PROJECT

TEACHER:

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OBJECTIVES:

The aim is to apply the method of uncertainty quantification that have been studied during the course on a realistic problem (A magnetic holder) and to assess and to compare them.

DELIVERABLES

1 report for each part (see below for the deadline) to send by email at stephane.clenet@ensam.eu. The report should give the main results along with comments. An algorithm of each numerical method should be also provided.

Deliverable deadlines	
Part number	Deadlines
I	01/02/2021
II	01/02/2021
III	03/02/2021
IV	05/02/2021

DESCRIPTION OF THE PROJECT

Part I-Crude Monte Carlo Simulation Method: Calculation of the statistics of the forces

We will consider as Random Variables only the following variables:

-Remanent magnetic flux density of the magnet (T) b_r=1.2 (+/-5 %)

-Height of the magnet (m) h_{aim}=10e-3 (+/- 5%)

-Air gap between the core and the yoke (m) e=0.5e-3 (+/- 15%)

-Parasitic air gap (m) e_p=50.e-6 (+/-40%)

-Current in the coil (A) current=0.0652 (+/-10%)

I-1 : 1 input RV

First, we assume that only one input is a random variable the other ones are constant and equal to their nominal value. For each parameter:

-Calculation of the mean, the standard deviation, the histogram of force1 and force2 for different probability density functions (uniform and Gaussian) with the same mean and standard deviation.

-Is there an influence on the pdf ?

-Which value seems to be the most influent on force 1 and force 2 ?

I-2 : 5 input RVs

-Calculation of the mean, the standard deviation, the histogram

-Comparison with the case 1

-What about the convergence speed of the mean with an increasing number of input RVs (from 1 to 5) ?

Part II-Hit or Miss Method: reliability analysis

Considering the 5 input Random variables.

Calculate the probability to have F1 lower than 120 N.m

Calculate the probability to have F2 greater than 10 N.m

Calculate the probability to have at least one condition above fulfilled

Part III-Improvement of the Monte Carlo Simulation Method

Try to improve the speed of convergence of the estimator of the mean of F1 and F2 in the case of the magnetic holder applying:

-Importance Sampling

-Antithetic Variates

-Stratified Sampling

And compare the methods.

Part IV-Sensitivity analysis

IV-1-Calculation of the sobol indices

We will consider again the magnetic holder with the following input RV:

-Remanent magnetic flux density of the magnet (T) b_r=1.2 (+/-5 %)

-Height of the magnet (m) h_{aim}=10e-3 (+/- 5%)

-Air gap between the core and the yoke (m) e=0.5e-3 (+/- 15%)

-Parasitic air gap (m) e_p=50.e-6 (+/-40%)

-Current in the coil (A) current=0.0652 (+/-10%)

Calculate the Sobol indices of first order using the MC method and the projection method. Which one is the faster ? Compare the influence of the input parameters

Determine a method to calculate the Sobol total indices in the case of the MC method and the projection method.

Reduce the interval of variation of the input RVs in order to have the same order for the first order sobol indices.

IV-2-Adaption of the variability of the inputs

We want to reduce the variability of the outputs (F1 and F2) by 5 (division by 5 of the standard deviation of F1 and F2) by acting on the variability of the inputs.

Assuming that the input variables are always uniform, determine new intervals of variations that satisfy the new specifications of the outputs F1 and F2.