جامعة القاهرة

Dept. of Electronics and Electrical Communications
Faculty of Engineering – Cairo University

قسم هندسة الإلكترونيات و الاتصالات الكهربية
كلية الهندسة - جامعة القاهرة
الجيزة- القاهرة – جمهورية مصر العربية

Seminar by

Dr. Ahmed Tewfik

Chairman, EE Dept. - University of Texas at Austin

Hammam Lecture Hall – Department of Electronics and Electrical Communications Engineering

Faculty of Engineering – Cairo University

Tuesday, 16 August, at 12:30 PM.

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Multi-channel Analog-to-Digital (A/D) conversion using a single A/D Converter

Many applications in signal processing such as audio, physiological signals, and brain machine interfaces, require digitizing analog signals from multiple channels. However, designers of such systems are often faced with restrictions that limit their ability to use multiple analog-to- digital (A/D) converters. We approach the problem of multichannel A/D conversion with the unique concept of using fewer A/D converters than channels. To the best of our knowledge, no such approach has been previously proposed.

A native approach to the problem involves modulating the analog signals so that they occupy non over lapping frequency bands and digitizing the sum of the modulated signal. The main drawback of such an approach is that it increases the frequency of operation of the sigma delta A/D converter, adding to power consumption. If several signals are multiplexed using such an approach, or if the bandwidth of the underlying signals is large, such an approach may lead to unfeasible frequency of operation for the sigma delta A/D converter.

In our solution to this problem, we deliberately mix the channels in such a fashion that we can later separate them. Given M channels of analog data, we generate N mixtures of the analog data such that $N < M$. The A/D conversion is done on the N mixtures. Finally the mixtures are separated into M digitized channels. We show that perfect separation of the input signals after A/D conversion is possible if all input signals are known to have sparse representations involving no more than a fixed number of atoms drawn from a known dictionary. Mixing is done by modulating and spreading some of the input signals so that the total bandwidth of the mixture is slightly larger than that of the original input signals. Under such a scenario, signals can be separated using any method for sparse signal representation. We quantify the amount of bandwidth expansion needed to achieve signal separation and also discuss the design of spreading sequences and dictionaries.

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Ahmed H Tewfik received his B.Sc. degree from Cairo University, Cairo Egypt, in 1982 and his M.Sc., E.E. and Sc.D. degrees from MIT, in 1984, 1985 and 1987 respectively. He is the Cockrell Family Regents Chair in Engineering and the Chairman of the Department of Electrical and Computer Engineering at the Univeristy of Texas Austin. He was the E. F. Johnson professor of Electronic Communications with the department of Electrical Engineering at the University of Minnesota until September 2010. Dr. Tewfik worked at Alphatech, Inc. and served as a consultant to several companies. From August 1997 to August 2001, he was the President and CEO of Cognicity, Inc., an entertainment marketing software tools publisher that he co-founded, on partial leave of absence from the University of Minnesota. His current research interests are in minimally invasive surgery, genomics and proteomics,, brain computing interfaces and programmable wireless networks. Prof. Tewfik is a Fellow of the IEEE. He was a Distinguished Lecturer of the IEEE Signal Processing Society in 1997 - 1999. He received the IEEE third Millennium award in 2000. He was elected to the position of VP Technical Directions of the IEEE Signal Processing Society in 2009 and served on the board of governors of that Society from 2006 to 2008. He has given several plenary and keynote lectures at IEEE conferences.

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