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Study on beamforming characteristic for a phased array-fed reflector

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Abstract This paper proposes study on beamforming characteristic for a phased array-fed reflector antenna. To confirm beamforming capability of the proposed antenna, a 4-element circular array is employed as the feeder, and the actual reflected steering angles are observed according to the steering angles of the array feeder. The results demonstrate that the proposed antenna is suitable as a phased array-fed reflector antenna for achieving beamforming operation.

Keyword Antennas, Reflector antenna, Phased array-fed reflector antenna

1. Introduction

Phased array antennas can be found in many applications since its numerous advantages over traditional single fed antenna systems. Phased array antennas are often used for very high again applications, and a significantly large aperture composed of multiple antenna elements is often utilized for increasing the antenna gain. Although the phased array antenna can steer the angle of the beam over a wide scan range, they have drawbacks such as increased design complexity and physical size. Recently, phased array-fed reflector antennas (PAFRs) have been attracting much attention due to their adaptive beam steering characteristics and high gain performance despite its relatively low manufacturing cost [1–3].

In this paper, we investigate the beamforming characteristics of PAFRs when the 4-element circular array is used as the array feeder. The beamforming characteristics are observed according to the F/D ratio of the reflector, diameter of the reflector, and radius of the array feeder. To confirm the beamforming capability, the actual reflected steering angles according to the steering angles of the array feeder are observed.

2. Phased array-fed reflector antenna

Fig. 1 presents the conceptual diagram of an array-fed reflector antenna with the 4-element circular array. The amplitude and phase of the feeder are adjusted using phase shifters to steer the beam pattern.

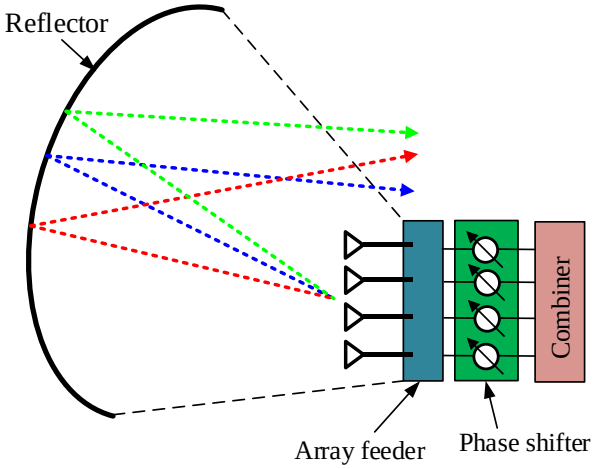


Fig. 1. Conceptual geometry of the phased array-fed reflector with the 4-element circular array.

Fig. 2 illustrates the geometry of the PAFR antenna. The diameter D of the reflector is 1.6 m. The 4-element circular array with log periodic dipole antenna (LPDA) elements is used as the array feeder. The feeder is located at the focal point of F, and the F/D ratio is 0.82. The beamforming characteristics of PAFR are investigated according to the parameters, such as the F/D ratio of the reflector, diameter of the reflector, and radius of the array feeder. Fig. 3 shows the beamforming performance by varying the radius ($2r$) of the feeder. The PAFR can steer the beam pattern from 0° to 0.9° without the gain degradation when $2r$ is 150 mm (about 1 λ), as shown in Fig. 3(a). Fig. 3(b) presents the beamforming performance at $2r$ of 200 mm. A slight difference between the actual reflected angle and the steering angle of the feeder occurs after 0.5°. Fig 4 illustrates the beam patterns of the PAFR with $2r$ of 150 mm. The beam pattern is steered from 0° to 0.9° at an interval of 0.1°.

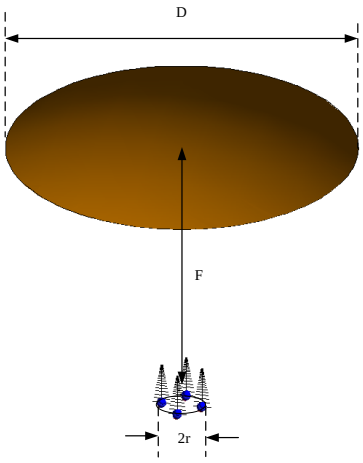
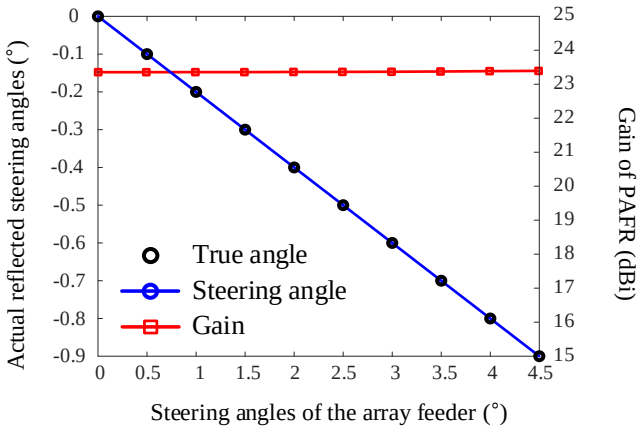
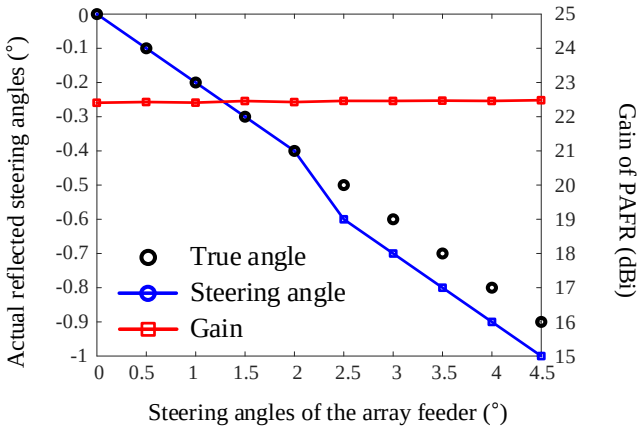


Fig. 2. Geometry of the proposed PAFR antenna.



(a) $2r$ = 150 mm



(b) $2r$ = 200 mm

Fig. 3. Actual reflected steering angles according to the steering angles of the array feeder.

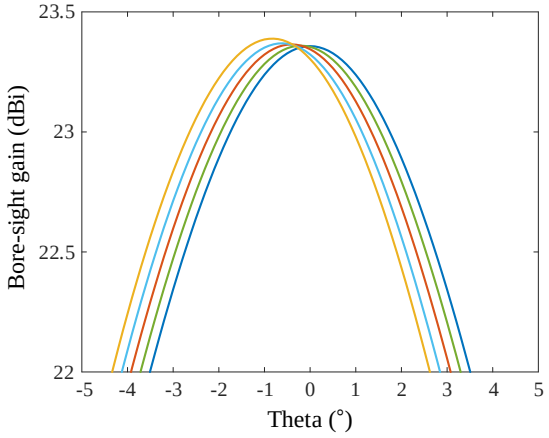


Fig. 4. Beam pattern of PAFR with $2r$ of 150 mm.

3. Conclusion

The beamforming capability of PAFRs with a 4-element circular array feeder was examined. The deviation between the reflected steering angles and the steering angle of the array feeder was observed according to the F/D ratio of the reflector, diameter of the reflector, and radius of the array feeder. The results demonstrate that beam steering in narrow angle is available for the PAFR.

References

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