Chaos Self-Adapting Parameter Modulate System
Base on Electro-Optics Device

Bai, Fengming Shen, Ke
Changehun Institute of Optics and Fine Mechanics
Address: No.7 Weixing Road, Changchun City, Jilin Province, P.R. China
Postcode: 130022 Tel: (0431)5398223 Fax: (0431)5383815
Email: baifm@china.com

ABSTRACT

This article make used of the Electro-Optics device to research chaotic phenomenon and their self-adapting parameter modulate system. Self-adapting parameter modulation system main is given priority to electronic modulation. It given some chaos equation of parameter modulation and analyze signal waves to self adapting change rule of the detection for measuring instrument — exterior modulate inject electronic parameter into photo-electricity system in this paper.

Keywords Electro-Optics device, chaos, self-adapting electronic parameter modulation, feed back controlling

1. INTRODUCTION

In recent years research about chaos dynamics has developed a new phase. The laser chaos appears an unprecedented “hot spot” too. Research chaos phenomena produce, control and synchronization, people have acquired obvious effect what adopt all kind of mode or method[1,2]. The Electro-Optics device is attended gradually because of it has some characteristic as volume small, function strong and carry expediency[3,4].

The chaos phenomena include profuse information so that it brings dense study interest. The Electro-Optics device starts call into play in application of photo-electricity communication chaos control and synchronization. People leave no stone unturned to explore the laser chaos such as acoustic-optic, electronic optic, saturated absorber and so on, find out their internal rule and actualize controlling.

Author try to use the hardware design method in the electronic optic modulate system, and establish a set of self-adapting electronic parameter modulation system of feed back control by the Electro-Optics device. It may realize automatic control in the chaos feed back system.

2. WORK PRINCIPLE

2.1 Self-adapting control theory

Assume a dynamics structure model, make goal parameter come into existence $\mu = \mu_g$ (it may suit
continuous system or discrete), vector \( \mu \) express a parameter aggregate, purpose of the self-adapting control that is as best one may maintain parameter aggregate \( \mu \) constant, and can also obtain need dynamics action. Therefore, to use suitable control algorithm or hardware structure take modifies to disturbance parameter (or signal). The \( \mu \) is a after modify parameter value that is a final expectation value.

Through correct complex coupling between system and model, may actualize self-adapting control their stability as high periods, quasiperiodicity, doubling periods and chaos action. Stable self-adapting control as shown in Fig.1.

So can establish simultaneous equations of self-adapting control

\[
\begin{align*}
x_{n+1} &= F(x_n, \mu) \\
y_{n+1} &= F_M(x_n, \mu_g) \\
\mu_{n+1} &= \mu_n + \alpha G(x_n - y_n)
\end{align*}
\]

(1)

2.2 Work principle of the electronic optic system

Joined a Kerr electronic-optics modulator and a set of colander, other append a set of the chaos self-adapting parameter modulate feed back system in the Electro-Optics device. Whole control system as shown in Fig.2.

From the Fig.2 can see, the laser pass through Kerr electronic-optics modulator make laser signal is modulated, next go to recognize signal again after tune signal at export signal to be adjust by ray filter \( n_2 \). At this point, light path is divided into two parts. As there into one of the laser is received by the photo-electricity detector and convert into electronic signal, after amplify sent to the electronic modulate chaos feed back system to take twice modulate then go to control some parameter of electronic optic modulator. Only meet preconcerted requires, the laser signal can achieve goal of self-adapting control and the signal sends out form \( n_3 \).

3. ACTUAL PROJECT AND PARAMETER ENACTMENT

3.1 Design of chaos electronic modulate self-adapting feed back system

The design project for electronic optic modulator and feed back system may see Fig.3. In this feed back loop,
input signal most may is four route, among other things, before the photo-electricity acceptor may have three route signal as laser signal, electronic modulate feed back signal and adscititious carrier wave signal. And other that is disturbance random signal on system outside, this signal is unavoidable in a general way, but it may be controlled or utilized. The disturbance random signal, it is technology sticking point of control chaos signal in circuit system.

Work process in the feedback control system of electronic modulate and self-adapting is describe as follow. When signal given value add to the system, the photo-electricity detector (acceptor) take laser signal convert into electronic signal and take to amplify, the signal is sent to a chaos control system what is made up of proportion amplifier and integrator, use control gate circuit to take parameter modulate. The modulated signal may be intervened by disturbance signal. When disturbance signal is a switch controlled, the modulated signal has two kind of state, one is natural, and other is an anamorphic modulated signal after impress turbulence. When two kind of signal is added in the electronic-optics modulator, first initial adjustment signal will be changed automatically in order to suit chaos laser information and according to require output immediately.

3.2  Circuit design and parameter enactment

3.2.1  Hardware design

The chaos signal comes from nonlinear system. So first ensure circuit of nonlinear. According to electronic optic modulator and design demand by feed back system, adopt simulate IC to fit together at exterior, the circuit as shown in Fig.4.

In the circuit, adopted three-switch circuit what input outside light or electronic inject signal and it that is composed chaos circuit by three operational amplifiers. So structure a self-adapting feed back controls system.

3.2.2  Parameter adjust

In the interest of insure input signal as best one may keep wave that it not is interfered and adopted 1:1 amplify circuit. at the same time, time control parameter need be modulated that include mostly adjust capacitor it may make signal from periods, pseudo period, final come into chaos state in the circuit. The table 1 is state parameter electronic modulate system after chaos.

4.  EXPERIMENT AND ANALYSIS

To take method of measurement analysis to the system that main include alternate frequency analysis, time field analysis and chaos graphics analysis in the phase space.

4.1  Alternate frequency analysis
Frequency sweep of the alternate current signal and analysis adopted mode of decimal system. Scan start frequency is 1.0 Hz, stop frequency is 1.0 G Hz. Finally, obtain its amplitude frequency characteristics, phase

Fig.5 Amplitude frequency and phase frequency characteristics

4.2 Times field analysis

4.2.1 Transient analysis in the times field

Input signal is 100M Hz frequency and is a cosine periods. The amplitude is 2v-10v. Points of automatic sampling are 100. Start time is 0, stop time is 1 × e-5s, Measuring point select x2 and x3, analysis result sees table 2.

4.2.2 The wave analysis with oscilloscope

Select x3 to test wave with oscilloscope, may find, the wave show Chaos State in the same time sampling. When adjust individual component in the RC circuit, find wave is changed and curve develop into chaos from periods, pseudo period, period doubled, final come in chaos along with capacitor is modulated from 30 nF to 10 pF change, waves as shown in Fig.6.

4.3 Chaos graphics analysis in the phase space

In whole electronic modulate feedback system, unite debugging three points (x1, x2 and x3) and analysis, debugging result see Fig.7. There fig.7a express x1-x2 chaotic state in the phase space, Fig7b is x1-x3, Chaos State of the feedback system according to control parameter modulate take place corresponding change. When adjust R from 100 kΩ to 0.3 kΩ, time field transient state wave take place convert from regular to out-of-order, final state figure become into chaos from periods doubled into chaos. So that, may modulate some idiographic device parameter make signal act on electronic optic modulator, may achieve goal of control to be modulated signal.

5. CONCLUSION

The paper main base on the Electro-Optics device design a set of electronic modulate feedback system add to the electronic optic modulator from exterior inject, analysis the system chaos produce and impress parameter adjust and takes chaos self-adapting electronic parameter modulation. It can achieve some automatic control.
Self-adapting electronic modulation system of the Electro-Optics device, it may get photo-electricity chaos easiest to controlling, and it may secure object of application. It also may realize laser communication aim with automatic controlling of chaos encrypt, and soon on. Its purpose may be various. In the article, it gives out a block diagram of photo-electricity chaos electronic modulate system base on the Electro-Optics device and their work principle of parameters modulate.

Of cause, In this experiment, adopted circuit that is designed in idealization condition, each parameter of laser considers according to ideality station. But affect about exiguity disturbance not analysis further, that will do it after thesis.

6. REFERENCES

4. Shen Ke, Chaos in Optics, Northeast teachers university Press (China), 1999