

## **War and depth: Why your battlefield robot needs 3D**

William Finn, AMREL Senior Copywriter & Editor

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### **View to a war**

One way that modern warfare mirrors contemporary life is the dependence on Video Display Terminals. All of us have heard stories of warfighters remotely operating unmanned systems while staring at flickering images on computer monitors. Even manned vehicles are sometimes driven by personnel who use computer screens, so as not to expose themselves to hostile fire.

### **Depth perception**

Ordinary computer displays lack depth perception, a key source of visual information. This may not matter in many situations, but it does adversely affect the operator's ability to navigate dense, cluttered areas as well as their performance of delicate work, such as manipulating Improvised Explosive Devices (IED).

In nature, "depth perception" relies on parallax, convergence, shadows, textures and a host of other cues. A singularly important factor for three-dimensional vision is stereopsis. Stereopsis is the process of perceiving depth through binocular disparity, i.e. the mental fusion of two slightly dissimilar images produced by two different eyes.

### **Stereopsis technology**

Technology that uses stereopsis to create three-dimensional images dates back to Victorian times. In the modern era, stereopsis principles are utilized in theaters for 3-D movies. Since stereopsis imaging provides cues to depth perception for grayscale images with bad contrast, it was used during the Second World War for the analysis of aerial photographs.

### **3D warfighting**

A major goal of contemporary military applications is to use stereopsis to enhance visualization, including interpretation of complex scenes. Also, 3D imaging improves the ability to manipulate objects, as well as remote and non-remote operation of vehicles.

Military applications of stereopsis technology must improve depth perception while at the same time:

- Not degrade or interfere with other important visual cues
- Possess a small form factor (low weight and power consumption)
- Integrate into existing two-dimensional monitors as well as other legacy equipment

- Minimize impact to existing communication and video channels
- Not cause eye strain and headaches (afflictions experienced by some unlucky theater goers viewing conventional 3-D movies)

### **Modern 3D military applications**

Stereopsis for 3D imaging was applied to the Fox M93A1 Nuclear, Biological, and Chemical Reconnaissance System (NBCRS). This lightly armored vehicle has windows that are vulnerable to NBC warfare agents, so the crew drives the Fox with the assistance of a computer monitor from inside a shielded compartment. For this application, [Polaris Sensor Technologies](#) developed a patented 3D solution that successfully meets the requirements listed above. In addition to the Fox, this solution has been successfully used as a Driver's Vision Enhancer for a Navy crane, and for teleoperation of the Talon Unmanned Ground Vehicle (UGV).

### **The 3D advantage**

The advantage of 3D imaging for remotely operating a UGV was explained by David Chenault, President of Polaris. "With 3D, an experienced UGV operator could look down at a guardrail and tell if an object is on it. Without 3D, he would have to drive down the road in order to find out."

Dr. Chenault described the task of picking up a soda bottle, simple for a human hand, but challenging for a robot end-effector. "On a mission, success was defined by picking up object within 3 attempts," said Chenault. "With standard 2D vision, the success rate was 60%. With our 3D solution, the success rate was 100%"

A 2008 demonstration further confirmed the efficacy of 3D. 79% of Talon operators reported that 3D visualization system greatly improved their performance in manipulating a robot.

### **Polaris solution**

The Polaris solution is comprised of three basic elements:

- 1) Display or 3D computer (AMREL computers are used, since they are standard for Operator Control Units for unmanned systems)
- 2) Source of 3D, i.e. a stereo camera (Both day TV and infrared stereo cameras are made by Polaris)
- 3) Ballistic eyewear

This solution uses polarization to create distinct images, as opposed to color differences, which is commonly used in 3D movies. One image has light polarized perpendicularly with respect to the other image.

Polarization allows for natural color as well as reduced eyestrain and headaches. It is also compatible with night vision glasses, and can be used in the infra-red range. The glasses for the military are more expensive but provide the same ballistic eye protection as the regular protective eyewear. "Why give soldiers something less safe?" Dr. Chenault asks rhetorically.

### **Three dimensional worlds**

One intriguing capability of this solution is its ability to create a 3D world within the computer that accurately preserves spatial relationships. This allows the operator to backup the UGV, while fully visualizing the area behind him, even if the stereo cameras are facing forward. If the operator chooses to do so, he can even view a Computer Generated Image of the UGV on the screen in a full 3D environment. He can then visualize the vehicles relationship to nearby objects, which may not be within the cameras immediate field of vision.

### **Trust your robot**

Proposed applications for 3D imaging include improving situational awareness, mission rehearsal, mission planning, and training. Its ability to improve Human Robot Interaction may become more significant as autonomy increases for unmanned systems. As described in [Autonomy, Situational Awareness, and the User Interface — Part 2](#), "...if appropriate interfaces are not designed, human operators may experience greater frustration and less trust with vehicles as they become more autonomous. The lack of transparency in the robot's motivations can be confusing."

This lack of trust was illustrated by a story of a semi-autonomous UGV that refused to go through a door, despite the human operator's repeated instructions to do so. On closer inspection, the door was too small for the robot, a spatial relationship that was not revealed on the operator's 2D monitor. Very simply, the human was operating in a 2D world, while the robot was in a 3D one. With 3D imaging solutions, such as the one provided by Polaris Sensor Technologies, man and machine can operate in the same world.

*For information about 3D solutions, visit [www.polarissensor.com](http://www.polarissensor.com) or call David B. Chenault, Ph.D. at (256) 562-0087 ext 2436.*

*To learn about advance OCU solutions, visit [www.commoncontrolnow.com](http://www.commoncontrolnow.com) or call Mike Castillo, Senior Applications Architect for Robotics at AMREL at (626) 443-6818 ext 190.*