

Implementation and synchronisation of hyperchaotic systems

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Abstract— In this paper we present a new modified hyperchaotic communication systems has been simulated using simulation software. This is the first time, the stability of the transmitted signal, the intensity limit and the requirements to measure the accuracy of electronic components is presented by Multisim simulation software. There has been some methods like Chaotic Shift Keying (CSK), Chaotic Masking be presented but later it showed that might not self assured. The idea behind this communication systems is to provide secure communication links between sender and receiver through wireless channel using nonlinear dynamics of the hyperchaotic circuits. The nonlinearity of the hyperchaos cannot be predicted and it is very much harder to encrypt. Hence, the nonlinear hyperchaotic circuit is used for analog and digital signals. This can also be used in the private communications.

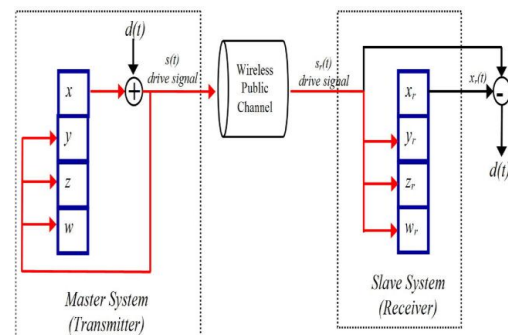
Keywords- Attractor, Simulation, nonlinearity, hyperchaotic circuit.

I. INTRODUCTION (HEADING 1)

In the present digital world, there is a striking rise in shopping, banking and trading transactions over the internet. So, we have to take effort in safeguarding communication links. Therefore, the data security should be increased in order to minimize the unauthorized access of data and fraudulent from the third parties. Hence Confidentiality, Integrity and Authentication are the three vital elements for secure communication[4]. Confidentiality can be best described as, content of the message being transmitted is only understood by the sender and receiver. Integrity states that, when two parties (or systems) are in communication, it ought to be ensured that there is no alteration in the content of the message being transmitted i.e. (only authorized users should be allowed to modify the message). Authentication is the process of verifying a identity of user. Recently, chaotic signals, have features like ergodicity, less predictability, broadband spectrum, more sensitive to parameter mismatch, it suits for implementing secure communication. The hyperchaotic systems comprises of some parameters like Master, Slave and Medium(Noise)[2]. The nonlinear dynamics and hyperchaos was the realization of a method which can be used in cryptography. This method is known as HYPERCHAOS SYNCHRONIZATION. The hyperchaos synchronization is a method in which the two similar chaotic systems (they can't be exactly alike) generates a same signal[3]. To implement hyperchaos communication, two chaotic oscillators are required. One of them is used as the

Transmitter (Master) and the other as Receiver (Slave). At the transmitter, the message is added in the chaotic data, that is coupled with the acceptor. In the way that this message will be first cover-up by the Chaotic data. Masking can be done by adding the two signals. At the time of analysis, the message being transmitted is taken in the form of Triangular Wave, Square Wave and Sinusoidal Signal[2]. At what time the Receiver synchronises with its Source, the received message is decrypted by performing Arithmetic operation between the data sent by Source and its copy created at the Acceptor by means of matching Hyperchaos mechanism. Meanwhile the Source output comprises of Chaotic carrier plus the message being transmitted and the Acceptor output contains only the copy of the chaotic carrier without message. After the encryption, the signal will look like noise and the message is transmitted through wireless channels which are inaccessible to possible eavesdroppers.

II. BASIC ELEMENTS FOR SECURE HYPERCHAOTIC COMMUNICATION SYSTEM



A. Ways to Achieve Hyperchaotic Synchronization

There may be two ways to achieve synchronization would be,

- Using two – transmission channel system:-

Here we are having two separate channels, one for carrying the encrypted signal, and the other

for carrying chaotic carrier wave for synchronization at the receiver.

- Using Single transmission channel system-

In this, the Chaotic carrier waveform itself acts as a driver signal to synchronise the receiver with the transmitter.

B. Shielded Hyperchaotic communication systems

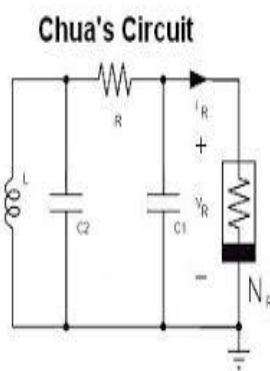
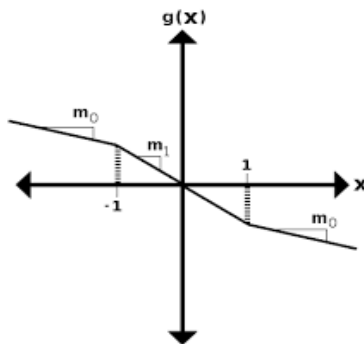


Fig1: Nonlinear diode characteristics of chua's circuit



The expression for the chua's oscillator is given by,

$$-x + y + yz = dx/dt,$$

$$-x - y + \alpha xz = dy/dt,$$

$$z - \beta xy = dz/dt,$$

where α and β are the parametric equations of values $\alpha = 0.4$ and $\beta = 0.3$ respectively. X, y, z are the 3D coordinates and 't' is the time.

1) A New Hyperchaotic systems

1.1) Lorentz Hyperchaotic systems

Consider the lorentz hyperchaotic systems,

$$\dot{w} = a(x - w)$$

$$\dot{x} = cw - wx + z$$

$$\dot{y} = wx - by$$

where w, x, y are the coordinates and a, b, c are the parametric equations

when $a = 8$, $b = 8/3$ and $c = 20$ it shows the hyperchaotic behaviour of lorentz attractor.

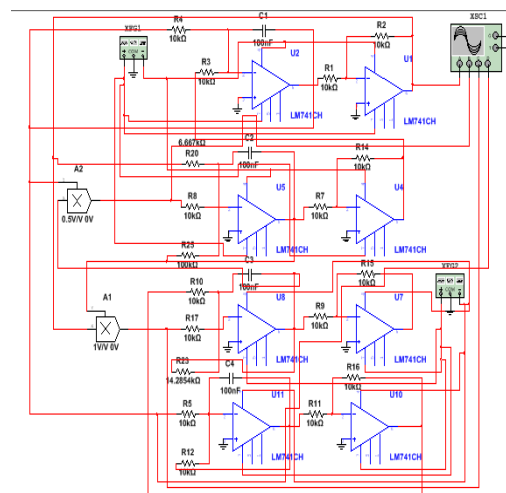


Fig2: Circuit for hyperchaotic Lorentz system



Fig3: Hyperchaotic behaviour of lorentz system

1.2) Rossler Hyperchaotic systems

Rosslar attractor is the solution of 3 coupled non linear differential equation,

$$dx/dt = -y - z$$

$$dy/dt = x + ay$$

$$dz/dt = b + z(x - c)$$

where $a = 0.4$, $b = 0.4$ and $c = 5.5$

This rossler system cannot form a limit cycle nor it reaches steady state.

As with other hyperchaotic attractors, the rossler attractor is sensitive to initial conditions.

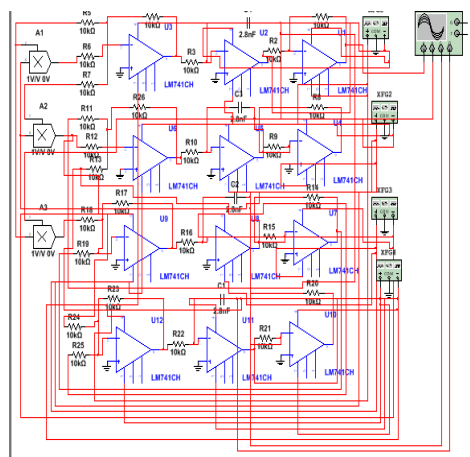


Fig4 : Circuit diagram for Hyperchaotic-Rosslar systems

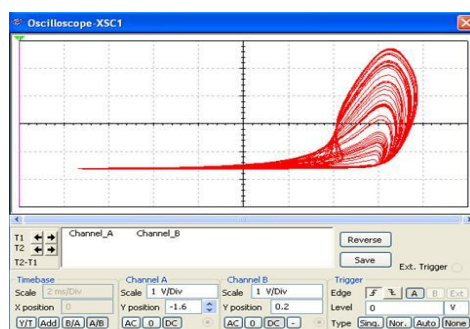


Fig5 : Hyperchaotic behaviour of Rossler Attractor

1.3) Combination of Lorentz-Rosslar Hyperchaotic systems

For the performance analysis of the system, Simulation software is taken, and the communication system is designed using the desired components. The transmitter circuit consists of the chua's circuit for the generation of Hyperchaos signals and some Op-Amps are used for designing an adder and masking circuit. The receiver circuit consists of the synchronous sub-system, which synchronizes the receiver with the transmitter to retrieve the message.

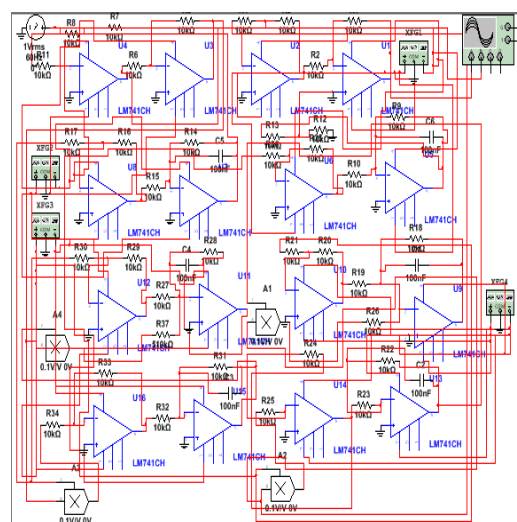


Fig6: Circuit for hyperchaotic Lorentz-Rosslar system

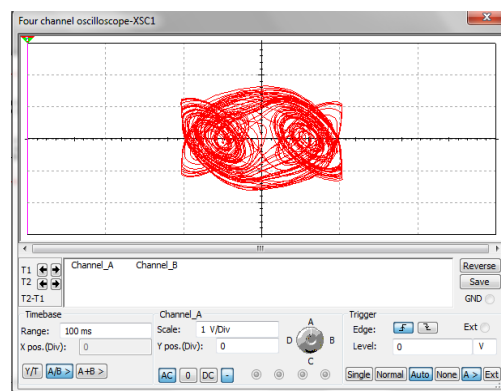


Fig7: Hyperchaotic behaviour of Lorentz with Rossler Attractor

2. Chaotic Masking circuit

The message signal is hidden in the broad chaotic spectrum by adding message to the chaotic mask.

At receiver the chaos mask which is estimated from hyperchaos synchronisation is removed from the receiving signal to obtain the original message.

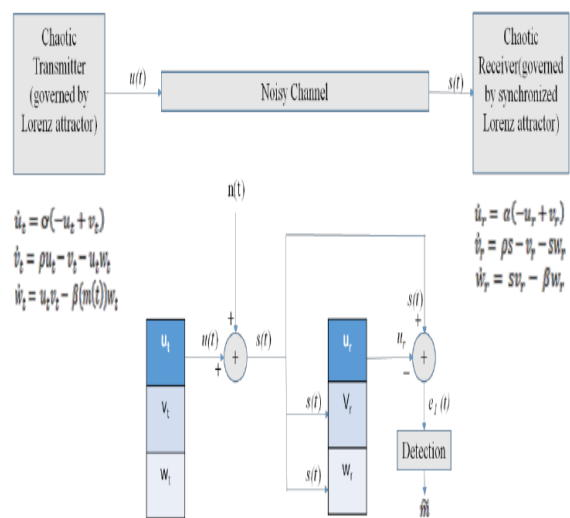
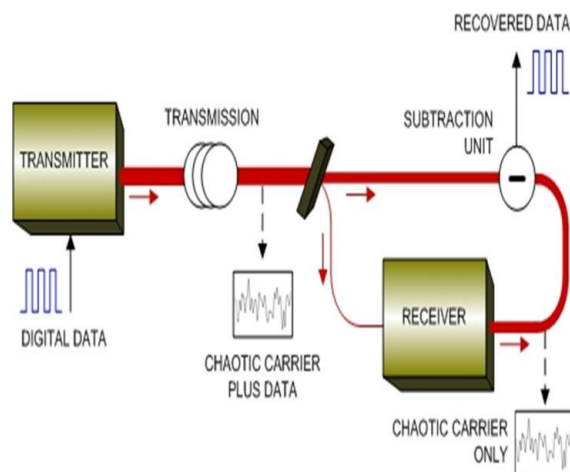


Fig8 : Schematic diagram of Chaotic masking circuits



3. Simulation Results

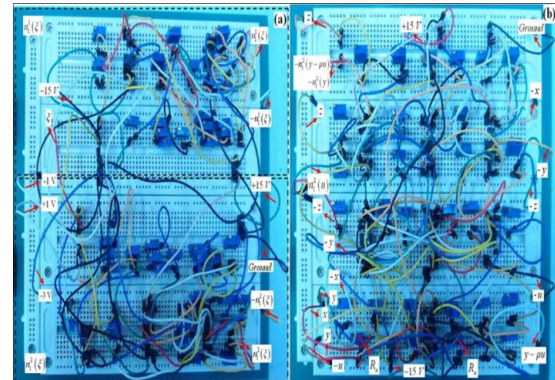


Fig9 : Hardware implementation of Hyperchaotic Lorenz-Rossler systems

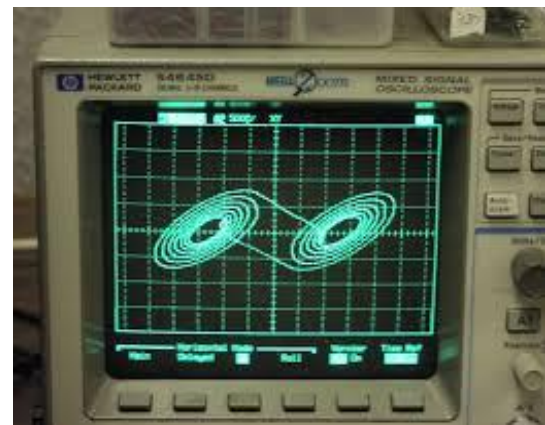
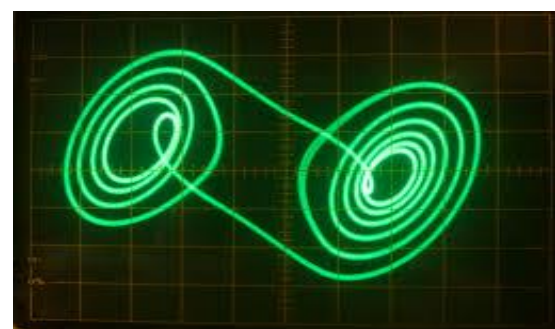
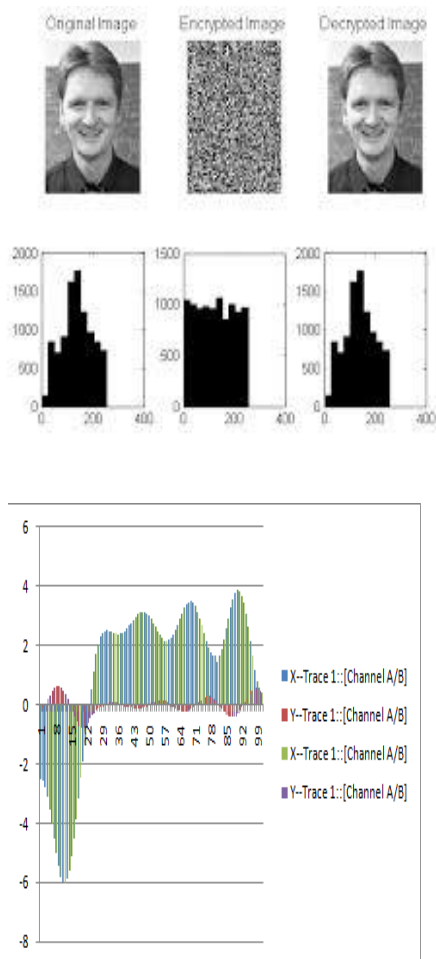


Fig10 : Hyperchaotic behaviour of Lorenz-Rossler system



4. Chaotic Map

Chaotic map is a function that exhibits some sorts of hyperchaotic behaviour. Chaotic maps often generate Fractals.



IV.CONCLUSION

In this paper, we construct Lorentz based hyperchaos, Rossler based hyperchaos and the combination of Lorentz and

Rosslar based hyperchaos by introducing the method of Feedback Control System. We find that the Circuit has a large range of orbit. The adjustment range of circuit parameter to achieve synchronisation are Synchronisation control and Estimated output parameters in order to verify the hyperchaotic circuit in the above parameters and corresponding hardware circuit is designed. The experimental results are tested with circuit simulation. Also we have shown that the comparison among different chaotic attractors which reflect the proposed synchronisation methods is better than the others. Using these different attractors will improve the noise quality of a hyperchaotic systems. The main advantage of using hyperchaotic synchronisation is that it is very much difficult to predict the message data. Since hyperchaotic systems have less predictability than chaotic systems, it is used in image encryption, trading sections etc.

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