Evaluating Stereo Displays for Manual Control

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The current study was conducted to evaluate the relative benefits of stereo presentation versus higher update rates for controlling simulated vehicle motion. Visual displays are used to convey critical control information to pilots of aircraft and space vehicles. Recent developments in display technology enable the use of stereo displays, but these displays incur significant costs. In addition to increasing the complexity of system hardware and software, stereo necessarily decreases the spatial or temporal resolution of the display, since the two required fields (one for each eye) must be interlaced temporally or spatially. In the past, we developed analysis tools to examine which visual cues are required to support manual control tasks. This year, we applied this tool to determine whether stereo displays improved operators' control of motion in depth (as in a docking task), given that stereo halves the update rate of the display.

Our model of the depth control task is shown in Figure 1. We previously demonstrated that stereo disparity provides a more useful cue for position than for motion, Thus, we predicted that stereo would prove more useful when operators control vehicle rate (*i.e.,* change in position) than acceleration (*i.e.,* change in motion). In our experiments, pilots performed both kinds of control tasks while viewing either stereo or non-stereo displays at two different update rates.

We found that pilots performed significantly better with stereo on the rate-control task, but gained no benefit from stereo on the acceleration-control task. As can be seen in Figure 2, operators had smaller errors (as measured by depth rms) with stereo displays in the rate control task (top panel), but not in the acceleration control task (bottom panel). These findings validated our model's predictions and the utility of our analysis tools.

Our research provides an effective demonstration that the specification of critical visual cues is task specific. Thus, display designers need to consider the nature of the operators' task in order to make an intelligent selection of visual interface parameters. The design issue is not to determine whether or not stereoscopic displays are useful, but rather to determine where and when stereo provides control information more effectively than does other types of cues. Our analysis tools support such determinations, for stereo as well as other display parameters (e.g., update rate, resolution, contrast), enabling designers to optimize displays for specific missions.