Model-Free Controller Design based on Simultaneous Perturbation Stochastic Approximation

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Symbols and Definitions

In this thesis, we use the following symbols and definitions. The symbols $\mathbb{R}$ and $\mathbb{R}_+$ represent the set of real numbers and the set of positive real numbers, respectively. The symbol $\mathcal{S}^{n \times n}$ denotes the set of $n \times n$ positive definite matrices. The cardinality of set $\mathcal{S}$ is denoted by $|\mathcal{S}|$. The vector whose all elements are one is denoted by $\mathbf{1}$. For the vector $\mathbf{\theta}$, we use $\| \mathbf{\theta} \|$ to express the standard Euclidean norm. For the random variable $V$, the probability of event $V = a$ is represented by $\mathbb{P}(V = a)$. The expectation of the random variable $b$ is denoted by $\mathbb{E}(b)$. For $\delta \in \mathbb{R}_+$, $\text{sat}_\delta : \mathbb{R}^n \rightarrow \mathbb{R}^n$ denotes the saturation function whose $i$-th element given as follows:

$$\text{The } i\text{-th element of } \text{sat}_\delta(\mathbf{\theta}) = \begin{cases} 
\delta & \text{if } \delta < \theta_i \\
\theta_i & \text{if } -\delta \leq \theta_i \leq \delta \\
-\delta & \text{if } \theta_i < -\delta
\end{cases}$$

where $\mathbf{\theta} \in \mathbb{R}^n$ and $\theta_i \in \mathbb{R}$ is the $i$-th element of $\mathbf{\theta}$. 