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Georgia Institute of Technology
Research Communications Office
Atlanta, Georgia 30332-0800
404•894•3444

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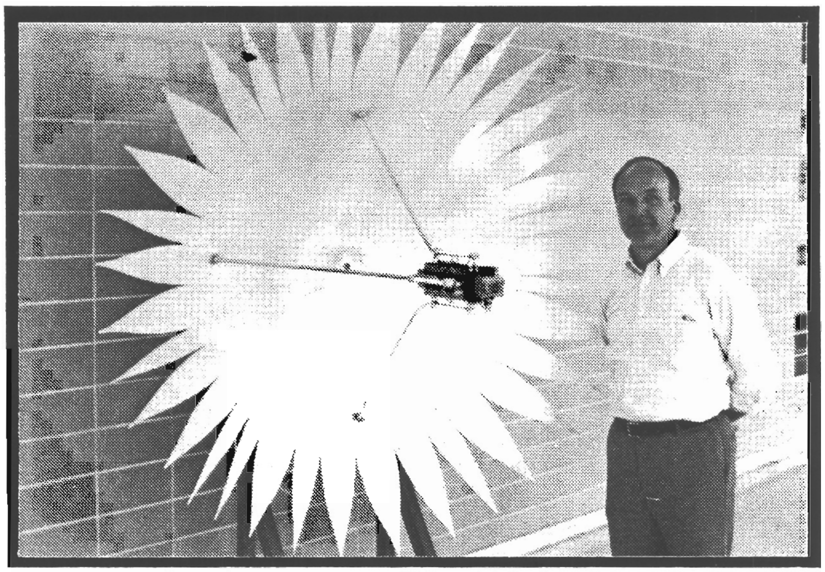
"FLOWER PETAL" EDGE IMPROVES PERFORMANCE OF RADAR, COMMUNICATIONS & SATELLITE DISHES, REDUCING SIDELOBE RADIATION & INTERFERENCE

Radar, telecommunications and satellite dishes of the future may look a lot more like creations of Mother Nature, thanks to the work of electrical engineers at the Georgia Institute of Technology. The researchers have found that adding serrations shaped like flower petals to the outer edges of the dishes can significantly improve their performance.

The serrations gradually reduce the electrical fields reflected at the edges of the dishes, explained Dr. Edward B. Joy, professor of electrical engineering at Georgia Tech. Tapering the fields reduces unwanted "sidelobe" radiation and improves control over the resulting signals.



Dr. Edward Joy shows antenna dish which has been given an edge treatment with non-uniform serrations. The serrations improve the antenna's performance. (Color/B&W Available)

Reducing the sidelobe radiation -- energy unintentionally scattered by the dishes -- minimizes the chance that antennas will interfere with each other or send signals in undesired directions. Sidelobe interference, Joy noted, could be a problem for future telecommunications satellites, which will be placed much closer together in geosynchronous orbit.

The flower petal design was incorporated in an outdoor compact range recently built for the U.S. Army's Electronic Proving Grounds at Fort Huachuca, Arizona. At least one manufacturer of compact antenna ranges has already adopted the technology, developed with support from the U.S. Joint Services Electronics Program (JSEP).

FOR MORE INFORMATION:

ASSISTANCE/PHOTO: John Toon/Lea McLees, (404) 894-3444
RESEARCHER: Dr. Edward Joy, (404) 894-2936
WRITER: John Toon

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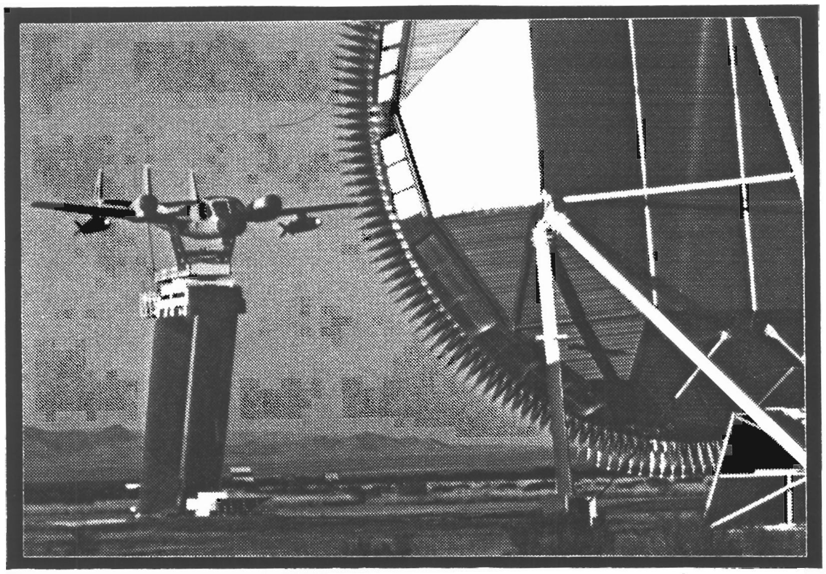

The outdoor compact range built at Fort Huachuca for testing antennas on vehicles and aircraft uses the serrated edge treatment developed at Georgia Tech. (Color/B&W Available)

"Any high-gain antenna would be suitable for this kind of edge treatment," said Joy. "The basic idea would be useful for reflectors of any kind, though the primary use would be parabolic reflector antennas."

In modern high-gain antennas, designers attempt to maximize gain performance by creating a uniform electrical field across the surface of the antenna. Careful design of antenna feed devices and even the use of sub-reflectors -- smaller dishes which bounce energy toward the main dish -- help create uniform fields and desirable beam patterns.

But at the edges of the dish, the amount of electrical energy reflected by the dish suddenly drops to zero. That abrupt transition creates the unwanted sidelobe radiation.

Reducing the energy directed at the edges of the antennas would be one solution, but that would lower the efficiency -- or gain -- which designers usually wish to maximize.

Designers have attempted to deal with the problem by rolling the antenna edges, placing absorbing materials at the outer edges of the dishes or including triangular serrations. But by gradually reducing the amount of metal at the antenna edges -- and therefore the amount of energy reflected -- the computer-designed flower petal serrations can make a smooth transition, Joy believes.

"We would like to have some compromise with the uniform illumination and a very smooth transition from the very high levels of energy," he said. "What this technology of the shaped serrations does is give you one more control for the tapering of the field at the edge. With shaping our serrations, we can get any shape of transition that we want."

Because the requirements for gain and sidelobe energy vary according to an antenna's use, serration design must be customized to produce the best compromise, Joy noted.

"Every application would have its own set of most desirable shapes for sidelobe levels and shaping," he explained. "Part of the optimization involves asking how much gain you will lose to reduce the sidelobe levels."

The optimal length for the serrations appears to be about 10 times the wavelength the dish is designed to reflect. The petals need not be of uniform size to accomplish the job.

Compact ranges are used to test the performance of electronic equipment, but they require extremely uniform electrical fields that can be affected by sidelobe radiation. Because of their need for "quiet zones," compact ranges gain special benefit from the edge treatment, Joy noted.

Believed to be the world's largest outdoor compact range, the Fort Huachuca project includes a 75-foot diameter reflector used to measure how vehicles such as tanks and aircraft affect the performance of antennas located on them. The serrations allow the Army to use a larger portion of the reflector than would normally be possible.

Though some experimental measurements have been done, Joy and fellow researchers have so far relied primarily on computer simulations to study the performance of the flower petal serrations. He believes the edge treatment -- for which Georgia Tech has applied for a patent -- will add little to the manufacturing cost of dishes.

The serrations could even be retrofitted onto existing dishes, though changes resulting from the larger effective area of the dishes would require alterations to the feed systems of any modified antennas.

One test antenna built by researchers in the School of Electrical Engineering resembles a flower -- raising some interesting questions about the value of flower petals in nature.

"We still do not appreciate Mother Nature's use of the flower petal," Joy noted.

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