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Comparison Methodology for Robotic Operator Control Units

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ABSTRACT

Operator controls and interfaces for military unmanned systems are being developed and used in both laboratory and field research. These controls are considered to be an efficient method of controlling unmanned systems in tactical settings and scenarios. Performance comparisons of different controls and interfaces in differing tactical environments need further study. This paper proposes a methodology of evaluating two selected controls in a laboratory experiment.

The Advanced Robotics Simulations STO research being conducted at the Technology Development Center (TDC) at STRICOM and The Mounted Maneuver Battlespace Laboratory (MMBL) in Fort Knox, Kentucky is using two different control systems. Both are based upon the OneSAF Testbed Baseline (OTB). The first is a version of the OTB that has been extensively modified. Currently it is not instrumented and cannot log the user's actions to the button press level. Instrumenting the SAF would be a relatively straightforward exercise. The second, known as the Operator Control Unit (OCU), has been developed for Future Combat system Experimentation, is built on top of the OTB. The OCU has been instrumented to facilitate analysis. The OCU has the ability to send DIS (Distributed Interactive Simulation) PDUs (Package Data Units) to a logger.

Once fully instrumented, the two controllers would then be run in an exercise. The TDC and the MMBL both have capabilities where 20-30 OCUs and a comparable number of OTBSAF control stations could be utilized. Using the information from varying FCS scenarios an exercise will allow us the ability to analyze the user's actions and the corresponding results. Some of the questions to be examined include:

1) Compare survivability of robots controlled from different stations
2) Compare time to execute commands
3) Compare steps necessary to execute commands
4) When an interesting event happened (e.g. firefights, robot destroyed, etc.), and what actions preceded the event

This research would allow the user community to evaluate not only the effectiveness of the control stations, but in the future evaluate the effectiveness of the man-robot units and interactions.

KEYWORDS: Robot, Control, Compare, Evaluate

1. MEASURING ROBOTIC CONTROLS

There are many ways to measure human to robot controls in tactical scenarios. First you must decide the degree of fidelity for the robotic vehicles and their environment. This ranges from complete immersion in a real world scenario (the robot is in the field in an actual scenario e.g. war) to total simulation (the robot and its environment are modeled by computers.) The most accurate method would be to always test in real situations. Unfortunately that is prohibitive across numerous domains. The complexity of this is also intensified because many robotic systems are still in the design phase. For the purposes of this paper and this experiment we choose to simulate both the robotic vehicle and its environment with a modified version of OTBSAF and a under development experimental FCS OCU. This simulation tool is accurate enough in most battlefield scenarios. We will strive to make the measurements as objective as possible. Only certain aspects of the robotic controls will be measured. One problem that will not be addressed is the level of operator training. Obviously, a poorly trained operator will limit the use of the control unit, so we will assume that all the operators have been sufficiently trained on their control unit.

2. TEST FACILITY

The STRICOM TDC and the Mounted Maneuver Battlespace Laboratory in Fort Knox, Kentucky is the proposed facilities to conduct these experiments. Currently, both facilities have two ways of controlling simulated robotic vehicles at their respective sites – the OTBSAF controller and the FCS Operator Control Unit. Data will be collected with a logger which will record all Distributed Interactive Simulation messages including experimental Package Data Units for button presses from either controller and any communications between the Operator Control Unit and robotic platforms.

2.1 OTBSAF Controller

The first is with an extensively modified version of OTBSAF 1.0. The mechanism for controlling vehicles with this tool has not been changed from the OTBSAF 1.0 baseline. Feedback from controlled vehicles is through a two dimensional tactical map which displays friendly and other known vehicles' status. This version of OTBSAF has not been fully instrumented for button presses, but doing so will be necessary before it can be used for this exercise.

2.2 FCS Operator Control Unit

The second way for controlling robots is with the Operator Control Unit developed for the Mounted Maneuver Battle Laboratory. The Operator Control Unit is a further modified version of OTBSAF 1.0. This tool was designed to simplify many of the user's choices during combat, but still allow flexibility in the system. The Operator Control Unit was also designed to control all robotic entities in the Future Combat System. Feedback from controlled vehicles is through a tactical map as before and with realistic images from sensors on the robotic platform. There have been exercises with more than twenty Operator Control Units in use at the same time. It has been completely instrumented down to the button press level.

3. EXERCISE QUESTIONS

The experiment to be conducted at the TDC and Mounted Maneuver Battlespace Laboratory facilities is proposed to be on up to thirty OCUs and a comparable number of OTBSAF control stations. The same scenarios will be performed with only the robotic control station being different at the start. After the selected scenarios have been completed the information collected by the data logger can be analyzed.

3.1 Mission Success

The most basic question to ask is which robotic controller had the highest success rate for its robots completing their assigned missions.

This may be a difficult problem to solve because of the varying mission types and characteristics of the robots. Scout vehicles may be evaluated on the percentage of enemy vehicles identified or the stealthy ness of how they conducted their mission. Direct fire robots may be evaluated on the amount of enemy vehicles disabled and or destroyed. The mission success for other types of robots (re-supply, engineer) can be assessed in comparable manner.

3.2 Platform Survivability

The next evaluation criteria are which robotic controller allow for the highest survival rate for its robots. The meaning of "survival" must be discussed. Does survival mean the robot is 100% functional or that it still has some use to the controller? A control station that consistently has more platforms completely functional at the end of the exercise must be given more credit than one that has more robots partially disabled (movement impaired, sensors destroyed, etc.)

3.3 Executing Commands

Several ways will be used to evaluate the tasking of vehicles from the control stations. Since the control stations will be completely instrumented, either the time it takes or the number of steps required to complete the command will be captured. Another interesting question currently being posed is what will the number of platforms destroyed be while the user was trying to do other tasks or had their attention diverted to another task and was it significantly different between types of control stations.

4. KNOWLEDGE GAINED

If the appropriate scenarios are conducted and the correct questions are asked and evaluated, the effectiveness of the robotic control requirements can be assessed and evaluated. This method is not limited to the OTBSAF control station and the Operator Control Unit. Other control stations can be integrated into this environment. The Demo III Operator Control Unit was previously used in the Mounted Maneuver Battlespace Laboratory simulated environment to train soldiers before controlling actual robots in the field. An effort to make the messages of the current Operator Control Unit both JAUGS and 4D-RCS compliant is being discussed. This would enable integration of another JAUGS or 4D-RCS compliant controllers with minimal effort. In the future with a consistent method to evaluate measure and asses robotic control stations, the encompassing problem of evaluating the man-robot unit and their interactions can be addressed.