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Performance Analysis of Spread Spectrum Communication System Based on C-T Coupling Cascade Chaotic Mapping

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1.Introduction

In order to solve the problems of limited number and low randomness of traditional spread spectrum codes, this paper proposes a C-T coupling cascade chaotic map with complex dynamics structure as a spread spectrum code generation algorithm.The Cosine map and Tent map are linearly coupled by coupling control factor, which increases the address space of the sequence.In addition, the coupled map and Cosine map were used as the root of the spread spectrum code, which improved the complexity of the generated sequence, so that the generated spread spectrum code had stronger pseudo-randomness.The direct spread spectrum system of C-T mapping was built through Simulink platform in Matlab, and the bit error rate of the system under different noise environment was analyzed. It was verified that the C-T coupling cascade chaotic mapping spread spectrum system has stronger anti-interference ability.

2.Chaos performance analysis

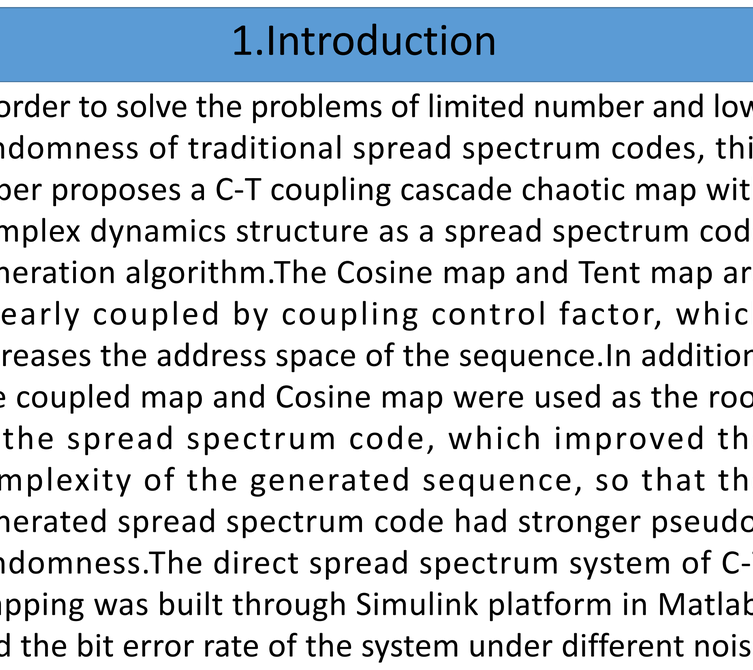


Fig. 1. Mapping bifurcation diagram

Table 1.Comparison of information entropy

M	*Logistic*	*Chebyshev*	*Tent*	*LC*	*C-T*
50	5.3640	5.3718	5.5982	5.3697	5.4504
100	6.3367	6.3471	6.5971	6.3471	6.4344
200	7.3178	7.3286	7.5956	7.3286	7.4208
400	8.3013	8.3131	8.5928	8.3151	8.4106
600	8.8778	8.8890	9.1751	8.8919	8.9913

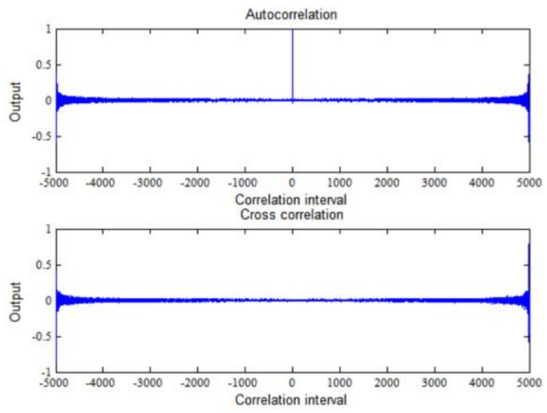


Table 2. Chaotic pseudorandom sequence equilibrium

sequence	*m*	*Logistic*	*Tent*	*LC*	*C-T*
Number of 1	9912	9936	9516	6729	9970
Number of 0	10088	10064	10484	13271	10030
Difference	176	128	968	6542	60
Balance	0.0088	0.0064	0.0484	0.3271	0.003

Table 3.Sequence run characteristic comparison

n	*m*	*Logistic*	*Tent*	*LC*	*C-T*
1	0.4922	0.4968	0.4758	0.6635	0.5015
2	0.3334	0.3348	0.3270	0.3240	0.3255
3	0.1429	0.1465	0.1356	0.1459	0.1338
4	0.0639	0.0726	0.0627	0.0847	0.0629

Table 4.C-T mapping NIST randomness test results

Test index	*P-value*	*Pass/Fail*
Frequency	0.213309	Pass
Block Frequency	0.266044	Pass
Cumulative Sums	0.795464	Pass
Runs	0.046525	Pass
LongestRun	0.768138	Pass
Rank	0.247472	Pass
FFT	0.978900	Pass
Non-Overlapping Template	0.604286	Pass
Overlapping Template	0.266044	Pass
Universal	0.327854	Pass
ApproximateEntropy	0.563176	Pass
Serial	0.534146	Pass
LinearComplexity	0.681642	Pass
Random Excursions	0.122325	Pass
Random Excursions Variant	0.141256	Pass

As shown in Figure 1, Figure 2 ,Table 1,Table 2,Table 3 and Table 4, the chaotic map generated by C-T shows good scores in terms of bifurcation diagram, relevant features, information entropy,balance,run characteristic and randomness.Therefore, C-T coupled cascaded chaotic map is suitable to be used as spread spectrum code in spread spectrum communication.

3.Performance Analysis of Chaotic Spread Spectrum System with C-T Mapping and Conclusion

In this paper, the Simulink module of MATLAB is used to simulate the C-T coupled cascade mapping chaotic spread spectrum system to analyze its bit error rate. Simulink is a visual simulation framework that allows users to modify the model in real time, reducing the cumbersome programming. The random number generator module is selected as the source of the transmitter, the sampling time in the module is set to 1, and the initial seed is set to 37. It is modulated by the BPSK module, and then modulo-2 is added to the spreading code of the mat file generated by C-T mapping. In order to simulate the negative impact of interference in the actual information transmission process, simulate the real communication environment, and finally enter AWGN and Band-Limited White Noise.The interference superimposed by the module is transmitted in the channel, and the initial seed in the AWGN module is set to 67. The receiving end uses the reverse design to demodulate and despread, and restore the original signal.

Fig. 3. Direct Sequence Spread Spectrum System

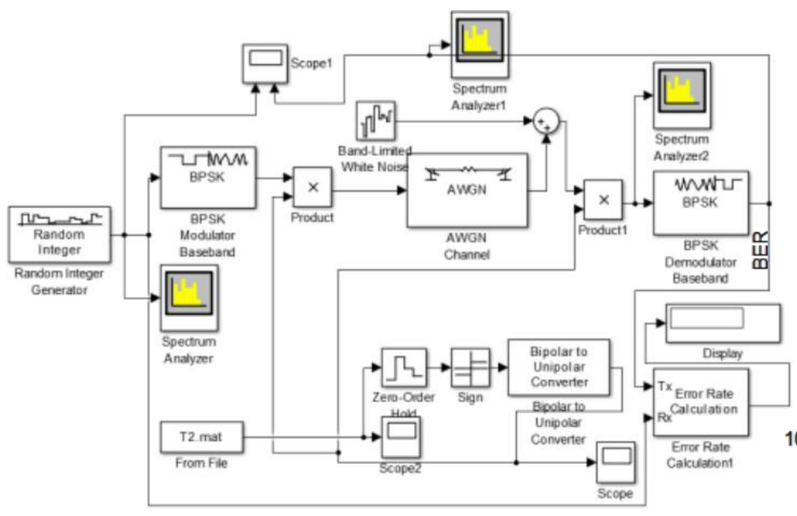
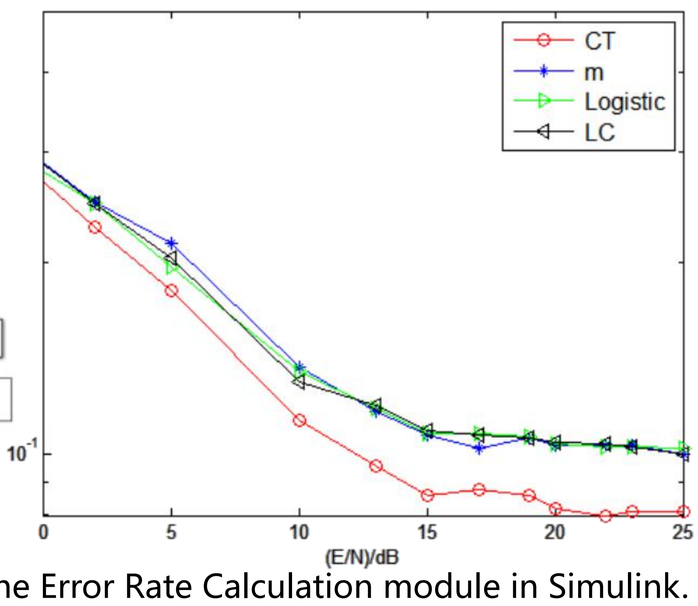


Fig. 4. BER Comparison



Calculate the bit error rate of the system through the Error Rate Calculation module in Simulink. When the signal-to-noise ratio of the additive white Gaussian noise channel is 10dB based on the C-T coupled cascade mapping spread spectrum system, the bit error rate is less than 0.12, and the bit error rate is It is lower than other systems and has excellent performance. As the signal-to-noise ratio increases, the bit error rate continues to decrease. However, the performance is better in a high-resistance environment, and high-quality communication can be guaranteed.

Chaos is a subject which is widely used in many fields. The direct spread spectrum method is a classical one, which shows new vitality with the combination of chaotic mapping with good performance.By analyzing the uniformity, correlation, balance, running characteristics, complexity and randomness of C-T coupling cascading mapping, it can be seen that C-T coupling cascading mapping avoids the problems of the previous one-dimensional chaotic mapping, such as fewer parameters, low complexity, uneven distribution and low randomness.The C-T coupling cascade mapping spread spectrum system proposed in this paper is very satisfactory in the aspect of anti-jamming performance and is suitable for secure communication.

Acknowledgement

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