Optimal Bayesian Resampling for OFDM Signaling over Multi-scale Multi-lag Channels
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Motivation & Introduction

- **Underwater acoustic (UWA) communication channels suffer from:**
  - Long delay spreads,
  - Significant Doppler effects
- Such channels are also **ultra-wideband** in nature. Thus, the typical UWA distortion can be well-described by a multi-scale/multi-lag (MSML) channel model.
- Resampling compensate for the **scale effects** of UWA channels. In this paper, the **optimal resampling factor** for OFDM signaling over MSML channels is investigated from a Bayesian perspective.

System Modeling

- **MSML Channel model:**
  \[ h(t, \tau) = \sum_{n=1}^{M} h_n \delta (\tau - \tau_n(t)), \quad \tau_n(t) = \tau_n - a_n t \]
- Received Signal:
  \[ y(t) = \sum_{n} h_n x ((1 + a_n) t - \tau_n) + \nu(t). \]
- Decoded Signal:
  \[ \hat{x}_m = \left( \frac{1}{T} \int_{0}^{T} h_m \left( \frac{t}{1+b} \right) e^{-i2\pi f_m t + \frac{\pi}{b} t} dt \right) x_m + \]
  \[ \sum_{k \neq m} \left( \frac{1}{T} \int_{0}^{T} h_k \left( \frac{t}{1+b} \right) e^{-i2\pi f_k t + \frac{\pi}{b} t} e^{-i2\pi (f_m - f_k) t} dt \right) x_k + \nu_m, \]
- ICI term induced by the MSML channel
- **ICI Power**
  \[ P_{ICI}^{(m)} = E \left\{ \sum_{k \neq m} c_{km} x_k \right\}^2 = E \left\{ |c_{km}|^2 \right\} \]

Simulation Result

- **Mobility** induces **unique time-scaling** on each path of the **multipath channel**, which in turn, results in **ICI at the receiver**.
- The optimal resampling factor for the MSML channel was determined under the assumption of statistical models for the delays, scales and path gains of the MSML.
- The **exact ICI power** was determined and then a **tight upper bound** to this power was developed which enabled optimization.
- For the special case of **K-state modeling** of the scale parameters, the upper-bound was evaluated and optimal resampling factor calculated.
- Simulation results show that the proposed method and model result in better performance than that of the classical resampling factor computation via comparison of the transmitted and received packet durations.
- Current approach assumes a **Rayleigh-like model** for the channel coefficients; However a **Ricean model** may be more accurate; this is an avenue of future work.