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Forward and inverse structural uncertainty propagations under stochastic variables with arbitrary probability distributions

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**Highlights:**

1. A general frame is proposed to implement the forward and inverse uncertainty propagations with arbitrary probability distribution.
2. The derivative $\lambda$-PDF is developed to represent a large class of arbitrary mono-peak or mono-valley probability density function.
3. A mathematically derived fitting region is proposed to analyze the fitting ability of the derivative $\lambda$-PDF.
4. Based on the frame of the derivative $\lambda$-PDF, the dimension reduction method and Gauss-Gegenbauer quadrature are adopted to implement the forward uncertainty propagation.
5. Optimization method and the proposed forward uncertainty propagation method are utilized to realize the inverse uncertainty propagation.