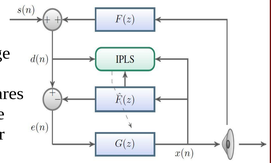
ECE Open House

Optimization for Signal Processing and Communication

Zhi-Quan (Tom) Luo

Adaptive Feedback Cancellation in Hearing Aids Using the IPLS Algorithm

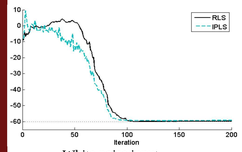
- Problem
  - Cancel the positive feedback between the receiver and the microphone in the hearing aid
- Specification
  - Low complexity
  - Adaptive to input change
  - Robust to environment change
- Approach
  - Use Interior Point Least Squares (IPLS) to adaptively adjust the weight of the cancellation filter



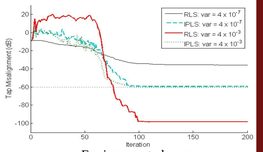
1

Adaptive Feedback Cancellation in Hearing Aids Using the IPLS Algorithm

- Simulation



White noise input



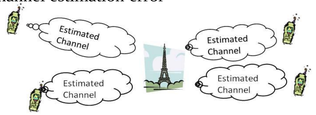
Environment change

- Benefit
  - More robust to environment change than RLS
  - Low initial divergence
  - Low steady-state error

2

Robust Beamforming in MISO Downlink System

- Model
  - A single base station is equipped with M antennas, and tries to serve K users with single antenna simultaneously.
  - Allow channel estimation error

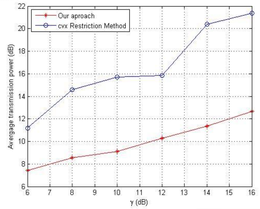


- Goal : minimize the transmit power, while satisfying the Quality-of- Service constraints under all possible channels
- Difficulty: Infinitely many constraints due to channel estimation error

1

Robust Beamforming in MISO Downlink system

- Approach
  - S-Procedure → transform infinitely many constraints into a single constraint
  - Semi-Definite Relaxation
  - Solve by existing solver, e.g. SeDuMi
- Result
  - If the estimation error is small enough, our approach guarantees to provide a global optimal solution to the original problem with a implementable algorithm.

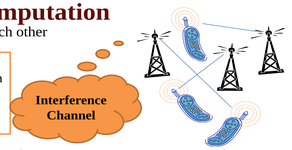


2

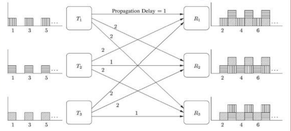
Interference Alignment: Complexity and Computation

- Users can cause interference to each other

Applications:
- Multi-cell Coordinated Transmission
- DSL
- Cognitive Radio
- Ad-hoc wireless Networks



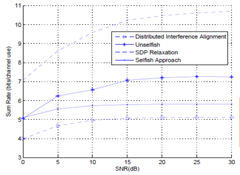
Interference Management Approaches:
- Decoding
- Treat as Noise
- Orthogonalizing (TDMA, FDMA)
- **Interference Alignment (every one gets half of the cake !!!!)**



1

Interference Alignment: Computation and Complexity

- **Although IA have benefits, but it is too complex in MIMO:**
  - Maximizing the total degrees of freedom in **NP-hard**
  - Checking the achievability of a set of degrees of freedom in MIMO case ($M \geq 3$) is **NP-hard** too
- **Using Convex Optimization Methods to Approximate IA:**



- Introduced a set of utility functions which capture interference alignment
- Proposed Iterative Algorithm for linear tranceiver design

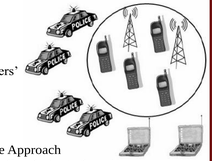
Benefits:

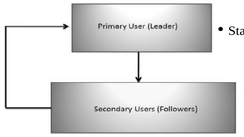
- No need for a-prior knowledge of DoF's (this knowledge cannot be gained in polynomial time)
- Doing Joint Power allocation and IA

2

A Stackelberg Game Approach to Distributed Spectrum Management

- Primary Users (Licensed)
- Secondary Users (Unlicensed)
- How to Allocate the power of secondary users?
- Difficulties:
  - Secondary users don't know where the primary users' receivers are.
  - How to sense the spectrum?



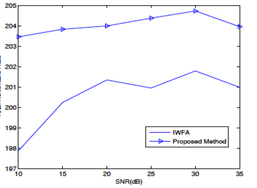


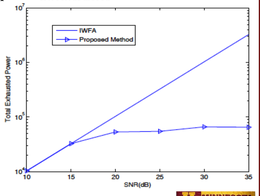
- Stackelberg Game Approach
  - Primary User (Leader) sets the prices for each tone.
  - Each Secondary User Maximizes its own utility, using the announced price (IWFA).

1

A Stackelberg Game Approach to Distributed Spectrum Management

- Benefits of the algorithm:
  - Distributed
  - Low complexity (like IWFA)
  - Little overhead communication
  - Respecting the interference temperature constraint





2