Statistical Measures of Random Processes

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1. Consider *N* samples of *K* examples of a random process *X* sampled at a uniform rate f_s arranged as a matrix:
$$\begin{bmatrix} t_1 & x_{11} & x_{12} & x_{13} & \dots & x_{1K} \\ t_2 & x_{21} & x_{22} & x_{23} & \dots & x_{2K} \\ \vdots & \vdots & \vdots & \vdots & \dots & \vdots \\ t_N & x_{N1} & x_{N2} & x_{N3} & \dots & x_{NK} \end{bmatrix}$$
2. Write a MATLAB function that accepts the matrix of step (1) and returns a vector with *N* estimates of the mean for each time *t*. Averages are for a particular time slice and are thus across the ensemble.
3. Write a MATLAB function that accepts the matrix of step (1) and returns a vector with *K* estimates of the mean across time for each ensemble member. This is the time average for each ensemble.
4. Write a MATLAB function that accepts the matrix of step (1) and estimates the autocorrelation function $R_{xx}(\tau)$ across the ensemble as in (3.20) of [1] centered at a specified time index.
5. Write a MATLAB function that accepts the matrix of step (1) and estimates the autocorrelation function $R_{xx}(\tau)$ across time as in (3.22) of [1] centered at a specified time index.
6. Apply your code from steps 1-5 to Example 3.13 of [1]. Compare ensemble and time based statistics to theoretical results. Comment on the stationarity and ergodic properties of that random process.
7. Repeat step 7 for Example 3.14 of [1].

Prepare a technical report describing your results. Attach a listing of all code. Be sure your code contains explanatory comments. **You are cautioned that you must write your own code.**

Reference

[1] Frank L. Severance, *System Modeling and Simulation: An Introduction*, John Wiley & Sons, New York, 2001.