International Journal of Hybrid Information Technology
Vol. 5, No. 4, October, 2012

Proposed Technique for Improving the Efficiency of Communication by Using Hamming Code along FHSS

Rahat Ullah[1], Shahid Latif[1], Adeel Ahmad[2] and Amjad Ali[3]

[1]*Department of Computer Science and IT, Sarhad University of Science and Information Technology Peshawar, 25000 Pakistan*

[2]*Institute of Physics and Electronics University of Peshawar Pakistan*

[3]*Electrical Engineering Department, Sarhad University of Science and Information Technology Peshawar, 25000 Pakistan*

rahat.csit@suit.edu.pk

Abstract

In this paper a technique is offered for improving the efficiency of communication. The prime objective of any Communication Technique is not only to make the communication clear, efficient and noise free but also to make the communication well secured from its interception from unauthorized users in both commercial as well as in defense communication. For this purpose nowadays the most commonly used technique is frequency hopping. The hopping technique is characterized by its flexibility of changing hopping carrier i.e, change of carrier randomly that is if it is intercepted by unauthorized user the hopping pattern should be changes at any time. There will be no need of synchronization at transmitter and receiver side i.e at any time if the transmission is taking place and the receiver comes into power in the middle of transmission, than the receiver can receive the information at any instant. The error may occurs in the information during passing through the channel, and there will be the need for re-transmission , so for that reason we will apply Hamming code before transmission so that at the receiver side if the error occurred through the channel than that error will be detected and corrected at the receiver side without retransmission because of which the competence will be improved.

Keywords: *Spread Spectrum, Frequency Hoping spread spectrum, Error correction/detection*

1. Introduction to Spread Spectrum

In a normal communication channel, it is often desirable to concentrate the information in as narrow a region of the frequency spectrum as possible in order to conserve available bandwidth and to reduce power [1]. Spread spectrum is a resources of transmission in which a signal occupies a bandwidth in the excess of minimum necessary to send the information; the band spread is accomplished by means of a code, that code is independent of the data, and a synchronized reception with the code at the receiver is used for dispreading and subsequent data recovery [3].

Before the Spread spectrum , cordless phones were in use but due to poor voice quality , high cross talk interference especially in densely populated urban areas, lack of privacy, and short operating distances, they becomes obsolete after the introduction of Spread spectrum [2-5]. Spread spectrum technology was first developed by the military which offers some diverse advantages which can alleviate the problems of conventional cordless telephones. However, because the technology was at first developed for military applications, it could not be readily applied for commercial use due to its high cost and large size. This technology and the components was continue to develop, integrated circuit technology has also undergone extreme advancement. These two factors have made commercial use of spread spectrum technology a realistic intention. Some recent commercial applications of the technology include digital cellular telephony, digital cordless telephony, and the global positioning system (GPS). Since its early on development in the mid 1950's for military applications, spread-spectrum communications have, over the years, become more and more popular for the most part due to its interference tolerance and coexistence capabilities. In the present day, the commercial use of spread spectrum technology ranges from digital cellular phones and wireless PCS (for wide-area wireless voice applications) to wireless LANs (for local-area wireless data transmission). A general definition for spread spectrum technology is [3]:

Spread-spectrum system uses a process except the information signal to expand, or spread, the bandwidth of the signal [6, 7, 9]. The fundamental techniques for spectrum spreading are direct sequence, frequency hopping, time hoping, hybrids [7]. Ideally the transceiver should support some form of spread spectrum modulation, preferably frequency-hopping spread spectrum (FHSS), instead of direct-sequence spread spectrum (DSSS) [8].

2. Executive Summary about FHSS

FHSS is a method of transmitting radio signals by rapidly switching a carrier signals among many frequency channels, using a pseudorandom sequence known to both transmitter and receiver [10]. Figure 1 and 2 shows the block diagrams of a usual frequency-hopping transmitter and receiver. At the transmitter side, a pseudorandom hopping code is used to control the output frequency of a PLL (Phase Lock Loop)-based synthesizer. The data signal is modulated over carrier and than transmitted. The example for a hopping signal (frequency versus time) is shown in Figure 3. At the receiver side, an identical copy of the hopping pattern (same pattern like at transmitter) plus an IF-offset is subtracted from the incoming signal in the frequency domain (i.e., by mixing). If the desired signal is received, and if transmitter and the receiver are properly synchronized, the result of the subtraction is the FM carrier modulated with the information and centered at the IF. As the output will merely contain significant energy at the desired IF if the codes at transmitter and the receiver are well correlated, frequency-hopping presents an opportunity for the use of CDMA [11].

Since the carrier is often being hopped in frequency, frequency-hopping provides resistance to motionless interference and multipath fading. The degree of efficiency of a exact frequency-hopping system for a given transmission channel depends on several factors, such as hopping rate, size of each hop, and number of data symbols transmitted during each hop interval [12–14]. If number of the data symbols transmitted during a hop interval is less than or equal to the unity, than that process is called fast frequency hopping. In the fast frequency-hopping, a high level of the redundancy is present because there can be several hops/data symbol. This even means that if some of the hops/data are not properly received, Because of interference or fading, than there is still enough information available by the use of diversity combining techniques to make the correct symbol decision. The number of hops symbol/data interval is known as order of the diversity [15]. The two main problems that were encountered in PLL-based frequency-hopping are spectral splatter, and transient mismatch linking between transmit and the receive synthesizers [16]. During a hop transient, a simple frequency-hopping system has no control over transmitted frequency spectrum, and many undesired frequency components that are present in the output of a transmitter. This phenomenon is often known as spectral splatter and that results in a loss of useful transmitter's energy during each hop, as well as neighboring channel interference. Moreover, if there is a mismatch in a hopping transient of the receive synthesizer from that of the transmit synthesizer, a bursts of frequency error occurs in the receiver IF next to the hopping rate, which produces an overall degradation in the receiver's SNR. Some of the common solutions that are used to reduce spectral splatter and the effects of synthesizer difference are voltage-controlled oscillator pre tuning [16], "ping-ponging" multiple synthesizers [16], and than transient the hop interval dwell and the guard times [17]. These methods are momentarily reviewed over here.

VCO pre tuning makes use of the digital-to-analog converter (DAC) and also a summing block is placed in synthesizer PLL between a loop filter and VCO of together the transmitter and the receiver. Whenever a hop occurs, the VCO control voltage is directly changes, as well as the normal loop frequency controls, in a well coordinated manner to reduce the effects of the transient mismatch. As the DAC and the summing blocks are both outside of the loop, than the output frequency of the synthesizer can be changed rapidly, and the loop catches up afterwards, by removing residual error. The frequency-hopping system that "ping-pongs" the two synthesizers in mutually the transmitter and the receiver can be designed easily. Whenever the one frequency is being transmitted, than the second synthesizer is preset to the next very hop frequency. To transmit the next frequency in hopping sequence, than the two synthesizers are exchanged (ping-ponged), which eliminates the effects of PLL transient error and than increasing the potential hopping rate, but here the making of phase-coherence is very difficult to achieve. The Transient guard and dwell times are often employed in frequency-hopping systems to avoid the effects of IF error. During a frequency hop, the IF signal is not sampled at the receiver side until the loop transients have settled out. Because the IF contains no frequency error during the sample (dwell) time, and the received data is not corrupted. In some of the systems, the transmitter output power is turned to off during the guard times in order to reduce the spectral splatter produced by the hop transients.

3. Hamming Code

In today's digitized world, the security of information has become a major issue for making critical decisions about stored information [18]. Also security of information is concerned with the assurance of reliability, privacy, and availability of information in all forms [19]. Messages that are transmitted over a communication channel can be damaged; their bits can be masked or inverted by noise [20], the detecting and correcting of these errors is needed. There are codes that can only detect errors [21, 22]; while there are some codes which can detect and correct the errors [23]. Hamming coding technique is used now days not only for detection but also for correction of errors [20]. In hamming code parity bits are used for locating the position of errors. To find the position of check bits both at the receiver and transmitter side, we need to design a matrix for finding the position of check bits [19]. Theses bits can be found by Ex-OR logic and also by AND-OR logic [20]. After receiving of data at the receiver side, the check bits will be explored and will Ex-ORED with the bits at transmitter side. It will locate the position of error. Figure 4 shows the designing of matrix for finding the parity bits. And Figure 5 shows how to compare the parity bits of the two sides for finding the error.

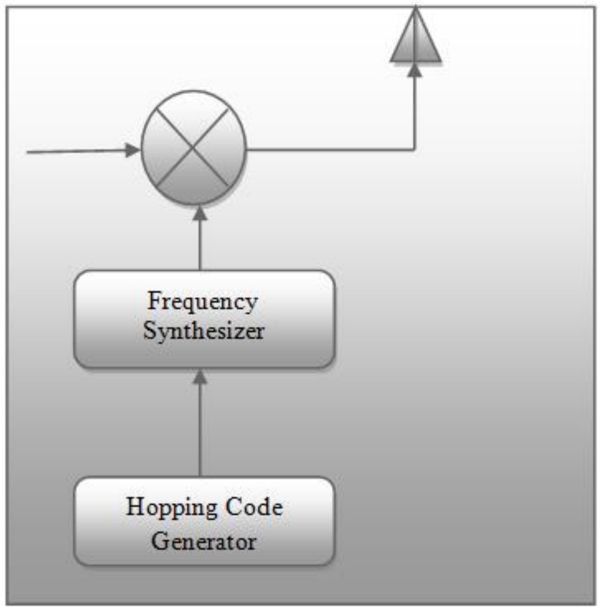


Figure 1. Transmitter for Frequency Hopping Spread Spectrum System

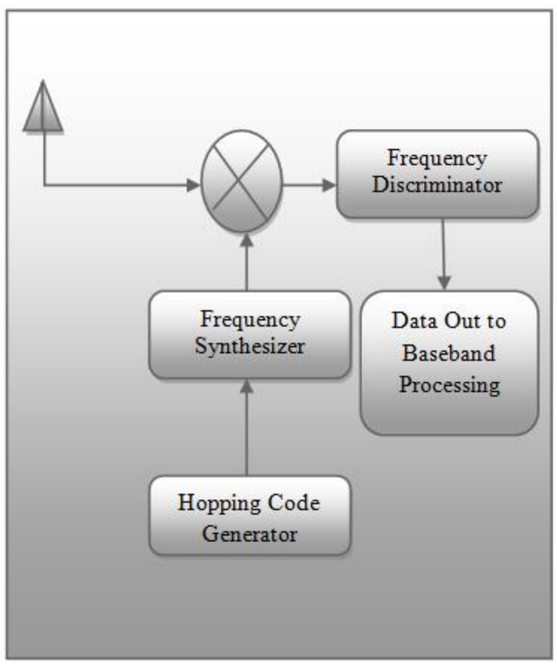


Figure 2. Receiver for Frequency Hopping Spread Spectrum System

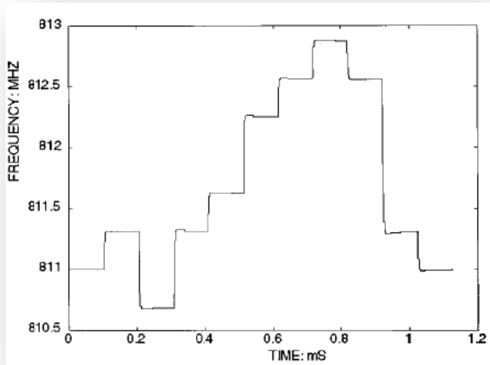


Figure 3. Frequency Hoping: Frequency Vs Time

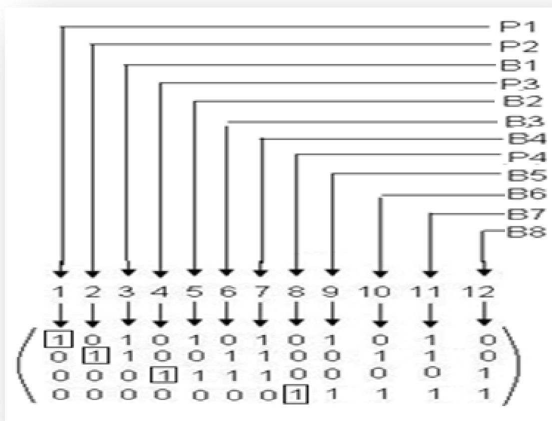


Figure 4. Locating the Positions for Insertion of Check Bits

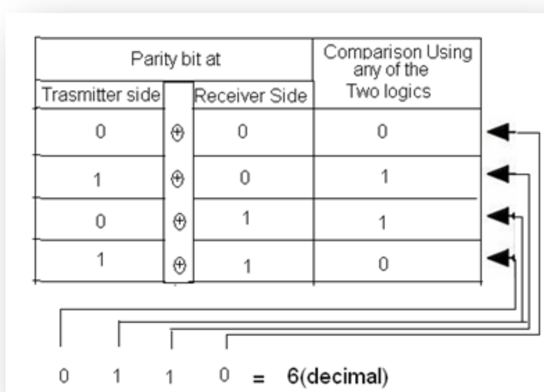


Figure 5. Detecting the Location of Error

4. Main Theme of the Paper

As for making our wireless communication efficient we apply Hamming code for detecting/correcting of the message and in FHSS when the data is transmitted than still there is a chance that due to some interference or noise the data may be distorted, & some of the data bits may be inverted. Here in this paper we proposed an algorithm that if we apply Hamming code and insert check bits before the transmission of the data and if at the receiver side, the error is occurred due to bits inversion than that could be corrected easily without retransmission of the data. Figure 7 and Figure 8 shows my proposed technique (to be applied) for transmitter and receiver of FHSS technique along Hamming code.

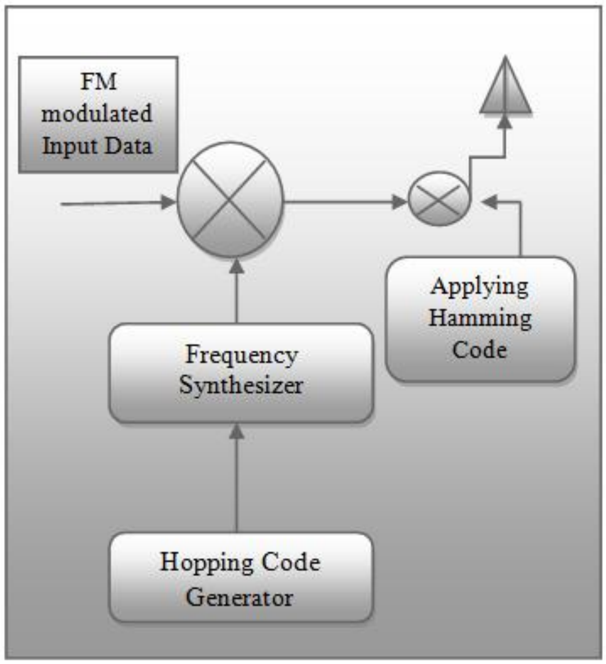


Figure 8. Transmitter for FHSS along Hamming Code

5. Conclusion

In this paper a new idea is proposed for the improvement of efficiency in wireless communication. As FHSS is an efficient technique for the data transfer, it will be more and more time efficient if the hamming code is implemented at the receiver and transmitter side, for detection and correction of data, as in FHSS redundancy is achieved by the possibility to execute re-transmissions of data on different carrier frequencies(hops). So if hamming code is applied on each hop than there will be no need of retransmission of data, and automatically the communication will be time efficient.

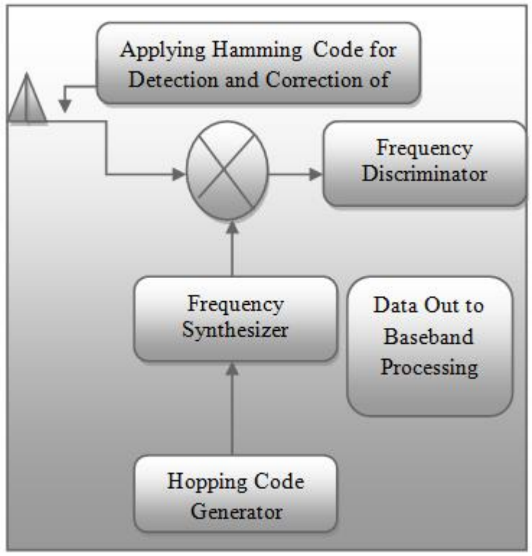


Figure 9. Receiver for Frequency Hopping Spread Spectrum System using Hamming Code for Detection of Error

References

[1] P. Dutta, D. Bhattacharyya and T. -h. Kim, "Data Hiding in Audio Signal: A Review", International Journal of Database Theory and Application, vol. 2, no. 2, **(2009)** June.

[2] R. A. Scholtz, "The spread-spectrum concept", IEEE Trans. Commun., vol. COM-25, **(1977)** August, pp. 748–755.

[3] R. L. Pickholtz, D. L. Schilling and L. B. Milstein, "Theory of spread-spectrum comm—A tutorial", IEEE Trans. Commun., vol. COM-30, **(1982)** May, pp. 855–884.

[4] M. K. Simon, J. K. Omura, R. A. Scholtz and B. K. Levitt, "Spread Spectrum Communications Handbook", revised ed. New York: McGraw-Hill, **(1994)**.

[5] R. L. Peterson, R. E. Ziemer and D. E. Borth, "Introduction to Spread Spectrum Communications", 1st ed. Englewood Cliffs, NJ: Prentice Hall, **(1995)**.

[6] R. C. Dixon, "Spread spectrum Systems with Commercial Applications", 3ed, John Wiley & Sons, New York, **(1994)**.

[7] M. K. Simon, J. K. Omura, R. A.Scholtz and B. K. Levitt, "Spread Spectrum Communications Handbook", McGraw-Hill, New York, **(1994)**.

[8] K. Sharma, M. K. Ghose, D. Kumar, R. P. K. Singh and V. K. Pandey, "A Comparative Study of Various Security Approaches Used in Wireless Sensor Networks", International Journal of Advanced Science and Technology, vol. 17, (2010) April.

[9] H. Taub and D. L. Schilling, "Principles of Communication Systems", 2ed, McGraw-Hill, New York, **(1986)**.

[10] J. Schiller, "Mobile Communication", 2nd edition by ISBN 978-81-317-2426-2.

[11] R. L. Pickholtz, D. L. Schilling and L. B. Milstein, "Theory of spreadspectrum communications—A tutorial", IEEE Trans. Commun., vol. COM-30, **(1982)** May, pp. 855–884.

[12] D. J. Torrieri, "Principles of Secure Comm. Systems", Dedham, MA: Artech House, **(1985)**.

[13] D. N. Romalo and Q. Wang, "Design and implementation of a frequency-hopping modem", in Canadian Conf. Electrical Computer Engineering, Ottawa, Ont., Canada, **(1990)** September.

[14] J. G. Proakis, "Digital Communications", New York: McGraw-Hill, **(1983)**.

[15] J. S. Bird and E. B. Felstead, "Antijam performance of fast frequencyhopped M-ary NCFSK—An overview", IEEE J. Select. Areas Commun., vol. SAC-4, **(1986)** March, pp. 216–232.

[16] J. R. Alexovich and R. M. Gagliardi, "Effect of PLL synthesizer in FSK frequency-hopped communications", IEEE Trans. Commun., vol. 37, (1989) March, pp. 268–275.

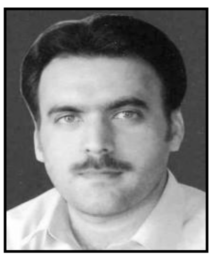
[17] L. E. Miller, J. S. Lee and D. J. Torrieri, "Analysis of transients affecting the selection of hopping rate for FH/CPFSK systems", in IEEE MILCOM'91, pp. 0590–0600.

[18] A. Hamou-Lhadj and A. Hamou-Lhadj, "A Governance Framework for Building Secure IT Systems", International Journal of Security and Its Applications, vol. 3, no. 2, **(2009)** April.

[19] D. Bhattacharyya, R. Ranjan, F. Alisherov and M. Choi, "Biometric Authentication: A Review", International Journal of u- and e- Service, Science and Technology, vol. 2, no. 3, **(2009)** September.
[20] R. Ullah, J. Khan, S. Latif and I. Ullah, "Convienient Way for Detecting Check Bits in Hmming Code", T.-h. Kim et al. (Eds.): CA/CES3 2011, CCIS 256, **(2011)**, pp. 344–356, © Springer-Verlag Berlin Heidelberg 2011.
[21] T. F. Bogart Jr., "Introduction to Digital Circuits", International Edition, **(1992)**.
[22] B. Forouzan, "Data Communication and Networking", 2nd edn.
[23] R. Hamming, "Error Detecting and Error Correcting Codes", Bell System Technical Journal, **(1950)** April, pp. 147–160.

Authors

I **Mr. Rahat Ullah** have achieved MS(CS) Degree in Telecommunication and Networking from Gandhara University Peshawar Pakistan, in 2012 and M.Sc Electronics Degree from University of Peshawar Pakistan in 2008. I joined Department of Computer Science and IT, Sarhad University of Science and Information Technology Peshawar, Pakistan as a Lecturer in 2008. My area of interest is wireless Telecommunication and Networking.



Mr. Shahid Latif have achieved MS(CS) Degree in Telecommunication and Networking from Gandhara University Peshawar Pakistan, in 2012 and M.Sc Electronics Degree from University of Peshawar Pakistan in 2005. He joined Department of Computer Science and IT, Sarhad University of Science and Information Technology Peshawar, Pakistan as a Lecturer in 2009. His areas of interests are wireless communications, transmission security. At present he is a research scholar of PhD.

Mr Adeel Ahmad has been teaching in Dept of Electronics University of Peshawar, Pakistan as Asst Professor. His area of Research/Interest is Telecommunication. He has number of Research Papers published in various International Journals related to my field. At present he is a research scholar of PhD Program. Moreover he has supervised a large number of Thesis/projects at M.Sc level.

Mr. Amjad Ali completed his B.Sc Electrical Engineering from University of Engineering and Technology Peshawar, Pakistan in September 2002, and began his graduate career in esteemed institutions at the national level. He returned to the same university for Masters in Electrical engineering in 2004. Now he has completed his PhD in Information and Communication Engineering department of Beijing University of Posts and Telecommunications. His research interests focus on Communication, Pattern Recognition, Image processing and Biometrics.