AFRL ENGINEERS PUT NEW SPIN ON OLD CONCEPT FOR PATENTED BREAKTHROUGH

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WRIGHT-PATT AFB, OHIO – Making communication easier for the warfighter while also having commercial viability is the overall idea behind an invention recently patented by two Air Force Research Laboratory (AFRL) engineers. Carl Pfeiffer and Thomas Steffen of the Sensors Directorate (RY) have developed a device that appears simple in nature but has the ability to convert linear polarized antenna arrays into circularly polarized antennas. The device is called a Linear-To-Circular Polarizer (United States Patent Office #11,283,142).

"The vast majority of antennas are linearly polarized. This device is a structure you can put in front of any linearly polarized antenna and the output will be circularly polarized," Pfeiffer explained. "This is important because it is generally easier to design linearly polarized antennas than circularly polarized antennas. Therefore, this device allows users to retrofit previously built linearly polarized antennas for circular polarization."

Circular polarization is used for many applications and isn't dependent on a particular orientation. Circularly polarized antennas maintain communication while rotating, which the engineers say would be helpful on aerial platforms that don't always fly level with the ground. However, linearly polarized antennas need to be properly aligned to be useful.

"If you don't know what the orientation of two linearly polarized antennas are going to be, such as on an aircraft, you can get very low signal strengths," Pfeiffer said.

Pfeiffer and Steffen built this idea from a previous patent on which they had been working; Millimeter wave, wideband, wide scan phased array architecture for radiating circular polarization at high power levels (United States Patent Office #10,547,117).

"The whole point of the other patent was it described a particular combination using an antenna with this structure we developed. We developed this concept to use a linearly polarized antenna array that operates at millimeter wave frequencies (between 20 GHz and 60 GHz) – basically the 5G frequency band," Pfeiffer began. "It's challenging to make these antennas for Department of Defense (DoD) applications that are at these frequencies. So, we said we're going to simplify the antenna design by making it linearly polarized. Then we can slap our invention on top of it and we can radiate circularly polarized."

The two engineers combined their backgrounds – Pfeiffer pulling from his experience in designing surfaces that controlled or modified electromagnetic waves and Steffen using his device fabrication experience – to produce the prototype.

Pfeiffer compared the concept to polarized sunglasses. The light that we see has a polarization associated with it. When light bounces off objects, it usually has a particular polarization. The glasses work with linear polarization, which stays in a straight line, to decrease the glare reflected from surfaces.

“Our application works with electrical polarization that is circularly polarized. Circular polarization is useful if you have two circularly polarized antennas because its orientation doesn’t make a difference. If you have two linearly polarized antennas and their orientations are crossed, they can’t talk to each other,” Pfeiffer said.

Though Pfeiffer says this concept isn’t new, he says the real breakthrough with this device is its wide bandwidth ability compared to earlier devices of the like.

“This means you can have a signal structure that operates from 17 to 65 gigahertz. Your cellphone has many antennas, and they all operate at different bands. There’s talking on your phone versus the GPS signal versus all sorts of other things. So, you need lots of different antennas to operate over different bands. The real novelty here, especially for the DoD, is that we care about doing things over as much of the spectrum as we can, we just want a single antenna that can cover the whole thing,” he said.

Aside from allowing for easier communication in various situations, the engineers also see this benefiting the warfighter in other applications such as radar imaging. Commercially, the duo believes this device would work well with 5G technology for high data rate applications.

“There are several different bands within the 5G band. They also need a wide bandwidth. Instead of using separate antennas for 5G, you’d just have a single antenna with our structure that makes it circularly polarized,” Pfeiffer said.

United States Patent Office #11,283,142

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