UNIVERSITI TEKNOLOGI MARA

BIFURCATED BEAM BY BENT ARRAY RADIATOR FOR WIDE-ANGLE BEAM COVERAGE IN MOBILE SATELLITE TERMINAL AND 5G BASE STATION APPLICATIONS

ZANURLIDA BINTI TENGAH

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ABSTRACT

At the fifth generation (5G) mobile base station (BS) antenna, a dielectric lens antenna is formed into a cylindrical structure. The surface of the cylinder works as a lens antenna, while feed radiators are arranged on the center line of the cylinder. The feed radiator must illuminate the lens area at a wide angle. In addition, wide-angle coverage is also requested at terrestrial terminals for mobile satellite communications. For wide-angle coverage purposes, a single patch and dipole antennas are considered. However, 5G base station antenna and mobile satellite terminal applications require high gain and variable coverage. Therefore, this study proposes a bent array configuration achieving a bifurcated beam pattern. Initially, the fundamental data for the wide-angle beam coverage functions were clarified depending on the bent angle and array element number. Then, to obtain an optimum antenna performance, a 4x1 patch array with a series feed line method is designed to achieve a constant amplitude and phase over each array radiating element. After that, this study forms the design of a bifurcated beam antenna by bending the 4x1 array to be in a convex and concave bent array configurations. Each bent array configuration consists of four radiating elements in a serial feedline network. At the initial stage of designing the bent array, it is designed in a convex bent array configuration. Nevertheless, the bifurcated beam shifting angle is not achieving the targeted value. Hence, an extended convex bent array antenna is designed using the fringing effect method, where an increment of 5° shifting angle is achieved. Numbers of feed radiators need to be arranged to achieve multi-beam for the 5G mobile base station application. Therefore, considering the mutual coupling between neighboring array configurations when more than one bent array is arranged, the convex bent array is then reconstructed as a concave bent array configuration in an unextended and extended design. As a result, an increment of 4° bifurcated beam shifting angle, θ_{s}, for the concave bent array antenna is also achieved. Then, this study investigates the mutual coupling when arrays of dual convex and dual concave configurations are arranged. The spacing distance for both configurations is investigated to reduce the mutual coupling to maintain the single-bent array performances when more than one bent array is arranged. The concave bent array produces the lowest mutual coupling between neighboring compared to the convex bent array. $s = 3\lambda_o$ and $s = 4\lambda_o$ produces the lowest mutual coupling for the concave and convex configurations, respectively. However, as expected, the convex bent array configuration achieves a bifurcated beam with optimum antenna performance. Then, the achieved antenna configurations are fabricated and finally measured. A good agreement between simulated and measured results is verified.

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CHAPTER ONE
INTRODUCTION

1.1 Research Background

Mobile telecommunication base stations can be defined as base transceiver stations or radio communication infrastructure (RCI), which is any mobile equipment installed for the radio transmission applied in cellular communication or wireless installation for the local area networks. It includes all the radio transmitters and associated antennas and can be categorized into single RCI and complex RCI. The single RCI contains a single transmitter, including three antenna sectors for coverage in all directions. Whereby the complex RCI has two or more transmitters in each sector. The RCI consists of base station transmitters, repeaters, and broadcast transmitters (Malaysian Communication and Multimedia Commission, 2021). The antennas are mounted on high-raised structures such as transmission towers, roof-mounted structures, and many more. These structures required a certain height to produce more comprehensive coverage (Hoong, 2003).

For future mobile satellite terminals, wide-angle beam operation becomes highly demanded to ensure consistent communication. Therefore, the mobile satellite terminal system requires the mobile mount antenna with a wide-angle coverage for applying the mobile angle change, as shown in Figure 1.1.

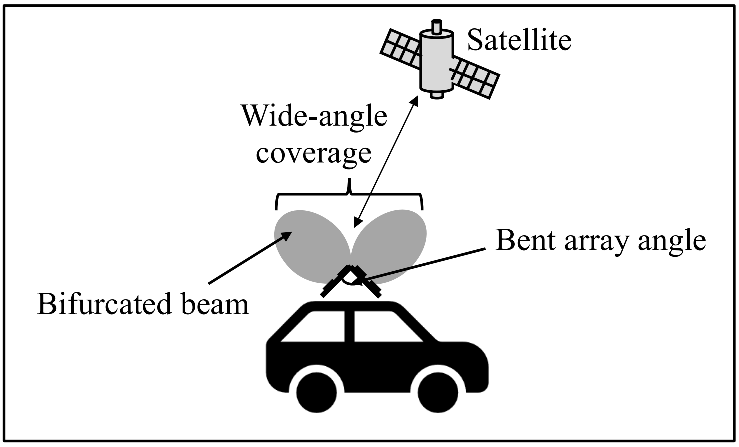

Figure 1.1 Satellite Mobile Earth Station Configuration

It ensures a consistent communication system and high efficiency with optimum coverage in an area with many interferences, such as in the buildings and hills area