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Systems That Work for Humans

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HUMAN FACTORS AND TRAINABILITY OF PILOTING A SIMULATED MICRO UNMANNED AERIAL VEHICLE

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In 2004, the U.S. Army Research Institute's (ARI) Simulator Systems Research Unit began studies involving the training requirements for operators of a micro-unmanned aerial vehicle (MAV). Our research involved the use of a touch-screen operator control interface developed for the DARPA MAV Advanced Technology Demonstration. This control system allowed operators to plan and run autonomous flight missions or to tele-operate a simulated MAV around a static synthetic environment. An initial study focused primarily on the usability of the system. Extensive heuristic evaluations were conducted by seven volunteers with backgrounds in human factors and military training systems. Each evaluator completed a self-paced training session including exercises that tested their ability to perform various control functions. Lack of immediate feedback from touch-screen inputs and missing or obscure status information formed the basis of several of the usability issues. Manually piloting the MAV presented the most difficulty to operators. As such, a second study was conducted that focused specifically on manual control tasks. In this study, participants were trained on manual control of the MAV, and then completed four increasingly difficult missions, requiring them to pilot the vehicle through the synthetic environment. This experiment was designed to compare the effect of supplemental sensor imagery on mission performance. During Study 1, operators could choose to view a sensor image taken from a fixed camera pointed 15 degrees below horizontal or straight down (90 degrees), but only one view was available at a time. During Study 2, operators were provided with three sensor views simultaneously. The 15-degree view was presented in a primary sensor window, and two additional views were displayed in smaller windows below it. The camera angle of one of these supplemental views was the manipulated independent variable – 30, 60, or 90 degrees from horizontal. The remaining window always contained an overhead satellite view (downward view from 5000 feet above the MAV). Data were collected on time to complete each mission, the number of physical interactions each user made with the interface, SME ratings, workload, and usability. Results indicated that mission requirements had a greater effect on performance and workload ratings than the camera angle of the supplemental view, though the camera angle of the supplemental view did affect mission time required to capture images of designated target buildings. Session averages of workload, usability, mission completion time, and SME rating were significantly inter-correlated. Higher SME ratings were associated with lower participant ratings of workload, shorter mission completion times, and higher usability ratings.

INTRODUCTION

With the movement toward a more automated Future Force, the U.S. military will become increasingly reliant on unmanned and robotic systems. One platform currently under development is a vertical-lift micro-unmanned aerial vehicle (MAV) that can be used for reconnaissance missions at the platoon level. Designed for use by dismounted infantry units, the portable MAV is small enough to be transported in a backpack and can be readily deployed in the field as needed. With prototypes already being field tested, there is currently a need to provide a more intuitive operator control interface that can be used by a non-specialist. In addition to refining the control interface, there is also a void in the area of training. At this time there is not an accepted training methodology for the operation of the MAV, so ultimately our research efforts should help establish future training standards in both live and simulated environments.

In April 2004, the U.S. Army Research Institute's Simulator Systems Research Unit received a prototype control system that can be used to pilot a simulated MAV within a synthetic natural terrain database. This prototype was developed by Northrop-Grumman for DARPA, and runs in conjunction with a MAV simulation engine developed by NASA-Ames. A laptop computer acts as the operator control unit (OCU), and a second laptop manages the simulation and synthetic environments. One unique aspect of this system is that it allows the operator to control the MAV by touching directly on a sensor image displayed within the control interface. Using the touch-screen for manual control, in theory, should be easier for a non-specialist to learn. In our initial study, participants learned how to operate the simulated MAV in both autonomous and manual modes and provided data on OCU usability. The study provided insight as to which portions of the control system were intuitive and easily trainable, and which areas need further development. After reviewing the results of the first study, it was evident that manual control posed the greatest difficulty for operators. As such, a second study was run that focused solely on manual control of the MAV. Demographic data were also collected during both studies and correlated with performance, with a focus on users with video game or remote control experience.

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