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Performance Evaluation of DSSS and FHSS Using Modulation Technique

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ABSTRACT: The technique which has the bandwidth of the transmitted signal is much greater than the bandwidth of the original message is called Spread Spectrum modulation techniques and the bandwidth of the transmitted signal is determined by the message to be transmitted. In this modulation technique, Linear Feedback Shift Register (LFSR) is the basic unit or element, which produces Maximal length PN sequence. Linear Feedback Shift Register represented by a primitive polynomial. In this system each user has a pseudo noise sequence (PN) which is helpful in spreading as well as de-spreading. Thus PN-sequence generation is the heart of Spread Spectrum system. The maximal length PN-sequence (m-sequence) is the best PN-sequence whose length is same as its period. Various PN-codes can be generated using Linear Feedback Shift register (LFSR).The generator polynomial gives the necessary feedback taps for the LFSR circuit. Performance evaluation of DSSS and FHSS using modulation technique is implemented in VHDL and simulated and synthesized on Xilinx 13.1 tool.

KEYWORDS: FDMA, TDMA, CDMA, SSMA, DSSS, FHSS, PN Sequence.

I. INTRODUCTION

The history of communication influenced the development of civilization and still exerts an influence on modern societies. 'Sending and receiving messages', or 'the transmission of messages from one person to another person' is simply known as Communication. When the receiver understands the exact message sent by the transmitter then we say Effective communication occurs. But the interference in the communication channel decreases its efficiency. Interference in the channel is intended to jam the transmitting message or interference by another user who uses the same transmitting channel.

One such technique where the access of unidentical persons is evade by increasing the channel bandwidth, thus providing a secure form of communication is said to be "Spread Spectrum Technique." Spread Spectrum technique is a Wide-Band technique. It uses a special code which is only known to the transmitter and receiver. The special code appears as a noise signal to the jammer who jam the communication channel. Mainly Spread Spectrum techniques are DSSS and FHSS. It further gives the performance analysis of the above techniques.

II. RELATED WORK

Spread spectrum techniques are very useful to overcome the communication problems like interference and security. In this technique, the information signal to be transmitted is first multiplied by the PN code called spreading code signal. The signal which is obtained after this is called spread signal which is then transmitted. The receiving side received the transmitted signal, which is then multiplied by a same spreading code signal, so that the original signal is get back. It can be seen that the required signal gets multiplied by two times but the interference gets multiplied only once, which will reduce the interference and that will be a great protection against jamming.

III. MULTIPLE ACCESS TECHNIQUE

Multiple access technique where many users or local stations can uses the communication channel at the same period of time or nearly so despite the fact originate from different locations. A multiple access method is a definition of how the radio spectrum is split into channels and how the channels are allocated to the many users of the system.

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Since there are different users transmitted over the same channel, a method must be established so that individual users will not disrupt one another.

There are three basic types of multiple access technique

A. Frequency Division Multiple Access **(FDMA)**
B. Time Division Multiple Access **(TDMA)**
C. Spread Spectrum Multiple Access **(SSMA)**

- Direct sequence spread spectrum **(DSSS)**
- Frequency hopped spread spectrum **(FHSS)**

*A **Frequency Division Multiple Access (FDMA)***

Each user is allocated a unique frequency band or channel. These unique frequency band are provide to users who want service of communication. In this the period of the time, no other user can uses the same frequency band. If the FDMA channel is not in use, then it sits idle and cannot be used by other users to increase or share capacity. Receiver only has to know the frequency to tune in to.

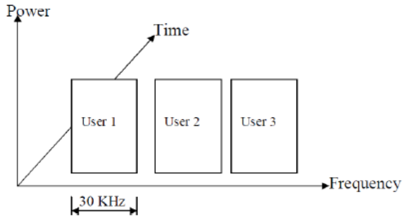

Fig.1 FDMA channel allocation

*B **Time Division Multiple Access (TDMA)***

TDMA allows use of entire frequency bandwidth but for a limited period of time. All user uses the same frequency in at different time. If two transmissions overlap, then it is known as co-channel interference. Precise clock synchronization required.

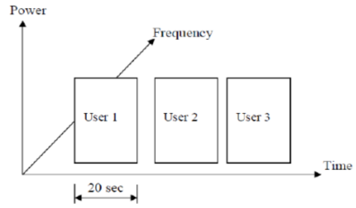

Fig.2 TDMA time slot allocation

*C **Spread Spectrum Multiple Access***

Spread spectrum multiple access (SSMA) uses signals which have a transmission bandwidth greater than the minimum RF bandwidth. Pseudo-noise (PN) sequence converts a narrowband Signal to a wideband signal. SSMA also provides immunity to multipath interference. SSMA is not very bandwidth efficient when used by a single user. However, many users can allocate the same spread spectrum bandwidth without interfering with one another. Spread spectrum systems are bandwidth efficient in multiple user environment. It is this situation that is interesting to wireless system designers. Spread spectrum multiple access techniques mainly of two types; frequency hopping multiple access and direct sequence multiple access. Direct sequence multiple access is also known as code division multiple access (CDMA).

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There are three types of spread spectrum techniques to which the bandwidth of the signal spread. They are

• Frequency hopping (FH): The signal is switched between different frequencies in given the hopping bandwidth pseudo-randomly, and the receiver knows before hand where to find the signal in any given time.
• Time hopping (TH): The signal is transmitted in short bursts pseudo-randomly, and the receiver knows when to expect the burst.
• Direct sequence (DS): The digital data is directly coded at a higher frequency. The code is generated pseudo-randomly, the receiver knows how to generate the same code, and correlates the received signal with that code to obtain the given data.

IV. DIRECT SEQUENCE SPREAD SPECTRUM

Figure (3) shows transmitter, receiver and channel of DSSS system. In the transmitter side, the baseband data signal m(t) is spread using PN-Sequence c(t). Then the obtained spread signal s(t) is given to (BPSK) modulator. The output signal of the (BPSK) modulator x(t) is transmitted over channel. From this transmitted signal is thus a direct sequence spread binary phase-shift-keyed (DS/BPSK). If the spread sequence is again multiplied by c(t), the output of the receiver would be

$$d(t)\ \ c^2(t) = d(t).$$

In the receiver side, the received signal is then demodulated with the help of coherent detector and is then multiplied by the same PN code. Since the code existed of +1s and−1s, the operation completely removes that code from the signal and the original data-signal is left. Other observation is that the spread operation is the same as that of de-spread operation.

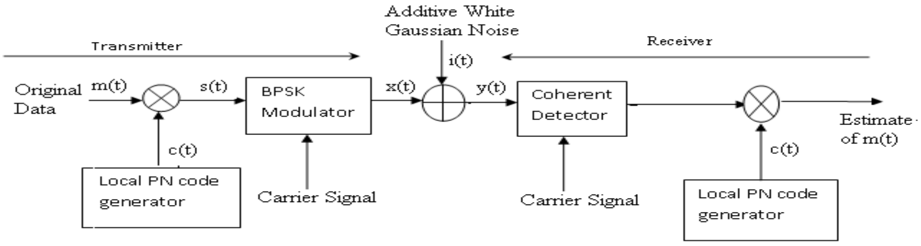

Fig.3 Block Diagram of DSSS Technique

V. FREQUENCY HOPPING SPREAD SPECTRUM

The main problem while applying Direct Sequence spreading is that the Near–Far effects are less in FHSS. Spread Spectrum in which the carrier hops from one frequency to other frequency is known as frequency-hop ping spread spectrum. In Frequency hopping spread, the input carrier frequency to the modulator varies in a fixed bandwidth. With time, the frequency assigned for modulation is changed with a central frequency but with a fixed bandwidth. When the frequencies change from one to another and the allocation of frequency is pseudorandom, the term 'hopping' comes to represent the allocation of frequency with respect to time. With this carrier frequency hopping, obviously the bandwidth of the signal is increased.

The disadvantage of Frequency-Hopping spread spectrum over Direct-Sequence spread is that we obtain a high processing-gain. As frequency hopping spread spectrum does not cover the total Spread Spectrum instantaneously, we are led to consider the rate at which the hops occur.

The two basic types of frequency hopping are:

- Slow-frequency hopping: In this type of hopping the symbol rate is multiple of hop rate
- Fast-frequency hopping: In this type of hopping the hop rate is multiple of symbol rate

Fig.4 shows the block diagram of FHSS modulation. A PN sequence creates a k-bit pattern for every hopping period Th. The frequency synthesizer gives a carrier signal with different frequencies, and the source signal modulates the carrier signal. At receiver side, first received signal is de-spread using same PN-sequence and then demodulated to get the estimated data.

The carrier frequency which is used in frequency modulation is here determined by the PN sequence generator as given above. The signal which is modulated can be send to the mixer to spread the using generated PN-sequence. The obtained signal is therefore responsible for instantaneous transmission bandwidth.

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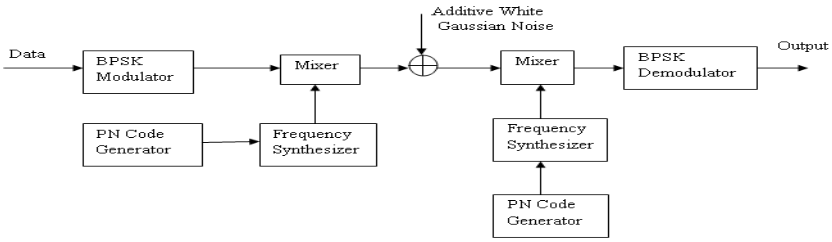

Fig.4 Block Diagram of FHSS technique

VI. PN SEQUENCE

PN sequences are generally used in different types of wireless application such as data encryption and decryption. The codes which are used in spread spectrum systems are longer than the codes used in other systems, as they are proposed for spreading of bandwidth rather than transmitting the information. In order to alter the system's spreading capability it is important to alter the coding arrangement. All spread spectrum communication systems employ a pseudo-noise (PN) code sequence to spread the data modulated carrier to the transmitter and de-spread the desired carrier at the receiver. Spreading can be done by multiplying the information signal with a high rate pseudo-random sequence known to the receiver. The obtained signal is wideband and can be demodulated again by multiplying it with a same PN sequence used by the transmitter side. Spreading codes have good correlation properties so that each spread spectrum signal is uncorrelated with every other signal sharing the same bandwidth. The PN sequence is unique to each user, thus allows bandwidth sharing without any loss of information.

They are periodic, deterministic and binary sequences with noise wave form. It is also called as Pseudo-random noise since it looks random for the user who does not know the code. When the period of PN spreading code is longer, the harder will be the detection of the sequence. This PN sequence can be obtained with the help of feedback shift registers which are made up of m flip-flops that have two states memory stages and logic circuit as given in figure.

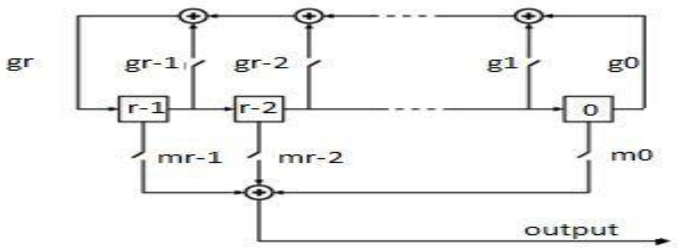

Fig.5 Block diagram of PN sequence

VII. SIMULATION RESULTS

Fig.6.1 shows the RTL view of the DSSS implementation in VHDL which consist of clock, reset, input signal, modulated output and demodulated output that is our original signal. Fig 6.2 shows the internal schematic of DSSS in VHDL.

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1.**RTL View of DSSS**

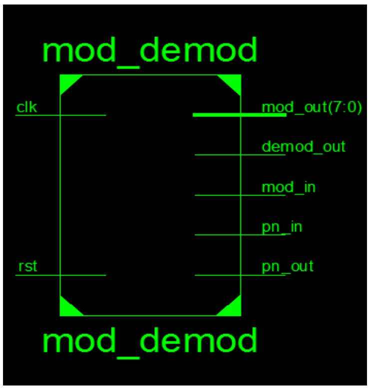

Fig 6.1 shows RTL view of DSS

2.**Internal schematic of DSSS**

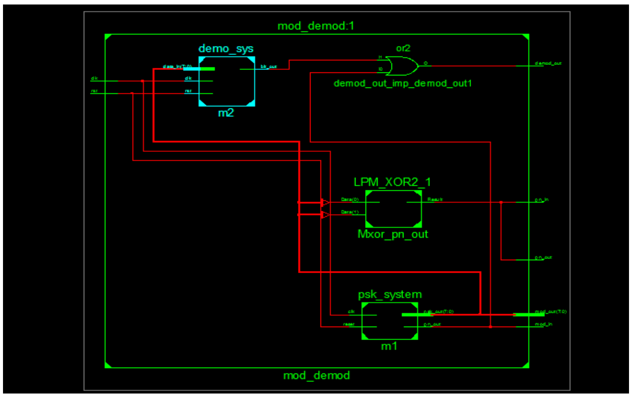

Fig 6.2 shows internal schematic of DSSS system

Fig 6.3 shows the simulation result of DSSS which shows that the input signal given in transmitter side is equal to output signal obtained in receiver side i.e the modulation input is exactly equal to demodulated output**.**

3.**Simulation Result of DSSS**

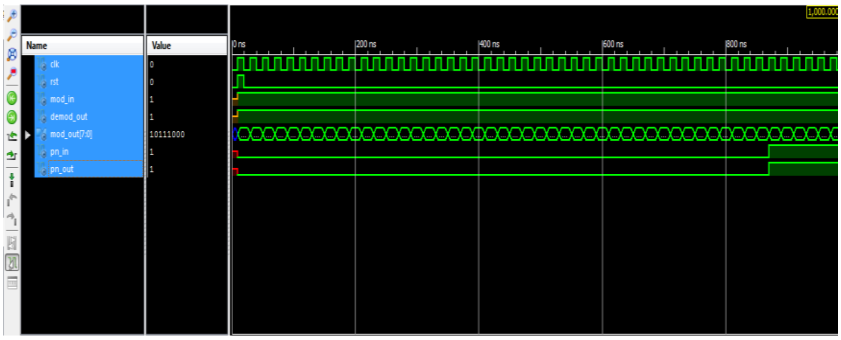

Fig 6.3 shows simulation results DSSS

Fig.6.4 shows the RTL view of the FHSS implementation in VHDL which consist of clock, reset, input signal, modulated output and demodulated output that is our original signal. Fig 6.5 shows the internal schematic of FHSS in VHDL.

4.**RTL View of FHSS**

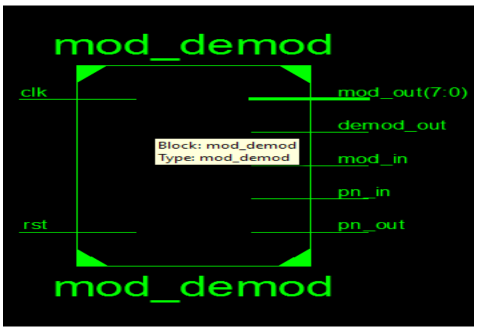

Fig 6.4 shows RTL view of FHSS system

5.**Internal schematic of FHSS**

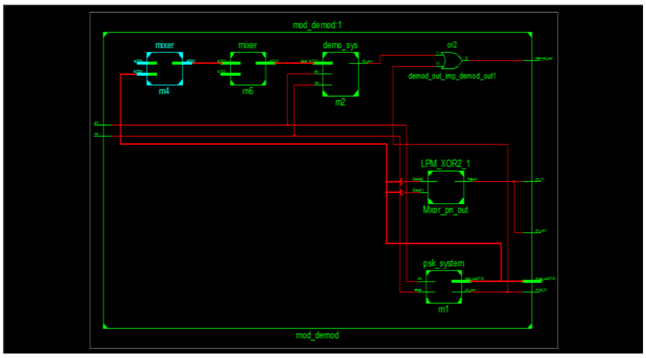

Fig 6.5 shows internal schematic FHSS system

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Fig 6.6 shows the simulation result of DSSS which shows that the input signal given in transmitter side is equal to output signal obtained in receiver side i.e the modulation input is exactly equal to demodulated output**.**

6.Simulation Result of FHSS

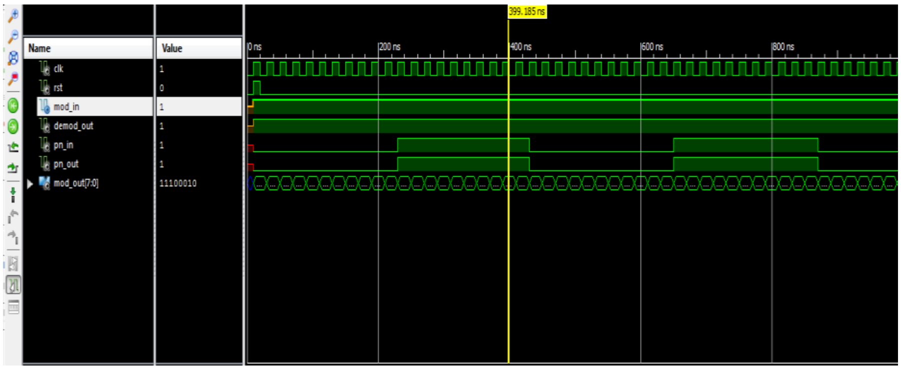

Fig 6.6 shows simulation results of FHSS

VIII. CONCLUSION AND FUTURE WORK

From the above simulation of both the system we concluded the performance evaluation of DSSS and FHSS as shown in below.

Table 8.1. 2: Comparison of DSSS and FHSS					
Parameter	**Delay**	**frequency**	**Slices Used**	**4 Input LUT**	**Bonded IOBs**
DSSS	2.266 ns	144.61mhz	88	169	11
FHSS	2.353 ns	31.731mhz	208	405	14

The designed transmitter and receiver have been tested using an arbitrary chosen data stream, where the given data have been transmitted through our implemented transmitter and then received by our implemented receiver. A comparison has been done between the transmitted and data received and satisfactory results have been achieved. Increasing the number of bits using the same topology, it is possible to reach the standard rates specified for CDMA. Implementation of a CDMA communication system with DSSS an FSSS technique in VHDL has the following advantages.

• The design is fully reconfigurable
• PN sequence and number of bits can be changed very easily
• Useful for both FPGA and ASIC implementations.

This proposed project can be further extended to implement with multiple transmitters and receivers. It can be implemented with various types modulation techniques and comparative analysis can also be made. Various techniques can also be implemented to improve the multipath interference effect. This concept can be further extended to design the Global Positioning System which is CDMA.

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BIOGRAPHY

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