within the actual flight environment by providing comparable acceleration forces in a more controlled research setting, while also reducing the complexity, safety risk, and cost of actual flight testing. Planned research building on the LVC approach will investigate the utility of visual and auditory mixed modality display concepts for SD mitigation during HMD use. The DRD will be configured to closely match the pilot/vehicle interface of the test aircraft used for the complementary data collection trials. These efforts and their practical implications will be discussed.

BIO

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Mr. Geiselman is a human factors researcher and program manager at the U.S. Air Force Research Laboratory where he specializes in visualization format design and evaluation for military applications. His primary research areas include human information processing, visual symbology development, imagery integration, and advanced data visualization design. His experience includes applied crew resource management process development, concept development, empirical evaluation, flight test, data analysis, findings reporting, formal presentation, airline operations, safety systems, and teaching. He has concentrated experience in the design and evaluation of pilot/vehicle interface concepts for tactical aviation applications as well as extensive experience utilizing flight simulation and airborne flight test for the purpose of operational evaluation. Mr. Geiselman is a pilot with approximately 7000 hours of flight experience.