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Making UWB Positioning Robust to Multiuser-Interference (MUI)

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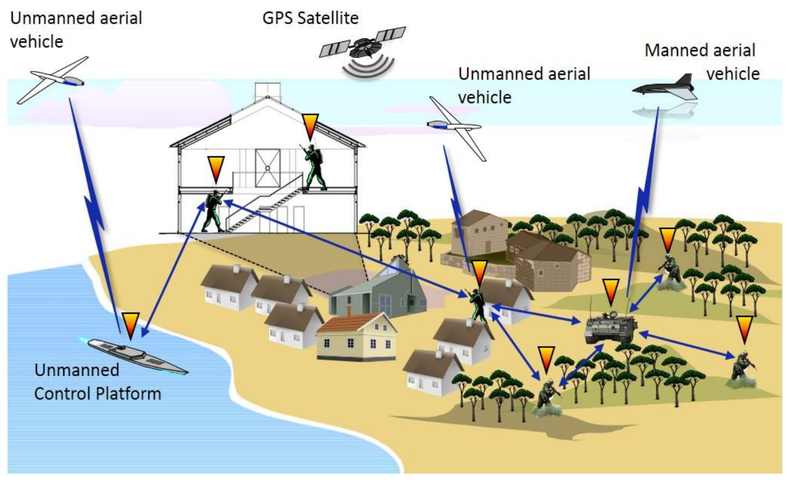
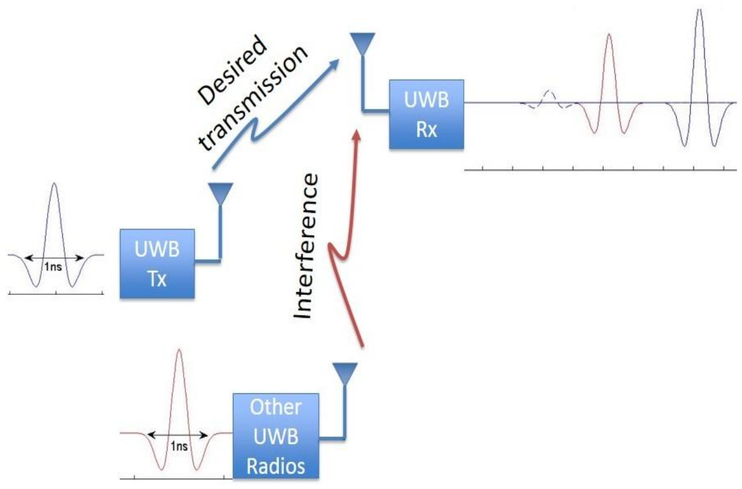
Why Multiuser Interference (MUI)?



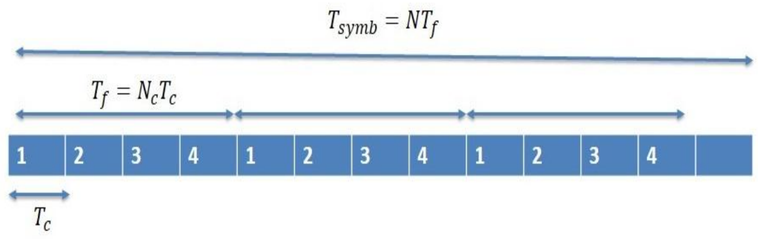
- No central controller to coordinate transmissions
- Delay critical applications: Battlefield, Disaster rescue

Impact of MUI on Ranging Accuracy



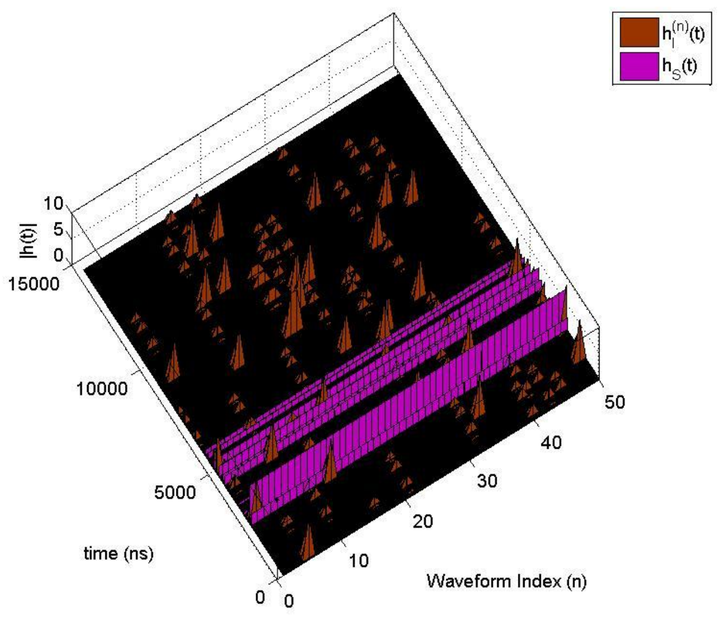
- Early false detection from Interference MPCs
- Miss detection of weak signal MPCs

Time-Hopping Sequences to Combat MUI



Users are assigned unique chip sequences $c_k(n)$
- Receiver only knows the chip-sequence of the desired user
- De-Hopping gives processing gain
- Drawbacks:
  - Processing gain often insufficient
  - Residual Interference comparable to first arriving MPC (LOS/NLOS conditions, Near/Far effect)
  - Finding a good threshold is difficult

Alternate Strategy: Do not Average Across Frames



- Signal MPC in different frames time aligned
- An interference MPC occurs at different locations in different waveforms:
  - $c_1(n) - c_k(n)$ is different for different *n*
- Odds of noise peak occurring at same location in multiple frames is low

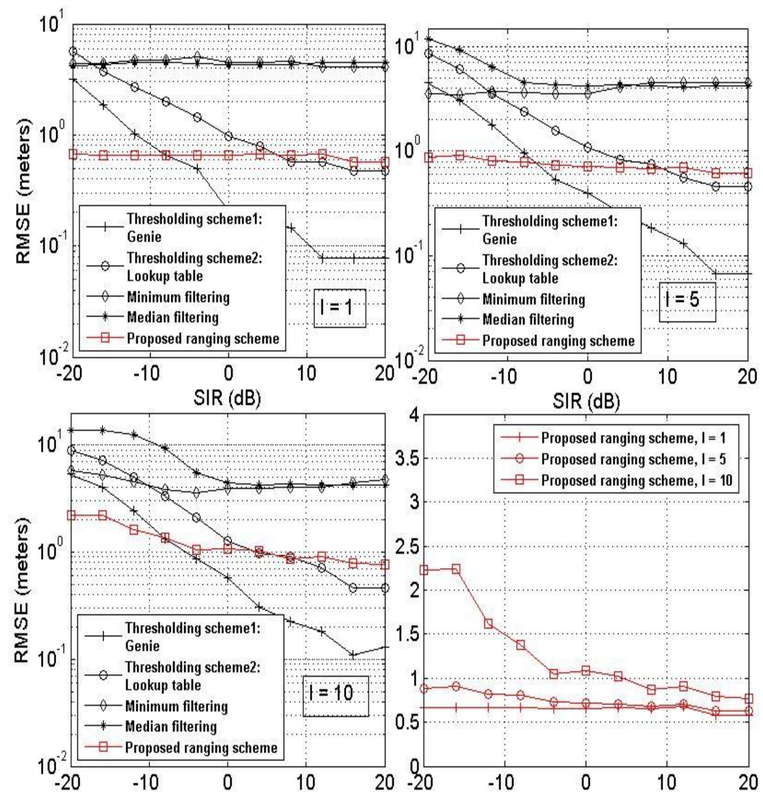
Separate Interference/Noise MPC From Signal MPC

Consider the set $\{\widehat{h_n}(\tau), 1 \le n \le N\}$
- If τ is a signal MPC: Most values are similar.
- If τ is an interference MPC: Several values are zero. Non- zero values are distinct.

Proposed Algorithm Principle

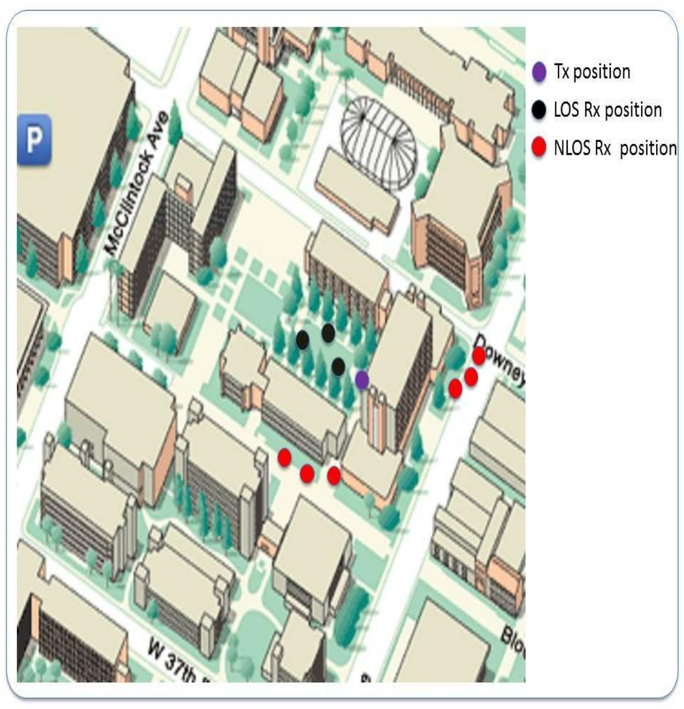
- Extract impulse responses from *N* waveforms $\{\widehat{h_n}(\tau), 1 \le n \le N\}$
- Loop over all MPC locations τ_k
  - Construct the set $\{\widehat{h_n}(\tau_k), 1 \le n \le N\}$
  - Declare τ_k as a signal MPC if there is a cluster of $\bar{N}$ points around $\widehat{h_k}(\tau_k)$
- Reconstruct the interference waveform and subtract its contribution
- Average the waveforms to suppress noise and any weak residual interference

Simulated Performance: Indoor LOS

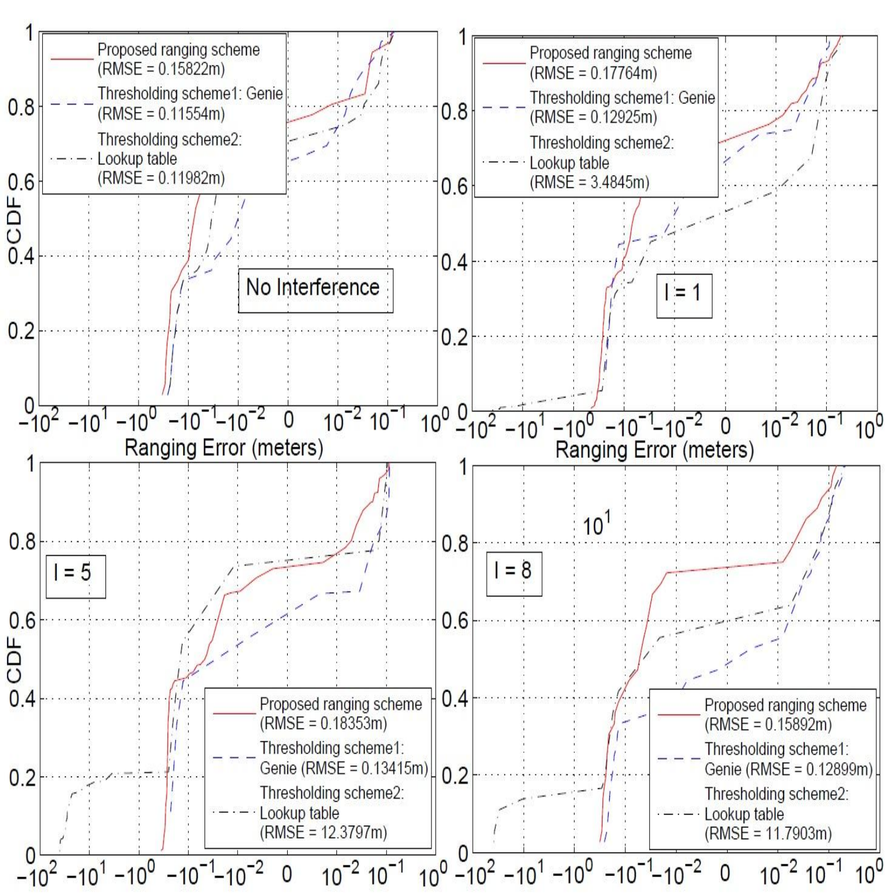


- Proposed scheme robust to number of interfering users and the strength of interference

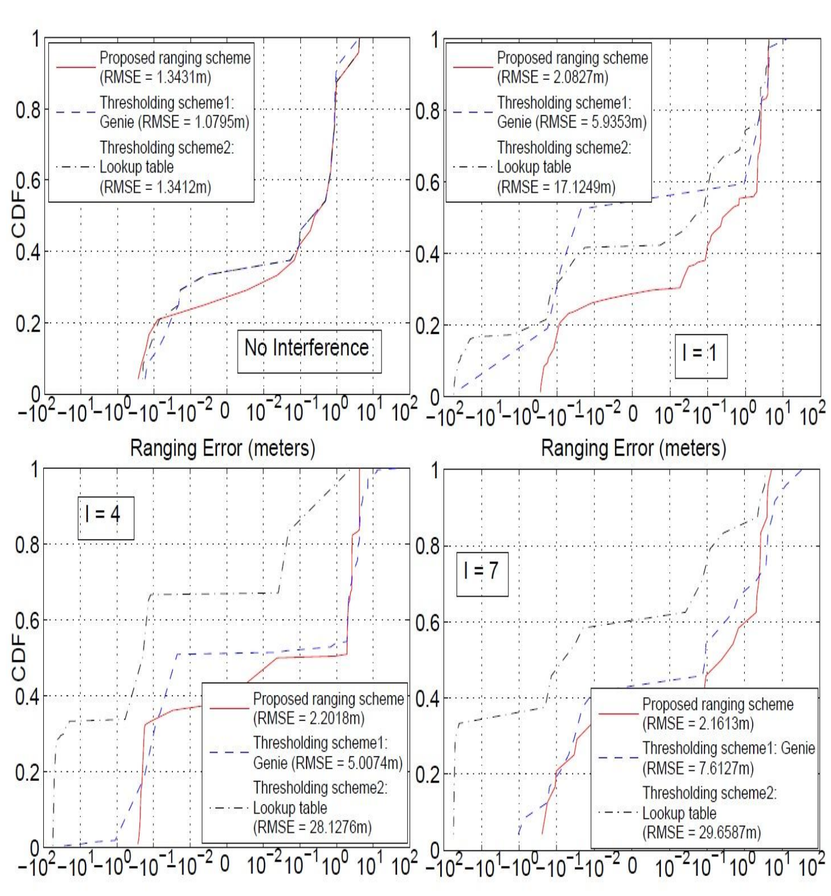
Outdoor LOS/NLOS Measurements



- LOS distance: 20m, 30m, 40m
- Virtual 1x4 SIMO for small scale fading
- Antenna heights: 10cm and 100cm



- No interference: Thresholding schemes are better
- With MUI: Proposed scheme is robust



- Proposed scheme robust to number of interfering users
- Proposed scheme even outperforms genie

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