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Advancing the Arizona State University Knowledge Enterprise

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Energy-Efficient Distributed Estimation using Nonlinear Amplifiers

Wireless sensor networks use spatially distributed sensors (nodes) to monitor physical or environmental conditions, for example, temperature, and pressure. Applications of such networks include battlefield surveillance, environmental monitoring, industrial process monitoring and control, vehicle monitoring and health monitoring. These sensor nodes may be deployed in difficult-to-access locations, and thus should be inexpensive. Furthermore, the nodes should have their own power source, typically a battery, to power the various required sensor components, such as a radio transceiver for communications, a microcontroller and electronic circuits for interfacing with the sensors. To maximize sensor lifetime, it is desirable to have high efficiency components. Linear amplification in a transceiver can provide high accuracy, but at the expense of consuming more power. Amplifiers are more efficient when operating in the non-linear (distortion) range, but provide lesser accuracy in the output. There is therefore a need to develop higher efficiency sensors to preserve battery lifetime, while maintain good signal accuracy. Conventional methods of amplifier predistortion adaptively linearize the amplifier. This works well in a small operating range, but may not be sufficient for sensor applications.

Researchers at Arizona State University have developed a method that allows highly-efficient non-linear amplifiers to be used in sensor nodes, providing a greater signal range, a higher quality signal, while also conserving energy. This method adaptively predistorts the amplifier to a model for the non-linear operation of the amplifiers. This ensures that the individual time-varying nonlinearities of the sensor transmitters are “fit” to the same nonlinear transmissions across all sensor nodes to ensure amplifier behavior is consistent between nodes. Non-linear outputs of sensor measurements from sensor nodes can then be analyzed using a distributed estimation algorithm in order to provide a high quality signal of the fused data.

Potential Applications

- Healthcare monitoring networks
- Environmental monitoring
- Battlefield surveillance and military tracking devices
- Vehicle monitoring
- Industrial process monitoring and control

Benefits and Advantages

- Lower Costs – Reduces maintenance costs by increasing battery life
- More Range – Allows network to transmit signals at greater distances
- Better Quality – Provides stronger transmitter signals; Estimation is more

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robust to heavy-tailed noise, and interference.

For more information about the inventor(s) and their research, please see Dr. Andreas Spanias' directory webpage

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