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Lightning Talk End-Gen Day, Feb. 27 2025

AI-based waveform generation exploiting information theory and propagation physics

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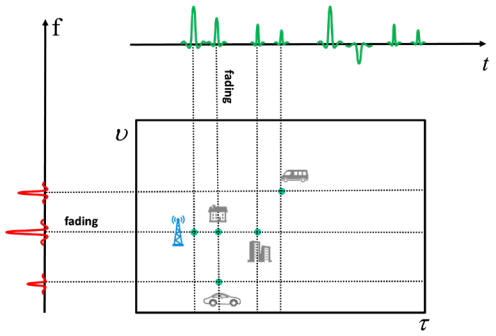
Universal characterization and sounding of channels

- Information-theory based characterization of channels
  - Transfer function
    - Amount of frequency selectivity unknown a priori
    - -> develop automated strategies for adaptive sampling
  - Time variations unknown a priori
    - Adaptation of sounding to different variation timescales
    - Automated generation of waveforms for overspread channels;
    - Exploitation of invariants: build on experience from OTFS
  - Nonlinear description
    - Sound for amount of nonlinearity



- Efficient protocols for conveying waveform choice
  - How to do sounding when sounding waveforms not known to RX?
  - Improve feedback efficiency by exploiting channel physics (different timescale of variations
  - Protocol design for multi-user communications
  - Feedback design for impulse responses
  - How to do feedback before communication is established ?

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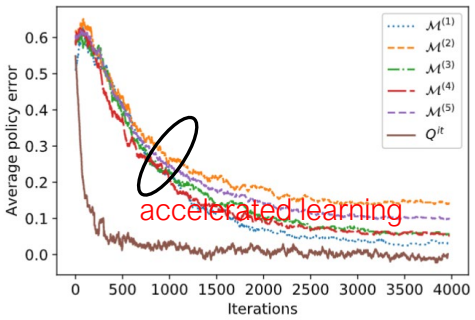
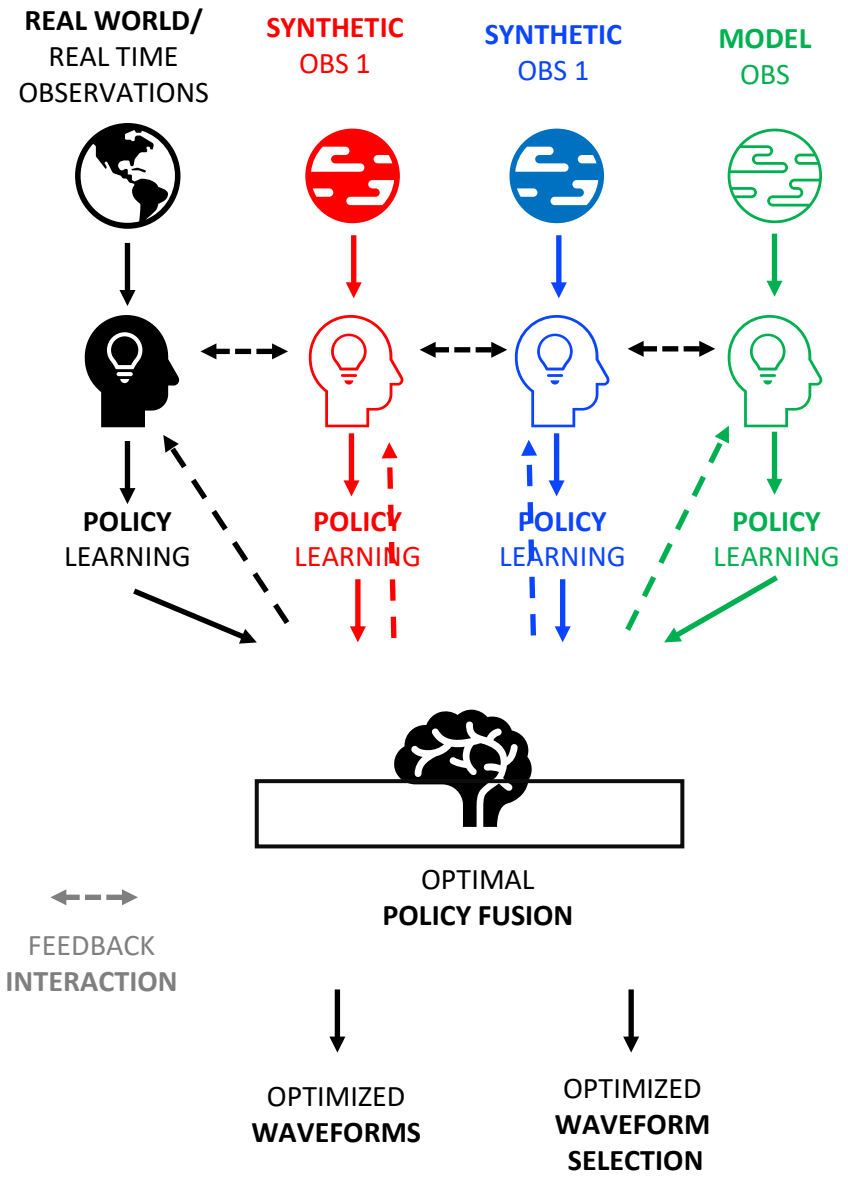
Generative Multi-Environment Learning

- New reinforcement learning paradigm
- Create structurally related synthetic environments/channels – based on real environments
  - Generating auxiliary training samples/observations
  - Achieves gains of multi-agent learning without needing identical agents with identical dynamics – significant acceleration of learning
  - NOT digital twins, but **digital cousins** (structurally related to real environment/channel)
- Can run cousins in "reverse" time
- Can perform learning on digital cousins with different cost functions (different waveform goals)
- Can explore impact of medium to low quality waveforms and policies to ensure that real system does not employ such strategies





Liu & M, IEEE Trans on Comm 5/2020,Bozkus & M, EUSIPCO '22, ICASSP'23, IEEE Trans on SP'24 x 2, Bozkus & M, SPAWC'24, in submission (also with Tara Javidi), Bozkus & M,ICASSP'25

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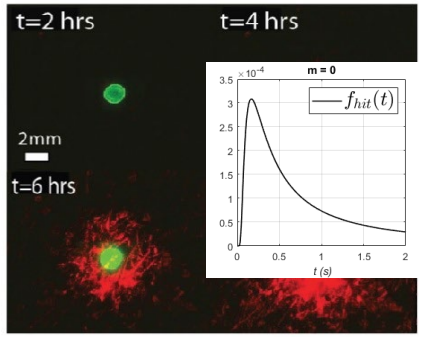
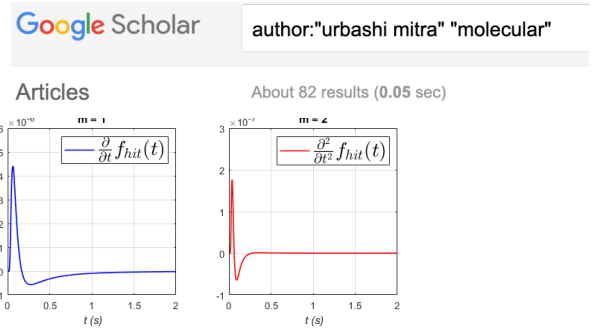
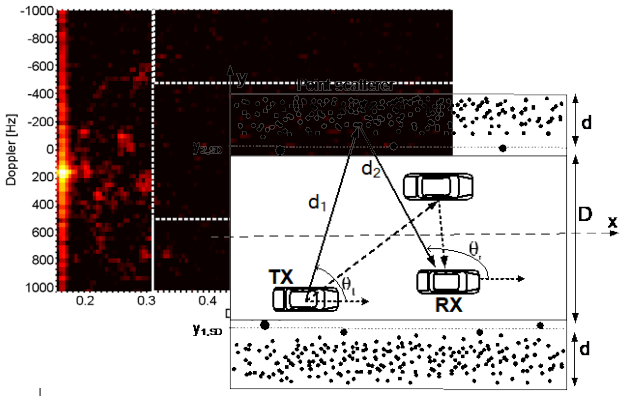
Channel Estimation/Modeling Experience

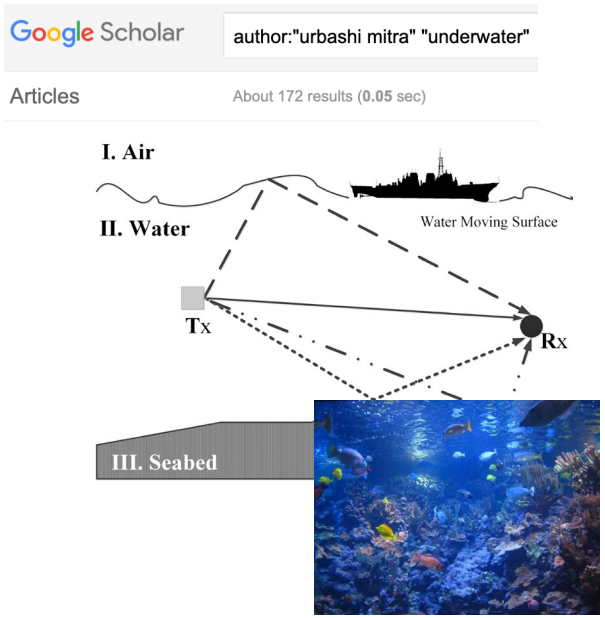




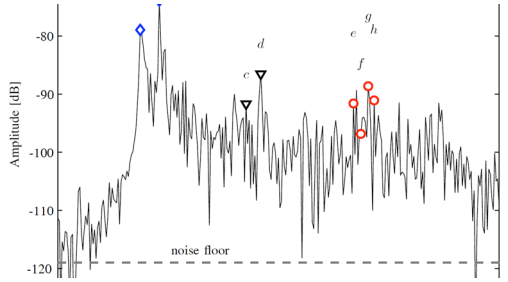
MOLECULAR

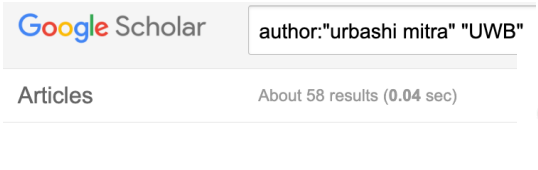


V2V

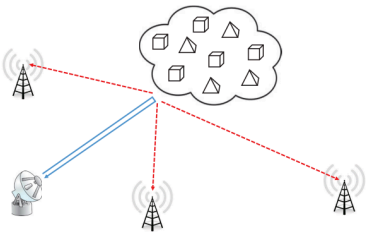


UNDERWATER

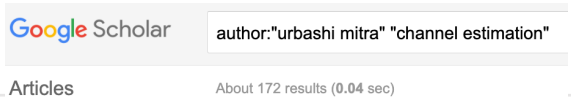




- MODELING
- **ESTIMATION**
- THEORETICAL LIMITS
- **TRANSCEIVER DESIGN**
- WAVEFORM DESIGN



RADAR/ISAC



Radar Waveform Design in Spectrum Sharing Environment: Coexistence and Cognition

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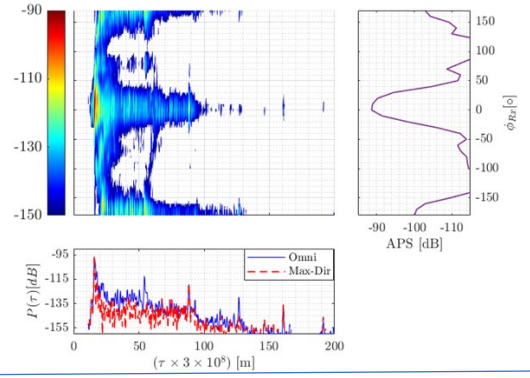
Channel Measurement/Modeling Experience

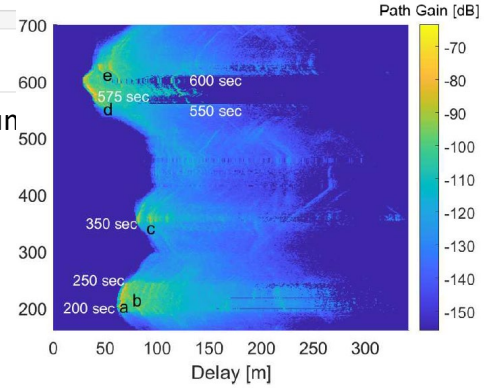
Google Scholar | author:molisch AND ("channel measurement")

Articles | About 216 results (0.06 sec)

Massive MIMO channel sounder

World's first Angular Delay Power Spectrum for outdoor Sub-THz wideband links



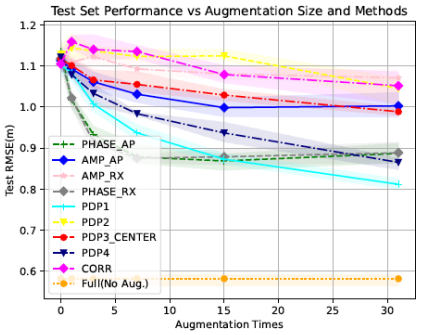


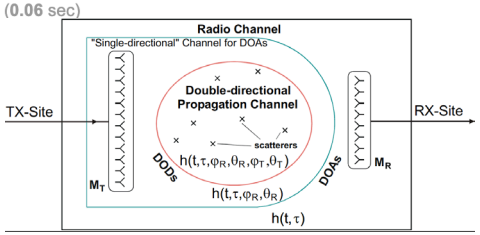
Distributed massive MIMO impulse responses

Google Scholar | author:molisch AND "channel model*"

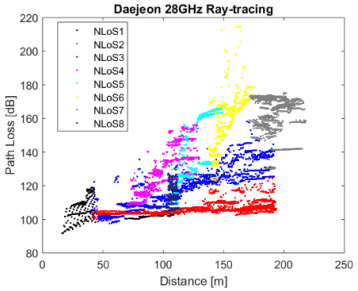
Articles | About 464 results (0.06 sec)

Physics-based data augmentation for machine learning

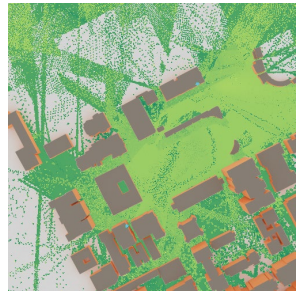




Double-directional channel model – now used in all standards



Street-by-street channel model for urban microcells

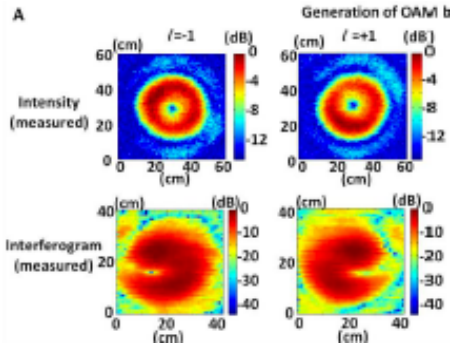


ML-based channel prediction

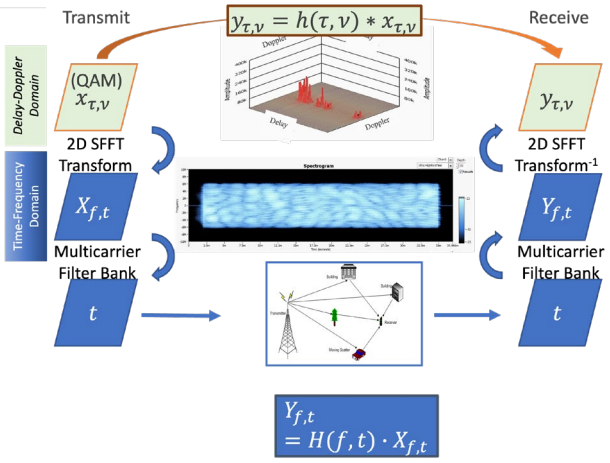
Google Scholar | author:molisch AND "modulation"

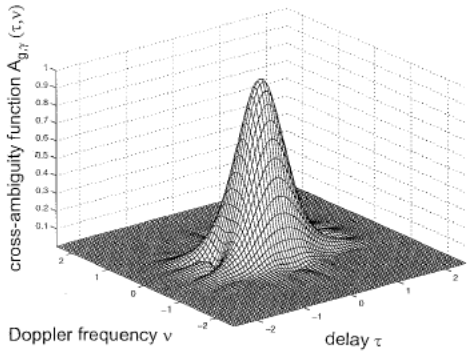
Articles | About 355 results (0.08 sec)

World's first Orbital Angular Momenta M=multiplexing demonstration at mmWave



Orthogonal Time Frequency Space (co-author of first paper, WCNC'17)





Non-orthogonal Multicarrier schemes