Spatial Beam Shaping Flat Lens using Phased Array Antenna for 5G Mobile Communication

Seungtae Ko, Yoongeon Kim, Seungku Han, Byungchul Kim, Jungyub Lee, and Yeongju Lee
Next Generation Communications Business Team, IT & Mobile Communications, Samsung Electronics, Suwon 16677, Korea

Recently, numerous state of the art studies for 5th generation (5G) mobile communication are disclosed by institutions and industry partners. Although a lot of standards for 5G are not determined yet, the visible developments are proceeding briskly by using the useful candidates in order to secure a wide band to accept a required huge traffic. Because of this, a millimeter wave has been increasingly regarded as one of strong candidates. However, the frequency changing over 10 times for 5G causes many challengeable issues technically. Especially, undesirable losses from a concrete wall, foliage, a moisture, and a glass become the critical parameters in mmWave band. To overcome the problems, an efficient phased array antenna systems that can support a beam steering and a high directivity simultaneously have been proposed.

Massive array antenna system is a good solution for getting the high gain and the wide coverage in a base station. However, it has several defects as follows. First, a massive array antenna requires an extensive area and it leads to a long signal line having a high insertion loss. This causes non uniform magnitude to each element and the undesirable beam distortions. Second, it causes the growth of circuitry complexity and cost.

In this paper, another approach using beam shaping flat lens is presented can have a higher gain and a wide beam steering. In common, the lens had been applied to ultra-high gain system with single antenna, and the most of previous researches were focused on the gain enhancement factor only. If the spherical wave from the antenna is converted to a plane wave in a specific region using a phase compensation method, the gain will be dramatically enhanced. Actually, the beam shape is depend on a deployment of the phase compensation in spatial. A narrow beam, a wide beam, or an angular shifted beam can be generated by the phase compensation. According to this possibility, a novel phase compensation technique is studied to support a gain enhancement and beam steering simultaneously by using the flat lens and a phased array antenna in this paper. First of all, the three layered unit-cells are designed to have from 0° to 360° phase compensation. Then, the phase profile to have the beam steering and the higher gain is calculated from a 4 x 8 array antenna. Finally, the N x N unit-cells are deployed in order to obtain the required phase profile. The design procedures, the simulation results, and the measured results will be discussed in the presentation.