論文 / 著書情報
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題目(和文)	EHF帯における人体遮蔽に影響される電波伝搬チャネルの測定と予測技術の開発
Title(English)	Measurement and Simulation Techniques of Dynamic Radio Channel Property under Human Body Shadowing at EHF Band
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種別(和文)	論文要旨
Type(English)	Summary

（博士課程）
Doctoral Program

論 文 要 旨

THESIS SUMMARY

系・コース： Department of, Graduate major in	融合理工学系 地球環境共創	系 コース	申請学位（専攻分野）： Academic Degree Requested	博士 Doctor of	（　工学　）
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要旨（英文 800 語程度）
Thesis Summary（approx.800 English Words ）

Chapter 1, "Introduction," introduces the necessity of the measurement and simulation for the human body shadowing (HBS) channel and the main motivation of this study. Regarding the extremely high frequency (EHF) band has been deployed for 5G mobile communication system, the fragile communication at EHF band need HBS channel models for developing robust network. However, there is a research gap in the conventional research to predict the HBS channel with the consideration of the detailed human body with experimental evidence. Therefore, this study aims to develop a synchronized measurement system consisting of dynamic channel sounder and motion capture (MoCap) system together with the point cloud (PC)-based human model for deterministic HBS channel simulation.

Chapter 2, "Literature review of Measurement and Simulation Technology for Human Body Shadowing Channel," provides the detailed explanations of the propagation theories used in this work together with the research gaps of the conventional works. In the conventional measurement for HBS channel, the synchronization between the channel sounder and the MoCap system were conducted via ground markers, motion triggers, and the trigger signal from the MoCap. In the former two cases, the synchronization accuracy was intolerable at the EHF band. In the latter case, the sampling rate was limited by the MoCap, which was too sparse to measure the Doppler frequency at the EHF band. Therefore, a novel synchronized measurement system using external trigger signal, that avails different sampling rates of the instruments, is needed. In the conventional HBS channel simulation, the human models for the simulation were always defined by few degrees of freedom and fixed during the measurement, which cannot accommodate the complex and changing shape of the human body. Therefore, novel human models for the HBS channel simulation generated from the instantaneous shape of the human body are needed.

Chapter 3, "Measurement System for Synchronized Channel Response and Point Cloud of Human Motion," explains the proposal for synchronizing the channel sounder and the MoCap system, the detailed hardware architecture of the instruments, and the validation for the proposal. Without triggering the channel sounding by the MoCap measurement repeatedly, the proposal uses the trigger signal for synchronizing only the timer of both instruments to allow the sampling rates in both sides different. Following the proposal, the hardware architecture and the signal processing in the instruments are detailed. Finally, the proposal is validated for the canonical problem, the knife-edge diffraction, by comparing the simulation result with the measurement result of a propagation channel shadowed by a metal plate. The results shows that the proposal is available for providing the experimental evidence to validate the HBS channel simulations.

Chapter 4, "Point Cloud-based Vertically long Models," proposes novel PC-based human model for HBS simulation. In Section 4.2, the vertically long models, cross-section screen model, Bollington screen model, and the elliptic cylinder model are proposed. The proposals are available in updating their parameters of definition according to the instantaneous shape of the human obstacle. In Section 4.3, the synchronized channel sounding at 58 GHz and MoCap measurement for validating the proposed human models is described. In Section 4.4, two quantitative comparisons in the shadow distance and the fading distance and one qualitative comparison against the measurement result are conducted. As the results, all the proposals are partially or completely superior to the conventional fixed human model. Especially the cross-section screen and the Bullington screen performed well in tracking the change of the fading distances between the measurements. The elliptic cylinder model improved the prediction of the shadow distance by 75 % on average. The results show the proposals achieved to simulate the HBS channel more accurately with efficient computation by conducting the simulation in 2D coordinate system.

Chapter 5, "Point Cloud-based Human body-shaped Model," proposes extends the PC-based human model to the 3D coordinate system with the consideration of the complex shape of the human body. In Section 5.2, the definition of the human body-shaped screen model is proposed. The proposal recognizes the cross-section of the human body in the viewpoint of the antennas to stably simulate the fading pattern in the lit region. In Section 5.3, the synchronized channel sounding affected by a standing-up/sitting-down human obstacle at 300 GHz and MoCap measurement for validating the proposed human models is described. In Section 5.4, an additional simulation is conducted to observe the performance of the models

in the lit region in a denser sampling rate, what the MoCap cannot do. In Section 5.5, one qualitative comparison in the general picture and two quantitative comparisons in the shadowing gain in the shadow region and the fading ripple in the lit region were conducted. As the results, the performances of both vertically long screen model and the proposal in the shadow duration and the shadowing gain in the shadow region are similar. Considering the shape of the human body is vertically long, the diffraction points usually exist on the side of the human body. Since the geometry surrounding the diffraction points is vertical edge-like, the simulation results of the vertically long screen and the proposal are similar. On the other hand, since the proposal can recognize the sitting human obstacle while the conventional model failed, the proposal outperformed the vertically long screen model.

Chapter 6, “Conclusion,” summarizes the work and the contributions of this thesis together with providing the possible research topics in various perspectives.