講演会

講演： **非線形動的システムに対するクスナー・ストラトノビッチ確率手法**
A Kushner-Stratonovich stochastic method for non-linear dynamical systems

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内容： David Mumford [1] argues stochasticity will set future directions in applied mathematics, systems and control. After accounting for stochasticity of dynamical systems, the standard dynamical equation is the stochastic differential equation. The Itô stochasticity and the Stratonovich are the formal theoretical interpretations. On the other hand, white noise process is a generalized stochastic process and an informal stochastic process. In systems and control literature, the problem of analysing stochasticity of dynamical systems accounts for three problems: filtering, stability and control of stochastic systems. First, we achieve filtering of non-linear stochastic systems in more general setting, subsequently, stability and control of stochastic systems.
In this talk, I will focus on non-linear filtering of stochastic systems and state very briefly standard results on stochastic stability and stochastic control. The cornerstone formalism is the filtering density evolution, i.e. (Pugachev and Sinitsyn ([2], p. 389)

$$dp = \mathcal{L}(p)dt + (h - \hat{h})^T \psi_\eta^{-1}(t)(dz_t - \hat{h}dt)p, \tag{1}$$

where the filtering density $p = p(x, t \mid z_\tau, t_0 \leq \tau \leq t)$ and the operator $\mathcal{L}(\cdot)$ denotes the Kolmogorov-Fokker-Planck operator. H. J. Kushner developed the above density evolution equation in the Itô setting. R. L. Stratonovich developed the filtering density evolution using different interpretations and notations. For this reason, the above filtering density evolution is usually known as the Kushner-Stratonovich equation.
More precisely, this talk is about non-linear filtering for the continuous state-continuous measurement system [3] as well as continuous state-discrete measurement system [4]. The results have deep connections with the Kushner-Stratonovich equation of this note. Subsequently, I will discuss the motion of orbiting satellite under stochastic influence [5]. Here, I choose the Kushner-Stratonovich (KS) equation as the 'beginning' point of the talk, since this equation opens up stochastic control that will set future directions in systems and control, see [1]. That demonstrates the beauty, power and universality of the KS equation. It is hoped that this tall will be useful for young Researchers, who will face and circumvent tomorrows's difficulty in control theory and control technology.
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[2] V. S. Pugachev and I. N. Sinitsyn, *Stochastic Differential Systems: Analysis and Filtering*, Chichester and New York: John Wiley and Sons, 1977.
[3] S. N. Sharma, "A Kushner approach for small random perturbations of the Duffing-van der Pol system," *Automatica*, Vol. 45, No. 4, pp. 1097-1099, 2009.
[4] H. G. Patel and S. N. Sharma, "Third-order continuous-discrete filtering equations for a non-linear dynamical system," *The ASME (The American Society of Mechanical Engineers) Transactions, Journal of Computational and Non-linear Dynamics*, Vol 9, No. 3, pp. 034502-1〜9, 2014. doi:10.1115/1.4026064.
[5] S. N. Sharma and H. Parthasarathy, "Dynamics of a stochastically perturbed two-body problem," *Pro. R. Soc. A–Mathematical, Physical and Engineering Sciences*, Vol. 463, pp. 979-1003, 2007.

略歴： Shambhu N. Sharma received Master of Technology degree in Control Systems from Institute of Technology, Banaras Hindu University, India and the PhD degree from University of Delhi, Delhi, India. All qualifications were earned in Electrical Engineering with specializations in Control Systems. Currently, he is working as an Associate Professor in the Electrical Engineering Department of National Institute of Technology, Surat, India. He pursues his research in 'stochastic control' with emphasis in stochastic processes, dynamical systems, non-linear filtering as well as their applications to stochastic methods in satellite dynamics, non-linear dynamic circuits and radio astronomy. His results are chiefly published in Automatica, International Journal of Control, ASME Transactions, Journal of Computational and Non-linear Dynamics, Transactions of Institute of Systems, Control and Information Engineers, Proceedings of the Royal Society A: Mathematical, Physical and Engineering Sciences, Differential Equations and Dynamical Systems with some contributions to IFAC and ISCIE Conferences and symposia.
He has supervised four PhD students on stochastic systems and non-linear filtering under single supervision.
His research key words are Itô stochastic differential rules, Stratonovich stochasticity, Markov processes, Diffusion processes, the Fokker-Planck equation, the Kushner-Stratonovich theory of non-linear filtering, stochastic stability and Hamilton-Jacobi-Bellman equations.

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