DIRECTIVE ANTENNAS

Radio antennas that are directive have many advantages over stationary antennas. They can observe in one direction while ignoring much larger signals coming in from the sides. In addition, as transmitting antennas, they can direct a small amount of radiation directly to the proper receiver. Conventional directive antennas use large mirrors for short waves, such as are used in radar. For longer-wave antennas, they use reflector and director elements aligned with the antenna. The basic problem with such arrays is that they are mechanically steered, which is slow and difficult to do with large antennas, especially in the presence of wind, ice, or snow.

One way of having a large steerable antenna with no moving parts is to use a phased array. A phased array is based on Huygen's principle, which states that a wave front can be determined at a point in time by constructing a surface tangent to a collection of secondary waves. Thus, if one has a large number of small antennas located on a line, and if the antennas are excited in phase, the resultant wave front is normal to the line. If each small antenna is excited with a small phase shift relative to the next antenna, the wave propagates at an angle to the line. Conversely, if the array is used for reception, the small antenna signals, combined with the individual phase shifts, allow the array to scan in azimuth. The principle can be improved by using a two-dimensional array located on a plane to scan in altitude as well as azimuth. In fact, by properly adjusting the phase shifts, such an antenna can be located on a curved surface, such as the nose or wing of an aircraft. The basic principle is shown in Fig. 1. Since the subject of directive antennas is so large, Professor Herb Neff, UTK Emeritus (an antenna specialist), recommends using Refs. 1 and 2 for reference.

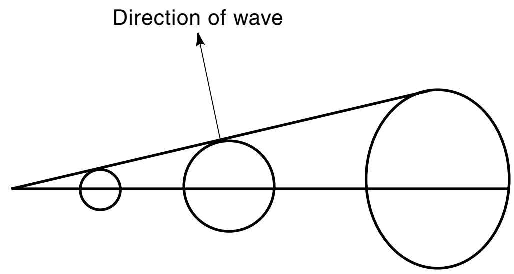

Figure 1. Three sources of waves giving a directed wave front. The phase of the middle and left sources have been delayed.

Newer antennas being developed include the "agile mirror" (3,4) designed by Dr. Wallace M. Manheimer of the U.S. Naval Research Laboratory. In this concept, a sheet of ionized air or other gas forms a reflecting surface. Since the sheet is not a mechanical body, it can be tilted and re-formed in a very short span of time. Thus, the direction of transmission or reception can be varied extremely rapidly. A magnetic field is used to help direct the sheet electron beam that forms the plasma. A second advantage of such an antenna is that it vanishes when the electrical discharge is terminated. This is a great advantage for stealth technology, because a mechanical antenna presents a large scattering cross section to radar signals near the antenna resonant frequency. One disadvantage of the "agile mirror" is that it must be formed in a gas at reduced pressure.

A second new type of antenna is the "stealth antenna," which is being developed by the Patriot Scientific Corporation in San Diego, California. The idea, originally developed by Dr. Igor Alexeff at the University of Tennessee (5), uses glow discharge tubes to comprise elements of an antenna. When the tubes are energized, the antenna is a complete conducting structure. When the tubes are deenergized, the antenna becomes either a large number of separate, nonresonant conducting components or just a nonconducting structure of glass tubing. By selectively energizing various tubes, the antenna also can be directed.

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