Title
Multihop Sensing and Communication Networks (SEN 5)

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Multihop Sensing and Communication Networks

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Introduction: Communicate and estimate variables intrinsic to given network

Standard Sensor Networks
- Detect and estimate variables extrinsic to given network
- Communication and estimation are not coupled - An optimal communication scheme can be used with an optimal estimation scheme to yield best results

Proposed Sensor Network System Model
- Variables of interest are intrinsic to the given network
  - Example: Channel impulse responses between nodes
- Communication and estimation are coupled - One needs poor communication schemes to generate good estimates and vice versa

Problem Description: Minimize sum distortion of channel estimates at the destination

Measure the fidelity of the estimate by: \( D_i = \mathbb{E}[\hat{h}_{t,i} - h_t]^2 \)
Also define the distortion diversity by: \( d(x) = \lim_{\text{SNR}_i \rightarrow \infty} D_i = \Theta(\text{SNR}_i^{-p}) \)

Assumptions
- Time orthogonal communication - one node “Talks” at each point in time
- Block Fading channels with independent, Gaussian channel coefficients and noise

Problem Statement: Minimize \( D = \sum_{i=1}^{n} D_i \) given a fixed total time \( T \)

Overview of Results

Estimate and Forward

\[ X_j \rightarrow Y_j \]
\[ h_{ij,1}, h_{ij,2}, h_{ij,3} \]
\[ t \in I_j \]

Amplify and Forward

\[ X_j \rightarrow Y_j \]
\[ m_{ij,1}, m_{ij,2}, m_{ij,3} \]
\[ t \in I_j \]

Where \( m_{ij} \) is a sufficient statistic

Final Result: The achievable distortion diversity for hop \( i \) given the Estimate and Forward scheme is upper bounded by

Final Result: The achievable distortion diversity for hop \( i \) given the Amplify and Forward scheme is upper bounded by

Building Towards Arbitrary Topologies

Final Result: Time domain multiple access is one of the optimal communication schemes for the first hop in a two hop tree network

Proposed Solution: Employ either Estimate-and-Forward or Amplify-and-Forward

Overview of Results

Estimate and Forward

Figures