NOVEL HIGH GAIN PRINTED ANTENNAS FOR MILLIMETER-WAVE APPLICATIONS

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Many of the present and future wireless communication systems require low-profile, lightweight and low cost antennas. On the other hand, the broadband information applications including high speed internet services, wireless cable TV / modem, tele-medicine and digital battlefield are in the midst of pushing the wireless systems to the upper microwave and into the millimeter-wave frequency regions. Technologies like local multipoint distribution system (LMDS) and hybrid fiber-optic wireless system are being developed at frequencies of 27 GHz and above for commercial as well as secure military applications. These systems would require high gain, low loss and lightweight antennas to be deployed in pico-cell base stations installed in outdoor or indoor environments. In indoor applications the base stations would be located in ceilings of offices and manufacturing facilities. To combat multipath these systems may also require dual frequency and/or dual polarization for diversity. These requirements provide challenging problems in optimization and design of the future generation of mobile communication antennas.

In the past standard printed linear arrays such as series-fed and corporate-fed microstrip arrays have been used for millimeter-wave applications. These arrays, however, suffer from high conductor as well as surface-wave losses that could result in very low antenna efficiency. In this project we are investigating three alternative techniques to achieve high gain operation. The first alternative technique uses a gain enhancement method based on the resonance condition of a single microstrip patch in a multi-layered geometry with a high permittivity focusing layer, whereas the second alternative technique uses a Yagi-like configuration of the stacked patches printed in a low permittivity multi-layer medium. The latter structure is a printed version of the conventional Yagi-Uda array but provides a few more degrees of freedom (i.e., the dielectric constants of the layers) when optimizing its design. In addition, it is more compact than Yagi-Uda array of wire dipoles. The third alternative configuration on the other hand, will use the focusing effect of an optimized Partially Reflective Surface (PRS), made of a two dimensional array of closely-coupled narrow printed strip, placed at a distance of about 0.5 wavelength in front of a feeder microstrip patch element. While these antenna concepts may not be good candidates for lower microwave frequency regions because of their relatively thick profile, they are well suited for millimeter-wave applications, where they offer the promise of high gain with low ohmic losses in a very small package; features that are particularly suited to the receiver unit.

Our investigation will include analysis, optimization, design, fabrication and measurement of these antennas for some candidate millimeter-wave applications such as LMDS. In addition, a tradeoff study of various feeding schemes, including probe, proximity and aperture feedings, in conjunction with these gain enhancement methods will be performed. The proximity and aperture feeding techniques are particularly well suited for dual-polarization designs. Finally, the performance of these antennas when used as radiating elements to form a linear or a planar array will be analyzed.