ET4394 Wireless Networking

Paper Summary: Jamming Mitigation by Randomized Bandwidth Hopping

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1. Introduction

Spread spectrum (SS) communication technique is a modulation scheme that that intentionally widens the signal bandwidth of the signal. This technique has many advantages like interference avoidance as well as jammimg avoidance. There exists two common SS schemes namely Direct Sequence Spread Spectrum (DSSS) and Frequency hopping spread spectrum (FHSS). In theory, any level of jamming rejection can be achieved in DSSS or FHSS by using sufficient Process Gaining i.e bandwidth of wide band signal over band width of narrow band signal. However Wireless spectrum is a scare resource and allocating higher spectrum just for jamming avoidance in practically not desired. Secondly, Malicious jammers detect the wide band modulated bandwidth of the signal in real time and matches the jamming waveform to the signal rendering even excision filtering ineffective.

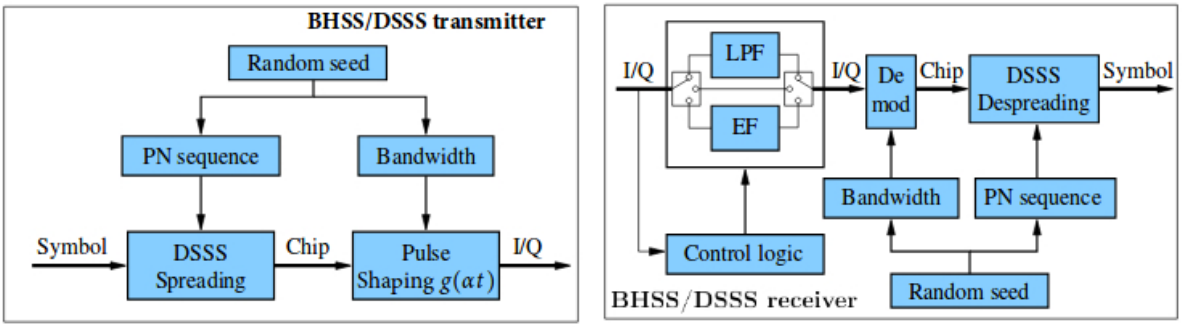
The paper shows technique for jamming Resistance in adverbial settings by bandwidth hopping without increasing the wide-band bandwidth of the signal i.e quickly hop the SS signal bandwidth according to a randomize hopping pattern that is known to the receiver, but unpredictable to the adversary.

Hence, when the signal bandwidth is hopping fast enough such that the jammer can't react quickly enough to the current bandwidth being transmitted, thus, it is no longer possible for the jammer to match its bandwidth to the one of the transmitter.

The designed transmitter and receiver structures are described in the next section- Approach taken.

2. Approach Taken

We can refer to the Figure:1 to understand the structure of the BHSS transmitter and receiver. In the current implementation of BHSS, DSSS technique has been used to spread the message and then the signal shape is changed using the same random seed which was used to generate the PN sequence.This results in spread signal of varying bandwidths.
In the receiver we first have a control loop that is made up of a control logic, a LPF and an excision filter. The job of this loop is to find out the jammer operation frequency and set the values of the two filters to remove the jamming signal. After the jamming signal is removed, we use the same random seed used at the transmitter side to demodulate the signal. After this the DSSS signal is despread and our message signal is obtained.



(a) BHSS Transmitter [2]

(b) BHSS Receiver [3]

Figure 1: BHSS Transmitter and Receiver from paper [1]

3. Strong Points

1. The paper adds one more dimension to the spread spectrum modulation scheme by considering bandwidth hopping.
2. Compared to DSSS and FHSS, a better theoritical SNR and bit error rate improvement has been shown.
3. Better Jamming protection than DSSS, without consuming extra bandwidth.

4. Three different hopping patterns: linear, exponential and parabolic(most robust if jammer is also bandwidth hopping) have been implemented. This gives us more flexibility of using these patterns depending on use case.

4. Weak Points

1. Didn't consider the case when Jammer sends AWGN throughout the whole channel.
2. In the experimental setup the signals were sent through co-axial cables, instead of sending them wirelessly. This means effects because of multipath propagation and shadowing have not been considered. Thus, the generated results doesn't include all the datasets required for the conclusion.
3. With this technique we cannot separate our original signal with the Jammer signal having a similar bandwidth and power.

5. Suggestions

Authors have not experimented in an actual wireless environment which may lead to incomplete results as they don't cover the corner cases. To get the complete picture we suggest that the experimentation must by performed in an actual wireless environment.

Secondly, The paper describes an improvement/addition to DSSS, while FHSS is ignored. This can have considerable impact on the results. We suggest that bandwidth hopping should also be added and tested with the FHSS technique because with the same wide band bandwidth. FHSS is more resistive to jammimng effects than DSSS, because unlike DSSS which covers the entire wide band FHSS hops through the entire wide band spectrum.

Bibliography

[1] Liechti, Marc, Vincent Lenders, and Domenico Giustiniano. "Jamming mitigation by randomized bandwidth hopping." Proceedings of the 11th ACM Conference on Emerging Networking Experiments and Technologies. ACM, 2015.

[2] Figure[4] of[1].

[3] Figure[6] of [1].