RESEARCH ARTICLE OPENACCESS

Design and Simulation of Frequency-Hop for 2.4 GHz Wireless Communication System

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Abstract:

FHSS is a component of spread spectrum technology. FHSS uses Industrial, Scientific and Medical (ISM) waveband for communication which is license free [4]. FHSS Transceiver model provide secure communication over the trail of communication. Its robustness against third party interception is thanks to use of PN sequence generator. supported the introduction of frequency-hopping communication system and its mathematic model, a simulation model was built using MATLAB. This paper researches the issues of a recurrence bouncing spread range (FHSS) and manages usage by and by. The FHSS procedure is valuable for stifling obstruction, making capture attempt troublesome, obliging blurring and multipath channels, and giving a numerous entrance ability. The beneficiary demodulates the got signal by the transporter frequencies that change simultaneously depending on a similar recurrence bouncing arrangement and makes an identification of it.

Keywords — **FHSS, PN Sequence Generator, BFSK, GSM, CDMA, RF.**

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I. INTRODUCTION

SSMA [12] is one among the Multiple Access techniques in communication systems, that works by expanding the transmitted signal bandwidth to be larger than the bandwidth of the information signal. Currently, Spread Spectrum techniques are widely utilized in many communication systems; like GLOBALSTAR satellite communications system, Low Earth Orbiting (LEO) satellite communications network systems, GPS for satellite navigation system, WLAN IEEE 802.11 system, optical codes for Fiber-optic LAN, UAV, underwater acoustic communication system. usually, the device discovery is taken under consideration because the time consuming [9]. Spread Spectrum systems [12] are utilized in various fields because of their characteristics which can solve interference problems. Receiver synchronization, is that the foremost complex stage in Spread Spectrum systems, requiring complex circuits and processes [2] [4].

Spread spectrum communication could also be a way of transmitting information [20]. Generally, there are two methods of Spread Spectrum, namely: Direct Sequence Spread Spectrum (DSSS) [10] and Frequency Hopping Spread Spectrum (FHSS). The utilization of spread spectrum techniques allows multiple simultaneous access and increases the robustness of the system against multipath-induced distortion and narrowband interference [2] DSSS and FHSS. DSSS [10] [14] transmits signals at one frequency but on very wide bands, while FHSS transmits signals with narrow bands, but quickly jumps from one frequency to subsequent [7]. the foremost difference is in how they spread the information into the broader bandwidth [20]. FHSS utilizes frequency hopping while DSSS utilizes pseudo noise to switch the phase of the signal [10]

[12].

Frequency Hopping is accomplished by partitioning the enormous data transmission into more modest channels which can fit the data. The sign would then be sent pseudo-arbitrarily into an exceptional channel. Since only one of the diverts is being used at some random time, you're really squandering transfer speed much the same as the data transmission capacity increased by the quantity of channels short one. DSSS spreads the information across the band during a truly extraordinary way [7]. It does as such by bringing pseudo-irregular commotion into the sign to shift its stage at some random time. This leads to an output that closely resembles static noise and would seem as just that to others. But with a process called “de-spreading,” the first signal is typically extracted from the noise as long because the pseudo-random sequence is understood. DSSS [14] execution better regarding cost and this strategy is perceived most effectively usage, while FHSS prevalent in narrowband obstruction, co-area channel and security [3] [7] [8]. Usually, optimum system performance in noise obtains, when the normalized delay spread is between 0.05 and 0.3 [1].

Table-1: Summary comparison of DSSS and FHSS

Item	DSSS	FHSS
Channel	2.4 GHz Amount 14 channels Width of 22 MHz. Spaced with 5 MHz.	2.4 GHz Amount 79 channels Width of 1 MHz. Spaced with 1 MHz.
Narrowband interference	in the same channel is reduced by the processing gain	in the same channel is not reduced, whereas interference in a different channel has no influence.
Main parameters	Modulated by DBPSK and DQPSK are very power efficient, high cost	Modulated by FSK is less power efficient in narrowband operation, lower cost [16]
Data rate	from 1 Mbps to 11 Mbps	from 1 Mbps to 2 Mbps
Co-location	Maximum of 3 co-located networks	Maximum of 12 co-located networks
Security	Low	High

II. FREQUENCY HOPPING

The spread spectrum communication scheme is predicated on Shannon theory. FH [11] could likewise be a part of spread range correspondence framework for its exceptional focal points of solid enemy of sticking and against multi-way blurring.It's widely utilized in military and civilian applications for its excellent performances. The spread spectrum technology [12] has many advantages like anti-jamming, anti-multipath fading, anti-capturing, and secret; it's widely utilized in civil fields and plays a more important part in military fields. With excellent anti interference, anti multi-path fading and multiple access networking performance, frequency hopping (FH) technique has been widely used not only in military communication but also in civil mobile communication like GSM, Home RF and Bluetooth. Many factors, e.g. FH succession, coding, adjustment, synchronization calculation and channel type, can impact the presentation of FH framework [2] [4]. In research project, it often must build a simulation platform to research the effect of a special factor on the performance of the FH system in terms of anti-interference, anti multi-path fading, multiple access networking, etc. However, no article has, so far, described the because of build an FH system simulation platform intimately. during this paper, we shall build a basic simulation model of FH system with MATLAB and describe it at length. The model can function a basic platform for analyzing and evaluating the performance of the FH system for various conditions.

The kind of Spread Spectrum during which the transporter bounces haphazardly from one Frequency to an exceptional is perceived as a FHSS [11]. Frequency bouncing was first utilized for military ECM, in light of the fact that the sent sign that utilizes Frequency jumping is hard to distinguish and screen. FHSS could even be the means by which of sending radio signals by quickly changing the transporter Frequency among numerous unmistakable frequencies involving an outsized unearthly band [12]. The progressions are constrained by a code known to both transmitter and recipient. FHSS is utilized to stay away from obstruction, to quit listening in, and to empower CDMA correspondences.

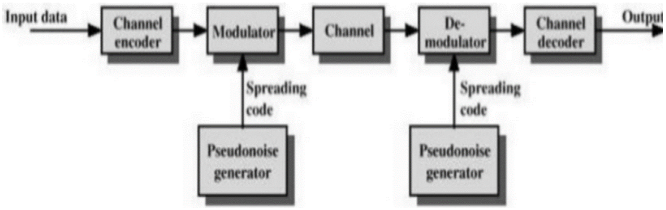

Fig. 1Block diagram of an FH Spread Spectrum System [4]

The available waveband is split into smaller sub-bands. Signals rapidly change ("hop") their carrier frequencies among the center frequencies of these sub-bands during a predetermined order. Interference at a specific frequency will only affect the signal during a quick interval. within the FH communication system, the transmitting frequency is hopped within the entire waveband according to certain frequency-hopping pattern [4] [11]. FH/BFSK is that the most typical modulation, and it uses Binary Frequency-Shift Keying (BFSK) modulation and non-coherent demodulation [5]. The diagram of FH communication system [12] [15] is shown in Figure 1.

In FHSS systems the spreading code is applied to the frequency domain rather than to the time domain [12]. Therefore, the system hops after a specific amount of some time, called dwell time, to a special frequency [20]. Important parameters of an FHSS system are the number of channels, the dwell time (Th) and if the system could also be a slow hopping or a fast hopping system. A system is taken under consideration to be slow hopping if the hopping rate is smaller than the data-rate. When the hopping rate is quicker than the data rates the system is known as fast hopping [11]. Simulation study by using MATLAB software as a digital signal processing tool has been exhausted the proposed work.

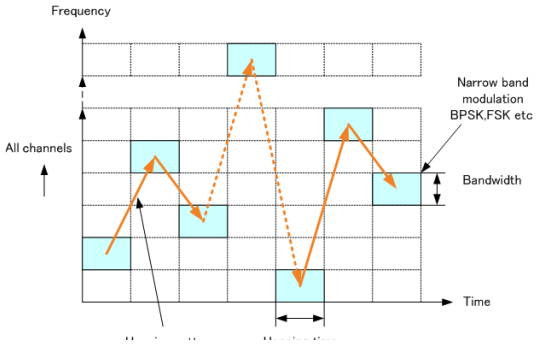

Fig. 2Fundamentals of the Frequency Hopping

III. FREQUENCY-SHIFT KEYING

Frequency Shift Keying (FSK) [12] could even be a FM plot during which advanced data is sent through discrete Frequency changes of a transporter signal. the lone FSK is double FSK (BFSK). BFSK utilizes a couple of discrete frequencies to send parallel (0s and 1s) data. With this plan, the "1" is perceived on the grounds that the mark frequency, and thus the "0" is known as the space frequency. Binary FSK could also be a constant-envelope kind of angle modulation almost like conventional FM except that the modulating signal varies between two discrete voltage levels (i.e., 1's and 0's) rather than with a continuously changing value, sort of a wave. Binary FSK is that the most typical kind of FSK. With binary FSK, the center or carrier frequency is shifted by the binary input. Consequently, the output from an FSK modulator could also be a step function within the frequency domain. because the binary input changes from a logic 0 to logic 1 and therefore the other way around, the FSK output shifts between two frequencies.

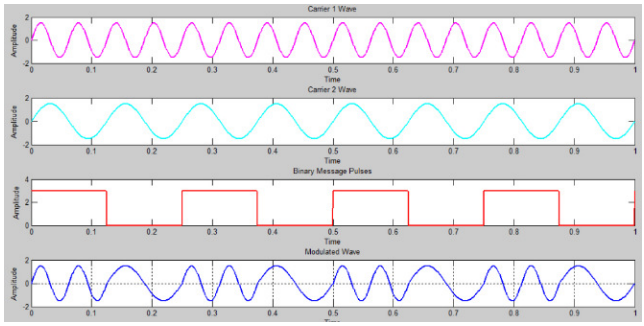

Fig. 3Binary Frequency-Shift Keying

IV. PRINCIPLE OF FHSS

An interfering signal would appear within the channel between the transmitter and thus the receiver [8] [20]. Frequency Hopping Spread Spectrum could also be a selection spectrum technique that uses a special frequency to transmit data quite 83 MHz Frequency agility depends on the facility to switch the frequency transmission of a sudden within the utilization of frequency (RF) bands. Divides the available 83.5 MHz spectrum (in most countries) into 79 discrete 1MHz channels. The IEEE 802.11 standard specifies data rates of 1 Mbps and a few of Mbps. so as for a frequency hopping system to be 802.11 compliant, it must operate within the two .4 GHz ISM

band, and operate between 2.402 and 2.480 GHz [8]. FHSS is usually utilized in wireless LANs like 1EEE 802.11x [3].

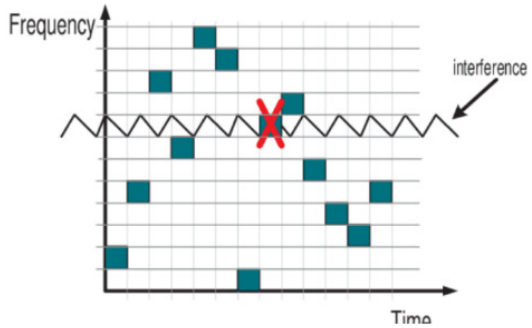

Fig. 4Frequency Hopping method's resistance to Interference [18]

In the example below, the sequences are:

2.449 GHz, 2.452 GHz, 2.448 GHz, 2.450 GHz, 2.451 GHz

After emit radio bearer information at 2.451 GHz, the radio will repeat the hop sequence (the order jump), then start again from the frequency of two .449 GHz. the method repeated sequence leap is going to be continued until the entire information received [18]. In FHSS, the frequencies to be used inside the bouncing succession could even be chosen by the client. inside the unlicensed band, any gathering of 26 frequencies or more (out of the 79 accessible) is legitimate.To "tune in", a listener should know the amount of frequencies selected within the system, the particular frequencies, the hopping sequence, also because the dwell time. The FHSS modulation acts as a layer 1 encryption process. FHSS systems, the transmitter and therefore the receiver hop from one frequency to a different in prearranged synchronized patterns. The hops occur frequently with little or no nonce spent on anybody frequency. This reduces the likelihood of interference [20] with other devices and enables several overlapping FHSS systems to be operational at an equivalent time [8].

V. SIMULATION MODEL

Take building a single-user system model as an example. The simulation tool is MATLAB. Firstly, the information takes care of into the BFSK Modulator subsystem for baseband balance. FH Sequence Generator subsystem produces FH succession, which controls the Frequency Synthesizer subsystem to encourage intermittent Frequency bouncing complex outstanding transporter signals.

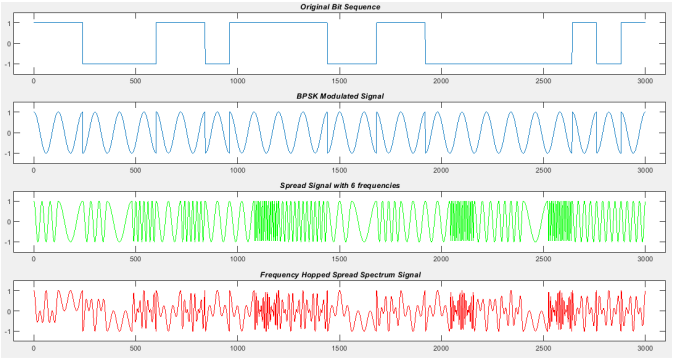

Fig.5Frequency Hopping with BFSK Digital Modulation

In the FH Modulator subsystem, the output complex exponential carrier signals of the Frequency Synthesizer subsystem and thus the output complex exponential signals of the BFSK Modulator subsystem are mixed together to urge a true wave. The frequency mixed signal is shipped to the Channel. At the receiver, all users receive multi-user mixed signals in noise. The frequency hopping signals first pass the FH Demodulator subsystem for de-hopping, then undergo the BFSK Demodulator subsystem for noncoherent BFSK demodulation [5] [6]. Demodulation of frequency hopping spread spectrum (FHSS) [11] signal is accomplished through detection and separation, parameter estimation like hop timing and hopped frequency, de-hopping and baseband demodulation [13]. First, a Digital Modulator has been wouldn't to convert the PN sequence [14] to BFSK [20], then the output has been changed to FHSS [4] [5]. FHSS we've used 6 frequencies, as is shown in figure 4. Figure 5 shows the spectrum through FFT which can be used for later analysis. Xiaopeng Tana et al. used the interference suppression algorithm of FFT overlap transformation to suppress narrowband interference [20].

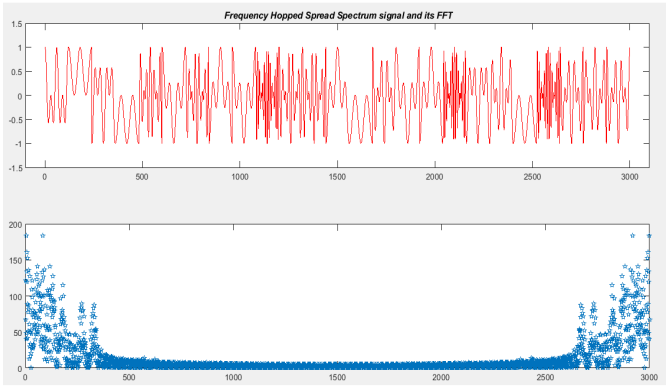

Fig. 6Hops and their FFT

The general transmission capacity needed for Frequency jumping is a lot more extensive [20] than that needed to send an identical data utilizing only one transporter Frequency [15]. Notwithstanding, on the grounds that transmission happens just on marginally segment of this transfer speed at some random time, the immediate impedance data transmission is really an identical [20]. While giving no additional assurance against wideband warm commotion, the Frequency bouncing methodology lessens the corruption brought about by narrowband obstruction sources. one among the difficulties of Frequency jumping frameworks is to synchronize the transmitter and beneficiary [2]. One methodology is to have an assurance that the transmitter will utilize all the channels during an intense and quick time of some time. The beneficiary would then be able to discover the transmitter by picking an irregular channel and tuning in for legitimate information subsequently channel.The transmitter and receiver can use fixed tables of frequency-hopping patterns, so as that when synchronized they go to take care of communication by following the indexing table.

VI. DISCUSSIONS AND CONCLUSIONS

FHSS [15] signals are highly immune to narrowband interference because the signal hops to a special waveband. Signals are difficult to intercept if the frequency-hopping pattern isn't known. Jamming is additionally difficult if the pattern is unknown; a malicious individual may only jam the signal for one hopping period if the spreading sequence is unknown. FHSS transmissions can share a waveband with many sorts of conventional transmissions with minimal mutual interference. Ahmed Jedda et al. [9] study on the side-effects of using the FHSS technique in Bluetooth and involves more publishing of comparable results to assist to know more distributed algorithms running over Bluetooth networks.

FHSS signals add minimal interference to narrowband communications, and thus the opposite way around. Adaptive frequency-hopping spread spectrum (AFH) [17] as utilized in Bluetooth improves resistance to frequency interference by avoiding crowded frequencies within the hopping sequence. this type of adaptive transmission is simpler to implement with FHSS than with noise. We'll control the frequency hopping sequences according to the design of frequency hopping sequences table [17]. So, on confirm the integrity and reliability of transmission in complex environments, Frequency-Hopping Spread Spectrum (FHSS) is suggesting. The characteristics of FHSS are good concealment, strong ability of resistance to multipath and narrowband interference, high transmission rate, big system capacity, high spectrum efficiency, etc. [17]. Frequency hopping are often superimposed on other modulations or waveforms to strengthen the system performance.

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