Nonlinear And Nonlinear Fractional Order Chaotic System Identification and comparison Between Two Chaotic System

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***Abstract*-- In the proposed paper the simulation studies has been carried out for the different nonlinear systems and nonlinear chaotic systems. The fractional order based modeling of the chaotic system will be carried out first. Using the MATLAB® the ANFIS commands has been developed for the identification of nonlinear and nonlinear chaotic system.**

Then it has been proposed to compare all the output of circuit and to make a decision for the nonlinear system is chaotic or not. In the next part the algorithm development and simulation study will be carried out for the identification of known nonlinear system.

***Index Terms*—Chua's Circuit, Artificial Neural Fuzzy Inferential System (ANFIS), Volta's Circuit, System Identification Tool Box**

I. INTRODUCTION

In this Paper Our aim is to identify An Control of Non linear Fractional order chaotic system For that we use Matlab® Software and simulate code for different chaotic system We have use Chua's circuit and Volata's circuit we have do different simulation with help of the circuit and compare output of the both Circuit's A system Which does not satisfy Super Position Theorem are called Non linear system We Know that it is difficult to control and Identify non linear system Nonlinear systems are very interesting to engineers and physicists because most real physical systems are inherently nonlinear in nature

We Know that It is difficult to solve non linear equations by analytical methods and it gives interesting phenomena such as bifurcation and chaotic system.

Bifurcation occurs when we make a small smooth change in values of system or circuit parameter causes a sudden change in its behavior

Chaotic means by slightly change in its initial condition there is been a drastically change in its behavior or output of the system or circuit.

In other words We can say that chaotic system are highly depend upon initial condition

II. Chua's Circuit

Chua's circuit[1][2] is a simple electronic circuit that exhibits a Bifurcation and chaotic behavior for Non linear Fractional order system. In fact, in order to exhibit chaos, an autonomous electronic circuit must satisfy some essential criteria which are necessary (not sufficient) conditions for the appearance of chaos: the circuit must contain at least three energy-storage elements, at least one nonlinear element and at least one locally active resistor. The Chua's diode, being a nonlinear locally active resistor, allows Chua's circuit to satisfy the last two conditions. Chua's circuit satisfies all the above-mentioned criteria.

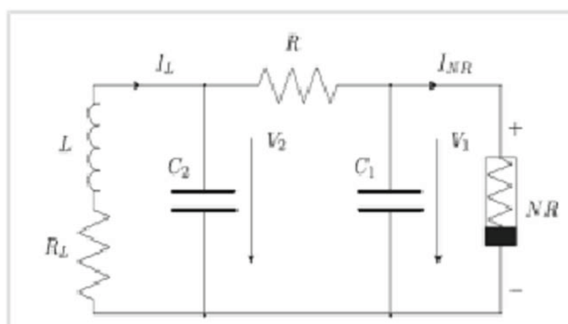

Fig 1. Basic Chua's circuit

The simplest and most widely studied nonlinear Chua's circuit consists of five elements[3][4]: two capacitors *C*1 and *C*2, an inductor *L*, a resistor *R* and a nonlinear resistor (*NR*), known as Chua's diode

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By applying Kirchhoff's circuit laws, such circuit, generally known as Chua's oscillator, can be described by the following equations

$dv1(t)/dt = 1/C1[G(V2(t) - V1(t)) - f(V1(t))]$ (1)

$dv2(t)/dt = 1/C2[G(V1(t) - V2(t)) + IL(t)]$ (2)

$dIL(t)/dt = 1/L[-V2(t) - RLIL(t)]$ (3)

where conductance $G = 1/R$, $IL(t)$ is the current through the inductance L, $V1(t)$ and $V2(t)$ are the voltages over the capacitors $C1$ and $C2$, respectively, and $f(V1(t))$ is the piecewise-linear $v-i$ characteristic of *NR* - Chua's diode,

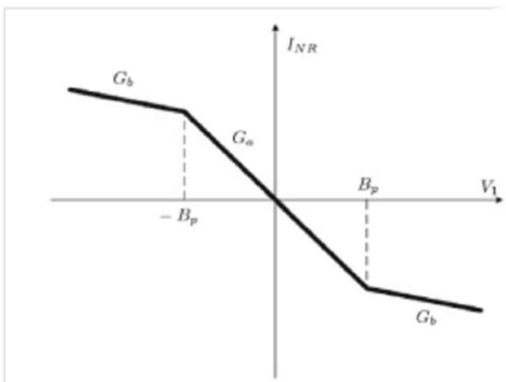

Fig 2. Typical three segment piecewise linear v-I Characteristics

$$x(t) = \alpha(y(t)-x(t)-f(x)) \quad (4)$$

$$y(t) = x(t)-y(t)+z(t) \quad (5)$$

$$z(t) = -\beta y(t)-\gamma z(t) \quad (6)$$

In the above equation value of **α β** and **γ** are same

I. Simulation results and MATLAB® code of chua's circuit

In simulation we have take 3 different methods to find whether system is chaotic or not

Here in 1st case we have take. Three different values of q1,q2,&q3

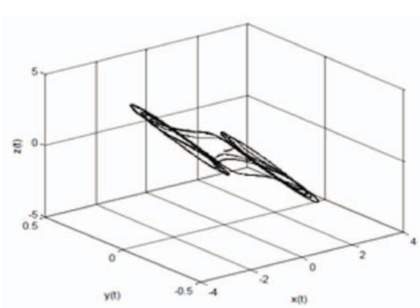

Fig 3. Chua's circuit simulation

$V(s) = \frac{1}{2} s.s^T$

We can see from the figure that system is chaotic. because it starts from one point and continuously oscillating from one side to another side.

In second case for q1,q2&q3 we take same value

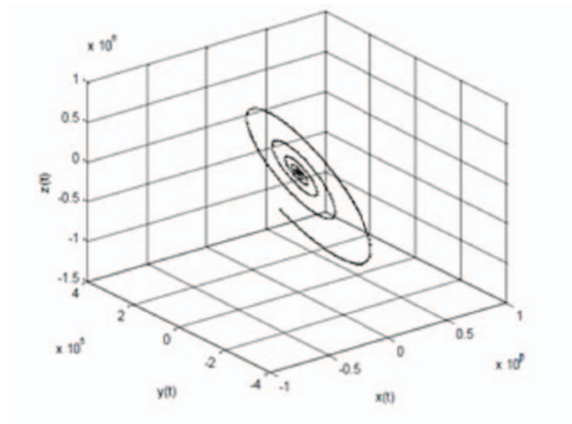

Fig 4. Chua's circuit simulation

In the 3rd case we take q1&q2 value same but value of q3 is different q1=q2=0.99, q3=0.92

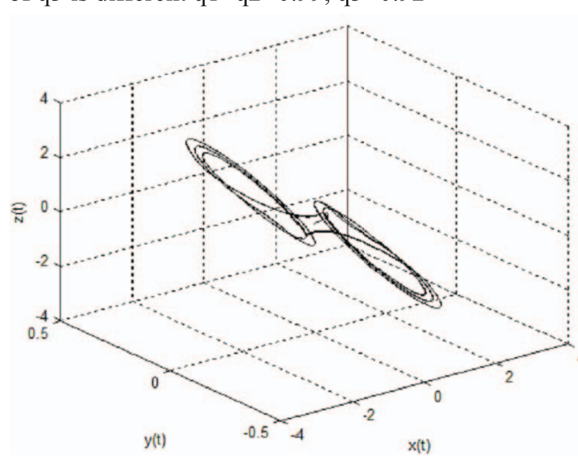

Fig 5. Chua's circuit simulation

From above three figures we can say that by taking different values a system remains chaotic even for non commensurate order. An ANFIS based program is used for the identification of the nonlinear chaotic system.

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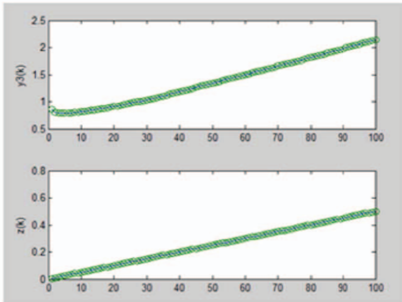

Fig 6. INPUT Z(K) VS OUTPUT Y3(K)

In this case we. train input output and error graph for chaotic system. Where input is z(k) and output is y3(k).Now using this input and output one can also train error graph for the chua's circuit

II. ANFIS MATLAB® PROGRAM AND ERROR GRAPH

For the identification an ANFIS based method is used the result is as shown in the figure 7,

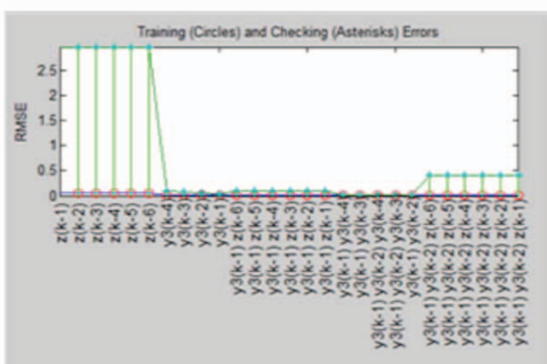

Fig 7. TRAIN ERROR GRAPH FOR Z(K) AND Y3(K)

We can see from the graph that error is reduced when inputs are more.

III. Volta's system

Volta's system is described by the system of state differential equations. We can generalize Volta's system to the following form[1][3]

$$\frac{dx(t)}{dt} = -x(t) - ay(t) - z(t)y(t) \quad (7)$$

$$\frac{dy(t)}{dt} = -y(t) - bx(t) - x(t)z(t) \quad (8)$$

$$\frac{dz(t)}{dt} = cz(t) + x(t)y(t) + 1 \quad (9)$$

IV. Matlab® coding for volta's system and simulation result

In simulation we have take 3 different methods to find whether system is chaotic or not as we have do in chua's circuit

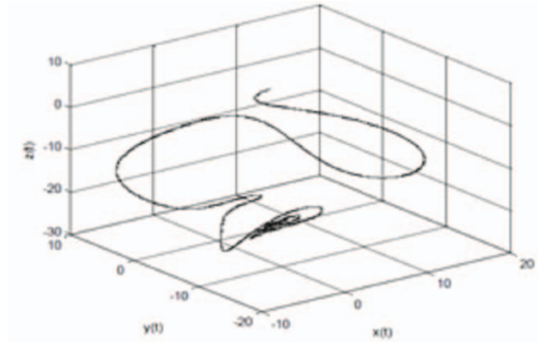

Fig 8. Volta's system

In fig (8) we have taken same value for the non-commensurate case for q1=q2=0.99 and q3=0.92

In the next case we have take value of q1, q2 & q3 are different. q1=0.92 q2=0.99 q3=0.93

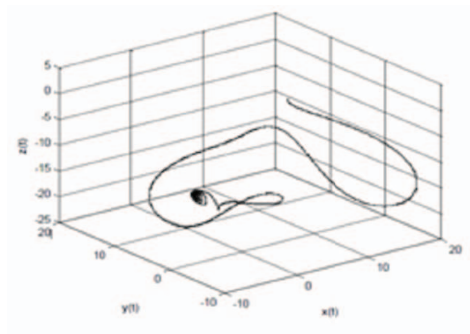

Fig 9. volta's system for non commensurate case

Now using this input and output we have also train error graph for the volta's. circuit

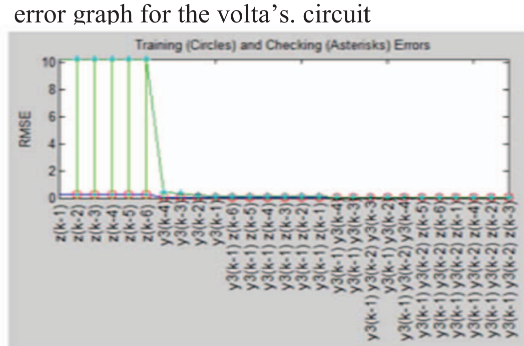

Fig 10. TRAINING ERROR GRAPH FOR Z(K) AND Y3(K)

We can see from the graph that error is reduce when inputs are more

V. Simulink® model for identification of nonlinear system

In Simulink® model we make a non linear model for identify nonlinear system and after that we use its input and output for system identification tool. in this tool we can identify how much percentage our system is fit with standard models and we use non linear ARX method for the non linear system

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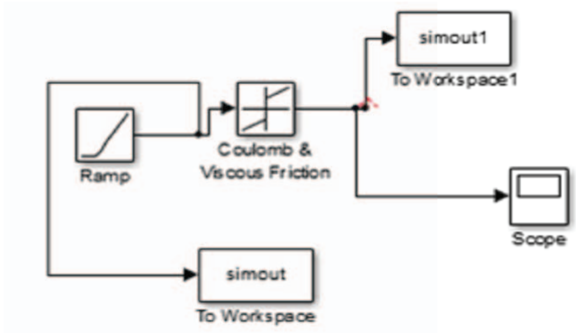

Fig 11. Simple Non linear Block

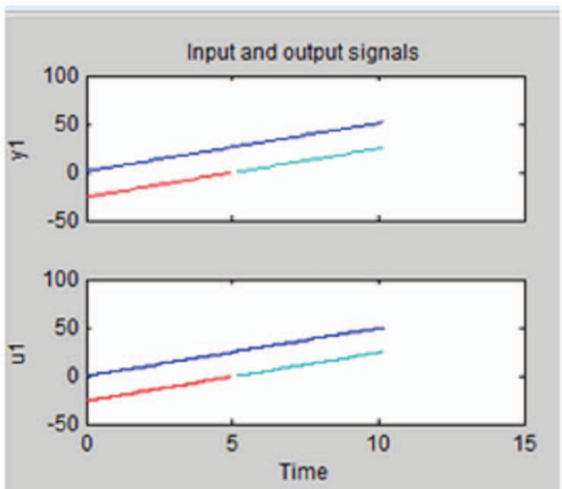

Fig 12. Time plot u1 and y1

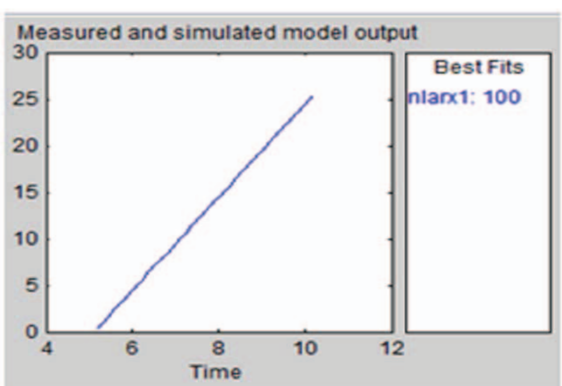

Fig 13. Best fit nlarx model

We can see from the above figures that our system is best fit. For nonlinear arx method

X. Conclusion:-

From above results of simulation we can conclude that using the ANFIS based model identification for the Volta's system is giving good responses and the ANFIS network is trained but for Chua's oscillator circuit the ANFIS network error is not properly trained and further effort is required to train the ANFIS network for the identification purpose. For the different nonlinear systems the nonlinear ARX model is giving the best response compared to the ANFIS network based approach.

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