Abstract: Comparing Situation Awareness for Two UAV Interface Approaches

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Our goal is to improve the design of human-UAV interaction so operators can have better situation awareness (SA) of conditions pertaining to the UAVs as well as the activities of distributed (human) team members. We began by performing ethnographic observations focusing on operators working with UAVs in military exercises. As a result, we developed a detailed definition of what it means for UAV teams to have SA. Also informed by the observations of UAV operators working with each other and the technologies given them, we developed a UAV interaction design approach that uses pre-loaded terrain data to augment real-time video data sensed by the UAVs (figure 1). We hypothesized that augmentation of the video in this manner would provide better SA than a video stream alone (figure 2). In particular, we hypothesized that this approach would improve the UAV SA component we identified as comprehension of "3D spatial relationships between the UAV and points on the earth."

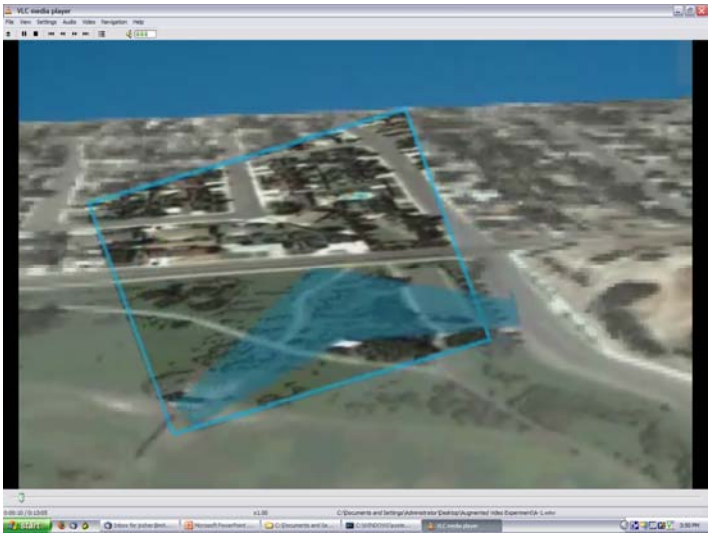

Figure 1: Augmented video presentation. The center of this screen shows a silhouette of the UAV from behind that changes attitude in real time as the aircraft flies through the virtual environment. The video display is in the inset box. The video is geo-referenced to the pre-loaded map data, meaning that it appears approximately on top of the map area to which it refers.

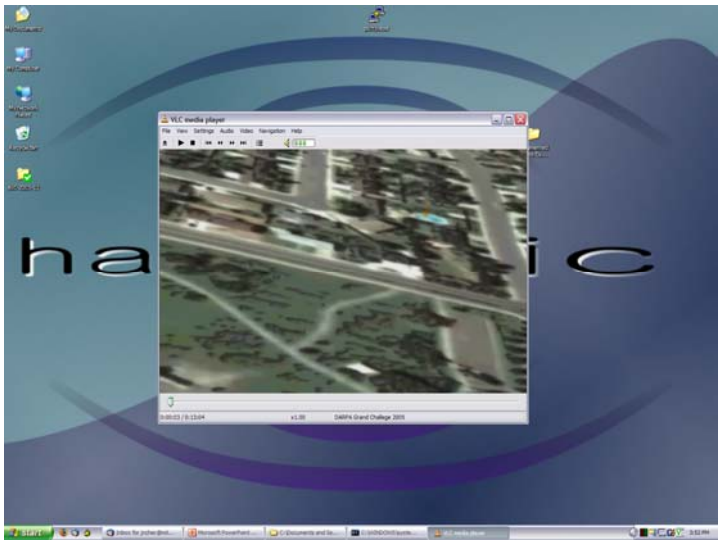

Figure 2: Non-augmented video presentation. The video is shown in a stationery window of the same size as the video presentation in the augmented display.

To test the hypothesis, we performed a counterbalanced within-subjects experiment in which the independent variable was video presentation approach. Experiment participants performed a search and rescue task in which they were asked to find lost hunters while the UAV flew autonomously between pre-loaded waypoints. They marked hunters' locations on a topographical map of a type often given to rural search-and-rescue workers. Each participant performed this task using both interfaces and we examined the differences in positional accuracy with one interface versus the other. By focusing on the differences, individuals' mapping capabilities were factored out. After our initial set of experiment participants, we found that participants were more accurate in hunter placement when using the augmented video interface versus the non-augmented interface (average of 22 millimeters versus 53 millimeters; $p<0.10$ using a paired, 2-tailed t-test with df=6). Also, participants preferred the use of the augmented video interface (6.25 vs. 1.25 on a Likert scale of 1 to 7; $p<0.002$).

Since hunters were stationery, our results point to an increase in comprehension of 3D spatial relationships between the UAV and points on the earth. Comments from experiment participants indicated that the additional context provided by the pre-loaded terrain data surrounding the video display contributed substantially to their enhanced understanding of where the hunters should be placed on the map. Accordingly, we are incorporating this video presentation approach in our current work designing multi-UAV control interfaces.