

Channel Modeling and Analysis of ULA Massive MIMO Systems

Xudong Cheng, Yejun He

*Guangdong Engineering Research Center of Base Station Antennas and Propagation
Shenzhen Key Laboratory of Antennas and Propagation*

*Shenzhen Engineering Research Center of Base Station Antennas and Radio Frequency
College of Information Engineering, Shenzhen University, 518060, China*

cx199181@126.com, heyejun@126.com

Abstract—In massive multiple-input multiple-output (MIMO) systems, the favorable propagation which can be also known as the orthogonality of the channel between different users is the most important property. In this paper, we establish a 3-D geometrical channel model for uniform linear array (ULA) massive MIMO systems, and we focus on the orthogonality of the channel, the condition number and the channel capacity. We use the plane wave (PW) to model the far-field signals, and use the spherical wave (SW) to model the near-field signals. Both the azimuth angle of arrival (AAoA) and elevation angle of arrival (EAoA) have been taken into account. Compared with the independent and identically distributed (i.i.d.) Rayleigh fading channels, the proposed channel model comprises the parameters of communication environment and antennas such as environment scattering status, SW effect, antenna spacing etc. The relationship between the performance of massive MIMO systems and parameters is analyzed. The proposed model is easy to be implemented and can be adjusted according to the communication environment.

Keywords—Massive MIMO; favorable propagation; condition number; spherical wave.



Xudong Cheng (M'17) received the B.S. degree in Communication Engineering from Shenzhen University, China, in 2013. He is currently pursuing his Ph.D. degree at the College of Information Engineering in Shenzhen University. His research interests include channel modeling, especially polarized MIMO channel modeling, energy harvesting communications, smart antennas, and signal processing.



Yejun He (SM'09) received the Ph.D. degree in Information and Communication Engineering from the Huazhong University of Science and Technology, Wuhan, China, in 2005. From 2005 to 2006, he was a Research Associate with the Department of Electronic and Information Engineering, Hong Kong Polytechnic University, Hong Kong. From 2006 to 2007, he was a Research Associate with the Department of Electronic Engineering, Faculty of Engineering, Chinese University of Hong Kong, Hong Kong. In 2012, he was a Visiting Professor with the Department of Electrical and Computer Engineering, University of Waterloo, Waterloo, ON, Canada. From 2013 to 2015, he was an Advanced Visiting Scholar (Visiting Professor) with the School of Electrical and Computer Engineering, Georgia Institute of Technology, Atlanta, GA, USA. Since 2011, he has been a Full Professor with the College of Information Engineering, Shenzhen University, Shenzhen, China, where he is currently the Director of Shenzhen Key Laboratory of Antennas and Propagation, the Director of the Guangdong Engineering Research Center of Base Station Antennas and Propagation, as well as the Deputy Director of Shenzhen Engineering Research Center of Base Station Antennas and Radio Frequency. He has authored or co-authored over 100 research papers, books (chapters), and holds 13 patents. His research interests include wireless mobile communication, antennas, and Radio Frequency.

He has served as a Technical Program Committee Member or the Session Chair of various conferences, including the IEEE Global Telecommunications Conference, the IEEE International Conference on Communications, the IEEE Wireless Communication Networking Conference, and the IEEE Vehicular Technology Conference. He has also served as a Reviewer of various journals, such as the IEEE Transactions on Vehicular Technology, the IEEE Transactions on Communications, the IEEE Transactions on Wireless Communications, the IEEE Transactions on Industrial Electronics, the IEEE Wireless Communications, the IEEE Communications Letters, the IEEE Journal on Selected Areas in Communications, the International Journal of Communication Systems, the Wireless Communications and Mobile Computing, and the Wireless Personal Communications. He is currently serving as an Associate Editor of the IEEE Access and the Security and Communication Networks. Prof. He is a Fellow of IET.