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SECURITY OF A NETWORK BY EMPLOY OF CDMA TECHNIQUES WITH CHAOTIC SEQUENCES

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Abstract*- Spreading codes play an important role in multiple access capacity of DS-CDMA.M-sequences , has been traditionally used as spreading codes, they are generated by shift registers , they are periodic in nature and less in number so this limits the security. This paper present an investigation on use of chaotic sequences ;that recently ,chaos theory has developed a new area that is relevant to future radio spectrum management and security. one of the chaotic systems is used as a generator of sequences is non –linear recursive equation (logistic map).

***Keywords* –** Code division multiple access, Direct sequences spread spectrum, chaos,Error rate

I. INTRODUCTION

Due to the limitations of available radio frequency bandwidth ,multiple access techniques have been used to provide the users access to the communication channel. CDMA systems assign uncorrelated codes to each mobile user,enabling them to transmit continuously over time using the full bandwidth over the complete call duration[1].Obviously ,the maximal length shift register sequences (Msequences)and Gold sequences are the most popular spreading codes in spread spectrum systems,nother category for use in DS-SS called chaotic saquences ,they are created using discrete,chaotic maps[2].The sequences so generated with both logistic map are well-known as,even though completely deterministics similar to those of random noise.Surprisingly ,the maps can generate large numbers of these noise-like sequences having low cross correlation .Generally these sequences have been used in CDMA systems and can improve performances in terms of allowable number of users.

II. LOGISTIC MAP

One of the simplest and most widely studied nonlinear dynamic systems capable of exhibiting chaos is the logistic map:

$$f(x,r) = rx(1.x) \quad (1)$$

$$x_{n+1} = rx_n(1-x_n), 0 \le x_n \le 1, 0 \le r \le 4 \quad (2)$$

Here, f is the transformation mapping function,and r is called the bifurcation parameter.Depending on the value of r the dynamics of system can change attractively,exhibiting periodicity or chaos.

For some values of r, x tends to a fixed point ,for other values,x oscillates between two points (period doubling)and for other values,x becomes chaotic.

f : v→v

f is chaotic on v means f is:

- f has sensitive dependence on initial conditions.
- f is topologically transitive.
- Periodic points are dense in v.

A. Bifurcation:

Qualitative change in the nature of the solution occurs if a parameter passes through a critical point (bifurcation or branch value) or in the number of solutions to a differential equation when a parameter is varied.

B. The bifurcation diagram

In which we plot the location of fixed (or periodic) points versus the parameters, so it show the chaotic attractor of the system (although the orbits are chaotic, they are bounded within a subset of the interval [0, 1].

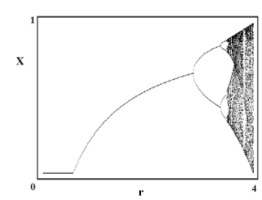

Fig. 1 Bifurcation diagram for the logistic map the asymptotic dynamics are plotted for 452 parameter values on the interval ,r=[0,4]

For each of 452 values of r on the interval, r = [0.4], equation (2) was iterated n+m = 756 times. Of these, the first n = 500 iterates were discarded and the final m = 256 points plotted

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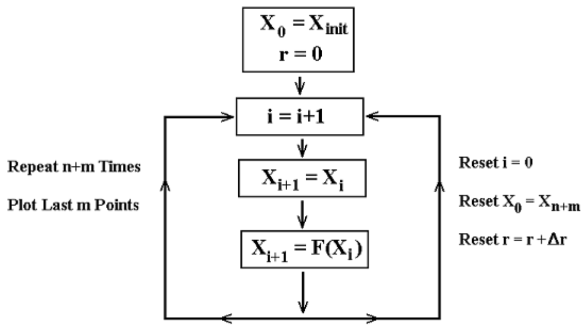


Fig. 2 Flow chart for the computation of bifurcation diagrams. In Figure1, n = 500; m = 256 and r = 4/452.

III. CHAOTIC SYSTEM

A chaotic dynamical system is an unpredictable, deterministic and uncorrelated system that exhibits noise-like behavior through its sensitive dependence on its initial conditions, which generates sequences similar to PN sequence. The chaotic dynamics have been successfully employed to various engineering applications such as automatic control, signals processing and watermarking. Since the signals generated from chaotic dynamic systems are noise-like, super sensitive to initial conditions and have spread and flat spectrum in the frequency domain, it is advantageous to carry messages with this kind of signal that is wide band and has high communication security. For this reason numerous engineering applications of secure communication with chaos have been developed.

A. chaotic sequences:

A chaotic sequence [3] is non-converging and non-periodic sequence that exhibits noise-like behavior through its sensitive dependence on its initial condition. Chaotic systems have sensitive dependence on their initial conditions. A large number of uncorrelated, random-like, yet deterministic and reproducible signals can be generated by changing initial value. These sequences so generated by chaotic systems are called chaotic sequences. Chaotic sequences are real valued sequences. Since the spreading sequence in a chaotic Spread Spectrum (SS) is no longer binary, the application of the chaotic sequences in DS-CDMA is thus limited. A further attempt to transform continuous values to binary ones by using digital encoding technique is therefore used to adopt it in DS-CDMA. Sorne criteria are performed.

B. Generation of Chaotic sequences

One major difference between chaotic sequences and PN sequences is that chaotic sequences are not binary. Therefore chaotic sequences must be transformed into binary sequences. There are various methods of generating binary sequences from chaotic real sequences. Various types of binary function are defined to get binary sequences based on a chaotic real valued orbit generated by ergodic maps.

METHOD 1: The chaotic sequences are transmitted into quantization and encoding block. The quantization performs an equal-interval quantization of the floating point input signal varying from -1 to + 1. The output signal is quantized into whole units, the unit size determined by the number of bits used in the binary representation. The coding block converts the quantized signal into a stream of bits. The sequence obtained in this way is called chaotic bit sequence

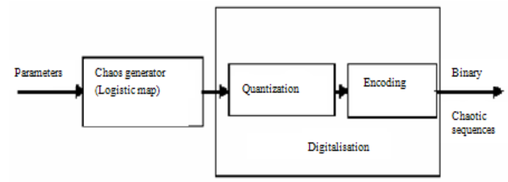


Fig. 3 Generation of binary chaotic sequences

METHOD 2: Let w be the real valued chaotic sequence. For transforming this real valued sequence to binary sequence, we define a threshold function

$\theta_t(w)$ as $$\theta_t(w) = \begin{cases} 0, w < t \\ 1, w \geq t \end{cases} \quad (3)$$

Where t is the threshold value. Using these functions, we can obtain a binary sequence which is referred to as a chaotic threshold sequence.

METHOD 3: Binary sequences $\{C_k\}$[4] can be obtained from a continuous chaotic signal x(t) by defining

$$C_k = g\{x(t) - E_t(x(t))\}|_{t=kTd} \quad (4)$$

Where g(x) = 1 for x $\geq$ 0 and g(x) = -1 for x < 0.

E(x(t)) denotes the mean function over the continuous time and Td is the basic period of x(t). By applying (4) to the logistic map in (1) in a chaotic regime, it is possible to obtain different by varying initial conditions or parameter values of the system. The sequences generated in this way are expected to have a low cross correlation.

C. Chaotic DS/SS system

In chaotic DS/SS system [5], each user is assigned a different initial value x_n, where n is the n^{th} user. Each user starting with his unique initial value, keep on iterating the chaotic map and gets the real valued chaotic sequence. This real chaotic sequence is transformed to binary (±1) for its use in DS/SS .In case of tent map, each user is assigned a different bifurcation parameter whereas each user is assigned different initial value in case of logistic map. In this paper, logistic map has been used to generate the real valued chaotic sequences.

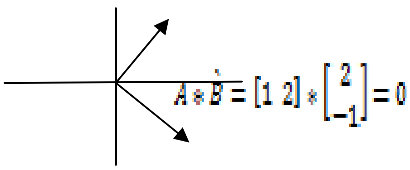
IV. ORTHOGONALITY[6]

Orthogonality is an important concept used in DSP (digital signal processing). The word comes from a Greek word (orthos) implying a perpendicular or right-angled relationship. In mathematics, two row vectors a and b are said to be orthogonal if their inner product given by a * b' is equal to zero. When a and b have just two or three elements, then the original meaning of orthogonality holds, and the vectors are perpendicular to each other, as illustrated in Fig 4. When vectors have more than three elements, we lose the spacial picture of orthogonality, but the definition, that is, a * b' = 0, holds for any number of elements, provided only that a and b have the same number of elements.

Two waveform vectors are orthogonal when their product vanishes as just described; sometimes these vectors occur from measurements, that is, analog-to-digital conversion. and sometimes they occur from the evaluation of functions. In the latter case. Orthogonality must be evaluated with respect to a specified set of samples. That is, the vectors in this case consist of specified samples of the functions. For example, suppose we have N samples of two funtions of t, a (t), and b (t). Sampled at t = 0, T… (N -1)T to produce elements a0… aN-1 and b0… bN-1, these are then the elements of two vectors, a and b, and the condition for orthogonality with respect to the N samples is a * b' = 0; that is

$$a * \dot{b} \equiv \sum_{n=0}^{N-1} a_n b_n = 0 \qquad (5)$$

A=[1,2]



B=[2,-1]

Fig. 4 Orthogonal vectors A and B form a right angle at the origin

V. PERFORMANCE OF SYNCHRONOUS DS-CDMA SYSTEM USING CHAOTIC SEQUENCES [7]

The configuration of the synchronous DS-CDMA is shown in Figure 4. In the synchronous DS-CDMA, users ernploy their own sequences to spread the information data. At each user's terminal, the information data are modulated by the first modulation scheme (e.g., QPSK and BPSK). Then, the first bits of the modulated data are spread by a code sequence. The spread data of all the users are transmitted to the base station at the same time. The base station detects the information data of each user by correlating the received signal with a code sequence allocated to each user.

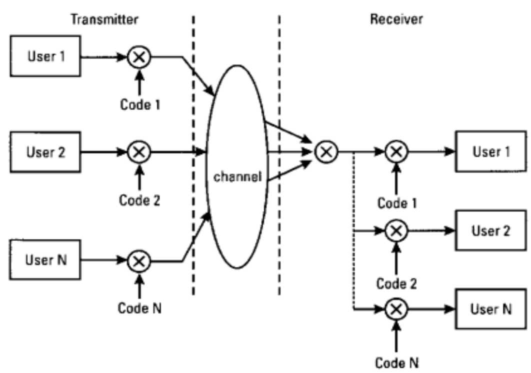


Fig . 5 Synchronous DS-CDMA system

VI. NUMERICAL RESULT

For comparison of chaotic and M-sequence spreading code, it is assumed that the parameters used for the simulation are defined as follows:
Symbol rate:sr =256000.0;
Number of modulation levels: m1=2;
Bit rate: br=sr*m1;
Number of symbols: nd=100;
Number of filter taps: irfn=21;
Number of oversamples: IPOINT=8;
Roll-off factor: alfs=0.5

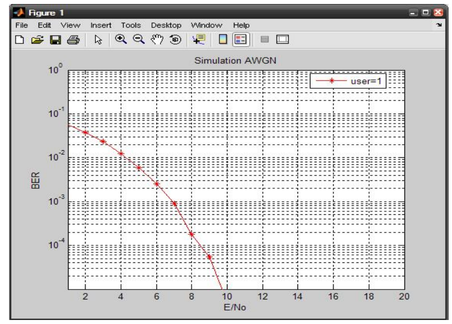


Fig.6 BER performance of DS-CDMA with chaotic sequences in AWGN for a user

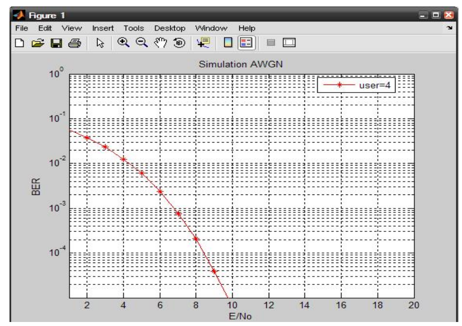


Fig.7 BER performance of DS-CDMA with chaotic sequences in AWGN for 4 users

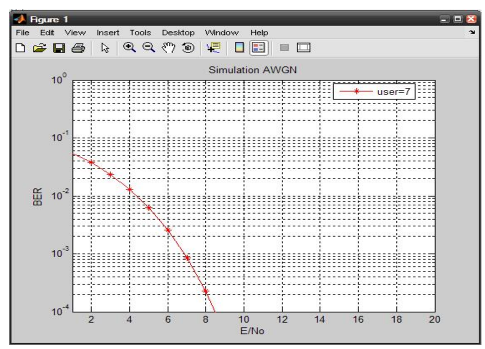


Fig.8 BER performance of DS-CDMA with chaotic sequences in AWGN for 7 users

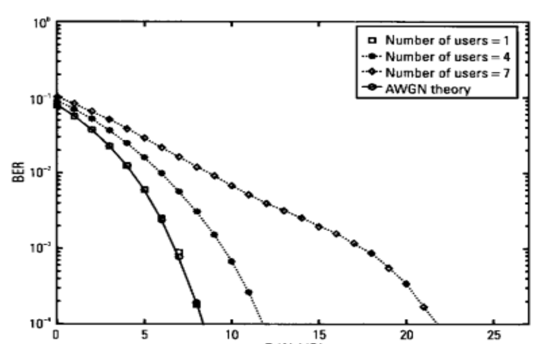


Fig.9 BER performance of DS-CDMA with M- sequence in AWGN [7]

VII. CONCLUSIONS

In this paper we give an exemple for the possibility to get a CDMA from a system of cryptography ,in wich we introduce different seven initials value.and of coefficient of bifurcation r =3.99 however we can acquire a CDMA another way by putting a simple initial value and doing many iterations for selection of different intervals to attain certain orthogonality[11].So in CDMA techniques we can reach it by different ways ,in condition to have the smallest bit error.whenever the bit error is less than other bit error we have the ideal system, the BER performance in an AWGN environment of a synchronous DS-CDMA discussed above is simulated and the results are shown in figures (6-9). In the M-sequence, the cross-correlation value is not 0 at the syn-chronized point. Therefore, this non zero correlation becomes interference for other users. As a result, as the number of users increases, the BER degrades. In contrast, in the chaotic sequence, the value of cross-correlation between the users is 0 at the synchronized point. This means that as the number of users increases, the value of BER is ideal.

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