An Augmented Virtuality Display for Improving UAV Usability[1]

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Unmanned Air Vehicles (UAVs) promise to change the way we think about aircraft and airspace and they are being used in many different environments; everything from entertainment to search and rescue operations. One thing common amongst the different UAV platforms is that all use very difficult user interfaces. These interfaces have been designed by engineers and roboticists who do not have training in incorporating the needs of end users. This research involves developing an innovative interface for UAVs that improves situation awareness for the user and demonstrating its effectiveness.

Existing UAV interfaces are almost always targeted towards experienced pilots, engineers, or someone who is an expert in both of those fields. The result is interfaces which are confusing and difficult to use for someone who isn't an expert in these areas.

The UAV pilot's interface is usually just a copy of an aircraft cockpit presented to the user. For someone with a great deal of experience looking at the various dials and gauges this can be helpful, but the experience of flying a UAV is not completely analogous to flying a manned aircraft, which involves associating the feeling of flight to the controls. When flying a UAV there is no feedback in the user's body to indicate what is happening with the aircraft, which makes it difficult to understand what the aircraft is doing.

In contrast to a pilot, an engineer who is developing and troubleshooting the UAV and its interface needs access to different elements of the aircraft's status, such as the status of the internal computer, tuning parameters, and servo positions. These elements are usually displayed in a list or a table. Once the aircraft can fly, this information is no longer as important and its presence in the display causes unnecessary complexity for UAV pilots.

Because UAVs have been relatively scarce assets, requiring the users to be experienced pilots or engineers has not been a significant problem in the past. However, an increasing number of UAV operators, particularly for small UAVs, are neither pilots nor engineers. Further, the lack of personnel with technical skills fundamentally limits the utility of UAVs unless their interfaces become more readily usable by a wider segment of the population. What is needed is an interface that allows the non-technical user to quickly understand the status of the aircraft and its surroundings. Such an interface would allow UAVs to be used on a much broader scale.

When approaching a new system, people construct a mental model regarding how it works. Mental models are often formed with the aid of metaphors such as that of the

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manned aircraft cockpit. For a more universally-understood metaphor, we have turned to virtual environments of the type represented in video games. Many of the people who have the need to fly UAVs (such as military personnel) have experience with playing video games. They are skilled in navigating virtual environments and maintaining situation awareness in these environments. A user interface that takes advantage of this experience should facilitate better performance among non-technical users with less training than is needed for existing systems.

"Augmented Virtuality" allows us to create just such an interface. We have created a virtual world using terrain information and photographs of the area in which the operator wishes to fly the UAV. This world is then augmented with information from reality, which in this case is video data from an on-board camera. The position and orientation of an avatar for the UAV is plotted in the virtual world exactly where it is in the real world. The avatar changes its orientation as the aircraft banks, climbs, and dives in the real world. The camera feed from the UAV is fed into this virtual world and gives a glimpse at what is occurring in real time.

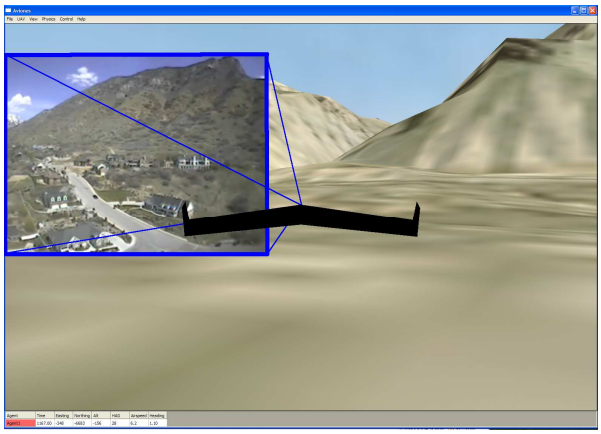

Figure 1: Screenshot from the new interface. Here you can see how the live video image is superimposed on the virtual world.

Another aspect of tailoring the interface to those with video game experience is to use familiar controls. Microsoft has developed a popular and versatile human input device for use with their XBox® video game console. We are using the XBox controller to map the necessary flight controls to buttons or the joysticks. This mapping allows the system to be controlled without requiring the use of the keyboard or searching through menus.

To demonstrate that this new interface is successful in improving the situation awareness of a non-technical user, we are planning two experiments. These experiments will measure the effectiveness of the interface both qualitatively and quantitatively. In the first experiment, we will observe participants' performance to identify issues with using a commercially-available interface versus the Augmented Virtuality interface for controlling the same UAV. Besides qualitative performance observations, we will take measures that have been derived from a detailed definition of situation awareness. After conducting the first experiment in simulation, the second experiment will be carried out on a smaller scale using real UAVs to verify the results.