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DCSK Communication System Choosing Different Chaotic Maps

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1. Introduction

Recently, research on a noncoherent CSK (Chaos Shift Keying) communication system is studied actively. In our previous research, it could be observed that the performance of the CSK communication system is changed depending on the initial value of the chaotic sequence. From this result, we expected that the noncoherent CSK communication systems also depends on chaotic maps. In this study, based on DCSK (Differential Chaos Shift Keying), where DCSK is one of typical noncoherent CSK communication systems, we propose a new DCSK transmitter which chooses a chaotic map depending on the initial value.

2. Basis of proposed method

Figure 1 shows the bit error rate (BER) of DCSK using 4 chaotic maps when E_b/N_0 is fixed as 10[dB], where E_b is the average energy per bit. This result was obtained from the following computer simulation.

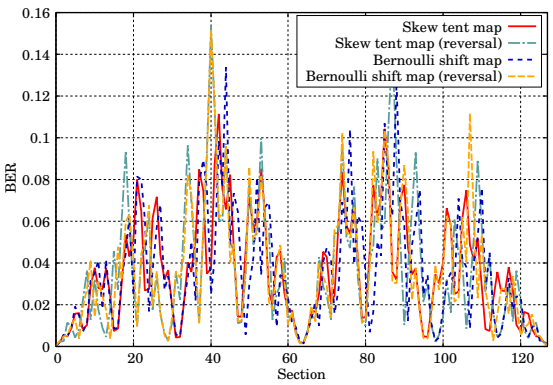

Figure 1: Basis of proposed method.

On the transmitting side, the interval of the chaotic map [−1 1] is divided into 128 sections. We choose one section and selected 10^4 initial points from this section at random. Using the chaotic sequences starting from these initial points, we transmit 10^4 bits of information. In this study, we used the skew tent map, the Bernoulli shift map and their reversal maps as a chaotic map. In addition, the chaotic sequence length N is 8, where the chaotic sequence length is the length of the modulated signal. From this figure, we can find that the BER strongly depends on the section selected. In other words, it can be said that the performance of the DCSK communication system is changed depending on the chaotic map.

From this result, we devise a new DCSK transmitter in which the chaotic map is choose by the initial value of the chaotic sequence.

3. Proposed method

Figure 2(a) shows the block diagram of the proposed DCSK transmitter. This system consists of three blocks. First, one section is determined by the initial value of the chaotic sequence in the 1st block. Next, a better chaotic map is decided using the results shown in Fig. 1 in the 2nd block. Finally, the chaotic sequence is generated using the better chaotic map in the 3rd block and used for the DCSK modulation. Therefore, the transmitted signal is given by

$$S_i = \begin{cases} x_i & (1 \le i \le N) \\ b_l x_{i-N} & (N+1 \le x_k \le 2N) \end{cases} \quad (1)$$

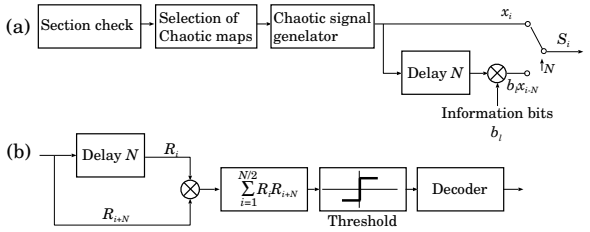

Figure 2: Proposed DCSK operation (a)transmitter, (b)receiver.

where x_i is the chaotic sequence, and b_l is the information signal (±1).

In the channel, noise is assumed by additive white Gaussian noise (AWGN) and is denoted by n_i $(1 \le i \le 2N)$. Thus, the received signal block is given by $R_i = S_i + n_i$ $(1 \le i \le 2N)$.

On the receiving side, it is evaluated by the correlation of 2 signals which divided the received signals into the half, as shown in Fig. 2(b). Thus, the output of the correlation can be written as

$$C = \sum_{i=1}^{N} R_i R_{N+i} \quad (2)$$

The decoded symbol is decided as "+1" or "−1" depending on C being larger or smaller than 0.

4. Simulated Results

In simulation, 10^4 symbols are transmitted and the BER is recorded for various E_b/N_0 values. Figure 3 shows the simulation results of the proposed method. To compare the performance of the proposed method, the performance of the existing DCSK is shown together in Fig 4. From the result, it can be observed that the performance of the proposed method is better than that of the existing DCSK. Therefore, we can find that choosing the chaotic map depending on the initial value is effective.

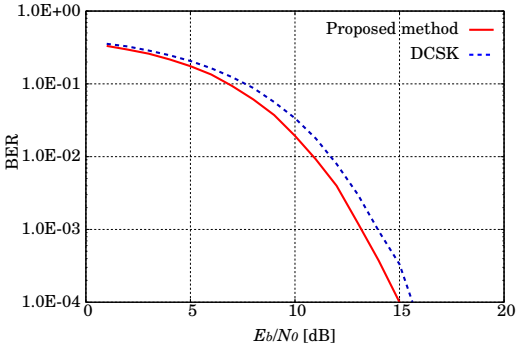

Figure 3: Simulation result.

4. Conclusions

In this study, we proposed the new DCSK transmitter which changes a chaotic map depending on the initial value. As a result, a better BER performance was obtained. In addition, we proved the effectivity of choosing the chaotic map depending on the initial value. Investigating the performance of the proposed method which increases the chaotic sequence length is our future work.