Goal-Oriented Wireless Sensor Networks: Error Exponent and Outage Analyses with Distributed Hypothesis Testing:

- Decision making via End-to-End Lossy Distributed Wireless Networks-

Tad Matsumoto, PhD
Life Fellow, IEEE
Professor Emeritus, Japan Advanced Institute of Science and Technology, Japan, and University of Oulu, Finland
Research Fellow of Institute of Science Tokyo, Japan
E-mail: matumoto@jaist.ac.jp

Abstract—The primary objective of this talk is to provide the participants with the knowledge on the analytical framework of identifying and evaluating a rate-threshold region and outage probability performance, respectively, in distributed hypothesis testing (DHT) against independence. In fact, DHT has recently been at the core of Network Information Theory, however, it is also related to Turbo Equalization, Distributed Lossless/Lossy Wireless Communications, Semantic Communications, and Semantic DHT, which are briefly introduced in this talk.

In the main part of this talk, we consider a single sensor–single decision center (DC) setup with side information, where a lossy source encoder (SE) transmits the quantized version of its observation to the DC with a specified communication rate via a fading wireless channel. At the same time, the DC has full access to side information via a static link having no rate constraint. The quantization process employs binary linear block codes, focusing on binary symmetric source (BSS) representing the observation, while the DC applies the Neyman-Pearson criterion for decision-making. Outage probability is then evaluated using the lossy source channel separation theorem. Numerical results compare the outage probabilities under the Nakagami fading model for different fading severity and correlation parameter values in the DHT problem.

Index Terms—Distributed hypothesis testing (DHT), error exponent, outage probability, rate-threshold, wireless sensor networks (WSNs)

Short Bio

TAD MATSUMOTO (IEEE Member '84, Senior Member '98, Fellow '10, Life Fellow ’21) received his B.S. and M.S. degrees in electrical engineering, and his Ph.D. degree in electrical engineering, all from Keio University, Yokohama, Japan, in 1978, 1980, and 1991, respectively. He joined Nippon Telegraph and Telephone Corporation (NTT), in 1980, where he was involved in a lot of research and development projects mobile wireless communications systems. In 1992, he transferred to NTT DoCoMo, where he researched on code-division multiple-access techniques for mobile communication systems. In 1994, he transferred to NTT America, where he served as a Senior Technical Advisor of a joint project between NTT and NEXTEL Communications. In 1996, he returned to NTT DoCoMo, where he served as the Head of the Radio Signal Processing Laboratory, until 2001. He researched on adaptive signal processing, multiple-input multiple-output turbo signal detection, interference cancellation, and space-time coding techniques for broadband mobile communications. In 2002, he moved to the University of Oulu, Finland, where he served as a Professor at Centre for Wireless Communications. In 2006, he has served as a Visiting Professor with the Ilmenau University of Technology, Ilmenau, Germany, supported by the German MERCATOR Visiting Professorship Program. Since 2007, he has been serving as a Professor with the Japan Advanced Institute of Science and Technology (JAIST), Japan, while also keeping a cross-appointment position with the University of Oulu. Since his retirement from JAIST in March 2021, his official affiliation has been moved to IMT-Atlantic, France, where he is serving as an invited professor. He is also Professor Emeritus of both JAIST and University of Oulu.

Prof. Matsumoto is a member of the IEICE. He has led a lot of projects supported by the Academy of Finland, European FP7, and the Japan Society for the Promotion of Science and Japanese private companies. He has been appointed as a Finland Distinguished Professor, from 2008 to 2012, supported by Finnish National Technology Agency (Tekes) and Finnish Academy, under which he preserves the rights to participate in and apply for European and Finnish National Projects. He was a recipient of IEEE VTS Outstanding Service Award, in 2001, Nokia Foundation Visiting Fellow Scholarship Award, in 2002, IEEE Japan Council Award for Distinguished Service to the Society, in 2006, the IEEE Vehicular Technology Society James R. Evans Avant Garde Award, in 2006, Thuringen State Research Award for Advanced Applied Science, in 2006, the 2007 Best Paper Award of the Institute of Electrical, Communication, and Information Engineers of Japan, in 2008, Telecom System Technology Award from the Telecommunications Advancement Foundation, in 2009, IEEE Communication Letters Exemplary Reviewer, in 2011, Nikkei Wireless Japan Award, in 2013, IEEE VTS Recognition for Outstanding Distinguished Lecturer, in 2016, and IEEE TRANSACTIONSON COMMUNICATIONS Exemplary Reviewer, in 2018. He served as an IEEE Vehicular Technology Distinguished Speaker, 2016-2018. Since January 1st, 2024, he has been serving as a secretary of IEEE Nagoya Section LMAG.