CHAPTER 4

CONCLUSION

In this work, we study conditions on the parameters that make the equilibrium points of (3.1), (3.2) asymptotically stable and conditions that make the equilibrium points of (3.1), (3.2) unstable. The result are summarize as follows:

1. Chua's Circuit System.

Theorem 3.1.1 If p and q are satisfies either inequality $q < \frac{5p}{7}$ or $q < \frac{10p^2}{49} + \frac{5p}{7}$, then the three equilibrium points E_+, E_0,and E_- of the system (3.1) are unstable.

2. Perturbed Chua's Circuit System.

Theorem 3.2.1 For p, q and r are positive real parameters, the equilibrium point $E_0 = (0, 0, 0)$ is unstable.

Theorem 3.2.2 For $p = 10$ and $q = \frac{100}{7}$, the equilibrium point $E_1 = (\alpha_1, \beta_1, \gamma_1)$ is

(i) asymptotically stable if $r > r_1$;

(ii) unstable if $0 < r < r_1$;

where r_1 is the positive root of equation (3.5), ($r_1 \approx 4.51841$).

Theorem 3.2.3 For $p = 10$ and $q = \frac{100}{7}$, the equilibrium point $E_2 = (\alpha_2, \beta_2, \gamma_2)$ is

(i) asymptotically stable if $r > r_2$;

(ii) unstable if $0 < r < r_2$;

where r_2 is the positive root of equation (3.8), ($r_2 \approx 0.73672$).

We have presented two methods for controlling chaos of the perturbed Chua's circuit system (3.2). Both methods, feedback control and adaptive control, suppress the chaotic behavior of system (3.2) to one of the three steady states E_0, E_1 and E_2.

2.1 Feedback Control Method

Theorem 3.3.1 The equilibrium point $E = (\overline{x}, \overline{y}, \overline{z})$ of the system (3.10) is asymptotically stable for $k_1 > k_1^* = \alpha + p + \frac{\beta^2 p}{2q}$, $k_2 > k_2^* = 0$ and $k_3 > k_3^* = \frac{1}{2}$.

2.2 Adaptive Control with two Controllers

Theorem 3.3.2 Assume that g^* and k^* are real satisfy the inequality $g^* \geq p + \alpha$ and $k^* \geq 0$. The equilibrium point $E = (\overline{x}, \overline{y}, \overline{z})$ of the system (3.16) is asymptotically stable.

3. Synchronization of Perturbed Chua's Circuit System.

3.1 Synchronization of Perturbed Chen chaotic dynamical system using active control.

The active control

$$\begin{aligned} u_1(t) &= V_1(t) + \frac{2p}{7}\Big(x_2^3 - x_1^3\Big) \\ u_2(t) &= V_2(t) - e_x - e_z \\ u_3(t) &= V_3(t) + qe_y - e_z - re_x(x_2 + x_1) \end{aligned}$$

where

$$\begin{pmatrix} V_1(t) \\ V_2(t) \\ V_3(t) \end{pmatrix} = \begin{pmatrix} \frac{-p-7}{7} & -p & 0 \\ 0 & -1 & 0 \\ 0 & 0 & -1 \end{pmatrix} \begin{pmatrix} e_x \\ e_y \\ e_z \end{pmatrix}$$

implies the synchronization of two perturbed Chua's circuit systems (drive system and response system).

3.2 Adaptive synchronization for Perturbed Chua's circuit system with fully uncertain parameters.

Theorem 3.4.1 If k_1, k_2 and k_3 are chosen to satisfy the following matrix inequality,

$$P = \begin{bmatrix} k_1 - \frac{p}{7} & -\frac{1}{2}\Big(p+1\Big) & 0 \\ -\frac{1}{2}\Big(p+1\Big) & k_2 + 1 & -\frac{1}{2}\Big(1-q\Big) \\ 0 & -\frac{1}{2}\Big(1-q\Big) & k_3 \end{bmatrix} > 0$$

or the inequality holds,

$$\begin{aligned} (i)\quad A &= k_1 - \frac{p}{7} > 0 \\ (ii)\quad B &= A(k_2+1) - \frac{1}{4}\Big(p+1\Big)^2 > 0 \\ (iii)\quad C &= A(k_2+1)k_3 - A\frac{1}{4}\Big(p+1\Big)^2 - \frac{k_3}{4}\Big(p+1\Big)^2 > 0, \end{aligned}$$

then the two perturbed Chua's circuit systems (3.27) and (3.28) can be synchronized under the adaptive control of (3.29) and (3.31).