Signal Processing Antenna Techniques for Wireless Communications

Yasutaka Ogawa
Graduate School of Information Science and Technology
Hokkaido University
Sapporo, 060-0814 JAPAN
ogawa@ist.hokudai.ac.jp

Abstract

Various applications of signal processing antenna techniques have been extensively studied over the last two decades for commercial wireless communications. An adaptive antenna (a simplified signal processing antenna) can suppress interference and accommodate more users. On the other hand, multiple-input multiple-output (MIMO) systems have rapidly been developed because they provide high data-rate transmission without increasing the frequency bandwidth. MIMO techniques are relevant to several research fields such as antenna technologies, radio wave propagation, signal processing, communications, and information theory. Many researchers in these different fields have been studying them, and MIMO systems are already in practical use in wireless local area networks (WLANs) and the long term evolution (LTE) of cellular networks. MIMO systems are another application of the signal processing antenna techniques. If cellular network traffic doubles every year due to the rapid and wide spread of smartphones, we will need to accommodate 1,000 times the current traffic in ten years. MIMO systems will play an important role in such a situation.

In this talk, the basic concept and applications of the signal processing antenna techniques will be shared with the audience. First, the principle of the adaptive antenna will be clarified, and the research history will be outlined. Then, this presentation will introduce space division multiple access (SDMA) with a multibeam adaptive antenna. The technique can accommodate multiple users at the same time and frequency. SDMA was implemented in the Personal Handy-phone System (PHS) in Japan. The implementation in which the speaker was involved is the world's first realization of SDMA.

Furthermore, some important features of MIMO systems will be discussed. On the basis of indoor measurement results, the performance of multi-user MIMO systems in time-varying environments will be clarified, and channel predictions, which are counter measures against the time dependent channels, will be introduced. Finally, future work on antenna researchers will be stated.

Biography

Yasutaka Ogawa received B.E., M.E. and Ph.D. degrees from Hokkaido University, Sapporo, Japan in 1973, 1975, and 1978. Since 1979, he has been part of the faculty at Hokkaido University, where he is currently a professor of the Graduate School of Information Science and Technology. In 1992–1993, he was with the ElectroScience Laboratory, Ohio State University, U.S.A., as a visiting scholar, on leave from Hokkaido University.

His professional expertise encompasses super-resolution estimation techniques, applications of adaptive antennas for mobile communication, MIMO techniques, and measurement techniques. He proposed a basic and important technique for time-domain super-resolution estimation for electromagnetic wave measurements such as antenna gain measurement, scattering/diffraction measurement, and radar imaging. Also, his expertise and commitment to advancing the development of adaptive antennas contributed to the realization of SDMA in the PHS.

He received the Yasujiro Niwa Outstanding Paper Award in 1978, the Young Researchers' Award from the Institute of Electronics, Information and Communication Engineers (IEICE) in 1982, the Best Paper Award from IEICE in 2007, TELECOM System Technology Award from the Telecommunications Advancement Foundation of Japan in 2008, and the Best Magazine Paper Award in 2011 from the IEICE Communications Society. He also received the Hokkaido University Commendation for excellent teaching in 2012.

He was a chairperson of the IEEE Sapporo Section in 2011–2012 and the IEICE Hokkaido Section in 2012–2013. He is a Fellow of the IEICE and IEEE.