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Unmanned Aerial Vehicle Cellular Communications

Springer

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Preface

The design and applications of adaptable unmanned aerial vehicles (UAVs) to operate in diverse and harsh environmental conditions are gaining quantum leap. Designing efficient UAVs to address several complex connectivity issues and improve the overall efficiency of beyond 5G wireless communication systems is the central focus. This book gives new insights into the real-world scenarios of the design, development, application, and associated benefits of UAVs in future wireless communication systems. Chapter 1 explores the historical perspectives and introduction to UAV cellular communications. Chapter 2 considers UAV cellular communication in 5G new radio wireless standards. Specifically, 3GPP updates and new 5G NR features for aerial devices are broached. Chapter 3 torchlights 5G NR massive MIMO for efficient and robust UAV cellular communications.

Chapter 4 presents the concept of an intelligent reflecting surface (IRS)-assisted UAV communication system. Emerging physical layer technologies corresponding to IRS-assisted UAV systems and their benefits and challenges are highlighted. The chapter covers joint optimization approaches to the UAV trajectory and IRS passive beamforming. In Chap. 5, the focus is on artificial intelligence–empowered models for UAV communications. In Chap. 6, RIS-assisted UAV cellular communication is discussed with practical scenarios. The chapter demonstrates that RIS can partially control the wireless transmission channels and provide more favorable propagation characteristics. Chapter 7 presents cell-free massive MIMO architecture for UAV cellular communications. The chapter highlights the effectiveness of CF-mMIMO in delivering improved spectral and energy-efficient UAV cellular communication. New expressions for UL and DL data transmission phases are derived for the achievable lower and upper spectral efficiency bounds.

Chapter 8 examines UAV-assisted reconfigurable intelligent surface (RIS) for energy-efficient reliable communication. Intelligent and blind UAV-assisted RIS schemes are proposed to increase energy efficiency. Analytical closed-form average bit error probability expressions are derived. Intelligent UAV-assisted RIS can convert a wireless fading environment into a superior communication environment, offering a low average bit error rate at extremely low SNR conditions. The idea of using blockchain technology to support UAV cellular communications is presented

in Chap. 9. Chapter 10 dissects unmanned aerial vehicle cellular communication with the non-terrestrial networks. The channel model and the vertical height of the UAV for both ground users and base stations are analyzed.

In Chap. 11, design and performance issues in UAV cellular communications are elaborated. Specifically, the chapter highlights some strategies for UAV design and performance optimization. Chapter 12 presents the evolution and significance of unmanned aerial vehicles and discusses the importance of UAVs to society and industry. Finally, Chap. 13 provides an overview of the energy consumption of unmanned aerial vehicles used in cellular communications. The chapter remarks that cleaner energy sources and energy-efficient batteries will hold great promise for UAV applications in future wireless communication systems.

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Agbotiname Lucky Imoize (Senior Member, IEEE) is a lecturer in the Department of Electrical and Electronics Engineering, University of Lagos, Nigeria. He received BEng (Honors) in electrical and electronics engineering from Ambrose Alli University, Nigeria, in 2008, and MSc in electrical and electronics engineering from the University of Lagos, Nigeria, in 2012. Before joining the University of Lagos, he was a lecturer at Bells University of Technology, Nigeria. He worked as a core network products manager at ZTE Nigeria Limited from 2011 to 2012 and as a network switching subsystem engineer at Globacom, Nigeria, from 2012 to 2017. Imoize was awarded the Fulbright Fellowship as a visiting research scholar at the Wireless@VT Lab in the Bradley Department of Electrical and Computer Engineering, Virginia Tech., USA, where he worked under the supervision of Prof. R. Michael Buehrer from 2017 to 2018. He is currently a research scholar at Ruhr University Bochum, Germany, under the Nigerian Petroleum Technology Development Fund (PTDF) and the German Academic Exchange Service (DAAD) through the Nigerian–German Postgraduate Program. He is a registered engineer with the Council for the Regulation of Engineering in Nigeria (COREN) and a Nigerian Society of Engineers (NSE) member. He has co-edited one book and coauthored over 80 papers in peer-reviewed journals and conferences. His research interests are beyond 5G and 6G wireless communications, chaotic communications, and wireless security systems.

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