WHEN CLASSICAL AND QUANTUM-SIGNAL PROCESSING MEET...

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Abstract

Classical signal processing theory and its nano-scale based implementation are set to depart from obeying the laws of classical physics. We embark on a journey into the weird & wonderful world of quantum-physics, where the traveller has to obey the sometimes strange new rules of the quantum-world.

Hence we ask the judicious question: can the marriage of applied signal processing and communications extented beyond the classical world into the quantum world?

The quest for quantum-domain communication solutions was inspired by Feynman's revolutionary idea in the 1980s: information-bearing bits can be mapped to particles such as photons or to the spin as well as to the charge of electrons for encoding, processing and delivering information.

Against the backdrop of numerous open research questions, we will explore some topical problems both in quantum-computing aided as well as in quantum-domain signal processing and communications.

Some of the multi-disciplinary questions to be answered are:

- How would you define quantum computing and quantum communications? What are the pros and cons?
- What are the most challenging limitations imposed on quantum computing and how as well as when they will be mitigated?
- What are the stumbling blocks in quantum communications and how as well as when they will be mitigated?
- In wireless communications we often encounter large-scale search problems, especially in the context of multi-component Pareto-optimization. **What are the most compelling applications?**
- How could the collaboration of the physics, computer science, electronics, material science and telecomms community expedite progress in this fascinating new field?

Quantum-search algorithms are potentially capable of searching through an N-element search-space with the aid of $\sqrt{N}$ cost-function evaluations, which is beneficial in large-scale Pareto optimization. Commencing with a brief historical perspective, a variety of efficient quantum-assisted solutions will be explored with a view to inspire the audience to explore further by reaching out to other research communities without requiring an engineering degree in wireless communications.

In the quantum-world the quantum channel may simply be constituted by the deleterious effects of the environmental perturbations corrupting the superimposed quantum-state of particles representing the quantum-bits. In a philosophical - rather than engineering - context this may be deemed reminiscent of the Brownian motion of electrons in a 'Gaussian channel' corrupting the classic information bits. Hence we will also discuss how the isomorphism of classic and quantum codes may be exploited for mitigating the hostile effects of quantum-decoherence, which results in quantum-bit flips. These quantum codes have the potential to expedite the development of quantum communications.

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