A Power Independent Detection Method for UltraWide Band (UWB) Impulse Radio Networks

IP#4

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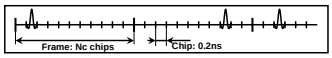
Objectives

We propose a detection method for *pulse level* synchronization in the presence of *Inter-User Interference (IUI)*, in particular in the *Near-far scenario*.

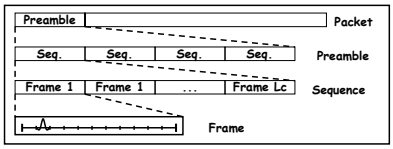
Further, we investigate concurrent transmissions using the *same time hopping code*.

1- Physical layer structure



✓ Common for all IR modulation schemes: BPSK, PPM,...

✓ Concurrent transmission using different TH code:



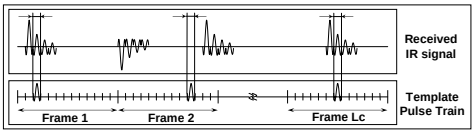
✓ Preamble: periodic sequence of frames.

✓ The number of frames in the seq. Defines the code length Lc.

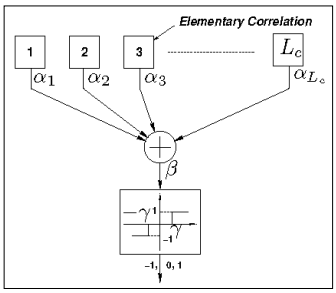
2- Conventional Synchronization Method

It involves 2 ingredients:

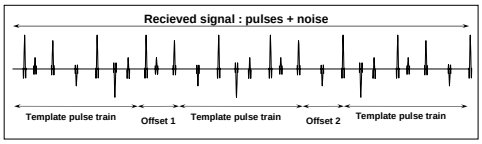
1- **Detection:** Correlation between the received IR signal and a TPT (a replica of the used code) + threshold check.



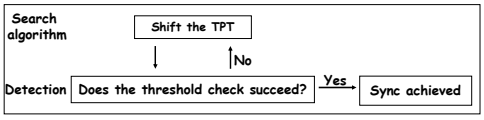
One correlation = Lc elementary correlations



2- **Search algorithm**: which shifts the TPT to cover all combinations between TPT and IR signal.



Interaction between Detection and Search Algorithm



3- Shortcoming of the Conventional Detection Method

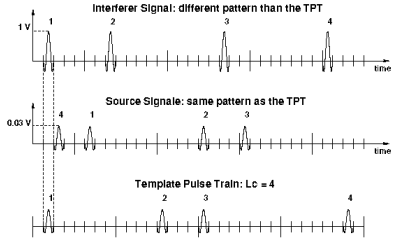
The conventional detection method results in a certain failure in scenarios with:

✓ multiple interfering transmitters,

✓ heterogeneous power levels at the receiver.

A strong parasite in one elementary correlation corrupts all the results

Failure example Based on measures done in [Win97]

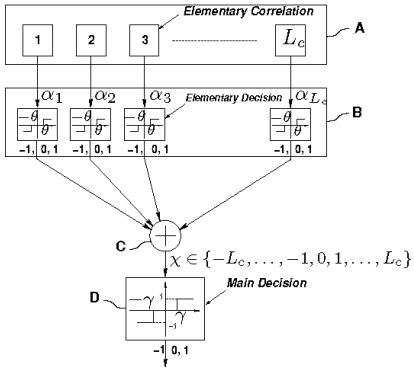


P_{FA} is much larger than P_{GD}

4- Our Proposal: Power Independent Detectio method

✓Elementary decision blocks to detect pulses.

✓ Mean decision block to detect signal based on the number of detected pulses.



The impact of a strong parasite in one elementary correlation is minimized by the elementary decision

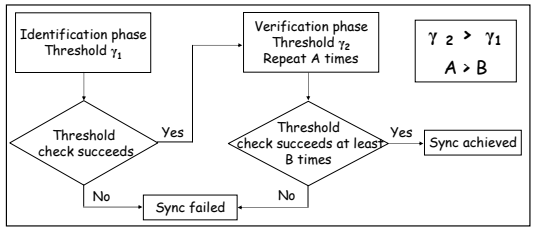
5- How to Evaluate the PID Method

✓ The PID method is embedded in a complete sync method.

✓ The complete synchronization method involves 2 phases:

1- Identification phase. 2- Verification phase.

✓ The complete synchronization phase adopts the serial search.



✓ The evaluation is done based on hybrid method: analysis + simulation

Simulation parameters:

✓ 802.15.4a indoor LOS *multipath* channel model.

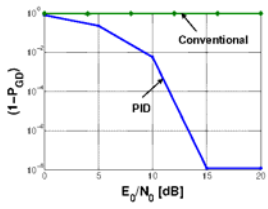
✓ Tc = 0.2 ns, Nc = 200 chips (40 ns).

✓ *Near far scenarios:* the source is the furthest one (-30 dBm). Interferer powers are uniformly distributed over [-30, -10] dBm (equivalent to 17 m)

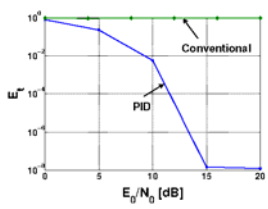
6- Performance Evaluation Results

1. PID vs. Conventional:

1 - Proba of Good Detection



Total Error: missing the signal + False Alarm



✓ 10 users, Lc = 20

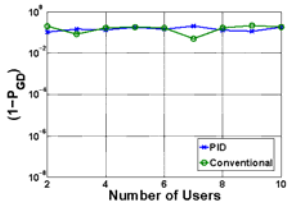
✓ Optimal parameters are chosen for both methods.

2. Concurrent transmissions with the same code:

✓ E_0/N_0 = 15dB

✓ L_c = 20

P_{GD} > 0.9



To have a collision, signals should be synchronized at the pulse level and having the same channel impulse response.

Conclusions

We identify the shortcoming of the conventional detection method in the presence of *Inter-User Interference*.

Our proposal, The *Power Independent Detection method*, solves efficiently the problem.

We show that concurrent transmissions on the *same time hopping code* does not result in collision. Then, such channel performs better than *Aloha channel* in narrow band systems

Then, using UWB IR, we can envisage ad hoc network structures with simultaneous asynchronous transmissions without referring to any coordinator or centralized scheme.

References

[Fawal05] A. El Fawal, J. Y. Le Boudec. "A Power Independent Detection Method for UltraWide Band (UWB) Impulse Radio Networks" Proceedings of IEEE International Conference on Ultra-Wideband (ICU 2005), Zürich, Switzerland, September 2005.

[Fawal04] A. El Fawal, J. Y. Le Boudec. "Synchronizing Method for Impulse Radio Network". P-26-526-US, October 2004.

[Win97] M. Z. Win, R. A. Scholtz, and M. A. Barnes. "Ultra-wide bandwidth signal propagation for indoor wireless communications". In Proc. IEEE Int. Conf. Communications, vol. 1, Montreal, Canada, June 1997, pp. 56 60.

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