Literature review on topic «Chaos optical communication»

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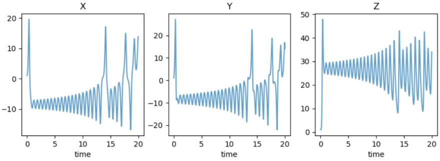
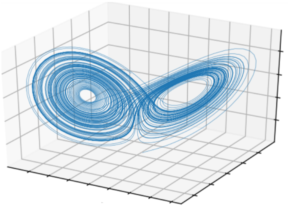
05.03.2021

Definition of dynamic chaos

Map[1] f is **chaotic**, if

- Periodic points are dense everywhere in $\boldsymbol{E}$.
- Orbits are mixed (almost):
  let $U_1, U_2 \subset \boldsymbol{E}$. $\forall x_0 \in U_1 \; \exists N \in \mathbb{N} : f^N(x_0) \in U_2$.
- f Sensitive to the i. c.
  $\forall x_0 \in \boldsymbol{E}, \; \forall U_\varepsilon(x_0) \; \exists y_0 \in U_\varepsilon, \exists N \in \mathbb{N} \colon |f^n(x_0) - f^n(y_0)| > \beta$.





[1]W. Hirsch, S. Smale, Introduction to Chaos.

Sensitivity to initial conditions

Example of sensitivity to initial conditions with map

$$x_{n+1} = r x_n (1 - x_n), \qquad r \in (0, 4]$$

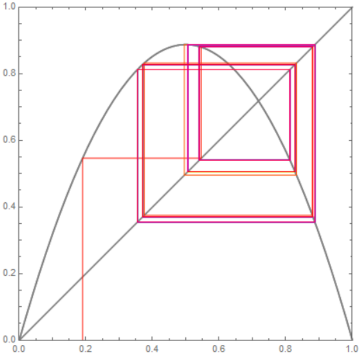


Figure 1: $r = 3.55$

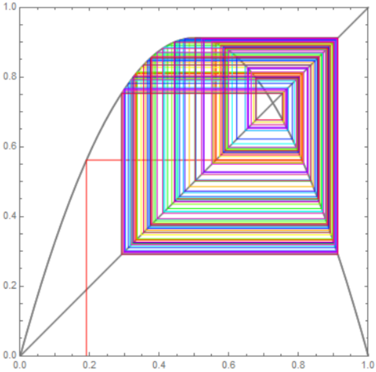


Figure 2: $r = 3.65$

Initial ideas

Consider[2] an autonomous n-dimensional dynamical system:

$$\dot{u} = f(u) \;\Leftrightarrow\; \begin{cases} \dot{v} = g(v, w), \\ \dot{w} = h(v, w) \end{cases} \quad \text{where} \quad \begin{matrix} v = (u_1, \dots, u_m) \\ w = (u_{m+1}, \dots, u_n) \end{matrix}$$

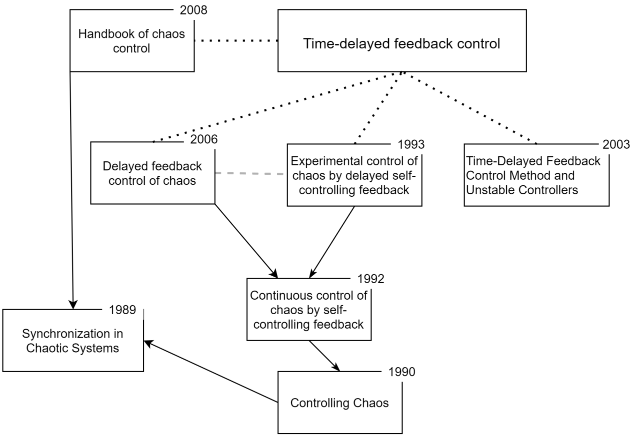
and $g = (f_1(u), \dots, f_m(u)),\; h = (f_{m+1}(u), \dots, f_n(u))$.
Then, at system $\dot{w}' = h(v, w')$ it's right that

$$\lim_{t\to\infty} \left(\Delta w = w' - w\right) = 0, \quad \text{only if} \;\; \text{LyapunovExponent}(w) < 0.$$

Also, it could be shown, that with noize in system parametrs $\Delta w(t) \to \text{const}$ at some additional conditions.

[2] M. Pecora, L. Carroll, Synchronization in Chaotic Systems, 1990.

Some articles



Greece realization

The use of such encryption on a commercial scale is possible[3]

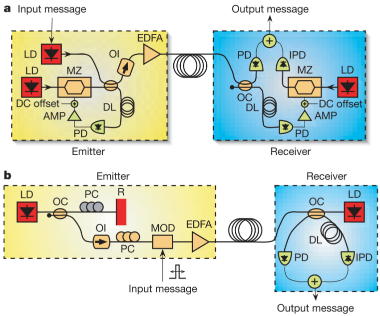


Figure 3: Two schematic set-ups for optical chaos communication

Possible realisatios:

- optoelectronic scheme (a)
- all-optical scheme (b)

[3] A. Argyris, D. Syvridis, Chaos-based communications at high bit rates using commercial fibre-optic links.

Some articles