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JSS Mahavidyapeetha
JSS Science And Technology University
(Established Under JSS Science and Technology University Act No. 43 of 2013)
(Formerly Known as SJCE)

JSS SCIENCE AND TECHNOLOGY UNIVERSITY MYSURU

Subject name: Advanced Communication

Event – 4

Report on: DSSS – QPSK Signal Generation

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INTRODUCTION

Digital Communication has led our world towards modern evolution. There are much of research going on in this field, for improvements and one such major milestone was invention of direct-sequence spread spectrum technique.

Direct-sequence spread spectrum technique primarily used to reduce overall signal interference. The direct-sequence modulation makes the transmitted signal wider in bandwidth than the information bandwidth. After the dispreading or removal of the direct-sequence modulation in the receiver, the information bandwidth is restored, while the unintentional and intentional interference is substantially reduced. Let’s look into much detail about the technique.

PROBLEM STATEMENT:

- In some communication system applications, we have some concerns that outweigh bandwidth efficiency.
- Mostly in wireless applications, stations must be able to share this medium without interception by an eavesdropper and without being subject to jamming from a malicious intruder to achieve these goals. Spread spectrum techniques add redundancy.
- The usage of spread spectrum techniques adds a strong layer of security for the transmission of information signals without the worry of them getting intercepted in between. This results in a much greater bandwidth than the signal would have if its frequency were not varied.
- One such technique provides efficient transmission over large distances by varying the sequence of the information signal pattern.

THEORY:

Direct-sequence spread spectrum combines data signals directly with a higher bit rate sequence. Initially the signal data is passed into a spreading modulator. Here, the Pseudo noise (PN) sequence is added and mixed. The PN sequence is a much higher bitrate sequence than the data signal. The PN sequence make the data signal identical to PN code, close to noise-level signals. The spreading modulator distributes the signals over a much wider band. At the receiving end these signals are demodulated with PN code, and the original data are restored. In the process of modulation and demodulation we achieve two major goals:

1. Each bit is coded
2. Signals bits are distributed over a much wider frequency band.

The spreading of signals over the spectrum could resist better against interference, jamming, and detection. In narrow band communication we need more power to overcome jamming and interference. After spreading, narrow band signals now take much larger bandwidth. The power is still the same but power density is spread out, resulting in lower-power, and noise-like signals, making it harder to interfere and detect.

Overall benefits of the technique are- more bandwidth is used; the data is encoded; and the low-power density and noise-like signals are obtained.

While a transmitted DSSS signal occupies a much wider bandwidth than a simple modulation of the original signal would require, its frequency spectrum can be somewhat restricted for spectrum economy by a conventional analog bandpass filter to give a roughly bell-shaped envelope centred on the carrier frequency. In contrast, frequency-hopping spread spectrum pseudo randomly retunes the carrier and requires a uniform frequency response since any bandwidth shaping would cause amplitude modulation of the signal by the hopping code.

If an undesired transmitter transmits on the same channel but with a different spreading sequence (or no sequence at all), the de-spreading process reduces the power of that signal. This effect is the basis for the code division multiple access (CDMA) property of DSSS, which allows multiple transmitters to share the same channel within the limits of the cross-correlation properties of their spreading sequences.

We have also used the concept of Quadrature Phase shift keying. It is form of phase modulation technique, in which two information bits are modulated at once, selecting one of the four possible carrier phase shifts state. We have used QPSK in order to boost the efficiency of the DSSS. QPSK gives us the following benefits: very good noise immunity; variation in QPSK amplitude is not much; because of the reduced bandwidth the information transmission rate of QPSK is higher.

ALGORITHM

DSSS Signal Generation

Step 1: We consider two signals for direct sequence spread spectrum technique viz., one is a Pseudo noise (PN) signal and the other is an information signal.

Step 2: The PN sequence undergoes binary to polar mapping technique where the digital bits ‘1’ is mapped as the same and ‘0’ is mapped as ‘-1’.

Step 3: The information signal is considered according to which the PN sequence is modulated by multiplying the information and PN signal.

Step 4: In this case, we consider two digital bits [1 0] as the information signal where the resulting the time period sequence from 0 to 1 to be exact PN sequence while from 1 to 2 resulting in phase-shifted PN signal.

Step 5: The resulting signal is termed as the DSSS baseband signal and is passed on to QPSK modulation for transmission.

QPSK modulation

QPSK modulation generally involves the input binary data to be polar mapped but in this case as the signal is already is in polar mapped form, we proceed with the demultiplexing of the signal into even and odd sequences respectively.

Step1: The input sequence (the DSSS baseband signal) is demodulated into two sequences namely, even and odd sequences respectively.

Step 2: The even sequence consists of even components of the DSSS baseband sequences likely to be *even_seq= x(0), x(2),….*, as its signal.

Step 3: The odd sequence consists of odd components of the DSSS baseband sequences likely to be *odd_seq= x(1), x(3),….,* as its signal.

Step 4: These sequences are represented as NRZ polar line coded sequences.

Step 5: The carrier signals viz., carrier-1 and carrier-2 are considered where carrier-1 is a cosine signal and carrier-2 is a sine signal. Note that the carrier signals are 90^{o} phase shifted and is further modulated into two sequences.

Step 6: The QPSK modulated signals of two sequences are then summed using a summer in the circuit, resulting in DSSS-QPSK signal.

WORKING

The pseudo-noise signal is generated and is polar mapped to generate a sequence. The information carrying sequence is modulated according to PN sequence by multiplying the sequences where the resulting DSSS baseband signal is a combination of the PN sequence in one-time frame and a phase-shifted PN sequence in the next time frame.

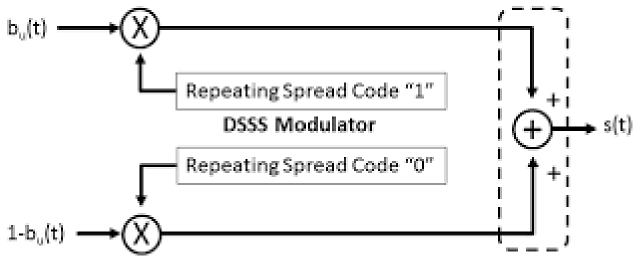
This resulting baseband signal is fed into QPSK modulator as input and is demultiplexed into even and odd sequences. These sequences are modulated with the carriers considered where NRZ line coded even sequence is modulated with cosine carrier and NRZ line code odd sequence signal is modulated with sine carrier.

These modulated sequences are fed into a summer and the resulting signal is termed as DSSS-QPSK signal.

BLOCK DIAGRAM

DSSS generation-

Fig.(a) represents the block diagram for a DSSS modulation for two-bit information signal. Fig.(b) represents a DSSS modulator block with the modulation of data bits and spread bits.



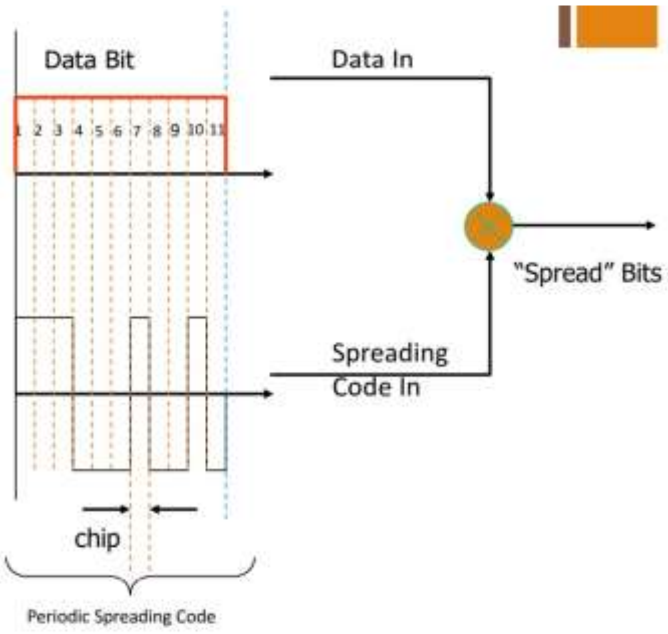


Fig.(a) Fig.(b)

QPSK modulation-

Fig.(c) and Fig.(d) represents the QPSK modulator.

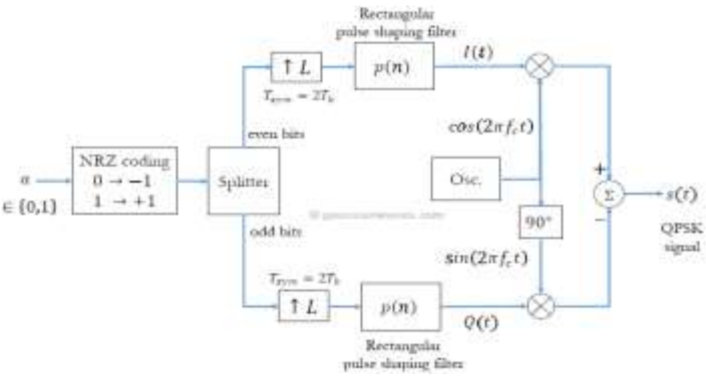


Fig.(c)

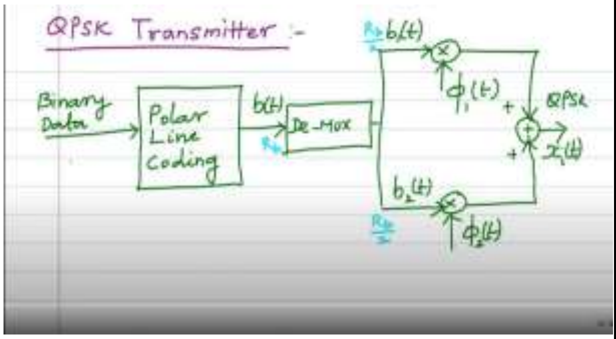


Fig.(d)

ADVANTAGES

- This system has a very high degree of discrimination against the multipath signals. Therefore, the interference caused by the multipath reception is minimized successfully.
- The performance of DSSS system in presence of noise is superior to other system such as FHSS system.
- This system combats the intentional interference (jamming) most effectively.
- Sharing of a single channel among multiple users
- Determination of relative timing between transmitter and receiver.
- Since the usage of QPSK modulation increases the efficiency of signal transmission, it is immune to all kinds of interference and jamming and can be only accessed by the receiver.

DISADVANTAGES

- With the serial search system, the acquisition time is too large. This makes the DSSS system slow.
- The channel bandwidth required, is very large. But this bandwidth is less than that of a FHSS system.
- The synchronization is affected by the variable distance between the transmitter and receiver.

APPLICATIONS

- The United States GPS, European Galileo and Russian GLONASS satellite navigation systems; earlier GLONASS used DSSS with a single spreading sequence in conjunction with FDMA, while later GLONASS used DSSS to achieve CDMA with multiple spreading sequences.
- DS-CDMA (Direct-Sequence Code Division Multiple Access) is a multiple access scheme based on DSSS, by spreading the signals from/to different users with different codes. It is the most widely used type of CDMA.
- Cordless phones operating in the 900 MHz, 2.4 GHz and 5.8 GHz bands
- IEEE 802.11b 2.4 GHz Wi-Fi, and its predecessor 802.11-1999. (Their successor 802.11g uses both OFDM and DSSS)
- Used in Automatic meter reading.
- IEEE 802.15.4 (used, e.g., as PHY and MAC layer for ZigBee, or, as the physical layer for Wireless HART)
- Radio-controlled model Automotive vehicles

RESULTS

The results are generated using MATLAB and the plots obtained are as shown.

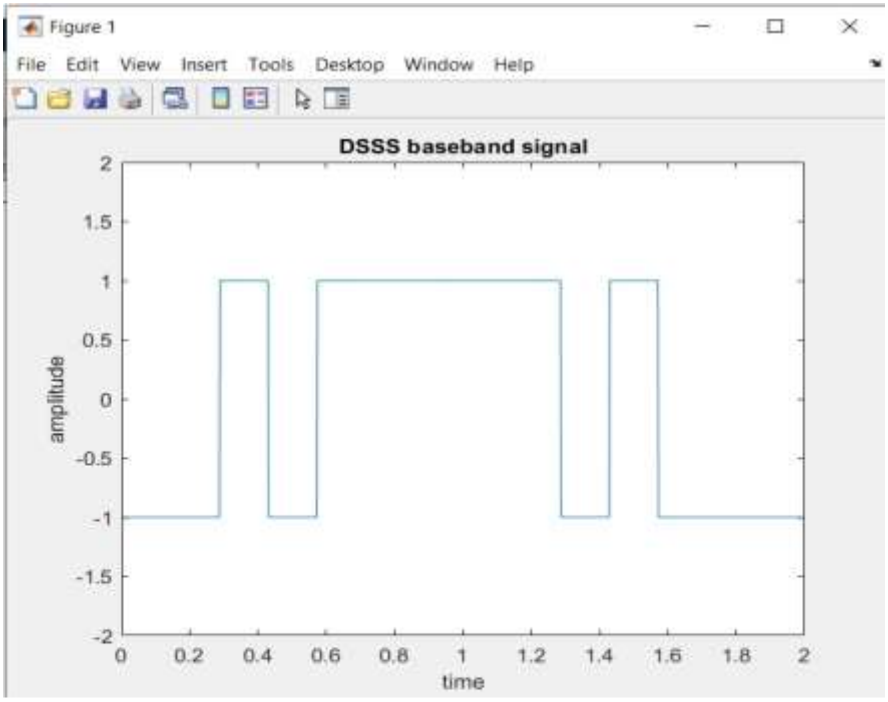


Figure (1)- The DSSS baseband signal generated using the input information signal and the pseudo-noise sequence.

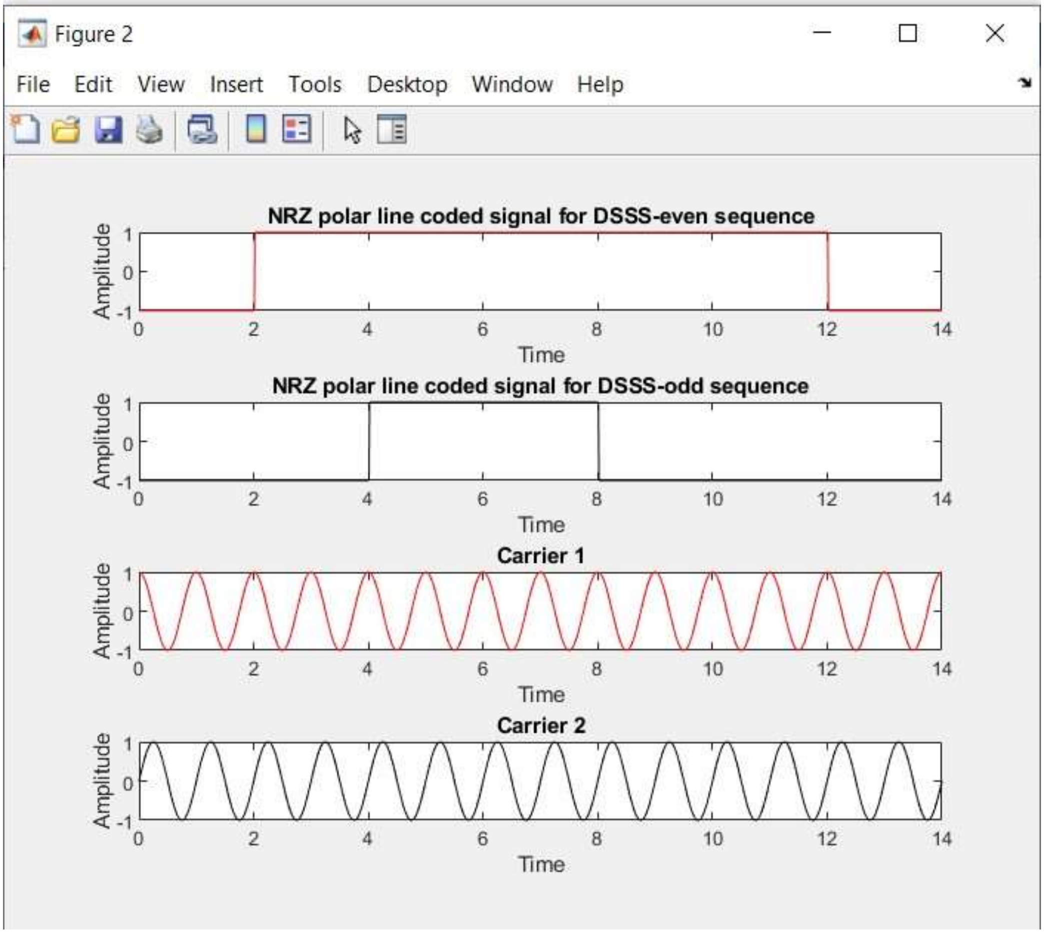


Figure (2) -

Plot 1—The NRZ polar line coded signal for the DSSS even sequence bits.

Plot 2—The NRZ polar line coded signal for DSSS odd sequence bits.

Plot 3—Carrier 1 used for QPSK modulation.

Plot 4—Carrie 2 used for QPSK modulation.

Note: The carrier 1 is a cosine signal and carrier 2 is a sine signal.

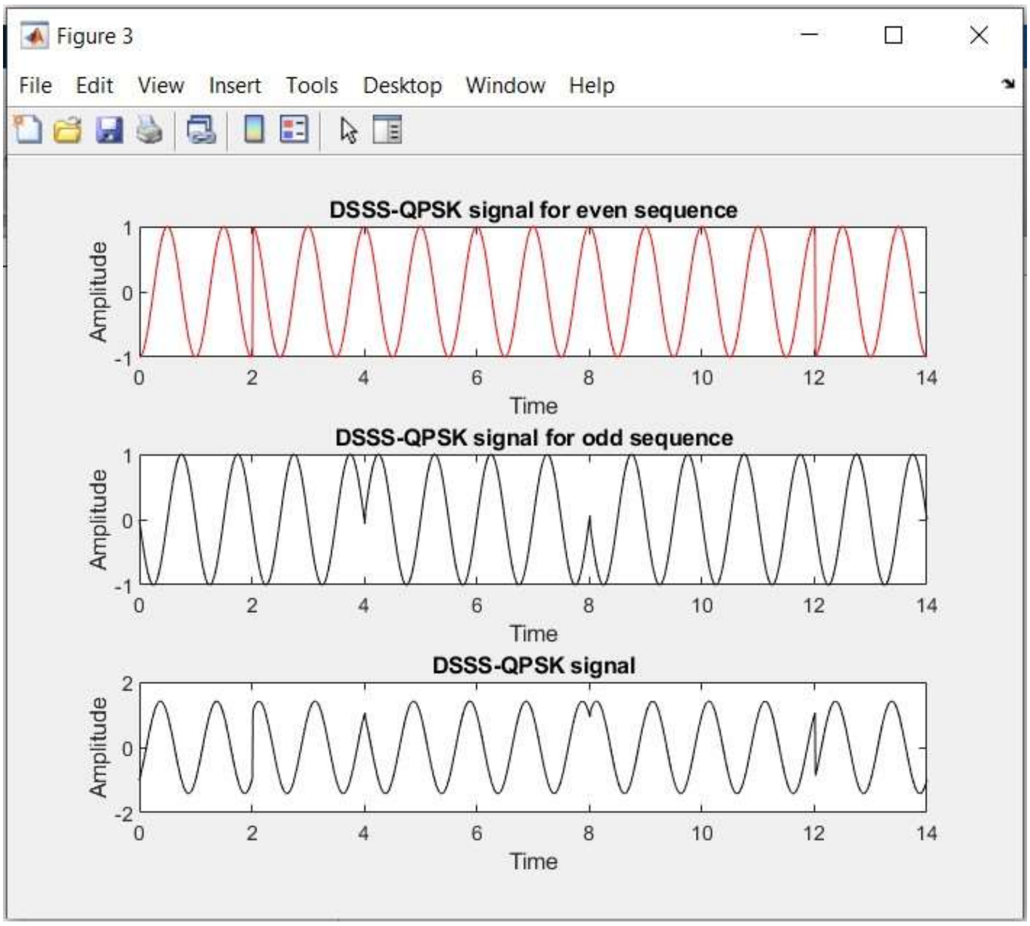


Figure (3)-

Plot 1—The DSSS-QPSK modulated signal for the even sequence bits.

Plot 2—The DSSS-QPSK modulated signal for the odd sequence bits.

Plot 3—The DSSS-QPSK signal

CONCLUSION

The direct sequence spread spectrum proved to be a useful and a accurate technique which can be used in transmission of signals and when modulated with QPSK, it is much efficient and the strength of the signal is increased despite the fact that the channel bandwidth should be higher.

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