International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 04 Issue: 09 | Sep-2017 www.irjet.net p-ISSN: 2395-0072

A Multiple Access Technique for Differential Noise Shift Keying: A review of relevant studies

Vijay Prakash Singh[1], Dr. Ajay Somkunwar[2], Dr. Anubhuti Khare[3]

[1] *Research scholar, U.I.T RGPV Bhopal-MP INDIA*
[2] *Professors, MANIT Bhopal- MP INDIA*
[3] *Associate Professor, U.I.T. RGPV, Bhopal- MP INDIA*

Abstract - *Due to the continuous broadband feature, the chaotic signals are used for encoding information in the spread spectrum communications. There are numerous shift keying techniques addressed such as CCDMA, FDMA, and DCSK. This research study presents a review on the shift keying methods, and multiple access technique for differential chaos shift keying. A detailed literature that describes each of the shift keying methods are presented. This research serves as a reference for the upcoming researches on differential chaos shift keying.*

Key Words: CDMA1, DCSK2, FDMA3

1. INTRODUCTION

As the technology progress increases rapidly, the wireless communication system comprises of large number of homogeneous and heterogeneous sensor nodes that communicate in wireless fashion to attain the research objectives. Homogeneous nodes are more preferred over heterogeneous nodes due to its less complexity and proper manageability. By means of radio communication range, each of the sensor nodes communicate with other sensor nodes (Rathi et al. 2012).The coherent transmission systems have dominated the world of wireless communication system. The coherent systems provide a number of benefits over the noncoherent systems (Leaven et al. 2010). Application of chaos to the digital communication particularly has studied intensely during the previous decades. The chaotic code division multiple access (CCDMA) and the Differential Chaos Shift Keying (DCSK) have been widely inspected in several studies. The former operates based on the coherent demodulation, where an identical and synchronized chaotic spreading signal was required at the receiver side. Relays could be used with conventional multiple access methods like Time Division Multiple Access (TDMA), Frequency Division Multiple Access (FDMA), and Code Division Multiple Access (CDMA). This research study provides review of relevant researches that have been done in chaos shift keying

2. RESEARCH OBJECTIVES

The research is undertaken with following research objectives:

1. To study and understand the Multiple Access Technique for Differential Chaos Shift Keying
2. To find the various applications of Multiple Access Technique for Differential Chaos Shift Keying
3. To review the recent advances and novel enhancements to the Multiple Access Technique for Differential Chaos Shift Keying

3. COMPARATIVE STUDIES

According to Yue et al. (2014), the DCSK used a chaotic signal as the carrier for transmission. The chaotic signal was generated by the simple Logistic chaotic map circuit. The Orthogonal Variable Spreading Factor (OVSF) code was used as spreading because of its complete orthogonality and easy generation. This study proposed a new multiple access scheme based on OVSF. The binary DCSK modulation unit transmitted a reference segment of the chaotic signal during the first half of the symbol duration. The second part of the bit served as an information-bearing signal, which depends on whether bit "-1" or"1" is being transmitted. The second part was spread by a unique OVSF code sequence. At the multiple access DCSK receiver, the received signal was first correlated with its delayed version and was de-spread by the OVSF code.

The typical RFID communication system uses the asymmetrical traffic loads between the uplink and the downlink. The commands and the data broadcasted to all the tags were small from the reader in downlink, but in case of uplink, a great number of tags transmit the heavy traffic to the reader. The multiple access DCSK modulation could be used in the tag to reader link in order to detect multiple tags simultaneously. The DCSK transmitter integrated on the RFID uplink provided a robust, against multi path and high security communication with low power and low complexity. Li et al. (2004) depicted the block diagram of the transmitter and receiver of the CDMA-DCSK system shown below in Figure 1 and Figure 2. Due to slight modification of the original DCSK system, the CDMA-DCSK could be easily instigated. In DCSK modulation, the bit information was mapped to m∈{-1, +1} and the basic function is given by as follows,

$G_m(k)$={x(k) for 0≤L; mx(k-L) for L≤ k < 2L

Where,
L is the length of chaotic sequence in T/2, half a symbol period.

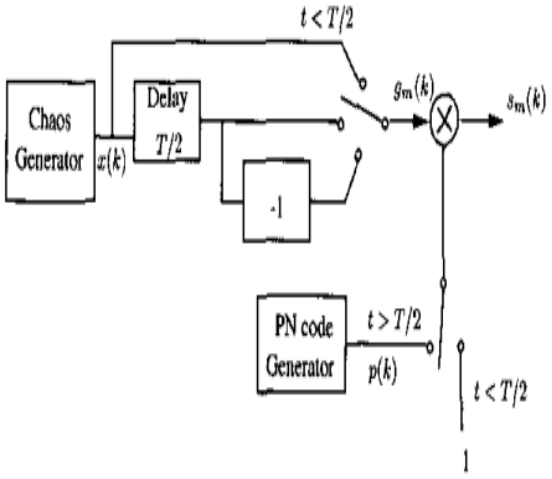

Fig- 1: CDMA-DCSK Transmitter

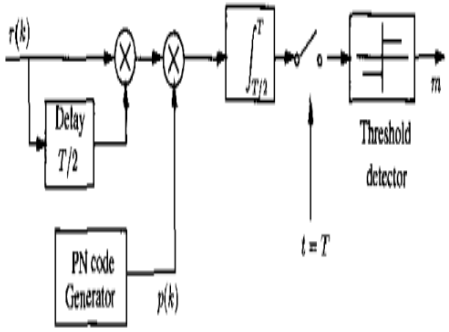

Fig- 2: CDMA-DCSK Receiver

In order to analyze the bit error rate of CDMA-DCSK in multiuser system, the mean and variance need to be calculated by assuming that power of each user received at the *i* th receiver was equal, and chaotic signal, noise and PN codes were all independent to each other.

According to Chen et al. (2016), the binary information to be sent in DCSK modulation was mapped to a differential chaotic wideband signal in order to alleviate the negative effect of multipath fading. By sampling the output waveform from the chaos generator, a DCSK based chaotic sequence corresponding to each bit can be obtained. Duan et al. (2017) described that to obtain effective and reliable no coherent communication scheme based on principle of RA-CDSK, the transceiver architecture of MA-CDSK -NII was introduced. Among the various schemed based on chaotic carriers, multiple access technique for Differential Chaos Shift Keying(DCSK) was the most popular since it doesn't require reconstructing reference signals at the receiver. In DCSK, two channels were formed by time division. The transmitter transmitted a piece of chaotic waveform known as reference chip, followed by a no inverted copy of itself, known as the information bearing chip. At the receiver, the demodulation will be performed by evaluating the correlation between the two pieces of the transmitted chips. More specifically, for a binary message m ∈{ 0,1 0,1} with symbol duration Tb, the transmitted signal becomes where x(t) is a chaotic waveform generated by a chaotic generator. If only additive Gaussian white noise (AGWN) is considered, the received signal is given by as,

$$s(t)=s(t)+n(t)$$

where n(t) is the sample function of the channel noise, namely a white Gaussian noise process having a two-sided spectral density. By proper design of the channel filter, the two sample functions of the noise become uncorrelated. Here the chaotic signal x(t) is different for every transmitted symbol, even if the same symbol is repeated continuously, however the energy per bit can be kept constant.

In this study of review, an outlook of various relevant methods of shift keying is addressed in the review of literature.

4. LITERATURE REVIEW

4.1 Different types of MA DCSK systems

Yue et al. (2014) presented a multiple access DCSK modulation scheme based on OVSF code. By using multiple access DCSK modulation in RFID system, a DCSK-RFID digital communication system was proposed. The tag's BER performance was evaluated in both theoretical analysis and simulations in DCSK-RFID system. Based on the proposed DCSK-RFID system, an anti-collision MAC protocol which supports multiple tag identification was studied. The proposed study showed that maximum throughput of the presented protocol was N times than S-ALOHA. Li et al. (2014) proposed a novel CDMA based multiple access DCSK scheme. Assigning of different PN codes for several users, the inter user interface could be minimized. The BER performance of the CDMA-DCSK system was carefully analyzed in both theoretical analysis and computer simulations for the synchronous and asynchronous system. The proposed CDMA scheme could be adopted in both synchronous and asynchronous multiuser system without the obvious deterioration in the BER performance. Additionally, the data security of the user could also be enhanced by using PN code. Zhou et al. (2008) described that multiple feature was an important factor for the future chaos communication system. The proposed research work introduced a new kind of MA-DCSK scheme which was based on chaotic binary signal and Walsh code. The system's BER and the BER calculation formula were evaluated. Whenever the number of users was more than 3 the simulation results exactly match to the theory supported by the theoretical

analysis. The Bit Error Rate performance was comparable to that of the VDMADCSK system which made the BWMA-DCSK system executable. From the theoretical analysis and the simulation results the BER performance of the BWMA-DCSK was found to be better than that of the VDMA-DCSK in AWGN channel. Xu et al. (2014) investigated the performance of the coexisting CS-DCSK and BPSK system. The BER expressions of the CS-DCSK and BPSK subsystems were derived based on Gaussian approximation. Analytic and simulated results showed that the coexisting CS-DCSK/BPSK system achieved better BER performance than the coexisting DCSK/BPSK system.

4.2 Permutation Division Multiple Access

Tam et al. 2004) proposed an Adaptive Receiver Multiple Access (ARMA) scheme for non-coherent chaos based communications. The transmission scheme appeared simple and easy one to implement. The training signals were sent to train an adaptive filter at the receiving end. The mean square error between the incoming training symbols and the expected symbols were reduced by the normalized least mean square algorithm, which in turn mitigated the interference between the users while performing the actual data demodulation. The results showed that the ARMA method outperformed the previously proposed multiple access technique. Alavi et al. (2014) considered two cases of the cooperative games, NTU and TU in an OFDMA network through NBS and bankruptcy game. A cooperative game theory approach based on NBS that dynamically allocates subcarrier, rate, and power that provided the acceptance tradeoff between optimality in terms of overall system throughput and fairness was developed. The resource allocation problem was solved in dual domain using dual decomposition approach. Diamantoulakis et al. (2016) studied time allocation methods in order to maximize the data rates and improve the fairness in wireless powered communication system along with NOMA. The optimization problems were solved by using linear programming methods and convex optimization tools. The proposed scheme was also compared with the case such that the energy harvesting nodes used TDMA. The extensive simulation results showed that the proposed scheme outperformed the baseline in terms of throughput and fairness. Finally, an interesting dependence between the sum throughput, minimum data rate, and the wireless power transfer was revealed.

4.3 Permutation Multiple Access Differential Chaos Shift Keying

Escribano et al. (2016) proposed a continuous mobility differential spread spectrum noncoherent system. The proposed system possessed direct application to the well-known DCSK setup. The proposed system model aimed at enhancing the adaptability of the receiver when the channel was affected by fast fading without the need of a thorough channel estimation, which was costly and time consuming. In order to achieve this target, a new framework was proposed where each of the reference sample was followed by the corresponding data carrier sample. Singh et al. (2017) developed a modulation and demodulation technique based on differential noise shift keying to improve the Bit Error Rate. Several techniques and algorithms were used to resolve issues such as noise reduction, reliability, and a cost-effective solution. This research study concentrated on three main detection: Bit Error Rate (BER), Gain and Signal to Noise Ratio. The existing methods improved the Bit Error Rate and gain by chaos shifting keying and achieved the Bit Error Rate and gain at the rate of -0.003 and 0.5 dB respectively. This research study achieved a bit error rate of 0.1 and 1.12.Taleb et al. (2016) proposed a new modulation and demodulation scheme, VHE-DCSK-WH. By sending N bits of the data in two time slots, the system reached N times the spectral efficiency of the DCSK system. Before being transmitted, the N bits were spreaded and separated by one chaotic sequence and N Walsh codes. This study showed that use of WH codes allowed widely to reduce the multiple access interferences. The comparison between the present research study and the previous research study work on VHE-DCSK showed that it has better Bit Error Rate while compared to the other existing research works, when N is large.

4.4 Frequency Division Multiple Access

Salahat et al. (2015) presented performance analysis of BER in multi access MIMO relay RM-DCSK-CD. The analysis was based on novel approximation for the error rates in RM-DCSK system. The analysis assumed AWGGN environment which included Gaussian, Gamma, and Laplacian models as special cases in Nakagami-m fading, in which the novel closed form expressions were derived. The proposed work could be incorporated in communication applications by providing them with secure based communication. Liang et al. (2017) proposed PC-CES, a novel PAPR reduction scheme with improved error correction, which could be applied to 16-QAM modulated SC-LFDMA or SC-IFDMA systems. The PC-CES primarily integrated PCs with CES to enhance the transmission signals by improving error correction and PAPR performance. Additionally, the PC-CES provided a mechanism for generating candidate sequences in the CES, thereby improving performance in tasks that involved a large amount of computation for CES. Simulation results showed that the PC-CES with random ordering not only outperformed conventional SC-FDMA systems and the SC-FDMA systems with PCs in PAPR reduction, but also reduced the overall complexity of the system circuitry by integrating PAPR reduction and channel coding technology. Wu et al. (2016) presented an SI embedding and detection scheme for SLM based SC-FDMA system in LTE uplink by exploiting block pilot symbols. At the transmitter side, the SI index for each data symbol was represented by a location set of some selected subcarriers in bloc pilot symbols. For SI detection, a pilot aided ML SI detector and a suboptimal LLR SI detector

were proposed at the receiver side. The simulation results showed that the proposed scheme significantly outperformed existing studies in terms of both SI detection and BER for SLM based SC_FDMA systems, while with the far lower complexity. Besides PAPR reduction, this scheme could be applied to any SC-FDMA systems to avoid explicit SI transmission such as uplink feedback of channel quality. Lin et al. (2017) proposed and demonstrated a B-IFDMA scheme with large frequency diversity, flexible bandwidth allocation, low complexity of channel equalization, and user separation for VLC. The PAPR of B-IFDMA signal increased with increasing number of SC per block, which induced a lower BER performance.

4.5 Direct Sequence Code Division Multiple Access

Rahnama et al. (2013) unveiled an innovative chaos-based code generation scheme by using a 3D chaotic system and demonstrated its potential for DS-CDMA system applications. Also performed simulations that confirmed the proposed solution's ability to satisfy the basic requirements for secure transmission over a CDMA-based communication environment. To evaluate the proposed algorithm's strength, BER performance comparisons were made against other popular methods and the results were plotted. A study of the results confirmed that the proposed chaotic binary sequences was comparable to the chaotic codes generated by 1D chaotic systems and the Gold code, which were considered as optimal codes and were commonly deployed in many modern digital communication systems. In comparison with classical codes, our approach not only outperformed those coding methods in dealing with noise disturbances and multi-user interferences but also offered superior properties. Kaddoum et al. (2017) proposed a DCSK system as potential candidate for power-line communication (PLC) applications. The performance of DCSK system was analysed over power line channel with multiple echoes and in the presence of background, impulsive and phase noise. A closed-form bit error rate (BER) expression was derived and computer simulations were carried out to confirm the accuracy of the analytical finding. The results indicated that the proposed system outperformed DSDPSK. For a perfect channel estimation, DS-CDMA provided a better performance at the expense of more complicated receiver design. Motivated by these facts, the DCSK system was introduced as a potential low-cost, robust modulation scheme for future PLC applications. Hang et al. (2013) proposed a novel blind joint interference cancellation and MUD algorithm, which does not require any knowledge about spread signals, hostile jamming and channel state information, has been proposed for uplink of DS-CDMA systems operating in the presence of unknown hostile jamming. Unlike most of the existing MUD techniques developed for unknown hostile jamming case, the proposed algorithm was applicable to more general hostile jamming and only required two receive antennas. By transforming the receive model into an overdetermined or determined BSS model with dependent sources, the blind jamming cancellation and MUD are obtained by using BSS algorithm based on non-Gaussianity measure simultaneously. The scheme can be easily extended to the situation that multiple hostile jammings coexist in system. Numerical experiments have revealed the robustness of the proposed scheme against the unknown hostile jamming. In addition, the proposed algorithm can be associated with other mitigation technologies, such as interleaving and channel coding. If Interleave and channel code were used at both transmitter and receiver, the performance will be further enhanced.

4.6 Time Division Multiple Access

Hu et al. (2014) aimed to design MAC protocol for enabling SUs to access the idle time slots in a primary TDMA network. Two different traffic scenarios were considered to design a MAC protocol. The Cog-CSMA and Cog-PRMA protocols were proposed to accommodate the different traffic scenarios to achieve better secondary and overall network performance. The secondary network throughput of Cog-CSMA and Cog-PRMA were derived and MATLAB simulations were performed. The analytical and simulation results showed that effective secondary network throughput was achieved which means that SUs could effectively use the idle time slots of primary TDMA networks and improved the overall spectrum utilization efficiency as a result. Han et al. (2012) proposed a TRDMA scheme for multi user downlink network over multi path channels. Single antenna and multi antenna schemes were developed to utilize the location specific signatures that naturally exist in the multi path environment. A variety of performance metrics including the effective SINR were analytically and numerically evaluated. TRDMA's improvement of achievable rate region over the rake receivers were demonstrated and investigated the impact of spatial correlations between users to the system performances. Liu et al. (2016) studied the optimal transmission problem for the energy harvesting MAC channel, where the multiple users with energy harvesting capacities shared the channel. In infinite capacity battery case, the equal power TDMA scheme was optional, and the optimal transmission power was only determined by the total average amount of energy harvested per slot. To analyze the performance of queueing based polling system, a multi-dimensional Markov chain was formulated. The energy loss ratio and the average system throughput were derived according to the Markov reward process.

4.7 Chaos-based direct sequence code division multiple access

Quyen et al. (206) proposed a novel chaos based DSSS technique where the symbol period was varied according to the behavior of chaotic spreading sequence. Mathematical model in discrete time domain for the spreading scheme with variable symbol period and the despreading scheme with the sequence synchronization were presented and

analyzed. The BER performance of the proposed technique in DS-CDMA communications system over AWGN channel was estimated with the use of theoretical derivation and numerical computation. Kaddoum et al. (2016) provided a literature survey on large number of related research studies which included chaotic coding, chaotic modulation, demodulation and multiple access communication schemes. This research study offered a strong, transparent and clear entry point to the topic. Further, classification for different modulation techniques were presented and provided a thorough discussion of the advantage and disadvantages. Litvinenko et al. (2016) presented an exhaustive search based selection methodology and evaluation of binary Chaotic Spreading Sequences (CSS) for direct sequence code division multiple access (DS-CDMA) communication systems. Performance evaluation in terms of an average Bit Error Ratio was assessed for both synchronous and asynchronous communication scenarios under the assumption of perfect chip synchronization and using an additive white Gaussian noise (AWGN) channel. Short chaotic sequences with length of 15 to 127 samples, generated by seven different one-dimensional maps served as basis for creation of spreading sequences. During the performance analysis, the impacts of selecting sequences with low maximum absolute values of Periodic Cross Correlation (PCC) have been studied.

5. CONCLUSION

Several research studies related to shift keying, and chaos in shift keying have been reviewed in this research. The literature survey which included the studies done in different types of MA DCSK systems, Permutation Division Multiple Access, Permutation Multiple Access Differential Chaos Shift Keying, Frequency Division Multiple Access, Direct Sequence Code Division Multiple Access, Time Division Multiple Access, Chaos-based direct sequence code division multiple access has been discussed. Based on the review paper, the reader should acquire guidelines for the proper choice of a chaos shift keying system in the light of the specific demands of the targeted **application.**

REFERENCES

1. Rathi, N., Saraswat, J., & Bhattacharya, P. P. (2012). A review on routing protocols for application in wireless sensor networks. arXiv preprint arXiv:1210.2940.

2. Leven, A., Kaneda, N., & Corteselli, S. (2010). Real-time implementation of digital signal processing for coherent optical digital communication systems. IEEE Journal of Selected Topics in Quantum Electronics, 16(5), 1227-1234.

3. Yue, K., Sun, L., You, B., & Zhang, S. (2014). DCSK Multi-Access Scheme for UHF RFID System. JNW, 9(4), 1061-1066.

4. Li, H., Dai, X., & Xu, P. (2004, May). A CDMA based multiple-access scheme for DCSK. In Emerging Technologies: Frontiers of Mobile and Wireless Communication, 2004. Proceedings of the IEEE 6th Circuits and Systems Symposium on (Vol. 1, pp. 313-316). IEEE.

5. Chen, P., Fang, Y., Han, G., & Chen, G. (2016). An efficient transmission scheme for DCSK cooperative communication over multipath fading channels. IEEE Access, 4, 6364-6373.

6. Duan, J. Y., Jiang, G. P., & Yang, H. (2017). A Novel Multiple-Access Correlation-Delay-Shift-Keying. International Journal of Bifurcation and Chaos, 27(02), 1750025.

7. Zhou, Z., Zhou, T., & Wang, J. (2008, June). Performance of a chaotic binary sequence based multiple-access DCSK communication system. In Information and Automation, 2008. ICIA 2008. International Conference on (pp. 1242-1245). IEEE.

8. Xu, W., Wang, L., & Chen, G. (2014). Performance analysis of the CS-DCSK/BPSK communication system. IEEE Transactions on Circuits and Systems I: Regular Papers, 61(9), 2624-2633.

9. Tam, W. M., Lau, F. C. M., & Tse, C. K. (2004, May). An improved multiple access scheme for chaos-based digital communications using adaptive receivers. In Circuits and Systems, 2004. ISCAS'04. Proceedings of the 2004 International Symposium on (Vol. 4, pp. IV-605). IEEE.

10. Alavi, S. M., & Zhou, C. (2014). Resource allocation scheme for orthogonal frequency division multiple access networks based on cooperative game theory. International Journal of Communication Systems, 27(8), 1105-1125.

11. Diamantoulakis, P. D., Pappi, K. N., Ding, Z., & Karagiannidis, G. K. (2016, May). Optimal design of non-orthogonal multiple access with wireless power transfer. In Communications (ICC), 2016 IEEE International Conference on (pp. 1-6). IEEE.

12. Escribano, F. J., Kaddoum, G., Wagemakers, A., & Giard, P. (2016). Design of a new differential chaos-shift-keying system for continuous mobility. IEEE Transactions on Communications, 64(5), 2066-2078.

13. Singh, V. P., Khare, A., & Somkunwar, A. (2017). To Improve the BER and Channel Capacity Through the Implementation of Differential Noise Shift Keying Using Matlab. Indian Journal of Science and Technology, 8(1).

14. Taleb, F., Roviras, D., & Bendimerad, F. T. (2016, September). Very high efficiency Differential Chaos Shift Keying system with Walsh Hadamard codes. In Multimedia Computing and Systems (ICMCS), 2016 5th International Conference on (pp. 523-527). IEEE.

15. Salahat, E., Shehada, D., & Yeun, C. Y. (2015, September). Novel Performance Analysis of Multi-Access MIMO Relay Cooperative RM-DCSK over Nakagami-m Fading Subject to AWGGN. In Vehicular Technology Conference (VTC Fall), 2015 IEEE 82nd (pp. 1-5). IEEE.

16. Liang, H. Y., & Chu, H. C. (2017). Improving the peak-to-average power ratio of single-carrier frequency division multiple access systems by using an improved constellation extension scheme with error correction. Telecommunication Systems, 65(3), 377-386.

17. Wu, K., Ren, G., Ji, J., & Wu, J. (2016). Side information embedding and detection scheme for selected mapping based single-carrier frequency-division multiple access systems. IET Communications, 10(11), 1294-1302.

18. Lin, B., Yang, H., Ye, W., Tang, X., & Ghassemlooy, Z. (2017). Experimental demonstration of block interleaved frequency division multiple access for bidirectional visible light communications. Optical Engineering, 56(1), 016112-016112.

19. Rahnama, N., & Talebi, S. (2013). Performance comparison of chaotic spreading sequences generated by two different classes of chaotic systems in a chaos-based direct sequencecode division multiple access system. IET Communications, 7(10), 1024-1031.

20. Kaddoum, G., & Tadayon, N. (2017). Differential chaos shift keying: A robust modulation scheme for power-line communications. IEEE Transactions on Circuits and Systems II: Express Briefs, 64(1), 31-35.

21. Zhang, J., Zhang, H., & Cui, Z. (2013). Dual-antenna-based blind joint hostile jamming cancellation and multi-user detection for uplink of asynchronous direct-sequence code-division multiple access systems. IET Communications, 7(10), 911-921.

22. Hu, S., Yao, Y. D., & Yang, Z. (2014). Cognitive medium access control protocols for secondary users sharing a common channel with time division multiple access primary users. Wireless Communications and Mobile Computing, 14(2), 284-296.

23. Han, F., Yang, Y. H., Wang, B., Wu, Y., & Liu, K. R. (2012). Time-reversal division multiple access over multi-path channels. IEEE Transactions on communications, 60(7), 1953-1965.

24. Liu, J., Dai, H., & Chen, W. (2016). On throughput maximization of time division multiple access with energy harvesting users. IEEE Transactions on Vehicular Technology, 65(4), 2457-2470.

25. Quyen, N. X., Duong, T. Q., Vo, N. S., Xie, Q., & Shu, L. (2016). Chaotic direct-sequence spread-spectrum with variable symbol period: A technique for enhancing physical layer security. Computer Networks, 109, 4-12.

26. Kaddoum, G. (2016). Wireless chaos-based communication systems: A comprehensive survey. IEEE Access, 4, 2621-2648.

27. Litvinenko, A., & Aboltins, A. (2016, November). Selection and performance analysis of chaotic spreading sequences for DS-CDMA systems. In Advances in Wireless and Optical Communications (RTUWO), 2016 (pp. 38-45). IEEE.