Mathematical Framework of Sequence Design for Wireless Communication Systems

Overview

There have been significant and far reaching changes in communications systems during past few years, which have vastly magnified their use and revolutionized the services they can provide. Recent developments in mobile radio and optical fiber systems, to mention but two, are clear examples of this. These changes have come about as a result of the very fruitful synergy between conceptual and theoretical advances in a range of communications techniques, on the one hand, and advances in technology leading to various very practical applications, on the other.

Sequences with good correlation properties play a pivotal role for every communication systems. Fundamental signal processing tasks such as synchronization and channel estimation may not be possible without the support of sequences, not to mention their applications in code-division-multiple-access (CDMA) communications in which good signature sequences have to be adopted to enable low/zero-interference multiuser communication.

The course on sequence design for communication applications will cover the topics where theory and practice have interacted beneficially, leading to exciting current and future developments in communications. Recent advances in the theory and synthesis of pseudorandom (PN) sequences have already led to practical applications in spread-spectrum and CDMA communication systems, with tremendous potential for future developments. But communication systems with PN sequences often suffer from inter-symbol-interference (ISI), multiple-access-interferences (MAI) in asynchronous scenarios. To overcome this, zero correlation zone (ZCZ) and low correlation zone (LCZ) sequences have been designed for quasi-synchronous CDMA systems. ZCZ sequences maintain orthogonality at small time lags, which results in zero ISI and MAI. Efficient sequence design like quasi complementary sequence sets (QCSS) also helps in supporting large number of users in multi-carrier CDMA (MC-CDMA) systems. The design of sequences is also important to Multi-user shared access (MUSA), a non- orthogonal multiple access scheme (NOMA), since it can determine the interference between different users and the system performance.

In the course we will discuss about the Golay complementary sequences (GCS), mutually orthogonal Golay complementary sequences (MOGCS), QCSS, Z-complementary sequences, ZCZ sequences, LCZ sequences and also discuss about their applications. A special session on ambiguity function and the application of GCS in radio detection and ranging (RADAR) waveform design will also be there. There will be a discussion on efficient sequence designs for 5G communication systems. There will also be a session where there will be discussion on Barker sequences, Rudin-Shapiro sequences, M-sequences, Frank sequences, Chu sequences, Huffman sequences, Frequency Hopping sequences, and Optical orthogonal sequences, which have many important applications in designing modern communication systems. In addition, spectrally-constrained sequences which have important applications in cognitive radio/radar systems are to be introduced. Hand-on experience on Matlab code and how to generate the Golay Sequences and ZCZ sequences by using Matlab code.

In this course, hardware design using Verilog will be presented. Apart from basic syntaxes of Verilog, writing of synthesizable Verilog code (or RTL code) will be stressed upon. This will be demonstrated with a hardware model for computation of GCD (greatest common divisor). Breaking up the design into data flow path and control flow will be highlighted using this example. There will be lab classes where the participants will implement the same. Separate assignments may be given based on the interest of the participants. Finally, Verilog programming will be explained to generate the Golay Sequences and ZCZ sequences.

Modules	Mathematical Framework of Sequence Design for Wireless Communication Systems: **January 13 - January 19** **Number of participants for the course will be limited to 60.**
You Should Attend If…	▪ 4th Year B.Tech in Electronics and Communication Engineering, 1st and 2nd year M.Tech in Communication, research student in the relevant areas.
Fees	The participation fees for taking the course is as follows: **Participants from abroad : US $400** **Industry/ Research Organizations: Rs. 5000** **Academic Institutions: Rs.1000 (Student), Rs. 3000 (Faculty)** The above fee include all instructional materials, computer use for tutorials and assignments, laboratory equipment usage charges, 24 hr free internet facility. The participants will be provided with single bedded accommodation on payment basis.

The Faculty

Dr. Zilong Liu has been with the School of Electrical and Electronic Engineering, Nanyang Technological University (NTU), Singapore, firstly as a Research Associate (since July 2008), and since November 2014 as a Research Fellow. He completed his PhD at NTU from August 2009 to August 2013, working on *Perfect- and Quasi-Complementary Sequences* and their applications in communication and radar. From May 2012 to Feburary 2013, he was a Visitor to the University of Melbourne, working with Prof. Udaya Parampalli. In June 2013, Dr Liu was awarded a Visiting Postgraduate Internship to the Hong Kong University of Science and Technology (HKUST), hosted by Prof. Wai Ho Mow. To date, Dr Liu has published **19 IEEE journal papers**, including **14 IEEE Transactions papers** (**4 in IEEE Transactions on Information Theory as the first author**), as well as 13 IEEE conference papers. Dr. Liu is an Associate Editor of IEEE Access since January 2017. More details of his research can be found in the link at: www.ntu.edu.sg/home/zilongliu

Dr. Sudhan Majhi is presently working as an Assistant Professor jointly in the department of Mathematics and EE, currently he is Sir Visvesvaraya Young Faculty Research Fellow. He has obtained his PhD in wireless communications from the school of computer engineering, Nanyang Technological University (NTU) Singapore. He has done postdoc from university of Michigan-Dearborn, MI, USA, Institute of Electronics and Telecommunications of Rennes, France, and NTU, Singapore. He received best academic NI ASEAN Graphical System Design Achievement awards in 2012. He received a young scientist start-up grant, DST, India. He is associate editor of Journal of Circuits, Systems and Signal Processing: Springer.

Dr. Arijit Mondal is an Assistant Professor in the Department of Computer Science and Engineering, Indian Institute of Technology, Patna. His research interest is in the area of CAD for VLSI, Analog EDA.

Course Co-ordinator

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