Chaos in a circuit with a chaotic oscillator Analytical dynamics

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Abstract: The primary goals of this study are to design an oscillation generating circuit, to demonstrate how to entirely prevent chaotic emerging in the output circuit. Additionally, the study investigates the chaotic state of electronic circuits using a chaotic oscillator circuit and the time-delay feedback theory, which allows for the control of chaos, maintains the system's equilibrium, and eliminates chaos. Simulation results that are displayed in MATLAB are used to support the analysis.

Kew Words:

Chaotic,feedback,oscillator circuit,electronic circuit,Vilnius,

Introduction:

There are several properties of chaotic systems. Chaotic systems are greatly influenced by their initial characteristics. Any non-linear system in the continuous system must be at least $3D$ for an independent system or $2D$ for a non-independent system to exhibit chaotic behavior.To enhance the performance of readily understood chaotic attractants for application reasons (coding, generic algorithms in optimization, control)[1], electronic circuit design uses a mathematical chaotic circuit model.Individual electrical components, such as resistors, transistors, capacitors, inductors, and diodes, are connected by conductive wires, which enable electric current to pass through them to form an electronic circuit. Signals can be amplified, computations can be completed, and data can be transported from one location to another.Thanks to the combination of components and connections. In a similar manner, we propose mathematical circuits made up of separate parts (generators, couplers, samplers, mixers, reducers, etc.)[2] connected by data streams.Lyapunov exponents must be determined in order to determine if a system behaves chaotically or not.When designing an autonomous circuit containing resistor, capacitor, andinductor components for an oscillator circuit, the following components must be considered[3];

1. One or more nonlinear elements
2. One or more locally active resistors
3. Three or more energy storage elements[4-5].

Chaotic Oscillator In Vilnius And its Analysis Dynamically

Figure1 shows a design for an oscillation generator circuit. It is common knowledge that during the operation of the circuit, some Chaoticwill be accompanied by the presence of a resistance element that will contribute to eliminating this phenomenon.

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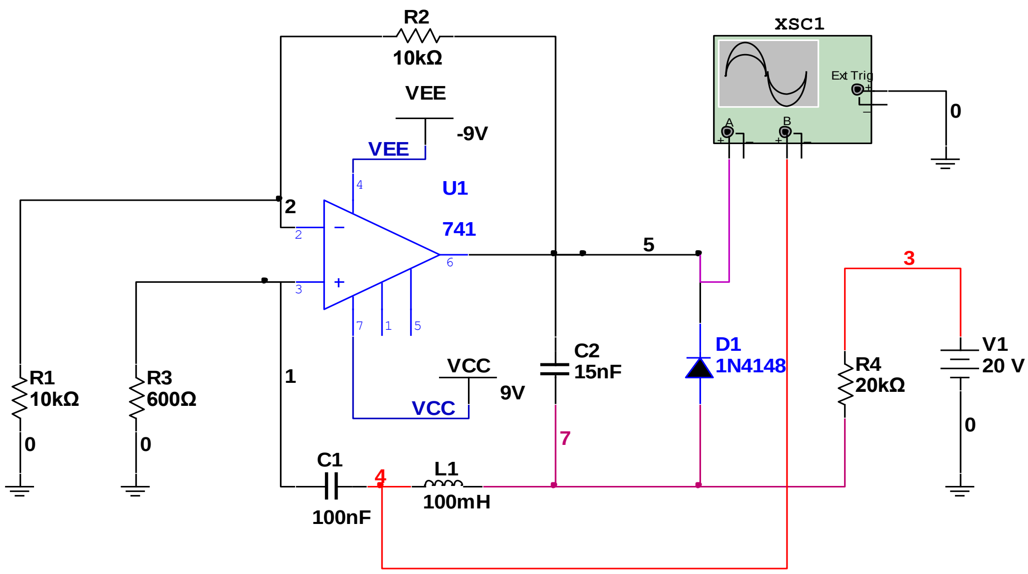

Fig. 1 Vilnius chaotic oscillator circuit

In the Multisim program, this circuit was built.Multisimis used to study the circuit's dynamic analysis by changing the value of the R_3 resistor, and the simulation results are shown in Fig. 2.

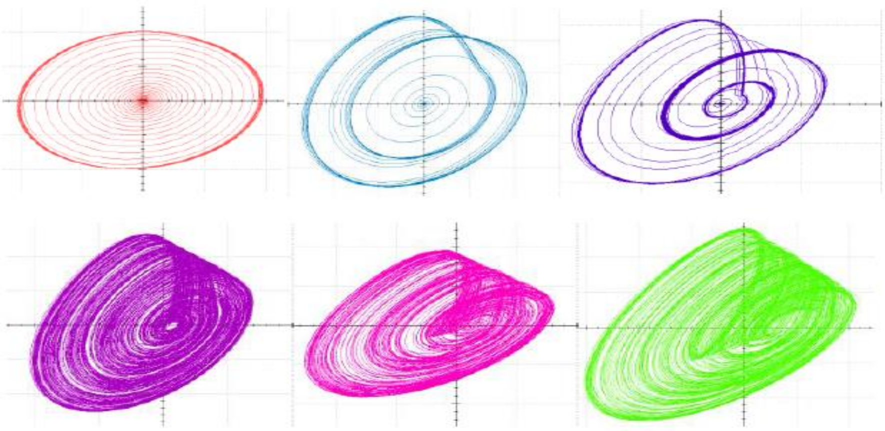

Fig. 2 Phase Portraits of Vilnius Circuit $R = 100, 220, 350, 400, 495, 600$ ohm

The shapes clearly demonstrate that when a resistance valueof 100 ohmsis used in a circuit, chaos will be eliminated, as shown in figure2, so there will not be any intersections, as compared to other cases where there are intersections, which represent the phenomenon of chaos at values higher than 100 ohms.

UsingKirchoff's Current Law(KCL) andKirchoff's Voltage Law(KVL) circuit theory, state equations of Vilnius chaotic oscillator circuit are obtained as shown[6-8]in$Eq1$;

$$C_1 \frac{dV_{C1}}{dt} = I_L (1)$$

$$L_1 \frac{dI_{L1}}{dt} = (k-1)R_3 I_{L1} - V_{C1} - V_{C2} \qquad (2)$$

$$C_2 \frac{dV_{C2}}{dt} = I_{R4} + I_{L1} - I_D \ (3)$$

To simplify the process of symbolizing and drawing shapes, the following authorizations will be used by making equations with units into equations without units[9-11]

$$x = \frac{V_{C1}}{V_T} \ , \ y = \frac{\rho I_L}{V_T} \ , \ z = \frac{V_{C2}}{V_T}$$

$$V_T = \frac{K_B T}{e} \ , \ \rho = \sqrt{\frac{L}{C_1}}$$

$$a = (k-1)\frac{R_3}{\rho} \ , \ b = \frac{\rho I_{R4}}{V_T} \ , \ c = \frac{\rho I_S}{V_T}$$

$$\varepsilon = \frac{C_2}{C_1} \ , \ k = 1 + \frac{R_1}{R_2}$$

Where;

$I_D = f(V_{C2})$ is the nonlinear current–voltage characteristic of the diode;

$I_D = I_S(e^{(eV_D/K_B T)} - 1)$

The final form of equations suitable for numerical analysis and simulation

$$\dot{x} = y \quad (4)$$

$$y' = ay - x - z \quad (5)$$

$$\dot{z} = \frac{1}{\varepsilon}(b + y - c(e^z - 1)) \quad (6)$$

For certain sets of the control parameters a, b and ε (normally c << 1, therefore the oscillations are insensitiveto its value)

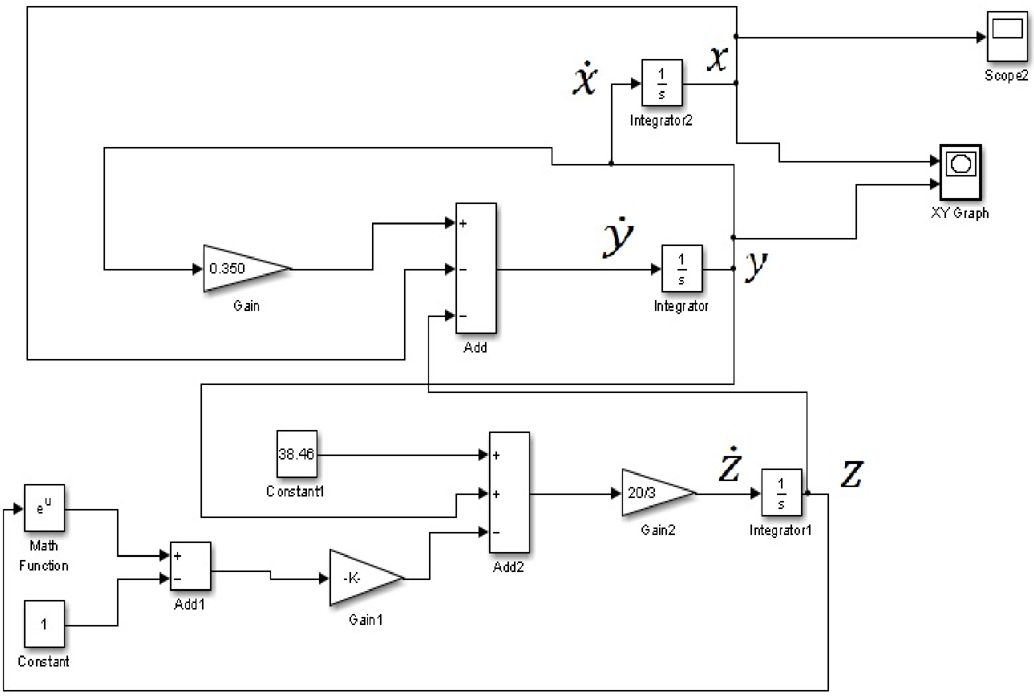

Fig 3.Matlab-Simulink model of circuit

Discussion:

Chaos or confusion theory sometimes – which deals with the subject of moving (dynamic) sentences the nonlinearity of random behavior is known as chaos, and this behavior is produced either by inability to determine initial conditions or by the probabilistic physical nature of quantum mechanics.In addition to the that; we use a simple electronic system to develop a scheme for chaos secure communication with two coupled Chua circuits. First, we analyze separately each oscillator to study their dynamic behavior when a parameter of control is changed, and then we investigate the synchronization effect in the coupled circuits. Bifurcations of the output voltage are constructed using a resistance as a control parameter. While using two channels, we may send an information signal via one of the channels and recover the signal via another channel. This scheme can improve synchronization in a system with coexisting attractors. Finally secure communicationswith chaos is demonstrated experimentally using the novel communication scheme.

Conclusions:

The study of the presented circuits leads to the conclusion that a variety of methods, many of which cannot be easily generalized, can be used to create chaotic circuits. Moreover, we conclude during our study in this paper that the resistance R_1 has a very important role in controlling chaos in electronic circuits as it starts with a mathematical model of chaos and then transforms its mathematical principles into the laws of physical devices electrical circuits.

المستخلص : في هذه الورقة البحثية دائرة مولد ذبذبات تحتوي علي العناصر الاساسية لظهور ظاهرة الشواش وللتحكم في الدائرة عن طريق المقاومة R3 حتي نتخلص من هذه الظاهرة التي تجعل الدائرة غير مستقرة وللحصول علي مدى قيم المقاومة R3 التي تجعل الدائرة تعمل بشكل صحيح قمنا بنمذجة الدائرة رياضياً باستخدام المعادلات التفاضلية ثم تحويل هذه المعادلات الي معادلات خالية من الوحدات ونمذجة هذه المعادلات باستخدام ماتلابسميلنك وكانت النتائج والرسومات مطابقة لنتائج الدائرة العملية ومن خلال رسم العلاقات بين جهد المكثف C_2 وتيار الملف L_1 يتضح انه يجب ان تكون قيمة المقاومة R_2 من 100 اوم فاقل حتي تكون العلاقة عبارة عن مسارات دائرة غير متداخلة اما عندما تكون قيمتها اعلي من 100 اوم تكون المسارات متداخلة ويزداد تداخل المسارات بزيادة قيمة المقاومة R_2 وبذلك تكون الاشارة الناتجة من مولد الذبذبات غير مستقرة .

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