論文 / 著書情報
Article / Book Information

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Title(English)	Radio Propagation Channel Analysis and Modeling in Outdoor Agricultural Environments for Wireless Sensor Networks at 2.4 GHz Band
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Category(English)	Doctoral Thesis
種別(和文)	論文要旨
Type(English)	Summary

（博士課程）
Doctoral Program

論 文 要 旨

THESIS SUMMARY

専攻： Department of	International Development Engineering 専攻	申請学位（専攻分野）： Academic Degree Requested	博士 Doctor of (Engineering)
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要旨（英文 800 語程度）
Thesis Summary (approx.800 English Words)

In precision agriculture, the wireless sensor network is used in gathering the variability in the fields for the management to improve the yield. Understanding the characteristics of the radio propagation in such environment is useful in deploying the wireless sensor networks. This thesis aims to model and predict the propagation characteristics in two common types of the outdoor agriculture environments - the tall food grass field and the fruit orchard - at 2.45 GHz band. The thesis is divided into seven chapters which are briefly summarized as follows.

Chapter 1, "Introduction", explains the background and motivation. This chapter points out the necessity of studying the unclarified impacts of the planting pattern of each common agriculture type on the path loss as well as the influence of the radio transmission in the short vegetation depth, shorter than 40 m, on the small-scale fading and wide-band RMS delay spread. The limitations of the existing path loss prediction approaches in such the environment are also discussed.

Chapter 2, "Radio Propagation in Vegetation Environment", describes the existing theory of the radio propagation and the existing empirical modeling of radio propagation in vegetation environment. The radio propagation is explained through the analytical method based radiative energy transfer in the random medium and the numerical electromagnetic scattering computation method. The methods of empirically modeling the path loss, small-scale fading and RMS delay spread are also briefly given.

Chapter 3, "Channel Sounding in Outdoor Agriculture Environment", explains the proposed techniques used to develop the suitable wide-band channel sounder for the measurement in the outdoor agriculture environment. The validation result in the laboratory is also presented.

Chapter 4, "Channel Analysis and Modeling in Outdoor Tall Food Grass Field", describes the measurement and the radio propagation analysis in the sugarcane field representing the tall food grass type. The vegetation obstruction model is proposed to represent the angular path loss variation. It is the function of the number of ridges between the line-of-sight direction from the transmitter to the receiver. Utilizing the proposed model, the path loss prediction at any points in the filed by using a few measurement efforts is proposed. The small-scale fading and the RMS delay spread are also characterized.

Chapter 5, "Channel Analysis and Modeling in Outdoor Fruit Orchard", describes the measurement and the radio propagation analysis in the jackfruit orchard representing the fruit orchard type. The vegetation obstruction model is proposed as the function of the number of trees between the line-of-sight to better represent the angular path loss variation than the existing models. Since the number of trees is angular dependent, the algorithm to calculate such value is proposed. In addition, the special measurement is

needed to evaluate the input parameter for the proposed algorithm. Utilizing the proposed model, the path loss prediction at any points in the orchard is proposed. The small-scale fading and the RMS delay spread are also characterized.

Chapter 6, "Relative Angular Vegetation Loss Prediction of A Single Tree", introduces the way to reduce the special measurement workload pointed out in chapter 5. The evaluation results show that the Monte Carlo simulation using the numerical electromagnetic scattering computation called hybrid T-matrix method can be used to evaluate the relative angular vegetation loss of a single tree which is used as the input to determine the number of trees for the proposed path loss prediction in the fruit orchard.

Finally, the conclusions are discussed and the future directions are given in chapter 7.

備考：論文要旨は、和文 2000 字と英文 300 語を 1 部ずつ提出するか、もしくは英文 800 語を 1 部提出してください。
Note : Thesis Summary should be submitted in either a copy of 2000 Japanese Characters and 300 Words (English) or 1copy of 800 Words (English).

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（博士課程）