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Autonomy, Situational Awareness, and the User Interface — Part 1

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Autonomy is coming

The US Army has announced plans to increase the autonomy of its Unmanned Ground Vehicles (UGVs). "We are moving along that spectrum from tele-operating to semi-autonomy where you can send a robot from point A to point B without any intervention," said U.S. Marine Corps Lt. Col. David Thompson, project manager with the Robotic Systems Joint Program Office (Army building smarter robots).

This should not come as a surprise to anybody. Conventional thinking has held that increased autonomy for all unmanned systems, not just UGVs, will reduce operator workload and allow robots to fulfill their promise of force multiplication.

Situational awareness

Tele-operation, the most widespread method currently employed for control of unmanned systems, relies solely on a human operator's cognitive abilities to navigate in extremely dynamic and complex environments. Increased autonomy requires that unmanned systems adopt similar cognitive capacities, including greater situational awareness. Situational awareness can be regarded as involving three-stages:

1. Sensory input – Information is collected from the environment
2. Perception– Assignment of significance to the perceived information.
3. Response– Using the acquired information to make a decision or formulate a plan.

In Stage One, a UGV receives the visual image of an object. During Stage Two, the UGV decides what the object is. Is it a rock, a bomb, or a child? In this example, let's say it's a rock. In Stage Three, the UGV plans whether or not to go over the rock or around it as well as what mechanical operations are necessary to complete this task.

In general, tele-operation relies on the situational awareness of the human operator, and assumes zero situational awareness and autonomy for the unmanned system. At the other end of the spectrum, a fully autonomous robot will have highly developed situational awareness, while the human operator, in theory, will require correspondingly less.

In practice this relationship is more complex. The situational awareness of the human operator and unmanned system can be interdependent, while the level of a robot's autonomy may fluctuate during any given mission. Furthermore, the nature and level of human interaction will be dictated by the operator's confidence in the unmanned system's situational awareness as well as the reliability of the information it provides.

Canine autonomy

To use a commonly employed metaphor, think of unmanned systems as dogs. Dogs are useful for hunting because of their keen smell and hearing, i.e. good situational awareness. Clearly, it is more advantageous to not use a leash (tele-operation) and let the dogs run freely (autonomy), because of the reduced effort of the hunter physically controlling the dogs and the greater area that can be covered (improved mission success). However, the hunter must have faith in the dogs abilities, monitor them carefully (both visually and audibly) and from time to time, rein them in (reduce their autonomy). For example, if he hears a dog barking, he must interpret the sound to know if a prey is located, the dog is in trouble, or if the dog is just yapping for no reason at all. Similarly, the operator of an unmanned system must evaluate incoming data as well as the appropriateness of the system's autonomous behaviors.

The above scenario contradicts the notion that that autonomy will necessarily reduce the operator's need for situational awareness and system understanding. Unleashing the dogs will diminish the hunter's physical workload, but it may increase his need to monitory sensory cues (maintain greater operator sensory awareness).

Increased autonomy equals increased data

Another possible issue with increased autonomy will be management of data. Increasing autonomy may not necessarily lessen the operator's workload. If autonomy is used to support force multiplication, this could lead to a significant increase of data. In fact, as autonomous systems gather more and more information, the workload demands on the individual human who must analyze this data may increase dramatically. Granted, most of the increased data will be filtered out from the operator, but even a small increase could have negative consequences.

As reported in a recent New York Times article, In New Military, Data Overload Can Be Deadly, the military is already suffering from information overload. The article described the inability of humans to track and process the tsunami of data gathered by UAVs and other means of surveillance. One memorable statistic stated that since 9/11, new technologies have increased the amount of intelligence by "1,600 percent." The New

York Times described an incident, in which a crucial piece of data was overlooked, and, as a result, 23 civilians were inadvertently killed.

Will the possible increase in data with autonomous systems make the overload problem worse? Is there a possibility that increased autonomy of unmanned systems will actually make their operation more difficult? Could it be that human, not technological, limitations will be the greatest barrier to autonomy?

In Part Two of this series, we will discuss these questions with a recognized authority on situational awareness and autonomy, David Bruemmer, Vice President of Research & Development at 5D Robotics.