

TECHNICKÁ UNIVERZITA V KOŠICIACH
FAKULTA ELEKTROTECHNIKY A INFORMATIKY

Elementy singularít a ich vplyv na chaos v Chuaovom obvode

Viktor Grus

Ing. Milan Guzan, PhD.

KEMT FEI TU v Košiciach

- V prostredí Matlabu realizovať:
 - výpočet vlastných čísel a vlastných vektorov
 - zobrazenie elementov singularít v 3D priestore
 - zobrazenie pohybu zastupujúceho bodu
- pozorovať vplyv elementov na chaos

Predmet analýzy – Chuaov obvod

- oscilačný obvod [1]
- stavové rovnice

$$C_1 \frac{du_{C1}}{dt} = G(u_{C2} - u_{C1}) - g(u_{C1})$$

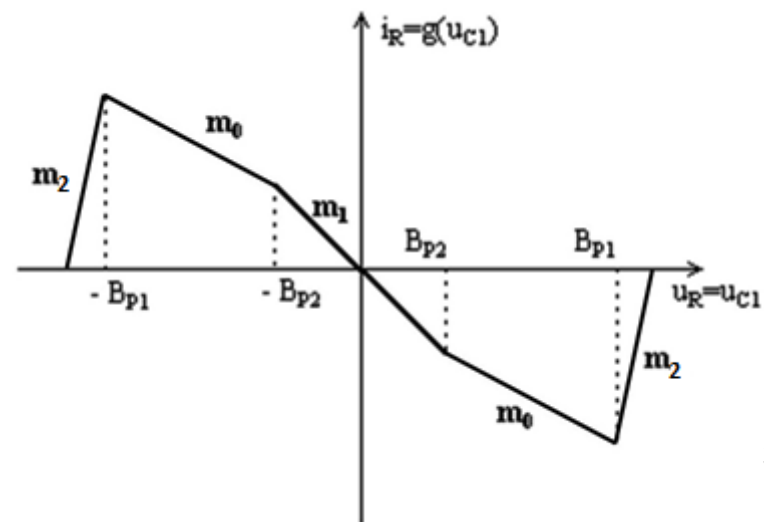
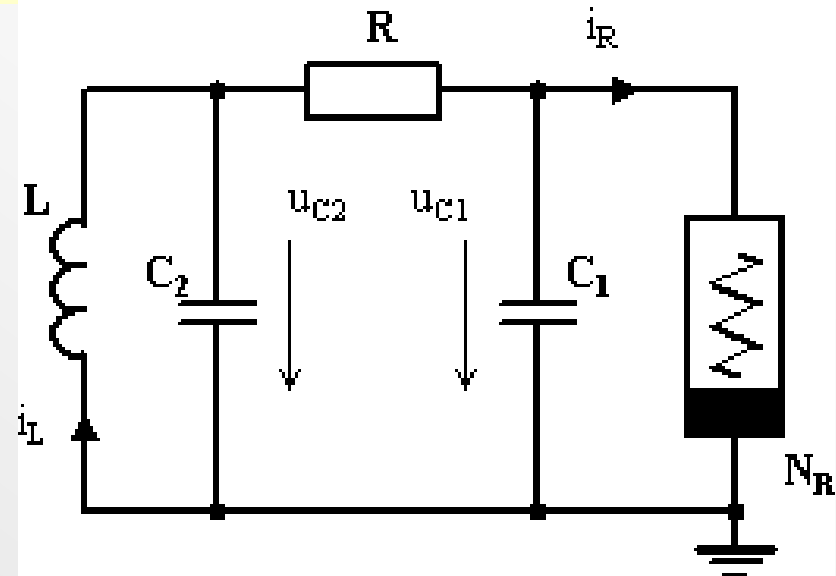
$$C_2 \frac{du_{C2}}{dt} = G(u_{C1} - u_{C2}) + i_L$$

$$L \frac{di_L}{dt} = -u_{C2} - R_L i_L$$

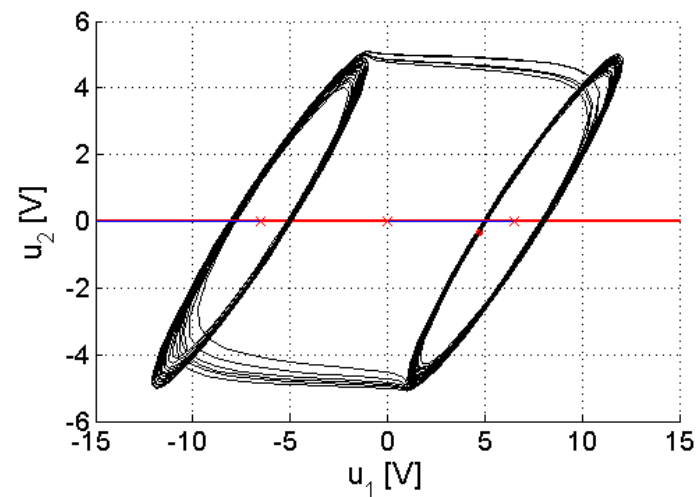
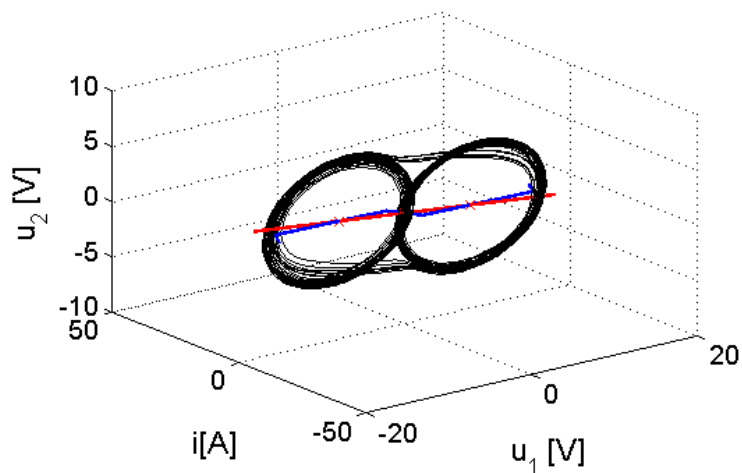
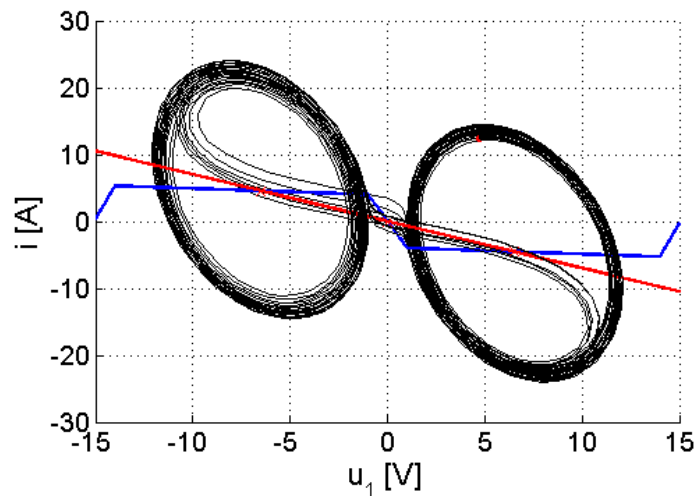
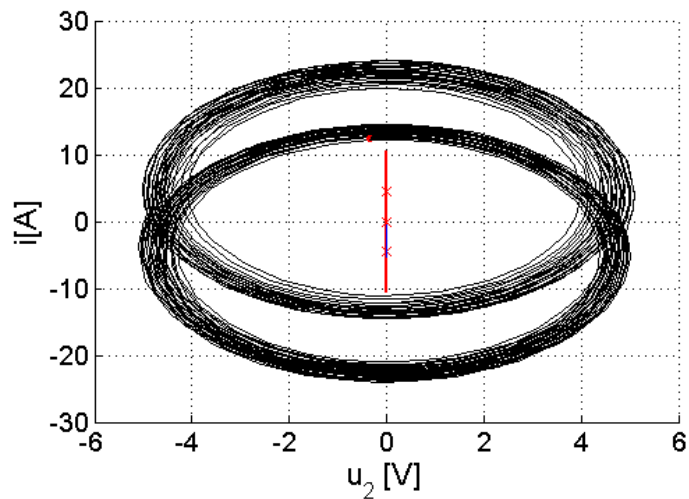
- VACH N_R [2]

$$g(u_{C1}) = m_2 u_{C1} + \frac{m_0 - m_1}{2} \left\{ |u_{C1} + B_{p2}| - |u_{C1} - B_{p2}| \right\} +$$

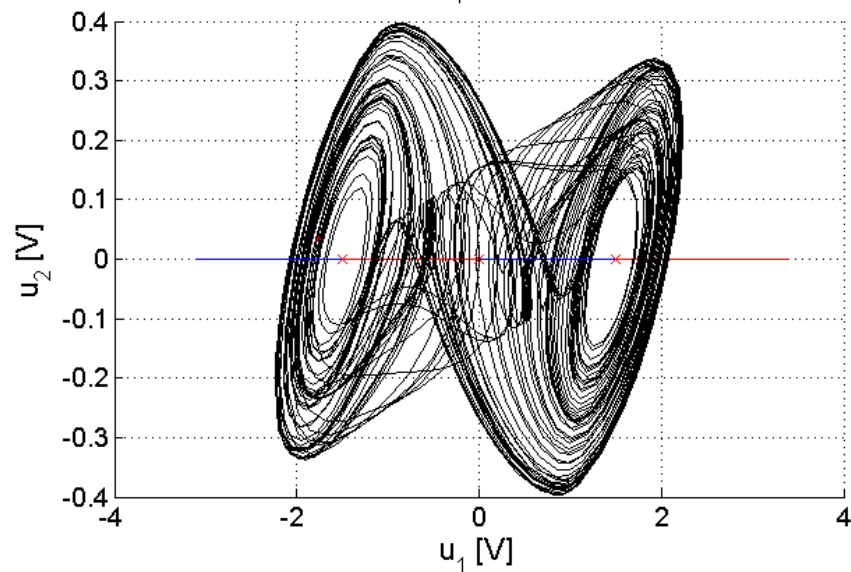
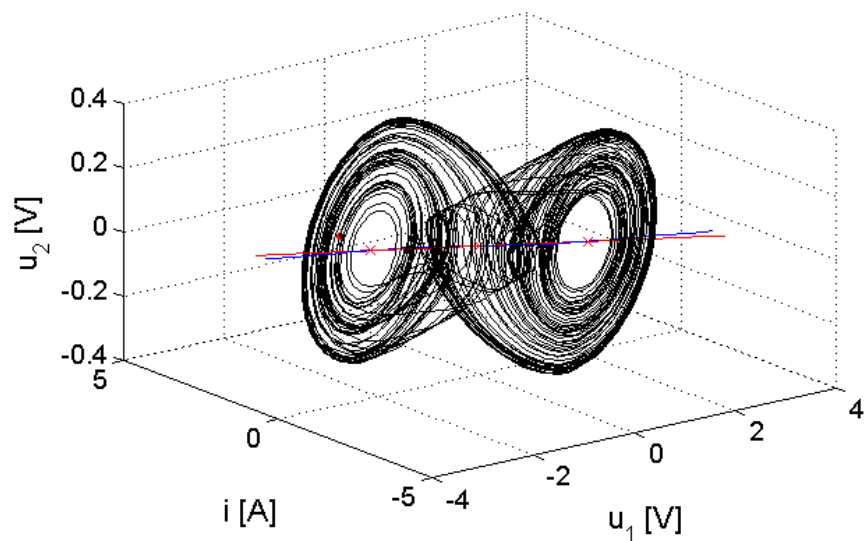
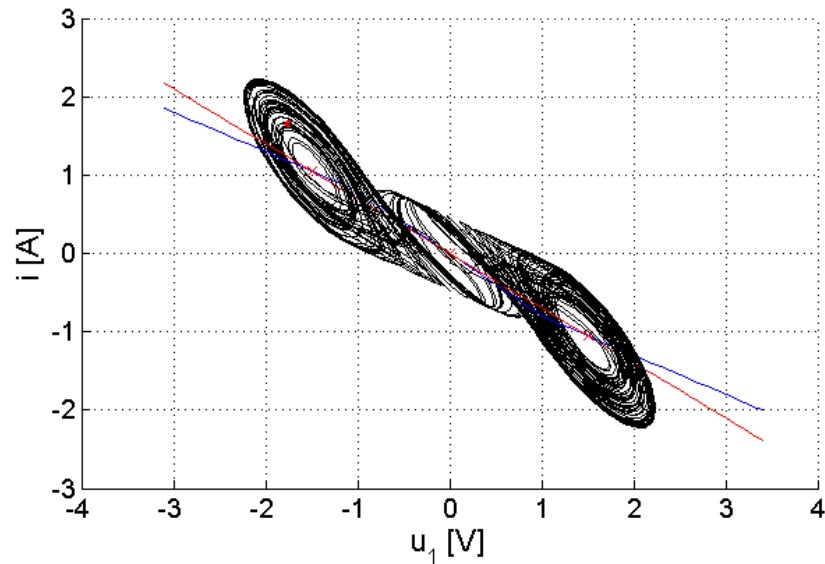
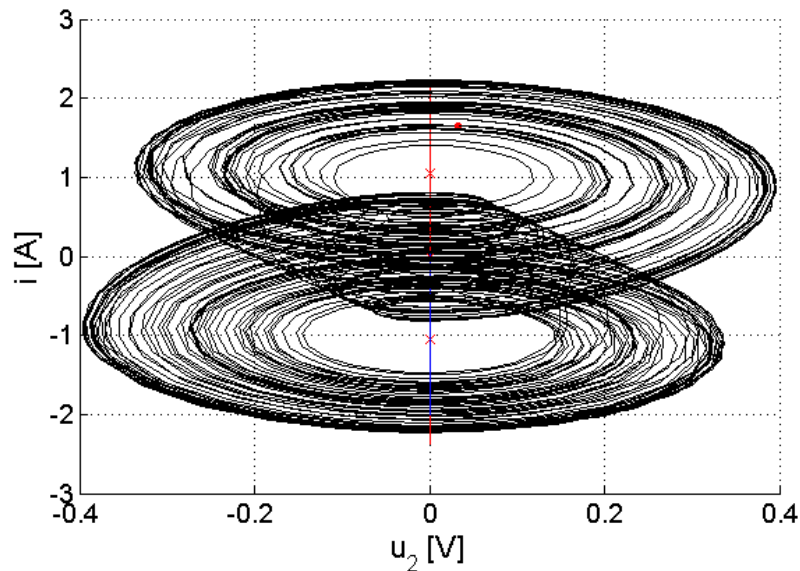
$$+ \frac{m_2 - m_0}{2} \left\{ |u_{C1} + B_{p1}| - |u_{C1} - B_{p1}| \right\}$$



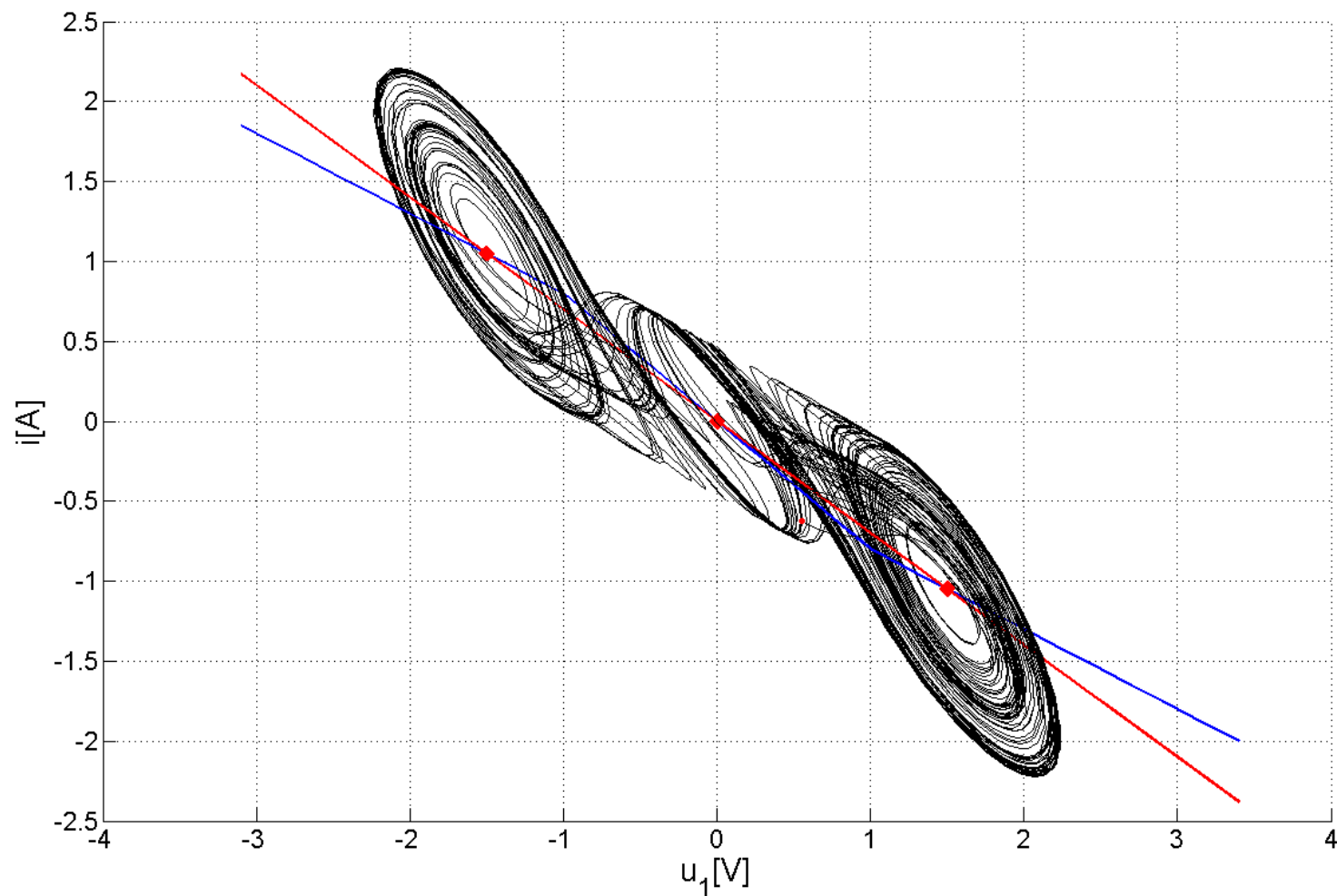
Mongeové projekcie a axonometria – hladký CHA [3]



Mongeové projekcie a axonometria – strapatý CHA [3]



Projekcia do roviny u_1, i



- Jakobiho matica:

$$J_{\vec{f}} = \begin{matrix} \frac{\partial f_1}{\partial x_1} & \dots & \frac{\partial f_1}{\partial x_m} \\ \vdots & \ddots & \vdots \\ \frac{\partial f_n}{\partial x_1} & \dots & \frac{\partial f_n}{\partial x_m} \end{matrix} \quad A = \begin{matrix} \frac{-G-m}{C_1} & \frac{G}{C_1} & 0 \\ \frac{G}{C_2} & \frac{-G}{C_2} & \frac{1}{C_2} \\ 0 & \frac{-1}{L} & \frac{-\rho}{L} \end{matrix}$$

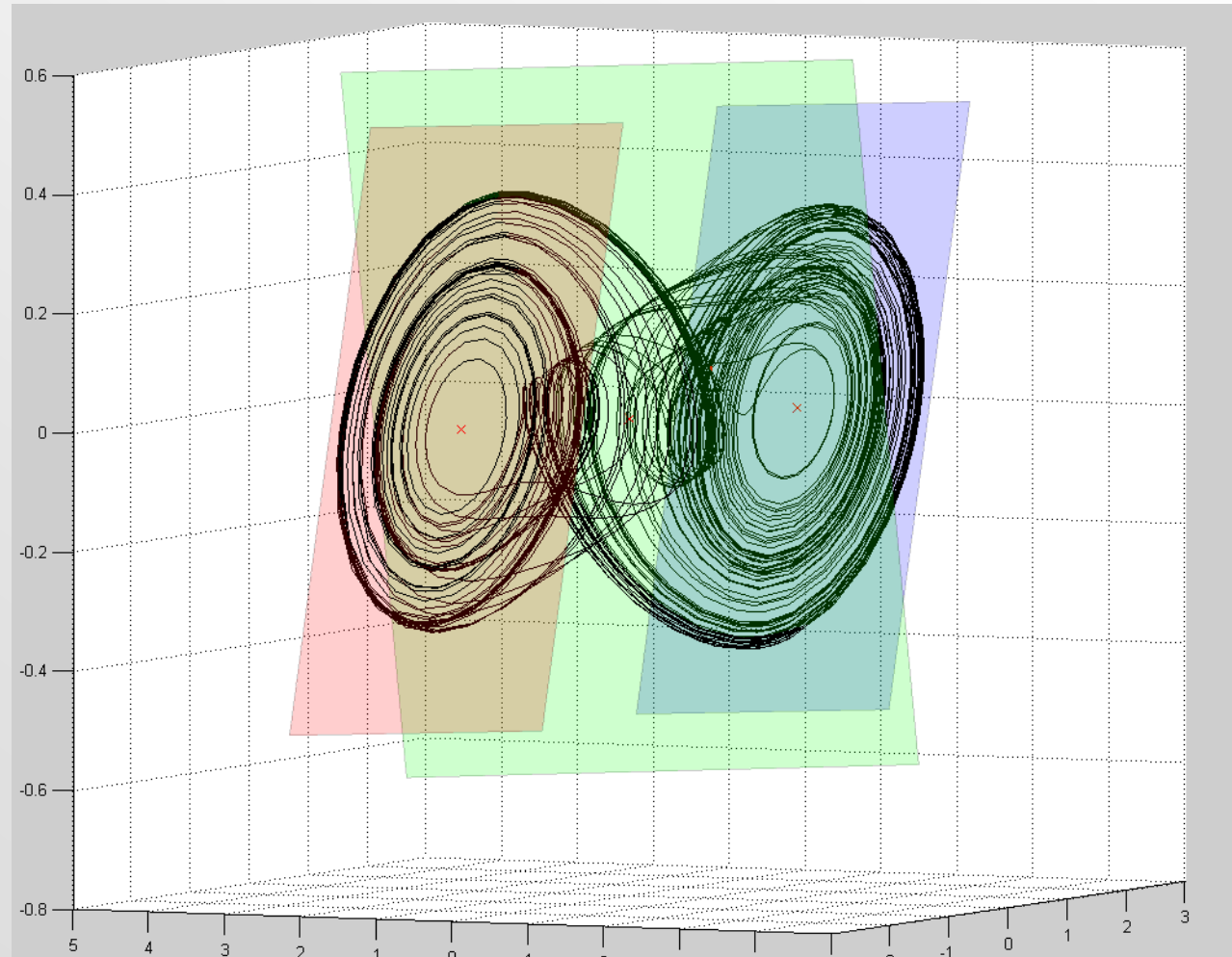
- Vlastne čísla a vlastné vektory

$$\alpha \cdot A = \Lambda \cdot \alpha$$

- Element singularity

$$y = \alpha_{11}(u_1 - u_{1s}) + \alpha_{12}(u_2 - u_{2s}) + \alpha_{13}(i - i_s)$$

Elementy singularít



Pohyb zastupujúceho bodu

```
save
Print
Indent
Find
Breakpoints
Run
Run and Time
Run and Advance
Advance
FILE
EDIT
NAVIGATE
BREAKPOINTS
RUN

).m x
obal Y u1_m1_0 i_m1_0 u2_m1_0 u1_m1_P1 i_m1_P1 u2_m1_P1 u1_m1_P2 i_m1_P2 u2_m1_P2;

figure('name','PC153 zastupujuci bod')

****_chaoticky atraktor a hranice plochy****

kva farba = [0.84 0.84 0.84]
xlabel('u1'); ylabel('i'); zlabel('u2');
axis('square');
hold on;
axis(45,10);

locha pre singularitu 0 (polygon z bodov plochy)
_p0 = patch(u1_m1_0,i_m1_0,u2_m1_0, 'g');
priehľadnosť plochy
c(p1_0,'facealpha',0.2)
c(p1_0,'edgealpha',0.2)
axis(axis);
hold on

locha pre singularitu P+ (polygon z bodov plochy)
_p1 = patch(u1_m1_P1,i_m1_P1,u2_m1_P1, 'r');
priehľadnosť plochy
c(p1_p1,'facealpha',0.2)
c(p1_p1,'edgealpha',0.2)
hold on

locha pre singularitu P- (polygon z bodov plochy)
_p2 = patch(u1_m1_P2,i_m1_P2,u2_m1_P2, 'b');
priehľadnosť plochy
c(p1_p2,'facealpha',0.2)
c(p1_p2,'edgealpha',0.2)

g =(gcf);
hlavicka = struct('Color','k','MarkerSize',10);
chvost = struct('Color','k','LineWidth',1,'MarkerSize',1);
PlotComet_3D(Y(:,1),Y(:,3),Y(:,2), 'Frequency',10,'cFigure',figure(fig), 'headFormat',hlavicka, 'tailFormat',chvost, 'blockSize',10000);
```

Ďalší postup

- FFT analýza
- výpočet aktuálních parametrov pre iné CHA
- analýza ďalších CHA, umiestnenie ich elementov singularít
- podrobnejšia analýza single scroll-u

Koniec

Ďakujem za pozornosť...

- [1] Matsumoto, T. [1984] "A Chaotic Attractor from Chua's Circuit," IEEE Transactions on Circuits & Systems, vol.CAS-31, no.12, pp.1055-1058.
- [2] Špány, V., Galajda, P., Guzan, M., Pivka, L., & Olejár, M. (2010). Chua's singularities: great miracle in circuit theory. International Journal of Bifurcation and Chaos, 20(10), 2993-3006.
- [3] Matsumoto T, Chua L. O., Kumoro M. The Double Scroll. IEEE Transaction on Circuits and Systems; August 1985; CAS-32(8):798-818.