Practical Aspects and Design Considerations of Millimeter Wave Thin Lens

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Extensive utilization of millimeter wave toward commercialization is a leading topic in the field of mobile communications. One who is keen to create or experience distinctly different next-generation services would be fascinated by high potentials of the millimeter wave fundamentally enabling the capability of processing huge data in an ultra-high speed. However, the advantage of employing the millimeter wave comes at the expense of increased signal attenuation and decreased angular coverage not only in wireless channels but also inside wireless devices. This demands for novel technology of millimeter wave large-scale phased antenna array to compensate the aforementioned drawbacks in a practical way.

Unlike currently dominant frequency bands of several gigahertz or below, the applicability of periodic electromagnetic structure such as frequency selective surface, electromagnetic band-gap, and metamaterials can be extended significantly in the millimeter wave frequencies. It has been reported that breaking the periodicity of the aforementioned electromagnetic structure can produce new phenomenology in designing radiators leading to the emergence of flat Metasurface and lens. Use of these components for millimeter wave applications is very attractive because they can have physically thin and flexible configurations. However, compared to study on the new scientific features and potential functionality of the Metasurface and lens, research on limits and design problems of those components from the practical aspects such as commercially available millimeter-wave fabrication process and system integration scenarios, are hardly addressed.

This paper presents several design problems with the corresponding feasible solutions for millimeter-wave thin lenses from the aforementioned practical aspects. Design techniques utilizing spatial filter modeling to mitigate tight fabrication conditions that the millimeter-wave thin lens may suffer from, are presented. The corresponding simulation and measurement results are discussed to confirm the proposed approaches. In addition, system-level design issues caused by combining the lens technology with the existing phased-array technology are addressed. Finally, comprehensively ongoing various study for practical realization of the millimeter-wave Metasurface and lens is introduced.