Challenges UAV operators face in maintaining spatial orientation

Leo Gugerty
Clemson University

Abstract

During extensive interviews with Predator UAV operators, we discovered a number of challenges that UAV operators face during flight (Gugerty, in press). This presentation will focus on challenges in maintaining spatial orientation. For example, operators reported difficulty using cardinal direction to identify target locations, e.g., in determining which location was east of a landmark. Also, DEMPC operators sometimes reported difficulty in telling the sensor operator which way to move the camera in order to view a target, especially when the UAV was headed towards the bottom of the map and 'right' and 'left' had to be reversed. Some operators reported that they received little formal training in these problems; instead they had to learn to solve them on the job. Spatial-orientation problems like this may be exacerbated in UAVs because of lessened visual, vestibular, and kinesthetic feedback. Research has shown that these kinds of feedback are important in maintaining spatial orientation (Klatzky, 1998).

We have collected extensive data, using controlled experiments and realistic simulation tasks, on how Air Force personnel solve spatial-orientation problems. Regarding the cardinal-direction-judgment problem, our data show that Air Force recruits find these problems fairly difficult (Gugerty & Brooks, 2001). In fact, the distribution of accuracy scores for recruits is bimodal, with a large group performing just above a chance, and another large group performing adequately. Also, performance is strongly affected by the orientation of the aircraft. When the aircraft is headed north, performance is accurate and quick; but when it is headed towards the south, accuracy decreases by 50% while response times double.

Thus, our research confirms UAV operators' reports that spatial orientation problems are difficult, and it suggests that operators need assistance in performing these tasks. Our research approach for providing this assistance has been to identify the strategies operators use to solve spatial orientation problems, and then to use these strategies to plan training and interface interventions. We have used both verbal-protocol and behavioral data, and both novices and experts, to investigate operators' strategies on the cardinal direction task (Gugerty, Brooks & Treadaway, in press). This research suggests than one common strategy used on this task is mental rotation, supporting findings of mental-rotation use in other spatial-orientation tasks (e.g., Aretz, 1991). However, we also identified another strategy that is more analytical and involves relatively little mental rotation. We called this strategy heading referencing, because it involves using a map heading as a reference in the 3D view.

Our understanding of operators' strategies on spatial-orientation problems is helping us design training and interface interventions. For example, heading referencing is a more step-by-step procedure than mental rotation, and it also involves less visualization of

complex scenes; thus it may be a more effective strategy to train than mental rotation. We are currently analyzing data on how eye-movements can be used to provide real-time diagnostic information about operator's strategies. Our next step is to use eye-movement-based diagnosis in a computer-based system to train strategies like heading referencing. Understanding operators' strategies also helps in designing better interfaces for maintaining spatial orientation. The mental-rotation and heading-referencing strategies map onto different interface features; i.e., a field-of-view wedge on the map, and a 3D ground-plane compass, respectively.

References

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