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Secure Communication Approach using Microcontroller Based Lorenz System

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Abstract—*In this paper, secure communication synchronization using Lorenz system is proposed. For that purpose, PIC microcontroller is executed into Lorenz oscillator which shows chaotic behavior. This system is implemented into Proteus platform with designed algorithm. The proposed concept provides encryption chaotic signal for secure communication*

1. INTRODUCTION

The Lorenz system is firstly studied by Ed. N Lorenz in 1963 where realized chaotic behavior using weather phenomena. The Lorenz system proposed mathematical model of three nonlinear a set of differential equations. This set differential equation system gives a non-periodic waveform pattern of certain constant parameter values and specific initial conditions. At today it has many advantages of the Lorenz system in the field of science and engineering for example, secure communication, image encryption, random number generation etc. Fig.1 shows the conventional analog Lorenz circuit.

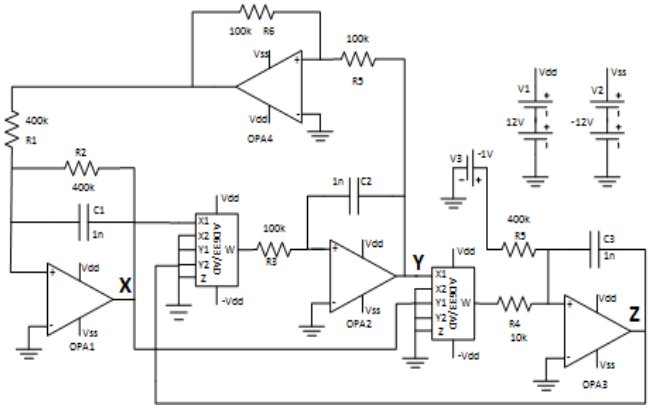

Fig. 1: Analog chaos circuit schematic diagram.

2. LORENZ SYSTEM

There are three differential equations in Lorenz system. These three differential equations were derived from analyzing weather phenomena. Mathematically, the Lorenz attractor is simple, but the result shows chaotic behavior [1-4]. Each x, y and z component of Lorenz equations are as follows:

$$\dot{x}(t) = p\big(y(t) - x(t)\big) \quad (1)$$

$$\dot{y}(t) = rx(t) - y(t) - x(t)z(t) \quad (2)$$

$$\dot{z}(t) = x(t)y(t) - bz \quad (3)$$

Above three set of differential equations, parameters x, y and z can be changed with respect to the time. To have the chaotic behavior of these set of differential equations, p, r and b are assigned to some specific constant values for the chaos based Lorenz attractor, those should be replaced with p = 10, r = 30.5 and b = 8/3. In the schematic diagram fig. 1 shows the analog circuit for analog, chaos circuit output at the points X, Y and Z.In order to implement the set of Lorenz equation, the equation must be in discrete format. Therefore, using the Euler method, equation set can be written in discrete format. For the discrete set of differential equation, it has been selected ts = 3ms as sampling time.

3. IMPLEMENTATION OF MICROCONTROLLER BASED LORENZ SYSTEM

Fig. 2 shows the algorithm of the Lorenz system and the equations are drawn in flowchart format. For this Lorenz system discrete time equations, initial parameter values have been selected as x1=0.1, y1=-10 and z1=0.1. Then constant values have been selected as p = 10, r = 30.5, b = 8/3 and ts = 3ms for chaos signal output by the Lorenz system. Thereafter, discrete time format of Lorenz equations will be processed iterative mathematically.After the process, each and every time interval microcontroller will provide out by it'sthe ports B, C and D.

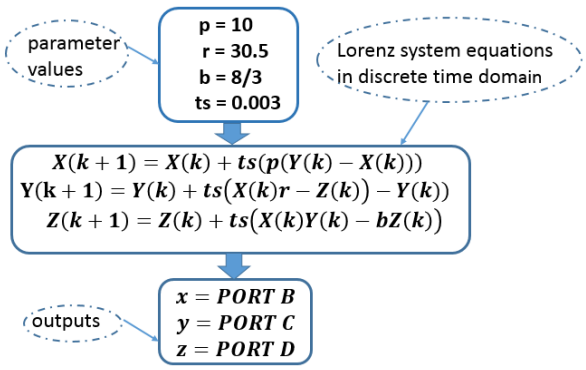

Fig. 2: Flow chart diagram of the microcontroller based Lorenz system.

For the microcontroller based chaotic oscillator, it has been selected PIC18F family, PIC18F4520 microcontroller to implement the Lorenz base chaos oscillator. The XC8 compiler has been selected for compilation the source code writtenin C language. In this circuit arrangement, three R-2R ladder networks have been implemented to convert digital signal into analog signal output. Microcontroller will provide the Lorenz signal output x(t), y(t) and z(t) by its port B, port C and port D respectively. Those three signal outputs are digital signal output from the microcontroller. Therefore, three R-2R ladder resistor networks have been connected to each port output of the microcontroller.

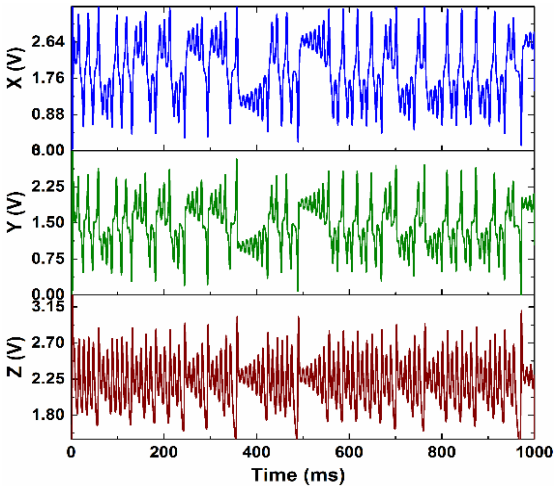

Fig. 4: Time waveform outputs for control parameter r = 30.5

Waveform diagram in fig. 4 shows output voltage time waveform by the microcontroller based Lorenz oscillator circuit chaotic time wave forms X(t), Y(t) and Z(t) from top to bottom in the diagram respectively.

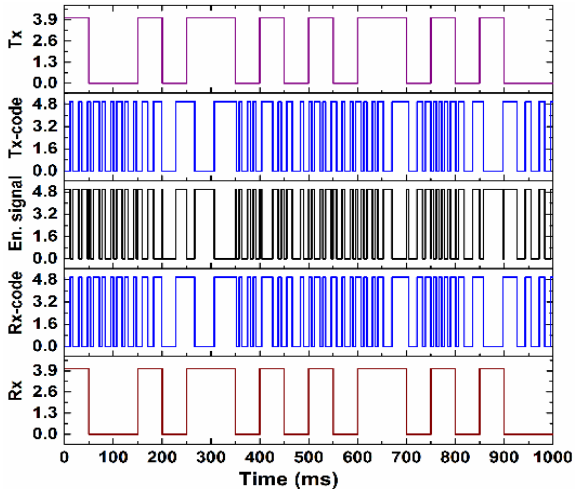

Fig. 5: Secure communication waveform diagram.

According to this chaotic analog waveform (Fig. 4) output chaotic digital Tx-code will be generated (Fig. 5). Our information signal (Tx) will modulate with this Tx-code and generate the En. Signal. After that this En. Signal can be transmitted through unsecure channel. At the receiving end information signal can be extracted using Rx-code at the receiving end and information signal can be extracted.

4. CONCLUSION

This paper presents secure communication synchronization using two microcontrollers engaging at Tx-end and Rx-end. The gained simulation results demonstrated that the Lorenz system can be implemented on the microcontroller and secure methods for information on the data communication is feasible,

5. ACKNOWLEDGEMENT

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