Dynamical Systems and Their Applications
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Four dimensional and singular perturbation systems of differential equations and two dimensional dynamical system with impulse

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Definition 1. Special four dimensional and singular perturbation system of differential equations is

$$\begin{cases} \varepsilon \dot{\overrightarrow{x}} = \overrightarrow{f}(\overrightarrow{x}, \overrightarrow{y}) \\ \dot{\overrightarrow{y}} = \overrightarrow{g}(\overrightarrow{x}, \overrightarrow{y}) \end{cases}$$

where ε is small positive parameter, $\overrightarrow{x} \in R^2$, $\overrightarrow{y} \in R^2$, $\overrightarrow{f} \in C^1(D)$, $\overrightarrow{g} \in C(D)$, $D \in R^4$

Let topology of R^2 to be a topology which is generated by two dimensional Euclid metric.

Definition 2. Special two dimensional dynamical system with impulse is four objects (W, M, A, H) where W is two dimensional subset of R^2 with relative topology; M is one dimensional subset of R^2 with relative topology which is defined by equation $G(x_1, x_2) = 0$ and $M \in \partial W$; A is mapping M in W which is named as an impulse action(jump operator); H is mapping topological product $(W \setminus M) \times R^1$ in W where $H|_{S_i} = H_i$, $S_i = \{(x_1, x_2) : (-1)^{i+1} \cdot G(x_1, x_2) > 0\}$ $H_i(t, x_1^0, x_2^0)$; is solution of the Cauchy problem

$$\begin{cases} \dot{x_1} = f_1(x_1, x_2) \\ \dot{x_2} = f_2(x_1, x_2) \end{cases}$$

where $(x_1, x_2 \in S_i)$, $(x_1^0, x_2^0 \in S_i)$.

Dynamics of elements $w \in W$ is accomplished by the following algorithm: if $w \notin W$ then w is moved by R^1 group action untill W will not be on M . If $W \in M$ then w undergoes mapping of A . On the basis of the theory of singular perturbation system of differential equations [1], it was given the solution of a problem with association of the special four dimensional and singular perturbation system of differential equations to special two dimensional dynamical system with impulse. It was also considered some problems of associated two dimensional dynamical systems with impulse. Some examples are given.

References

[1] A. N. Tikhonov, *Matematicheskiy sbornik*, 1952, vol. 31, no. 3, p. 575-586 (in Russian)