Lab 4: Spread Spectrum

Course Name: Wireless Data Networks

Course Code: CPIT-375

Exercises:

1) What is the relationship between the bandwidth of a signal before and after it has been encoded using spread spectrum?

The relationship between the bandwidth of a signal before and after it has been encoded using spread spectrum is that the encoded signal occupies a wider bandwidth compared to the original signal. Spread spectrum techniques spread the signal energy over a larger frequency range, resulting in a wider bandwidth requirement.

2) List three benefits of spread spectrum.

There are three benefits of spread spectrum:

- a) Increased resistance to interference: Spread spectrum spreads the signal energy over a larger frequency band, making it more resilient to narrowband interference or jamming.

- b) Improved security: Spread spectrum signals are more difficult to intercept and decode by unauthorized users due to the spreading and encoding techniques used.

- c) Multiple access capability: Spread spectrum allows multiple users to share the same frequency band by using different spreading codes, enabling multiple simultaneous communications without significant interference.

3) What is frequency hopping spread spectrum?

Frequency hopping spread spectrum (FHSS) is a spread spectrum technique where the carrier frequency of the transmitted signal changes rapidly and periodically over a pre-defined sequence of frequencies. The transmitter and receiver synchronize their hopping patterns to maintain communication. This technique provides robustness against narrowband interference and fading.

4) Explain the difference between slow FHSS and fast FHSS.

The difference between slow frequency hopping spread spectrum (FHSS) and fast frequency hopping spread spectrum (FHSS) lies in the hopping rate. In slow FHSS, the carrier frequency changes relatively slowly, typically on the order of a few hops per second. Fast FHSS, on the other hand, involves rapid hopping with a higher hopping rate, often in the range of hundreds or thousands of hops per second.

5) What is direct sequence spread spectrum?

Direct sequence spread spectrum (DSSS) is a spread spectrum technique where the original signal is multiplied with a higher-rate spreading code. The spreading code expands the bandwidth of the signal, spreading the energy over a wider frequency range. At the receiver, the spreading code is used to despread the signal and recover the original data. DSSS provides improved resistance to interference and can achieve higher data rates compared to FHSS.

6) What is the relationship between the bit rate of a signal before and after it has been encoded using DSSS?

The relationship between the bit rate of a signal before and after it has been encoded using DSSS is that the encoded signal has a higher bit rate compared to the original signal. DSSS uses a higher-rate spreading code, which expands the signal bandwidth and increases the number of transmitted bits per second.

7) What is CDMA?

CDMA stands for Code Division Multiple Access. It is a spread spectrum technique used in wireless communication systems. In CDMA, each user is assigned a unique spreading code that allows multiple users to share the same frequency band simultaneously. The spreading codes are orthogonal to each other, minimizing interference between users. CDMA provides efficient utilization of the available bandwidth and enables increased capacity in wireless networks.

8) Explain the difference between autocorrelation and cross correlation.

Autocorrelation and cross-correlation are mathematical operations used to analyze signals.

- Autocorrelation measures the similarity of a signal with a time-shifted version of itself. It is used to determine periodicity, detect repeating patterns, and estimate the fundamental frequency of a signal.

- Cross-correlation measures the similarity between two different signals. It compares how much one signal resembles another signal at different time shifts. Cross-correlation is used for tasks such as signal synchronization, channel estimation, and pattern recognition in communication systems.

The main difference between autocorrelation and cross-correlation is that autocorrelation compares a signal with a time-shifted version of itself, while cross-correlation compares two different signals to find their similarity.