UNIVERSITI TEKNOLOGI MARA

PRECISE BEAM SHAPING AND POSITIONING BY USING NON-SYMMETRICAL ARRAY FEED TECHNIQUE

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ABSTRACT

The array antenna technology nowadays is very popular in terms of easy of fabrication, light weight characteristic, inexpensive, simple structure and its very accurate to get simulation results through various electromagnetic simulators. Apart from that, the combination of techniques between array feed antenna and reflector antenna can generate the precise beam shape and coverage, which is very important and high in demand for commercial and also military used.

In this research, the critical element of the array feed design and feed network have been emphasized on getting the right or precise dimension for the desired beam shaping. In order to get the desired results, certain method was considered to be used. At the first place, the arrangement of the single array element were calculated and tested via a programme named Ray Tracing technique using MATLAB software. The results from that simulation determined the best positions of the patch element to be placed on the substrate. Normally, the position or range between the elements is based on *Lamda*/2 ($\lambda/2$) and *Lamda* (λ) in order for the fields at the aperture of the two slots to have opposite polarization.

Another criterion to design the array feed with a good VSWR and return loss (S11) is impedance matching for feed line network. From the previous research, to get a good impedance matching between patch and feedline for allowing the maximum power transfer, the 35Ω quarter-wave transformer is used to match the 50Ω coaxial feedline with the equivalence of 100Ω for each feed line.

In this research, the suggested frequency or reference frequency, *fr* is 8.144 GHz. The thickness of substrate is 1.6mm by using FR-4 substrate and substrate permittivity, ε=4.3. From the calculation using single patch element to get good VSWR and return loss (S11), the dimension of the single element antenna is 7.550mm in width, 6.547mm in length, while the thickness of the patch is 0.0035mm. The positioning of the proposed non-symmetrical arrangement of eight elements based on the ray tracing method for West Malaysia beam and the characteristics of the array feed have been verified through CST Studio Suite electromagnetic simulations.

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1.0 PROJECT OVERVIEW

1.1 INTRODUCTION

Shape of the contour beam of the satellite generated from reflector antenna play major role in broadcasting industry and also in military in term of security, where in those applications, it strictly requires that only specific area to be covered. Thus, to ensure constant data transmission for specific area or region, contour beam shall be accurately designed via reflector-shaping technique to avoid disruption from other signal in unwanted region.

There are two combining technique in designing the reflector-shaping. First, is a combination of the multiple beams [1] using ray tracing programme and second is an array feed [2] design using simulation software. In the case of any an array feed, the radiating elements have to be placed at the correct positions to produce antenna beams for the desired coverage [3].

A detailed trade-off analysis of multiple-beam antenna, in this research called MBA, performance for various configurations was presented [4, 5]. A database in term of precise feed positions, arrangement and ideal separation between the patch elements has to be generated.

Multi beam coverage for Malaysia region, shown in Figure 1 is viewed from a 91.5^0 east longitude geostationary satellite position. The orbital slot was chosen based on the Measat - 3A satellite, which was developed for MEASAT Satellite Systems of Malaysia to provide C-band and Ku-band communication services, [6]. In this research, all analyses were conducted at the frequency of 8.1GHz.

Many studies for caustics on a parabolic-reflector surface have been theoretically conducted. As fundamental research caustic-surface equations at the focal region were derived for incident plane waves in two distinctive planes: the elevation and the vertical directions [7]. The ray-tracing method for the focal region was applied in another practical work, shown in [8].

As for the dependency of the feed position on the f/D, the beam-deviation factor (BDF) expressions have been widely used [9]. In this expression, the beam direction and the relationship of the feed position is very accurate. However, due to the study model used in deriving the expression, the feed positions were expressed in a one-directional coordinate only.

In this research, non-symmetrical array feed antenna will be designed by calculation based on ideal impedance balance and also quarter-wave transformer to find the best feed positions around the point derived from the beam-deviation-factor equation.