Research may yield more compact antennas for military use

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(PhysOrg.com) -- While tall, bulky antennas seem like relics in an era of sleek, modern smartphones, they're still an unfortunate necessity for American soldiers.

"One of the problems that many military communications systems have is that they use low frequencies — anywhere from 2 MHz to below 1 GHz," says Nader Behdad, an assistant professor of electrical and computer engineering at the University of Wisconsin-Madison. "As a result, very often you see huge antennas sticking off of their vehicles."

Behdad thinks that those enormous antennas could be scrapped for low-profile, broadband antennas — thanks to a different approach to antenna design that replaces large dipole antennas with a more compact and conformal multi-mode radiator.

The Office of Naval Research agreed, giving Behdad a three-year, $510,000 research award through its young-investigator program, allowing him to develop the next generation of antennas for its vehicles.

With traditional dipole antennas, the lower the operating frequency of an antenna, the larger it needs to be. Rather than fighting the laws of physics and trying to lower the operating frequency of a single antenna, Behdad's concept involves tuning multiple parts of the same antenna structure to radiate at different frequencies, using synthetic "metamaterials" to shape their radiation patterns so that they won't interfere with one another. Composed of metals, dielectrics and other

materials, metamaterials react to electromagnetic waves differently, based on their index of refraction, making it possible to manipulate two competing radiation patterns and make them work in tandem within one antenna.

Behdad estimates that an antenna with dimensions of 20-by-20-by-3 centimeters could operate anywhere between 200MHz and 40GHz in a design that could be flush with the vehicle's surface. That combination of small size and a wide band of available frequencies makes Behdad's antenna design ideal for future military communications platforms, which will involve small and large devices operating over a wide range of frequencies.

But the implications for the military are even more important than preparing for a more connected future: Eliminating the large antennas from their communications equipment could also make U.S. soldiers safer.

"If you have something like a huge antenna sticking out of a soldier, it paints a pretty big target on them as they walk in the street," says Behdad.

Despite its very specific end goal, Behdad's project has much broader commercial implications. "Any wireless application that uses different, widely varying frequency bands could potentially benefit from this technology," he says.

Ultra-wideband wireless technology — which could power the next generation of wireless video and data connections for personal computers — could benefit greatly from the technology, as could telecommunications companies that will be looking for ways to best use the low-frequency bands that were vacated in the changeover to digital television.

Giving up those tiny, sleek smartphones for bulky UWB antennas isn't especially palatable for consumers, and Behdad's antenna concept could be the answer to a coming design problem in the cellphone industry. "

"If you want to have a cell phone that works in these frequencies of 600 MHz or 300MHz, having compact antennas that are broadband would be useful," he says.

Provided by University of Wisconsin-Madison