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## Navy Researchers Use Nano-Robots to Build Minuscule Sensors

*By Cynthia Greenwood*

With an eye trained on combating terrorism overseas and other vital missions, researchers working for the Office of Naval Research (ONR) have pioneered a process for constructing ultra-small sensors using nano-robot fabrication. Such infrared (IR) cameras would be tiny enough to fit on a mini-unmanned aerial vehicle (UAV) without cryogenic cooling, ONR officials reported.

Harold Szu, Research Physicist at ONR, spearheaded the process with James Buss, an ONR program manager, and Xi Ning, Professor of Electrical and Computer Engineering at Michigan State University.

To improve the ability of aircraft carrier strike groups to detect enemy missiles over the horizon, the Navy is searching for ways to enhance its surveillance capabilities using covert mini-UAVs. These vehicles are as small as a model airplane or a table top and are undetectable by satellite. Equipped with such passive sensors, the UAVs could cruise near the ocean surface at slow speeds for many hours and relay information back to the ship. The sensors would allow the Navy to protect multibillion-dollar U.S. aircraft carriers and thousands of sailors.

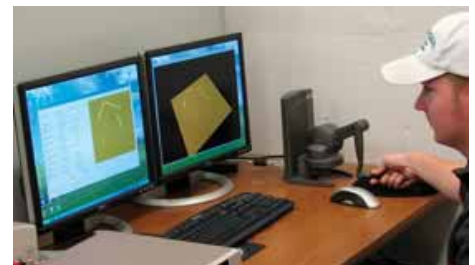
The tiny camera would be built using an atomic force microscope and an automated computer controller. A system operator would manipulate non-sized contact points remotely to construct the pixel elements that form the sensor's heart, Szu explained. "Each pixel will be composed of carbon nanotubes, which have nanoscale diameters and submicron lengths," he said.

The proposed camera offers advantages over a full-sized digital alternative. "One of the salient features distinguishing a missile plume from flare camouflage is the unique characteristics of a plume's IR signature, especially in the mid-IR spectrum," Szu said. "The proposed camera improves upon a full-sized, mid-IR spectrum camera because the signal-to-noise ratio of the latter's conventional IR-detector array requires liquid cryogenic cooling, a bulky technology unsuited for mini-UAVs. The minuscule camera uses electrical cooling, and would be one-tenth the price, weight, and size of a conventional camera."

"We believe that the next key step is to invest in the computer-aided design toolkit that would integrate the quantum mechanics, electronics, and biomimetics for the nano-robot," Szu contended. "The key to such discovery is a visionary leadership armed with about \$10 million per year over three years, leading the way to numerous applications."



*The ONR's proposed tiny infrared camera would ride on a 1-m-long, unmanned aerial vehicle to enhance surveillance powers of aircraft carriers such as the USS Enterprise. Photo by Kristopher Wilson, courtesy of U.S. Navy.*



*An operator interacts with the augmented reality interface portion of a nano-robotic manipulation system. Photo courtesy of Office of Naval Research.*

Szu foresees the possibility someday of using dual IR color, nano-pixel cameras built by the nano-robot to detect coating disbondment or corrosion on aircraft or ships. "Passive infrared spectrum imaging could reveal the inhomogeneous, heat-transport abnormality of a coating's internal layers, for example," he said.

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