CAN YOU SEE ME NOW?

Phase Sensitive Innovations' novel imaging technology sees through the fog

Getting shot down isn't the only threat faced by helicopter pilots flying in combat zones. In certain environments, the elements can be as dangerous as the enemy.

In Iraq and Afghanistan, for instance, the thick dust created when a helicopter hovers close to the ground can cause even experienced pilots to crash. Degraded visuals sometimes lead to controlled flight into terrain (CFIT), an accident scenario in which an aircraft, under pilot control, is unintentionally flown into an obstacle. In a CFIT situation, the pilot and crew are unaware of the imminent disaster until it is too late.

During recent wartime operations in desert theaters, the potential for CFIT necessitated that countless missions be modified. Operations that may have required the delivery of 100 marines into a contested area had to be adjusted because the helicopter could only handle 30 to 50 personnel in one transport. Due to dust clouds and the resulting lack of visibility, called "brownout" conditions, the pilot would have to wait for the air to clear, or do a second personnel drop in another area. Both options put soldiers at considerable risk.

In the late 1990s and early 2000s, a small group of researchers at the University of Delaware tried to solve the problem. Fortuitously, they were already working on a Defense Advanced Research Projects Agency (DARPA) funded millimeter-wave imaging project. Their goal was to identify frequencies of interest to the military. Situated between the microwave and infrared section of the electromagnetic spectrum, millimeter waves are electromagnetic radiation with wavelengths in the range of 10mm to 1mm (with corresponding frequencies of 30 to 300GHz). However, without electronic components that could generate or receive millimeter waves, this range of the spectrum was largely unused and represented a treasure chest of new opportunity.

"It was all about understanding what you see in these frequencies. The goal was to create a detector for passive imaging—basically a cross between radar and camera that can see in the dark without any light bulbs or transmitters. Imagine an infrared camera but with longer waves, so it can see through things," said Dennis Prather, now President of Phase Sensitive Innovations (PSI).

Leveraging their work, the university research group eventually formed PSI in order to respond to a Small Business Innovation Research (SBIR) solicitation from the U.S. Navy. The initial objective was to create a device to see through blowing sand. "The Navy wanted to see what things look like in those frequencies," Prather said. "Mechanical scan systems had been the state of the art until then. But they are big, heavy, and bulky. Size, weight, and power (SWaP) matter. The old technology, at hundreds of pounds, is not low SWaP and it could not be widely deployed on military platforms. Our approach is very different. We have low SWaP and better performance. To do this, we had to invent the devices that make the system work."

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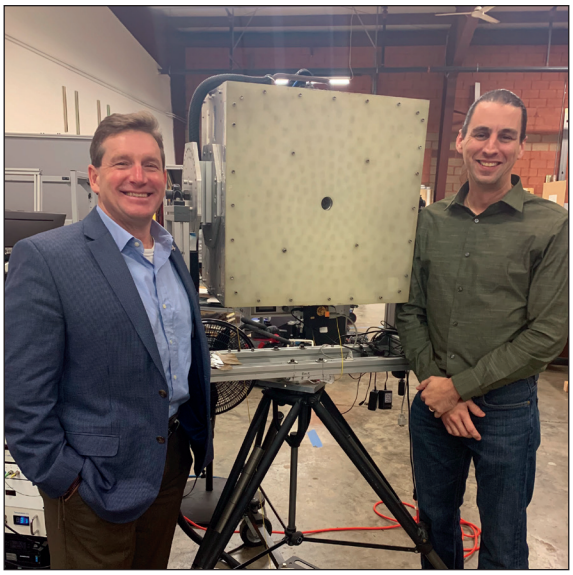
According to Chris Schuetz, chief technology officer of PSI, four teams proposed an idea. PSI and one other received Phase I SBIR contracts. "Most technology developments over the last two decades have been improved by fiber optics, which is one of the lowest-loss transmission mediums known to man. We said, if we are going to look at signals in the millimeter wave spectrum, we need to turn them into light first, and then use fiber optics to route and transmit the light."

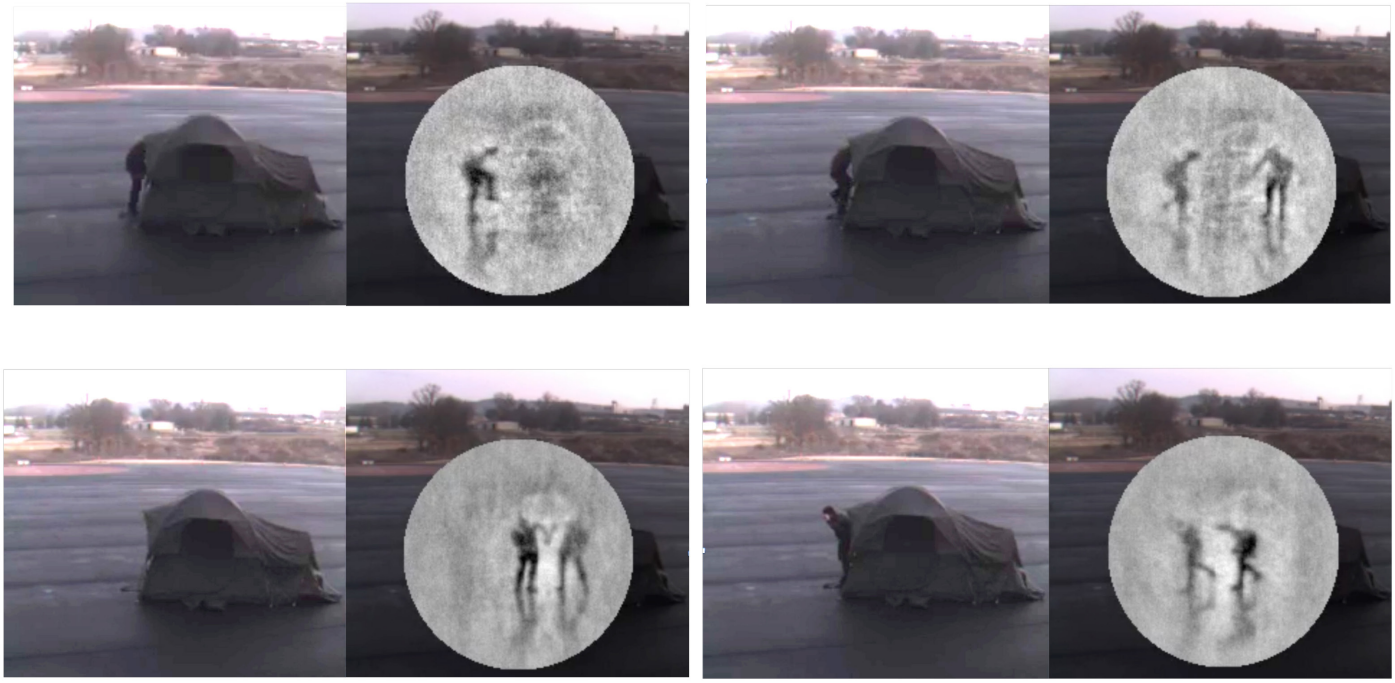
In order to do that, the company needed to create devices that encoded the technology about 3 to 4 times faster. On the way to achieving their objectives, PSI thus made the world's fastest optical modulators. The technology can encode signals over any radio frequency band, turn it into light, and route it using low-loss fibers. This development allowed the company to build an array of antennas that enable real-time video millimeter wave imagers, which is exactly what the military wanted. Schuetz added that the "idea was conceived in 2001 on a napkin. It has been successfully demonstrated on a helicopter and is now in the final stages of commercialization. It has been an amazing ride."

Prather further explained, "Our technological breakthrough offers a whole different way of seeing the world." Millimeter-wave technology allows the user to see through darkness, dust, smoke, clothes, plywood, tarps, tents, snow, and smog, to name a few. An especially attractive and unique feature of PSI's system is that it is not an active system, meaning it does not illuminate the scene. Rather, it visualizes passive signals from the environment similar to an infrared imaging system, which is important for avoiding detection from other sources —a key capability for military countermeasures.



Dennis Prather, left, and Chris Schuetz, with a passive millimeter wave imaging system built by PSI.

PSI has received a number of Department of Defense (DoD) Phase II SBIR contracts to continue work on the imaging technology. "If I can see things in a different part of the spectrum that allows me to see through things, I can use it for a host of other applications," said Prather. "For example, person-borne improvised explosive devices (PBIED). We can monitor a public gathering



The imaging technology developed by Phase Sensitive Innovations has a number of applications, including persistent surveillance.

and see people from a distance to determine if they are a threat to the greater population. In this way, it can be used as a persistent surveillance tool." Prather went on to explain a critical element of the technology, using airport security as an example. "That is considered a 'cooperative environment' where people voluntarily comply with security screenings. But what if we are considering 'uncooperative environments,' such as people intending to do harm? It turns out if someone has a concealed object, we can see that really well." Prather imagined a scenario in which the Las Vegas Mandalay Bay hotel entrance might have been equipped with his technology on that fateful day in October, 2017. Law enforcement would have been able to implement countermeasures the moment the gunman entered the building with firearms in his golf bag. Fifty-eight lives might have been spared.

The largest impact of the technology is still to come. Since it is composed of unique proprietary parts and not off-the-shelf components, PSI is necessarily ramping up its manufacturing capability to meet expected demand. In partnership with the Office of Secretary of Defense, Manufacturing Technology (OSD, ManTech), PSI is building out a 15,000 square foot state-of-the-art manufacturing facility under a SBIR Phase III effort.

Reflecting on their success, Prather remarked, "The SBIR program gave rise to the birth of our company and kept us from going out of business when times were lean. And it has allowed us to develop the technology for manufacturing. This capability would not exist otherwise, period. Considering the money invested, the return is enormous."

For the helicopter pilot who only has half a second to determine what is around him, PSI's technology is more than a return on investment, it is a life saver.

Phase Sensitive Innovations

Modernization Priority: General Warfighting Requirements (GWR)

Newark, DE • SBIR contract: N00024-11-C-4195 • Agency: Navy • Topic: N092-133, EW Countermeasures Against Passive MMW Sensors