

Optimal relay selection and power allocation in OFDM relay-assisted underwater acoustic sensor networks

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Underwater acoustic sensor networks (UW-ASNs) have received tremendous attention in both academia and industry during the past decade. Due to its indisputable advantages for reliable and high-speed applications with size and power limitations, cooperative transmission particularly in the form of orthogonal frequency division multiplexing (OFDM) is a promising physical layer solution in underwater acoustic (UWA) communications. Because of the limited budget of power consumption at both source and relay nodes in cooperative UWA communications, resource allocation becomes a crucial design issue, which can yield significant improvement in almost any performance metric of relay channels. Optimal resource allocation has been well investigated in terrestrial OFDM-based relay channels; however, literature on adaptive relay selection and power loading for cooperative UWA communications is sporadic. Due to the special properties of UWA channel such as long propagation delay, frequency-dependent path loss, and particularly colored ambient noise, the solutions and algorithms obtained for terrestrial radio channel cannot be directly applied to UWA channel. Therefore, investigating similar problems under proper considerations of UWA channel leads to new results which are required to be derived; one of the strategies followed in this talk.
In this presentation, both optimal relay selection and power loading issues are investigated for an OFDM cooperative transmission over UWA channel. Amplify-and-forward (AF) relaying is considered with perfect channel state information (CSI) at the source, relay, and destination nodes. Moreover, sparse and frequency-selective Rician fading is assumed in the presence of colored Gaussian ambient noise. Unlike previous works on this topic, in this study, the power of noise is not identical for all subcarriers at both the relay and destination nodes. Two optimization problem are formulated and solved that rely on the minimization of the bit error rate (BER) and maximization of the system capacity. In each problem, both optimal relay selection and power loading issues are addressed through two dependent phases. In the first phase of each problem, an unconstrained optimization problem is solved to determine the optimal relay out of multiple relays vertically located at different depths of water. All-subcarrier (AS) basis approach is adopted in proposed OFDM-based transmission model in which a single relay is engaged to transmit the entire OFDM block to the destination. In the second phase of each problem, after selecting the optimal relay, another optimization problem is solved to obtain the optimal power allocation. This is jointly done at both the source and relay nodes under total power constraint and fixed subcarrier rate. Extensive simulations are conducted to evaluate the performance of proposed algorithms under different scenarios. Results of this talk could be a good guidance to study the considerations of physical layer for the deployment and operation of UW-ASNs.

Keywords: BER, Cooperative communication, OFDM, Underwater acoustic sensor networks.

Biosketch

Abdollah Doosti-Aref received BSc, MSc, and PhD degrees all in telecommunication systems engineering from Shahed University, Tehran, Iran, Malek Ashtar University of Technology, Tehran, Iran, and Babol Noshirvani University of Technology, Babol, Iran in 2006, 2009, and 2017, respectively. He was ranked #1 among the students of telecommunication engineering during both the BSc and PhD periods. Since 2009, he has been teaching technical courses of telecommunication in several universities of both Tehran and Mazandaran Provinces. He has also published several books concerned with mathematics and electrical engineering. His general research interests include signal processing, wireless communications, soft computing, and optimization algorithms. Since 2008, he has been working in the area of underwater communications especially over the Persian Gulf channel. Recently, his research mainly focuses on channel modeling and resource allocation in cooperative OFDM underwater acoustic sensor networks.

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❖ EDUCATION

Feb, 2013 – Oct, 2017	Babol Noshirvani University of Technology PhD in Telecommunication Systems Engineering Thesis title: Cooperative Underwater Acoustic Communication over the Persian Gulf
Feb, 2007– Sep, 2009	Malek Ashtar University of Technology MSc in Telecommunication Systems Engineering Thesis title: Modelling of Underwater Acoustic Channel along with Experimental Study in the Persian Gulf
Oct, 2002– Sep, 2006	Shahed University BSc in Telecommunication Systems Engineering Thesis title: Design and Simulation of a TDMA-Based Protocol Suitable for Industrial Environment

❖ ACCOMPLISHMENT

- First Rank in PhD Period, Average Mark: 19.13/20.
- First Rank in BSc Period, Average Mark: 16.23/20.
- First Rank in Pre-University Course Completion Period, Average Mark: 19.02/20.
- First Rank in High-School Period, Average Mark: 18.08/20.

❖ PUBLICATIONS

➢ Paper

- **Adaptive Relay Selection and Power Allocation for OFDM Cooperative Underwater Acoustic Systems.**
  (IEEE Transactions on Mobile Computing, IEEE, 2018)

- **Determination of the Best Carrier Frequency Based on the System and Environmental Parameters in Underwater Acoustic Systems.**
  (Physical Communication Journal, Elsevier, 2017)

- **Efficient Cooperative Multicarrier Underwater Acoustic Communication over the Persian Gulf Channel.**
  (Wireless Networks Journal, Springer, 2016)

- **Modulation Identification of Satellite Signals Using an Intelligent System.**
  (Journal of Soft Computing & Information Technology, Scientific Research, Iran, 2012)

- **A Novel Space Time Diversity Generalized Decorrelating Rake Receiver for Multipath downlink DS-CDMA Systems.**
  (2011 IEEE GCC Conference and Exhibition (GCC), IEEE, United Arab Emirates, 2011)

- **Implementation of Cooperative Virtual MISO Communication in Underwater Acoustic Wireless Sensor Networks.**
  (International Journal of Computer Science Issues, Scientific research, India, 2011)

- **Design and Simulation of a Secure and Robust Underwater Acoustic Communication System in the Persian Gulf.**
  (Journal of Communication and Networks, Scientific research, California, 2011)

- **Design and Simulation Study of a Short range Underwater Communication System Using a Novel Model for Shallow Water Multipath Acoustic Channel in the Persian Gulf.**
  (The Modares Journal of Electrical Engineering, Scientific Research, Iran, 2011)
  (The most visited article of mentioned journal from 2011 until now)

- **Design and Simulation of a New Model for Shallow Water Multipath Acoustic Channel in the Persian Gulf.**
  (2010 5th International Symposium on Telecommunications, IEEE, Iran, ITRC, 2010)

➢ **Book**

- **Special Issues in Computer and Electrical Engineering with MATLAB**
  (Negarande Danesh, Academic Press, Iran, 2012)

➢ **Supplementary Reading Materials and Lecture Notes**

- **Calculus I**
  (Tehran University, Jahad Academic Center, Iran, 2012)
- **Calculus II**
  (Tehran University, Jahad Academic Center, Iran, 2012)

- **Engineering Mathematics**
  (Tehran University, Jahad Academic Center, Iran, 2012)
- **Ordinary Diffretional Equation**
  (Tehran University, Jahad Academic Center, Iran, 2012)
- **Signals and Systems Analysis**
  (Parseh High Educational Institute, Iran, 2012)

❖ **PROFESSIONAL MEMBERSHIPS**

- Member of editorial team in Frontiers and Mechatronic Engineering Journal of En-Press Publishing, Tustin, Irvin, United States. (Since 2017).
  http://systems.enpress-publisher.com/index.php/FME/about/editorialTeam

- Member of telecommunications advisory board in Cambridge Scholars Publishing, Newcastle, United Kingdom. (Since 2017).
  www.Cambridgescholars.com/t/TelecommunicationsAdvisory

- Member of editorial team in electronics science technology and application journal of universe scientific publishing, Hougang, Singapore. (Since 2017).
  http://Esta.usp-pl.com/index.php/esta/about/editorialTeam

- Member of editorial team in Signal and Information Processing Journal of Whioce publishing, Singapore. (Since 2018).
  http://ojs.whioce.com/index.php/S-IP/about/editorialTeam

- Member of technical committee in international conference on advanced computer control. (Since 2018, 8th ICACC).
  http://icacc.org/committee.html

- Reviewer for:
  - IEEE Sensors Journal
  - Journal of Marine Science and Application
  - Journal of Recent Advances in Communications and Networking
  - International Journal of Sensors, Wireless Communications and Control
  - Journal of Signal and Information Processing
  - International Conference on Sensor Networks and Signal Processing (SNSP)
  - International Conference on Advanced Computer Control (ICACC)
  - International Conference on Electronics, Communications and Networks (CECNet)

❖ RESEARCH INTRESTS

- Digital and Analog Signal Processing
- Wireless Communications
- Cooperative Communications and Relay Networks
- Wireless Sensor Networks
- Underwater Communications
- Underwater Cognitive Acoustic Networks
- Sonar and Underwater Acoustic Communications
- Soft Computing and Evolutionary Algorithms
- Mathematical Optimization

❖ TEACHING EXPERIENCE

- Different undergraduate lessons of electrical and electronic engineering as well as various graduate lessons of telecommunication systems engineering in several universities of both Tehran and Mazandaran Provinces. (Since 2009).
- MATLAB software, from elementary to advanced level. (Since 2009).
- Soft computing and evolutionary algorithms. (Since 2014).