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著者(和文)	RUCKKWAENTuchjuta
Author(English)	Tuchjuta Ruckkwaen
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論 文 要 旨

THESIS SUMMARY

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学生氏名： Student's Name	RUCKKWAEN TUCHJUTA		

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指導教員（主）： Academic Supervisor(main)	廣川二郎
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要旨（和文 2000 字程度）
Thesis Summary（approx.2000 Japanese Characters ）

This research is concentrated on the applications of waveguide slot array antennas in non-far region transmission, which includes both applications for wireless communication and wireless power transfer. The objectives of this study are to investigate candidate antennas and possibilities for their improvements as well as the performance evaluation for these applications. Chapter 1 reviews literatures regarding non-far region applications using waveguide slot array antennas. Features and limitations which are common to the non-far region applications are summarized. Degradation issues are pointed out.

Chapter 2 discusses intersymbol interference (ISI) degradation in a compact range communication using a large array antenna. Significant bit error rate (BER) degradation in the proximity of the array was shown in the experiment. The main cause behind BER degradation is ISI from the array antenna. Reproducing or accurately predicting the BER performance in the actual system would benefit the system planning. Though the prediction of BER is of outmost interest, the existence of several signal processing components, e.g., equalizer and automatic gain control (AGC), increases the complexity of the problem. To simplify the problem, we aim to evaluate ISI which is the dominant cause of the BER degradation while disregarding the signal processing components. The electrical size of the array antenna limits the use of commercial electromagnetics simulation software. As a result, an alternative method to evaluate ISI using the measured aperture near field distribution of the antenna is proposed. The procedure to evaluate ISI is demonstrated and the reliability of the proposed method is verified by measurement. The Tx antenna is a 30-GHz 64×32 array antenna with the aperture size of 583.2×301.6 mm^2. For this Tx antenna, the discrepancy between the estimated and measured ISI results is less than 3 dB for distances below 1 m and less than 5 dB for distances over 1 m. The effect of aperture field excitation on ISI is interpreted. The future considerations would be the modification of the ISI estimation method by taking the signal processing components into account and the reproducibility of the BER performance.

Chapter 3 presents the design of radial line slot antennas (RLSA) adopting the dog-bone cross-slot feeding to improve the transmission. The simulated transmission of 5.8 GHz RLSAs using the straight cross-slot feeding over short-distances suffers from large transmission ripples due to multiple reflections; This corresponds to the fluctuation of the transfer energy which is not a desired quality for wireless power transfer. Therefore, the objective of this chapter is to enhance the transmission and reduce the transmission ripples. The straightforward approach is to improve the quality of the antenna aperture field excitation. The dog-bone cross-slot which has a wider half beamwidth and a better rotating mode than a conventional straight cross-slot is adopted to realize better aperture field excitation. The design of a dog-bone cross-slot using eigenmode analysis is proposed and its design procedure is also demonstrated. The transmission results for RLSAs using the design dog-bone cross-slot and the straight cross-slot are then compared. The improvement on the transmission for RLSAs using the design dog-bone cross-slot were confirmed by simulation and experiment. The simulation over 50-100 mm. distances suggests 66% transmission efficiency and 2 dB reduction in transmission ripples compared to that of the straight cross-slot case, while the measurement over the same range suggests 61% transmission efficiency which is 15% higher

than that of the RLSA using the straight cross-slot feeding and 1.5 dB reduction in transmission ripples. The discrepancies between the simulation and measurement results caused by the fabrication error are discussed. The future work requires the fabrication of prototype RLSAs with better performances.

Chapter 4 presents the design of a parallel plate waveguide slot antenna as a candidate for short distance transmission. The objective of this chapter is to investigate a candidate antenna for the non-far region transmission. An antenna with parallel plate structure has a simple structure which is easy mass producibility; an example is the RLSA in chapter 3. The target of this study is to investigate an antenna with parallel plate structure, the performance of which could exceed that of the RLSAs presented in chapter 3 in terms of transmission efficiency, transmission ripples, size, and weight. For these reasons, a parallel plate waveguide slot antenna with a dipole layer is proposed in this chapter mainly for short-range wireless power transfer in microwave bands. Because of the fabrication limitations, the current antenna was instead designed for 26 GHz band. For wireless power transfer, A dipole layer acted as polarization converter is adopted to realize circular polarization. The simulation results suggest 26 dBi realized gain at the center frequency, 60% antenna efficiency, and 1 GHz bandwidth (3.85%) which shows the possibility for wireless communication. The overall antenna size is 78.5×90 mm^2. The future considerations would involve the fabrication of a prototype antenna and the possibility for fabricating a prototype in microwave bands, more precisely 5.8 GHz.

Chapter 5 presents the summary and the future prospects of this study.