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The Generation of Chaotic signals from Master System using Logistic map equation

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Abstract: We experimentally done the hardware implementation of Master System using logistic map which can be used for secure communication. The circuit is implementing for generation of deterministic chaos by non-linear equation using logistic map equation. Simulation result conforms that on changing the control parameter i.e. r different changes occurs in logistic map which leads from stable fixed point then period 2 oscillation which changes to period 4 oscillations to period 8 and finally moves on to the chaotic region as we go on changing the control parameter values.

Index Terms: Chaotic signal, One-dimensional map, Logistic difference equation , Bifurcation.

I. INTRODUCTION

Chaos is there in the unpredictable weather, in the share price fluctuations in stock market and even in the variation of commodity prices. We can see chaos in ecology, economics, and epidemiology, in the beating of the heart and in the electrical signals from the brain.[1,2]. The phenomenon of synchronization has been the subject of numerous theoretical and experimental investigations in many research areas. In particular, synchronized chaotic waveform have found applications in chaos based communication systems. Different setups for chaotic data transmission have been proposed.

The application of chaotic synchronization to secret communication systems was suggested in the pioneering work by Pecora and Carroll [3, 4]. In 1990 Pecora and Carroll reported that certain chaotic systems possess a self-synchronization property. A chaotic system is self synchronizing if it can be decomposed into subsystems: a drive system and a stable response subsystem that can synchronize when coupled with a common drive signal. They also discovered that a chaotic transmitter could consist of an electronic circuit that simulated the dynamics, for example Lorenz equation.

In particular, Logistic Map synchronization has been studied extensively, due to its huge potential application in secure commun-ication [5, 8]. Several methods have been proposed for synchronization based on Non-linear control method [9], where a method of synchronizing chaotic maps and its implementation within a CPM based chaotic communication system are proposed. The general approach to master slave chaotic map synchronization is demonstrated in this work on one dimensional cubic map master-slave system.

II. LOGISTIC MAP

Logistic Map belongs to one-dimensional maps which are discrete dynamical systems. These maps are very interesting to study as they are easy and fast to simulate on electronic devices as time is discrete and have got lot of utilizations in successful predictions about the route of Chaos in Semiconductor, Lasers, Heart cells, Digital Communications etc.

The Logistic equation is given as:

$$X_{n+1} = rx_n(1 - x_n)$$

Where x_n= dimensionless measure of the population in the n^{th} generation and r = intrinsic growth rate. The control parameter r is in the range $0<r<4$ so that x_n is in the range $0< x_n<1$.Logistic Equation is used to explain the population growth of any Species.

Bifurcation diagram which shows period doubling phenomenon for a logistic map is given below in figure 1.

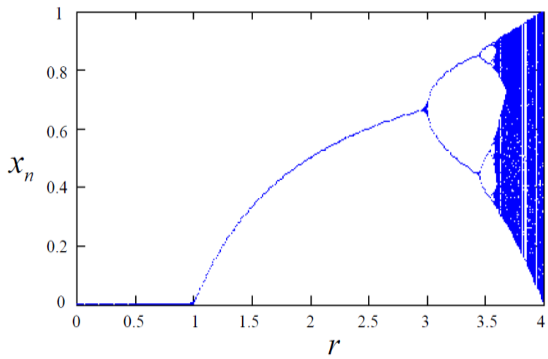

Figure 1: Bifurcation diagram of the logistic difference equation.

III. ELECTRONIC CIRCUIT REALIZATIONOF THE LOGISTIC MAP

Generation of deterministic chaos in electronic circuits by implementing non-linear equations. The attractive properties of chaos as discussed are sensitivity to initial conditions has made it very important in engineering applications. Chaotic signals can be generated easily in hardware electronic circuits by implementing non-linear equations like Chua's circuit, jerk circuit, tent map, logistic map or implementing differential equation in phased lock loop etc. Logistic map got its mainly in secure communication, data encryption and decryption, optics, cryptology, meteorology, biophysics, hydrodynamics.

The original hardware circuit is done using commercially available analog ICs, such as multiplier AD633,

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operational amplifier TL082, sample and hold circuit LF398 and other circuit components like capacitors of value 0.1 microfarad, resistors of 12 Kilo ohm , NOT gate IC 7400 etc. The TTL compatible square wave clock signal is used to the triggering input of the first sample and hold circuit and the inverted version of the clock signal is used in the second sample circuit and hold circuit as shown in figure 2. Two TL082 high frequency operational amplifiers are used here to perform subtraction operation and gain adjustment. According to the circuit configuration given in figure 2, the first TL082 act as the subtractor by producing output voltage(10 - X_n) , next analog multiplier gives an output X_n (10 - X_n) ÷ 10 Since its inputs are (10 - X_n) and X_n. The multiplier output is connected to the gain adjustment for four times amplification. The amplified signal is then passed through the remaining multiplier to multiply it by λ for producing the output. Finally the multiplier output passes through two successive sample and hold circuit as shown in figure 2.

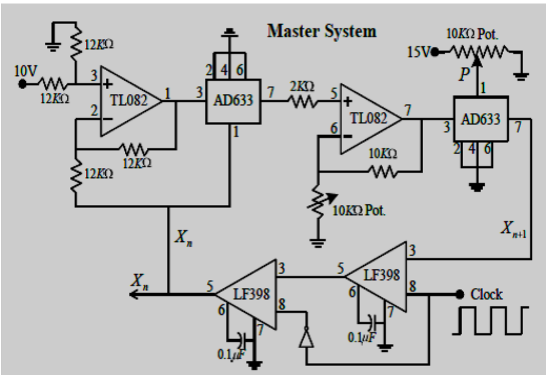

Figure 2: shows the circuit diagram of the logistic difference equation.

IV. EXPERIMENTAL RESULT

The electronic circuit of the logistic map as shown in figure 2 has been realized in our laboratory by utilizing the available resources. A function generator is used here as clock input to the sample and hold circuit by fixing its clock frequency at 6 KHz. By changing the values of λ we have observed different period doubling and chaotic oscillation with the help of a mixed signal storage oscilloscope. The results obtained in the mixed signal storage oscilloscope (Agilent 54641 D) with frequency of 350 MHz is given below:-

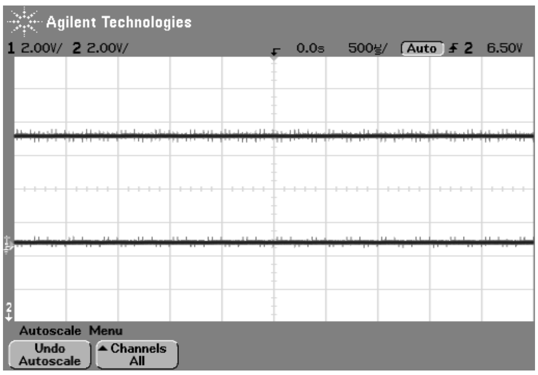

Figure 3: Fixed point of the logistic map; upper tracing shows x_{n+1} and lower tracing shows x_n for r =7.51.

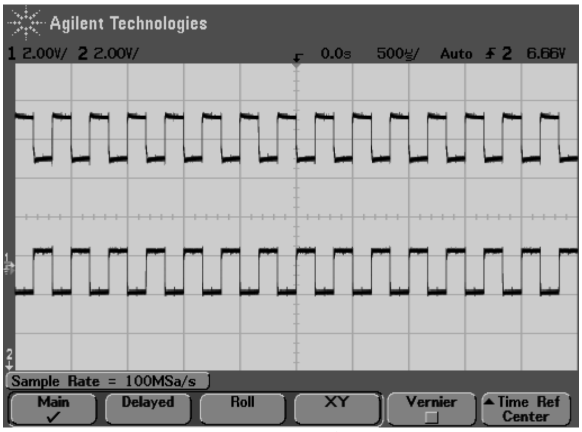

Figure 4: Period 1 oscillation of the logistic map; upper tracing shows x_{n+1} and lower tracing shows x_n for r =7.80.

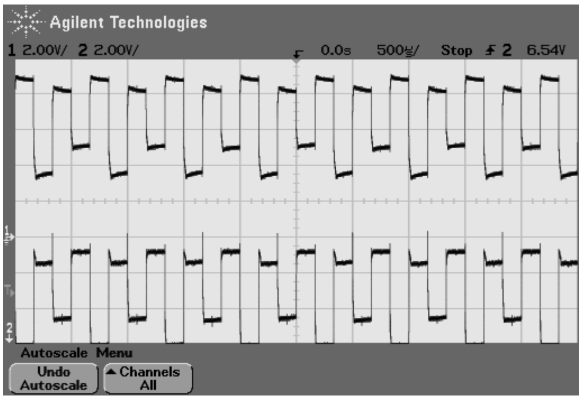

Figure 5: Period 2 oscillation of the logistic map; upper tracing shows x_{n+1} and lower tracing shows x_n for r =8.94.

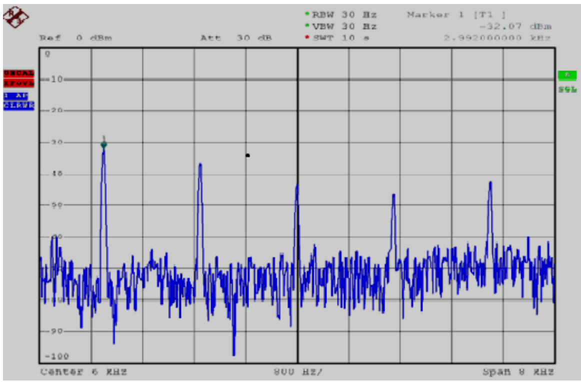

Figure 6: Spectrum of period 2 of logistic map.

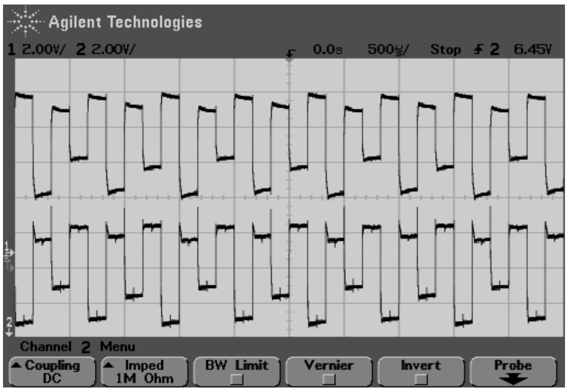

Figure 7: Period 4 oscillation of the logistic map; upper tracing shows x_{n+1} and lower tracing shows x_n for r =9.00.

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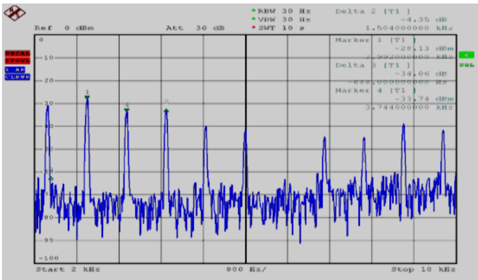
Figure 8: Spectrum of period 4 of logistic map.

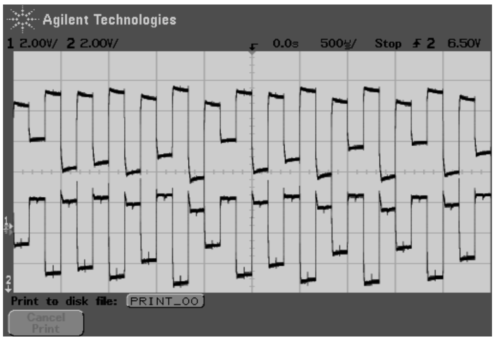

Figure 9: Period 6 oscillation of the logistic map; upper tracing shows x_{n+1} and lower tracing shows x_n for r =9.06.

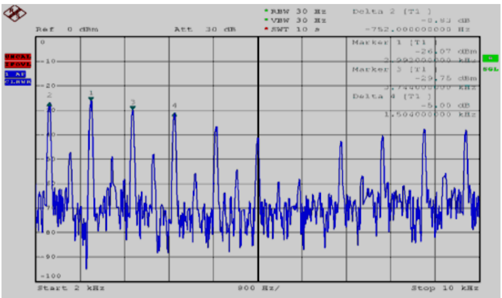
Figure 10: Spectrum of period 6 of logistic map.

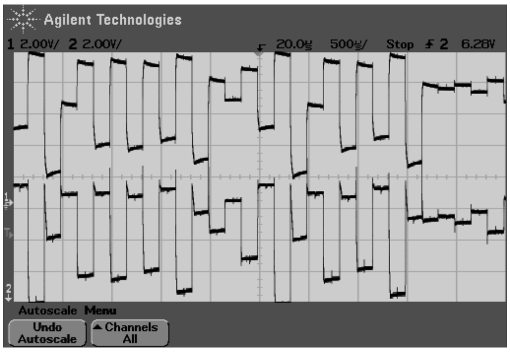

Figure 11: Chaotic oscillation of the logistic map; upper tracing shows x_{n+1} and lower tracing shows x_n for r =9.46.

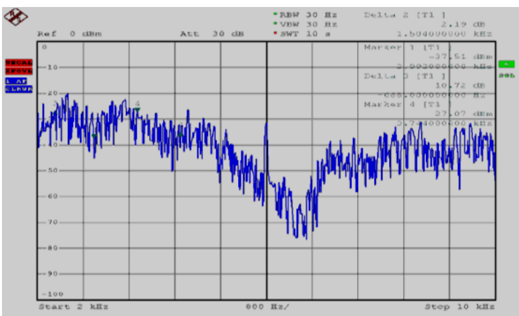
Figure 12: Spectrum of chaotic oscillation of logistic map.

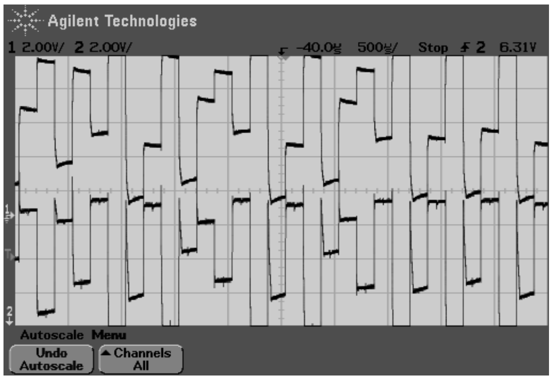

Figure 13: Chaotic oscillation of the logistic map; upper tracing shows x_{n+1} and lower tracing shows x_n for r =9.80.

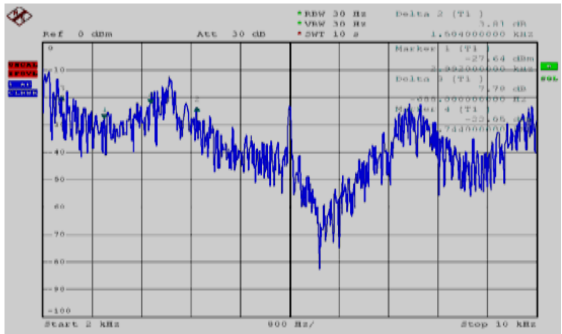
Figure 14: Spectrum of chaotic oscillation of logistic map.

V. CONCLUSION & FUTURE SCOPE

We have study Chaos theoretically and experimentally done the generation of Chaotic signals using logistic map. The experimental results are shown where changing the control parameter leads to stable fixed point then period 2 oscillation which changes to period 4 oscillations to period 8 and finally moves on to the chaotic region as we go on changing the control parameter values. The technique employed are simple and the approach can be extended to realize other types of maps such as piecewise linear or piecewise smooth maps. Such logistic map electronic circuits are useful in research tools-laboratory models of mathematical systems with complex behavior.

The circuit is simple and can be very useful for generation of chaotic signal for the purpose of secure communication. Thus these methods can be used in secure communication systems, weather predictions, parameter detection and sensing. From the simulation results and the hardware results, it can be clearly inferred that this system can be used in confidential communication.

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REFERENCES

[1] V.Z. Tronciu; "Chaos Generation and Synchronization using an Integrated Source with an Air Gap", IEEE J. Quantum Electron. Vol.46, no. 12, pp. 2010.
[2] N.Kumar; "Deterministic Chaos" , Complex Chance Out of Simple Necessity, Universities press in collaboration with JNCASR (1996).

[3] Pecora LM, Caroll TL "Synchronization in chaotic systems". Phys Rev Lett 1990;64:821-3.
[4] Pecora LM, Carroll TL "Driving systems with chaotic signals" .Phys Rev A 1991;44;2374-83.
[5] He L, Zhang G., A chaotic secure communication scheme based on logistic map". IEEE conference on computer application and system modelling 2010: V8-589-91.
[6] Singh N, Sinha A, "Chaos based secure communication system using logistic map", Optics and Lasers in Engineering, 2009:398-404.
[7] Sun Y, Wang.G., "An image Encryption scheme based on modified logistic map". IEEE conference on Chaos-Fractals Theories and Applications, 2011;179-182.
[8] Sahagun Mt, Sanchez JB, Mancilla D, Reategui R, Lopez J.H, "Image Encryption based on logistic chaotic map for secure communications", IEEE conference on Electroniocs, Robotics and Automotive Mechanics Conference, 2010; 319-324.
[9] L. M. Pecora and T. L. Carrol, "Synchronization in chaotic systems" Phys. Rev. Lett., vol. 64, no. 8, pp. 821–824, 1990.
[10] L. M. Pecora and T. L. Carrol "Driving systems with chaotic signals" Phys. Rev. A, vol. 44, no. 4, pp. 2374–2383, 1991.
[11] C. R. Mirasso, P. Colet, and P. Garcia-Fernandez, "Synchronization of chaotic semicondcutor lasers: Application to encoded communications", IEEE Photon. Technol. Lett., vol. 8, no. 2, pp. 299–301, Feb. 1996.
[12] A. Argyris, D. Syvridis, L. Larger, V. Annovazzi-Lodi, P. Colet, I. Fischer, J. García-Ojalvo, C. R. Mirasso, L. Pesquera, and K. A. Shore, "Chaos-based communications at high bit rates using commercial fibreoptic links" Nature, vol. 438, p. 343–346, Nov. 2005.
[13] C. R. Mirasso, P. Colet, and P. Garcia-Fernandez, "Synchronization of chaotic semicondcutor lasers: Application to encoded communications", IEEE Photon. Technol. Lett., vol. 8, no. 2, pp. 299–301, Feb. 1996.
[14] Wang Hao-Xiang andCai Guo-Liang "Nonlinear feedback control of a novel hyperchaotic system and its circuit implementation" , Nonlinear Scienti_c Research Center, Jiangsu University, Zhenjiang 212013, China. Chin. Phys. B Vol. 19, No. 3 (2010) 030509.
[15] O.E. Rossler, "An equation for continuous chaos",phys. Lett. A, 57, 397-398, 1976.
[16] Alexander N. Pisarchik and Flavio R. Ruiz-Oliveras "Optical Chaotic Communication Using Generalized and Complete Synchronization" IEEE journal of quantum electronics, vol. 46, no. 3, march 2010.
[17] Jianyong Chen, Junwei Zhou, Kwok-Wo Wong "A Modified Chaos-Based Joint Compression and Encryption Scheme" IEEE transactions on circuits and systems—ii: express briefs, vol. 58, no. 2, february 2011.
[18] F. M. Verdulla, M. J. López, M. Prian" A Pulsed Control Method for Chaotic Systems" IEEE latin america transactions, vol. 7, no. 1, march 2009