Mathematical Simulation of Regular and Chaotic Dynamics of a Single-Degree Robot Model

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1.Subject of Lecture/Poster :

Problem of robot model with one degree of freedom, described with nonlinear differential equation of second order, is numerically solved. Dynamic structure of system is studied as a function of length parameter which is treated as a free control parameter. Possible quasiperiodic, frequency locked, and chaotic features (transient and sustained chaos) are shown through power spectra and Poincare sections.

2.Single-Degree Robot Equation

nonlinear differential equation of second order, with dissipative terms, nonstacionary feedback terms and periodic driving force

$$\boxed{\begin{aligned} & x'' - \beta_2 x'^2 \operatorname{sgn}(x') - \gamma_2 \operatorname{sgn}(x') - \delta_{21} x - \delta_{23} x^3 = \\ & = L \frac{\omega_0^2}{2\pi} \cos(\omega_0 t) - \xi_{21} e^{\lambda_{21} t} - \xi_{22} e^{\lambda_{22} t} \end{aligned}}$$

with strengths of the feedback drive,

$$\xi_{21} = \frac{a_2}{c_2} \lambda_{21}^2$$

$$\xi_{22} = \frac{b_2}{c_2} \lambda_{22}^2$$

$$a_2 = \lambda_{22} z_2(t_0) - z_4(t_0)$$

$$b_2 = z_4(t_0) - \lambda_{21} z_2(t_0)$$

$$c_2 = \lambda_{22} - \lambda_{21}, \lambda_{22} \neq \lambda_{21}$$

Values of parameters are fixed, except for the control parameter L (and ω_o) ; Parametrization I ;

ω_0=2π, λ_{21}=-10.5, λ_{22}=-11.5, β_2=-5.18e-6, γ_2=-0.00298, δ_{21}=-0.7611, δ_{23}=-0.0127, z2(0)=0.01, z4(0)=0.01

Initial conditions: x(0)=0, $x'(0) = 0$