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Adaptive Resource Allocation for Wireless Multi-cast MIMO OFDM using Water filling Algorithm

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Abstracts

Multiple antenna orthogonal frequency division multiple access (OFDMA) is a promising technique for the high downlink capacity in the next generation wireless systems, in which adaptive resource allocation would be an important research issue that can significantly improve the performance with guaranteed Quos for users. . In this paper we look into the performance of such cooperative OFDMA systems under realistic conditions. We propose a transceiver structure to reduce the interference between transmitting subcarriers and receiving subcarriers. Its performance in terms of signal to interference and noise ratio (SINR) is evaluated by both analysis and simulation and is incorporated into a recently proposed cooperation strategy for OFDMA systems to examine its performance under the realistic structure. It is shown that although the cooperation strategy suffers from performance degradation due to the residual interference between the transmitting and receiving subcarriers, it still outperforms the conventional cooperation schemes. Moreover, most of the current source allocation algorithms are limited to the unicast system. In this paper, dynamic resource allocation is studied for multiple antenna OFDMA based systems which provide multicast service. The performance of multicast system is simulated and compared with that of the unicast system..

Keywords: MIMO OFDM

Introduction

The next-generation wireless networks are expected to provide broadband multimedia services such as voice, web browsing, video conference, etc. With diverse Quality of Service (Quos) requirements. Multicast service over wireless networks is an important and challenging goal oriented to many multimedia applications such as audio/video clips, mobile TV and interactive game There are two key traffics, namely, uni cast traffics and multicast traffics, in wireless multimedia communications. Current studies mainly focus on uni-cast traffics. In particular, dynamic resource allocation has been identified as one of the most efficient techniques to achieve better QoS and higher system spectral efficiency in unicast wireless networks. Furthermore, more attention is paid to the unicast OFDM systems. Orthogonal Frequency Division Multiplexing (OFDM) is regarded as one of the promising techniques for future broadband wireless networks due to its ability to provide very high data rates in the multi-path fading environment. Orthogonal Frequency Division Multiple Access (OFDMA) is a multiuser version of the popular OFDM scheme and it is also referred as multiuser OFDM. Multiple input multiple output (MIMO) technologies have also received increasing attentions in the past decades. Many broadband wireless networks have now included MIMO technology in their protocols including the multicast system. Compared to single input single output (SISO) system, MIMO offers the higher diversity which can potentially lead to a multiplicative increase in capacity. In multiuser OFDM or MIMO-OFDM systems, dynamic resource allocation always exploits multiuser diversity gain to improve the system performance and it is divided into two types of optimization problems: 1) to maximize the system throughput with the total transmission power constraint ; 2) to minimize the overall transmit power with constraints on data rates or Bit Error Rates (BER). To the best of our knowledge, most dynamic resource allocation algorithms, however, only consider uni cast multiuser OFDM systems. In wireless networks, many multimedia applications adapt to the multicast transmission from the base station (BS) to a group of users. These targeted users consist of a multicast group which receives the data packets of the same traffic flow. The simultaneously achievable transmission rates to these users were investigated. Recently scientific researches of multicast transmission in the wireless networks have been paid more attention. For example, proportional fair scheduling algorithms were developed to deal with multiple multicast groups in each time slot in cellular data networks. The dynamic resource

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allocation for OFDM based multicast system was researched, however it focused on SISO system and cannot be applied to MIMO system directly. On the other hand, the conventional scheme in current standards such as IEEE 802.16 or 3GPP LTE for multicast service considers the worst user very much, which may waste the resource. In this paper, we propose dynamic subcarrier and power allocation algorithms for MIMO OFDMA-based wireless multicast systems. In the proposed algorithms, the subcarriers and powers are dynamically allocated to the multicast groups. Our aim is to maximize the system throughput given the total power constraint. Let us assume that there are multiple multicast groups in a cell and each multicast group may contain a different number of users. The users included in the same multicast group are called co- group users and these can be located in different places in the cell.

Co-operative MIMO OFDM

In MIMO terminology, the "Input" and "Output" are referenced to the wireless channel, which includes the antennas. Performance gains are achieved as multiple transmitters simultaneously input their signal into the wireless channel and then combinations of these signals simultaneously output from the wireless channel into multiple receivers. For downlink communication, a single base station (BS) would contain multiple transmitters connected to multiple antennas and a single Mobile Station (MS) would contain multiple antennas connected to multiple receivers.

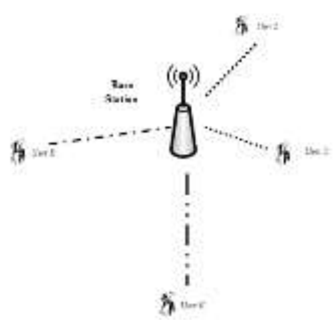

Fig:1Co-Operative MultiUsers in MIMO-OFDM

Like the relationship between OFDM and OFDMA, MU-MIMO (and, similarly, SDMA) can be thought of as an extension of MIMO applied in various ways as a multiple access strategy. A significant difference is that the performance of MU-MIMO relies on pre-coding capability than OFDMA so that if the transmitter does not use pre-coding, the performance advantage of MU-MIMO is not achievable. Multiple accesses MIMO, MIMO-SDMA, massive MIMO, cooperative MIMO, coordinated multipoint (CoMP) or in other words macro diversity, and ad hoc MIMO are all family terminologies within MU-MIMO, as each of those technologies leverages multiple users as a degree of freedom in achieving successful radio transmission.

Subcarrier resource allocation

Since the cooperative scheme require that subcarrier-based duplexing can be achieved, we will focus on the feasibility of subcarrier-based duplexing in this section to understand the tradeoffs and limitations that would occur in the cooperative OFDMA systems considere. The orthogonality between subcarriers is partially lost in OFDM systems due to the non-ideal characteristics of different subsystems (e.g., nonlinearity of power amplifier, frequency offset of local oscillator etc.), resulting in signal leakage between subcarriers or inter-carrier interference (ICI). When a user is operating in subcarrier-based duplexing mode, due to the enormous difference in the power of the transmitting signal and desired signal, the effect of ICI on the receivingsubcarriers could be significant, which should be taken into account in the cooperative OFDMA system, We will consider a user operating in subcarrier-based duplexing mode and look into the effects of the non-ideal subsystem characteristics on its performance. Then we will propose a transceiver structure that uses baseband echo cancellation to suppress the interference between transmitting and receiving subcarriers caused by these subsystem imperfections. For ease of notation, we will use “farend signal” and “near-end signal” to denote the desired signal (transmitted from other user(s)) and the signal transmitted by the user itself, respectively.

Echo cancellation process

When we transmit full-duplex data, the primary problem is undesired feed-through of the transmitted data signal into the receiver through the hybrid. This extraneous signal is called *echo*. Where the mechanism for echo was stated to be a mismatch between the impedance of the two-wire cable and the hybrid balancing impedance. The echo cancellation method of full-duplex transmission is illustrated. There is a transmitter (TR) and receiver (REC) on each end of the connection, and a hybrid is used to provide a virtual four-wire connection between the transmitter on each end and the receiver on the opposite end.

Fig:2 Echo Cancellation Using Duplexing in MIMO OFDM

The echo canceller is an adaptive transversal filter that adaptively learns the response of the hybrid, and generates a replica of that response which is subtracted

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from the hybrid output to yield an echo-free received signal.

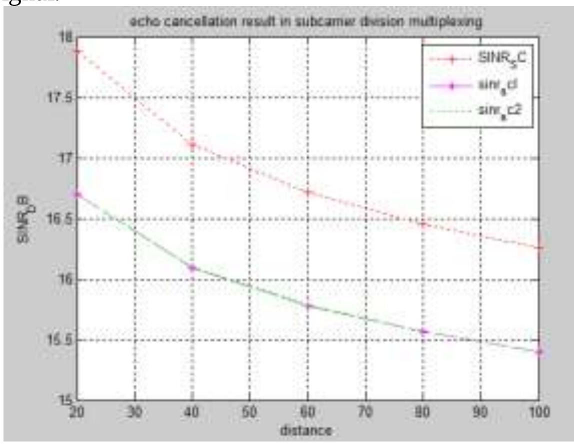

Fig:3(a): Performance of the proposed transceiver with localized subcarrier allocation

Interleaved SubCarrier analysis

In this paper our interest lies in the performance of cooperative OFDMA systems under subcarrier-based duplexing and in particular the tradeoffs and limitations in realistic configurations. To perform this we make use of a transceiver structure that utilizes baseband echo cancellation to suppress the interference between the transmitting and receiving subcarriers. The performance of this transceiver is verified by analysis and computer simulation, and it is shown that it is possible to achieve subcarrier-based duplexing in short-range low-transmit-power communication systems (e.g., 802.11a/g systems) with careful design. This scheme is then incorporated into the cooperation strategy of [10] to investigate its performance under realistic conditions. It is revealed that although the performance of the cooperative network is degraded due to the residual interference imposed on the receiving subcarriers by the transmitting subcarriers, it still performs better compared with conventional cooperation schemes.

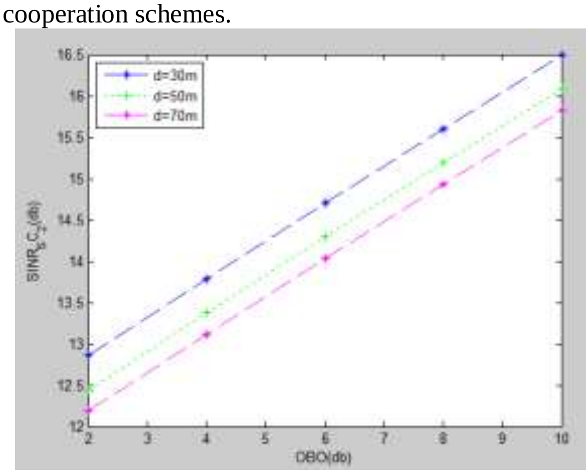

Fig:3(b): Performance of the proposed transceiver for different levels of phase noise (interleaved subcarrier assignment)

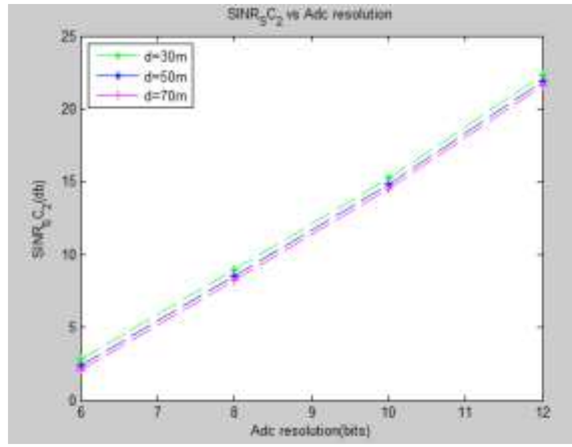

Fig:3(c): Performance of the proposed transceiver for different degrees of PA nonlinearity (interleaved subcarrier assignment)

Power distribution process

When the data rate of user 1 and user 2 varies while *d*10 is fixed to be 50m. It can be seen that the difference between the power consumption of DF cooperation in the ideal case and that in the realistic case increases with the data rate. The reason is that the transmit power of user 1 increases with the data rate, therefore more interference is generated to the data streams from user 2 to user 1, and user 2 needs to scale up its transmit power in order to compensate for the SINR loss. As the data rate increases, the extra transmit power required by user 2 also increases, thus the total power consumption of optimal DF cooperation will finally exceed that of AF&DF cooperation and that of no cooperation.

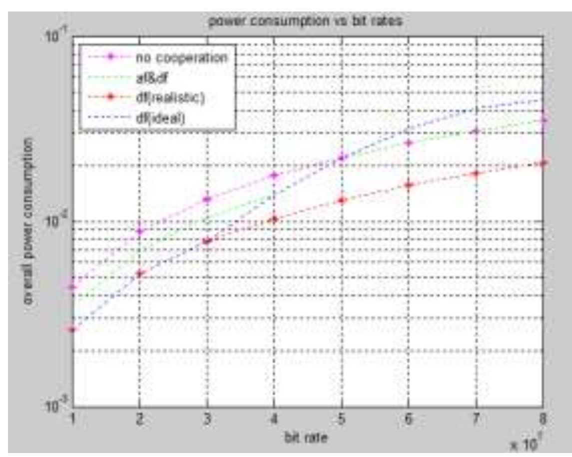

Fig:3(d): Total power consumption of 2-user cooperative OFDMA system for different data rates

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We also consider a 4 user system , where the base station is located at the origin of a 2-D plane, while the coordinations of user 1,2,3 and 4 are (50m,50m), (50m,-50m), (100m,50m) and (100m,-50m) respectively. User 1 and 2 help relay the messages of user 3 and 4. The data rate of user 1,2,4 are 20Mbps, and the data rate of user 3 changes between 0 and 40Mbps. It is shown in Fig. that optimal DF cooperation is better than AF&DF cooperation. The overall power consumption of optimal DF cooperation under realistic condition is atleast 25% less than that of the AF&DF cooperation scheme, which again demonstrates the advantage of the optimal DF cooperation scheme over the conventional schemes.

Power allocation in MIMO-OFDM

The concept of water filling can be extended to multiple users, where one resource is allocated to one user. Unfortunately, the computational complexity of the ideal solution explodes, because the two problems of allocating users to resources and distributing a user's transmit power budget are coupled. While the ideal solution is of interest for theoretical research, it has important flaws that prevent its use in a real-world application:Maximizing the sum throughput often means that cell-edge users with a "bad" channel get practically no throughput at all. This contradicts typical radio system design, where one of the most important design challenges is to reliably serve cell-edge users.Shannon's equation is not meaningful at extremes of the signal-to-noise ratio range. For example, a LTE radio link does not have modulation-and-coding schemes to exploit signal-to-noise ratios below about -2 dB. Water filling tends to spread the available power over the widest possible bandwidth, operating at very low signal-to-noise ratios.

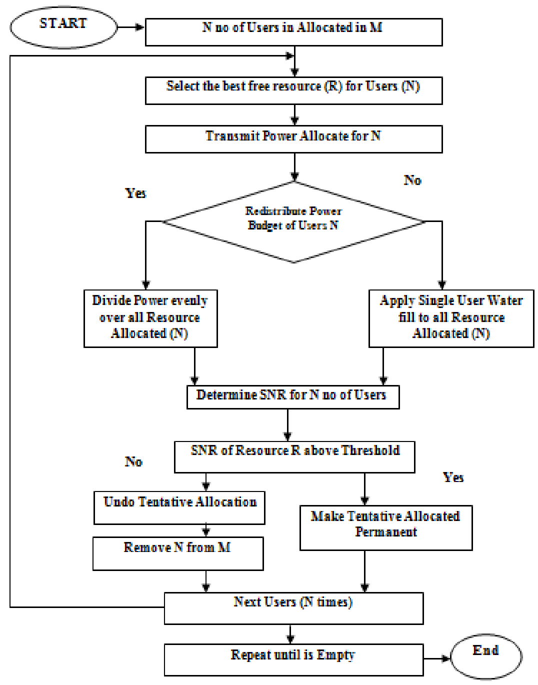

Fig:4:Waterfilling Process Flow Chart on MIMO OFDM System

Water filling Algorithm

- Users are handled in a Round-Robin fashion, and the best free resource is tentatively allocated to the current user. Since the best resource is picked first, the signal-to-noise ratio reduces for each additional resource. The process stops, when the signal-to-noise ratio drops below a user-defined threshold.
- The number of resources for any user can be limited to improve the performance of cell-edge users at the expense of sum throughput.
- The algorithm takes the power budget of each user as a parameter (again, for example one may allocate more power to cell-edge users).
- The mode parameter switches between fixed-power allocation. The code can be further optimized for fixed power allocation by replacing the iterative "water fill()" subroutine with another one that splits a user's power evenly between resources allocated to the user.

Result analysis

We incorporate the subcarrier-based duplexing scheme investigated in the previous section into the cooperation strategy to investigate its performance. To make the comparisons more meaningful we use the same configuration as. In particular we consider an OFDMA system with 20MHz bandwidth and 512 subcarriers, i.e., N= 512. The CP length is chosen to be 64. A raised cosine filter with rolloff factor of 0.2 is used for pulse

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shaping. The other parameters including those of the subsystem imperfections used in the simulation are the same as those used in the previous section. For each channel realization, we firstly assume perfect isolation between different subcarriers and obtain the optimal power and subcarrier allocation strategy as in (the ideal case). The power and subcarrier assignment is then incorporated into the simulation of the previous section to obtain the SINR values of the data streams from the source nodes to the relay nodes in the realistic model. Since these SINR values are lower than the ideal SNR values, we scale up the transmit power of the source nodes on the corresponding subcarriers by a factor of SNR/SINR to compensate for this loss. In this way, we can obtain the overall power consumption of cooperative OFDMA systems under realistic conditions. Resource Power allocation in the MIMO OFDM system with water filling algorithm requires lesser amount of power compared to the existing system of the capacity for the existing system and the proposed system. From the figure it is clear that there is an improvement in capacity of MIMO-OFDM channel when the water filling solution is implemented to achieve capacity maximization is used to allocate different power to the sub channels. illustrate the channel capacity versus SNR for different MIMO-OFDM systems. The graph shows that the capacity of the MIMO-OFDM channel increases as the number of antennas used at both the transmitter and the receiver increases. 4x4 MIMO systems provides better channel capacity.This indicates that a higher order MIMO system increases the system performance. It is interesting to note that the system performance remains almost the same when the number of transmitter and receiver antennas is altered (2x3 MI MO and 3x2 MIMO systems).It gives the comparison between various MIMO and SISO systems. This graph shows that MIMO System with water filling algorithm has the better performances compared to the all other systems.

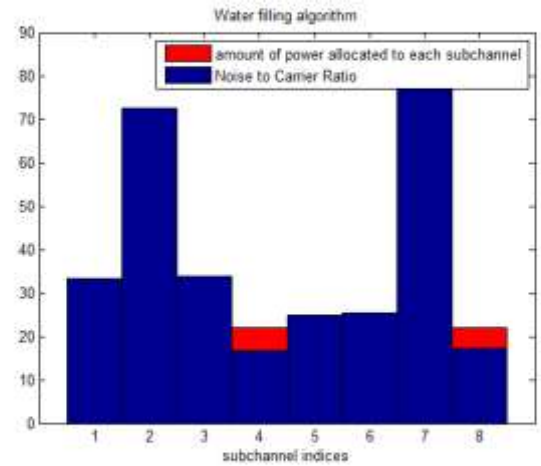

Fig:5(e) Power Allocation Process in MIMO OFDM

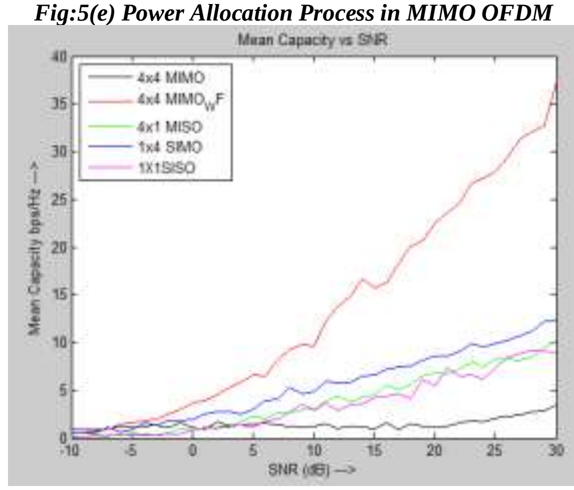

Fig:6(a) Capacity Ananlysis of SISO,SIMO.MISO,MIMO,MIMO-Waterfilling Process in Signal to Noise Ratio

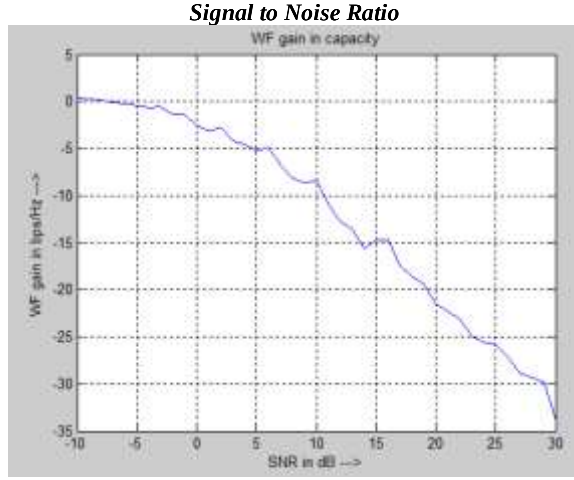

Fig:6(b) Waterfilling Gain Process in Signal to Noise Ratio

Conclusion

A particular subcarrier resource allocation approach investigated in this paper is a method based on nodes that transmit and receive on adjacent OFDM

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subcarriers simultaneously. To perform the investigation we proposed a transceiver structure that allows OFDM users to transmit and receive simultaneously on adjacent subcarriers so that the system tradeoffs and limitations of this approach could be understood. The performance of the transceiver was evaluated by both analysis and computer simulation and it was shown that the non-ideal characteristics of subsystems will limit the achievable SINR. In particular our investigation shows that the effects of quantization error and LO phase noise are more significant than other subsystem imperfections such as PA nonlinearity and Tx IQ imbalance. sum capacities of multicast and unicast schemes are shown for multiple antenna OFDM systems. Here it is supposed that there is no channel power difference between the users. In the multicast system, it is supposed that 4 users receive the same contents, while in the unicast system the contents of users are different from each other. 3 by 1 multicast and unicast system means that 3 users receive the same contents as one group and the left one user receives different content. And 2 by 2 multicast and unicast system means that 2 users receive the same contents as one group and the left two users are unicast users. It is noticed that the multicast scheme with the proposed method can achieve higher capacity than the unicast scheme or the mixed cases. The more multicast users exit, the higher system capacities can be achieved.

References

1. T. Alen, A. Madhukumar, and F. Chin. Capacity enhancement of a multi-user ofdm system using dynamic frequency allocation. IEEE, 2003.
2. T. Cover and J. Thomas. Elements of information theory. 1991.
3. A. Czylwik. Adaptive ofdm for wideband eadio channels. IEEE Globecom'96, London, UK, November 1996.
4. A. Goldsmith. Wireless Communications. Cambridge University Press, 2005.
5. Z. Hu, G. Zhu, Y. Xia, and G. Liu, "Multiuser subcarrier and bit allocation forMIMO-OFDM systems with perfect and partial channel information," in Proceedings of the IEEEWireless Communications and Networking Conference, vol. 2, pp. 1188–1193, March 2004.
6. T. Weiss, J. Hillenbrand, A. Krohn, and F. K. Jondral, "Mutual interference in OFDM-based spectrum pooling systems," Proceedings of the IEEE Vehicular Technology Conference (VTC '04), vol. 59, no. 4, pp. 1873–1877, 2004.
7. J. Jang and K. B. Lee, "Transmit power adaptation for multiuser OFDM systems," IEEE Journal on Selected Areas in Communications, vol. 21, no. 2, pp. 171–178, 2003.
8. T. C. Y. Ng and W. Yu, "Joint optimization of relay strategies and resource allocations in cooperative cellular networks," IEEE J. Sel. Areas Commun., vol. 25, no. 2, pp. 328–339, Feb. 2007.
9. A. Ghasemi and E. S. Sousa, "Fundamental limits of spectrum sharing in fading environments," IEEE Trans. Wireless Commun., vol. 6, no. 2, pp. 649–658, Feb. 2007.
10. L. Musavian and S. Aissa, "Capacity and power allocation for spectrum- sharing communications in fading channels," IEEE Trans. Wireless Commun., vol. 8, no. 1, pp. 148–156, Jan. 2009.
11. S. H. Li and R. D. Murch, "Full-duplex wireless communication using transmitter output based echo cancellation," in *Proc. 2011 IEEE Global Commun. Conf.*, pp. 1–5.
12. L. Ding, Z. Ma, D. Morgan, M. Zierdt, and J. Pastalan, "A leastsquares/ Newton method for digital predistortion of wideband signals," *IEEE Trans. Commun.*, vol. 54, no. 5, pp. 833–840, May 2006.
13. A. Wiewiorka and P. N. Noss, "Digital on-channel repeater for DAB," BBC R&D White Paper WHP120, BBC, Sep. 2005.
14. A. Guerin, G. Faucon, and R. Le Bouquin-Jeannes, "Nonlinear acoustic echo cancellation based on Volterra filters," *IEEE Speech Audio Process.*, vol. 11, no. 6, pp. 672–683, Nov. 2003.
15. C. Y. Chiu, C. H. Cheng, R. D. Murch, and C. R. Rowell, "Reduction of mutual coupling between closely-packed antenna elements," IEEE Trans. Antennas Propag., vol. 55, no. 6, pp. 1732–1738, Jun. 2007.