Structural Health Monitoring (SHM)
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Lecture – 16
Level of uncertainties in Structural Health Monitoring process – Part 2

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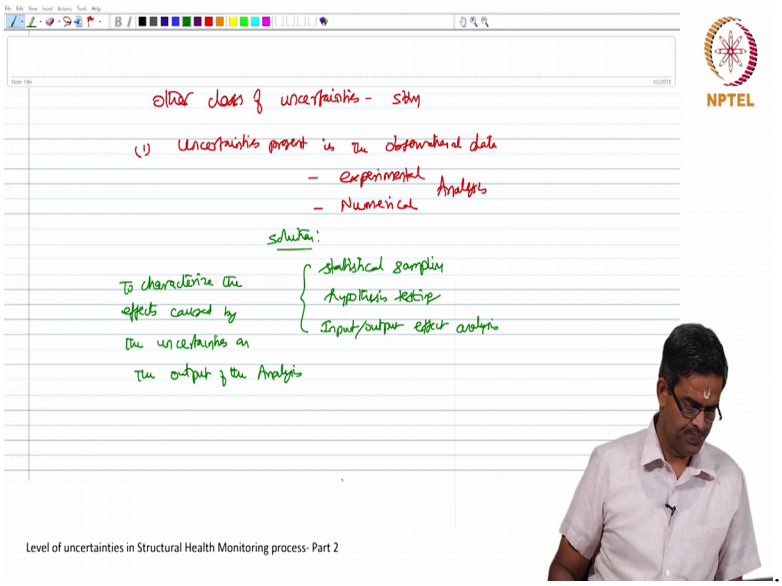

There are other class of uncertainties, which also pose problems in SHM process one of them is the uncertainties present in the observational data itself. It may arise from experimental or numerical analysis both ways it is possible. So, this can be handled by statistical sampling, hypothesis testing and input output effect analysis methods. These will be useful to characterize the effects cost by the uncertainties on the output of analysis.

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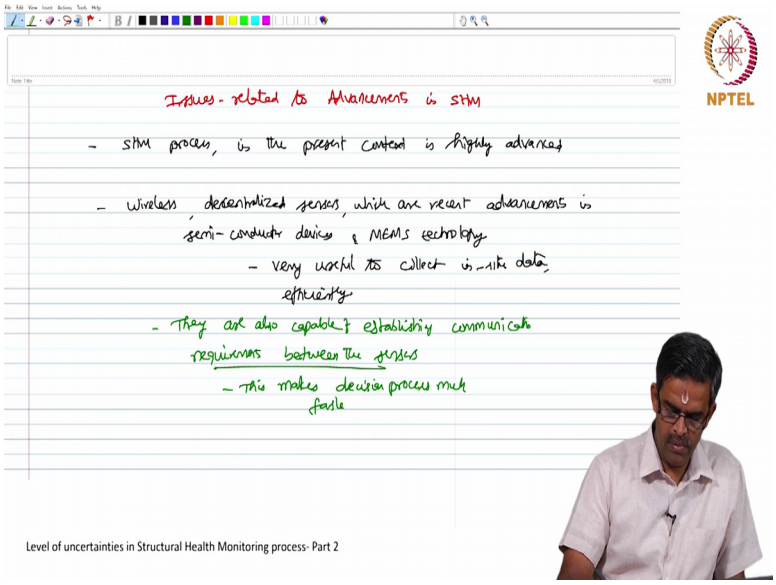

Friends, there are some issues related to advancements in SHM; which can also cause uncertainties. Now structural health monitoring process in the present context is highly advanced, it has got wireless decentralized sensors, which are recent advancements in semiconductor devices and MEMS technology. They are very useful to collect in situ data efficiently there is no doubt about it, interestingly and more importantly they are also capable of establishing communication requirements between the sensors, that is very important advantage we have because this makes the decision process much faster.

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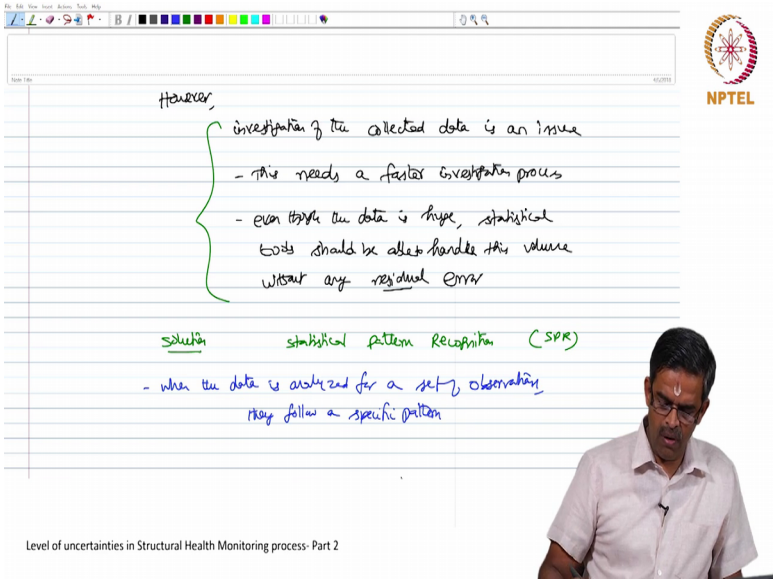

However, investigation of the collected data is a big problem because, one this needs a faster investigation process. Even though the data is huge in case of let us say continuous

monitoring statistical tools should be able to handle this volume without any residual error.

One important solution handle this issue is, instead of doing a statistical analysis people do statistical pattern recognition; which we call SPR, friends when you do a statistical data analysis for a set of observations, when the data is analyzed for a set of observations it is interesting to note they follow a pattern.

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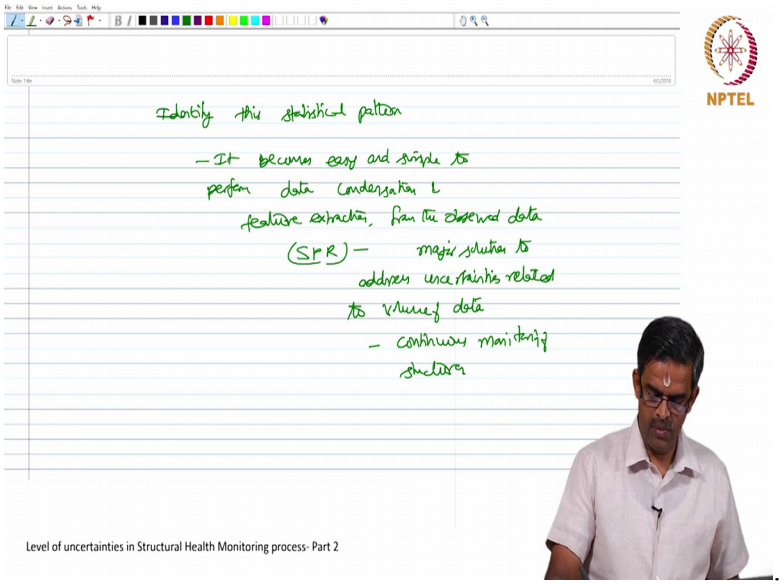

So, instead of all the time analyzing the new set of data what one does is; identify this pattern. Once identify this pattern it becomes easy and simple to perform data condensation and feature extraction from the data. So, statistical pattern recognition plays a very important role and offers a major solution, to address uncertainties related to volume of data. Usually this problem is very precarious in case of continuous monitoring of structures.

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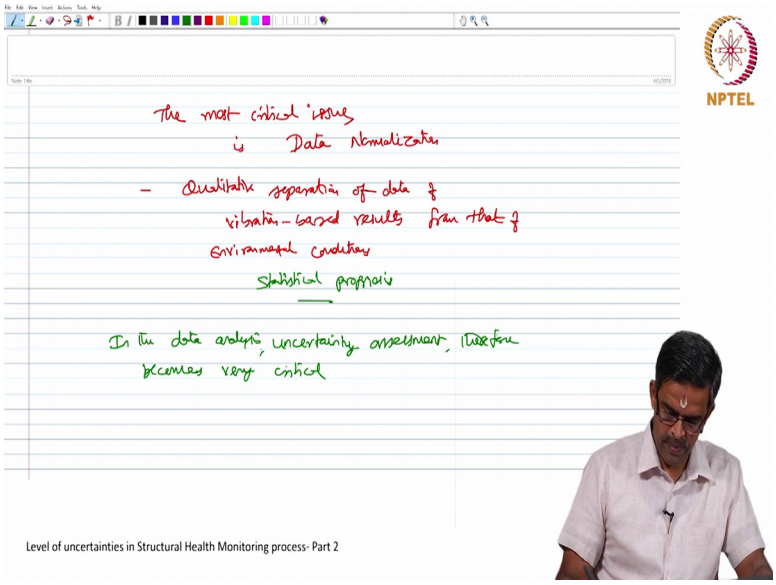

The most critical issue as I said in the beginning is data normalization; that is qualitative separation of data of vibration based results from that of environmental conditions. So, we should do what is called statistical prognosis. In the data analysis uncertainty assessment therefore, becomes very important and critical.

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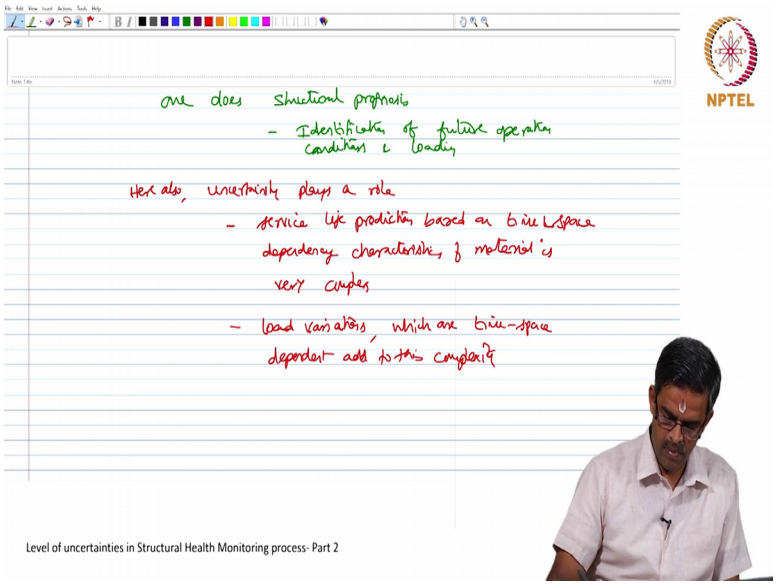

So, one does structural prognosis; which is identification of future operation, conditions and loading. Here also uncertainty plays a role because the service life prediction based on material is very complex, further load variations which are also time and space dependent add to this complexity.

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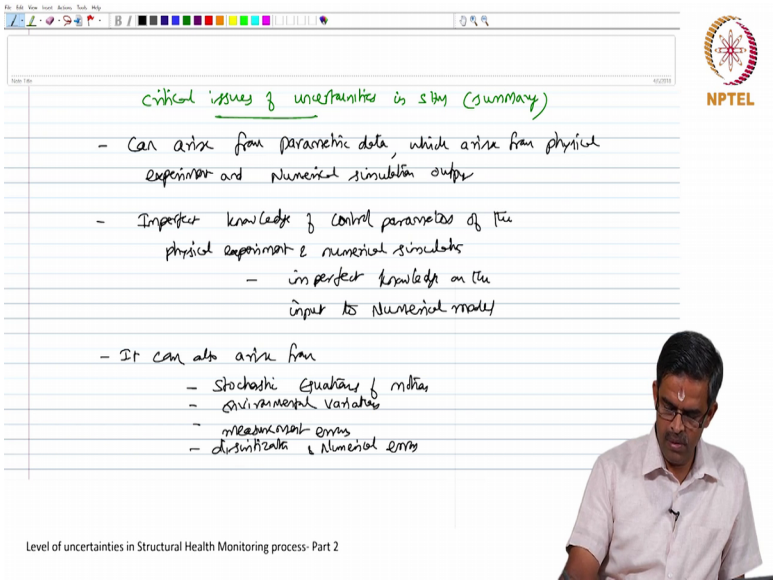

Let us now summarize what are the critical issues of uncertainties in SHM. So, let us say we are summarizing the critical issues; uncertainties can arise from parametric data; which arise from the physical experiment and numerical simulation output. Second can be the imperfect knowledge of controlled parameters of the physical experiment and numerical simulation. It can also add to imperfect knowledge on the input in numerical model, because you do not have a clear idea about the input numerical model.

It can also arise from stochastic equations of motion, environmental variations, measurement errors which are human based, can also come from discretization and numerical errors.

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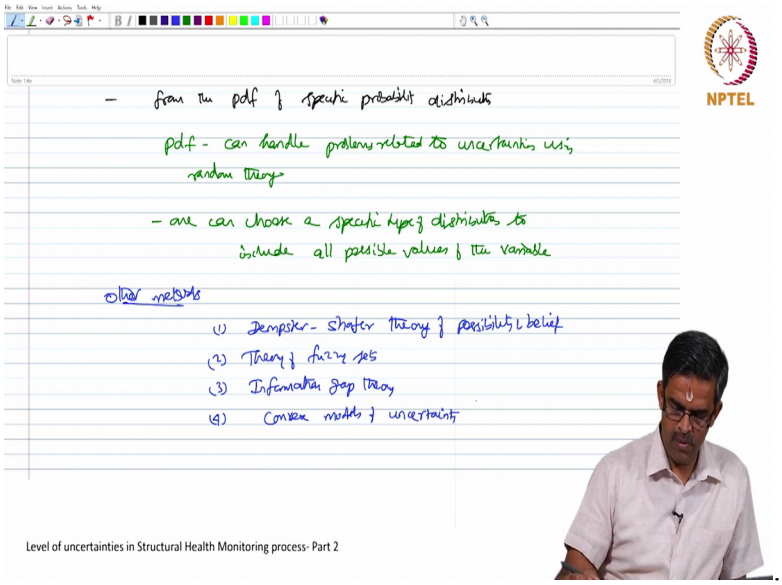

It can also arise from the probability density functions of specific probability distributions; interestingly probability density function can handle problems related to uncertainties using random theory. So, one can choose a specific type of distribution that is probability distribution to include all possible values of the variable.

There are other methods of doing this, other methods of handling this uncertainty will be dempster-shafer; theory of possibility and belief, theory of fuzzy sets, information gap theory and convex model of uncertainty.

Friends the most simpler way to address this uncertainty is Monte - Carlo technique.

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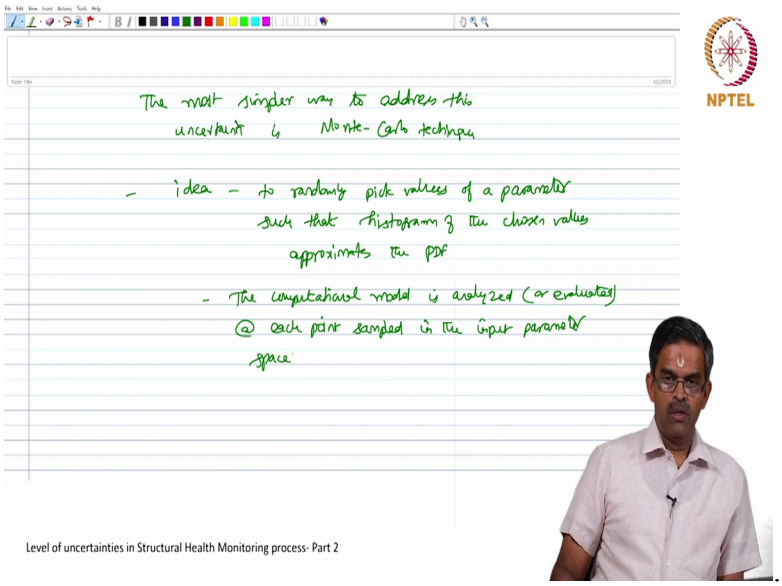

A small word about this technique it is actually an idea towards to randomly pick values of a parameter. I am talking about the idea of the monte-carlo technique as such randomly picked values of a parameter such that, histogram of the chosen values approximates the probability density function. Subsequently the computational model is analyzed; otherwise I should say is evaluated at each point sampled in the input parameters space.

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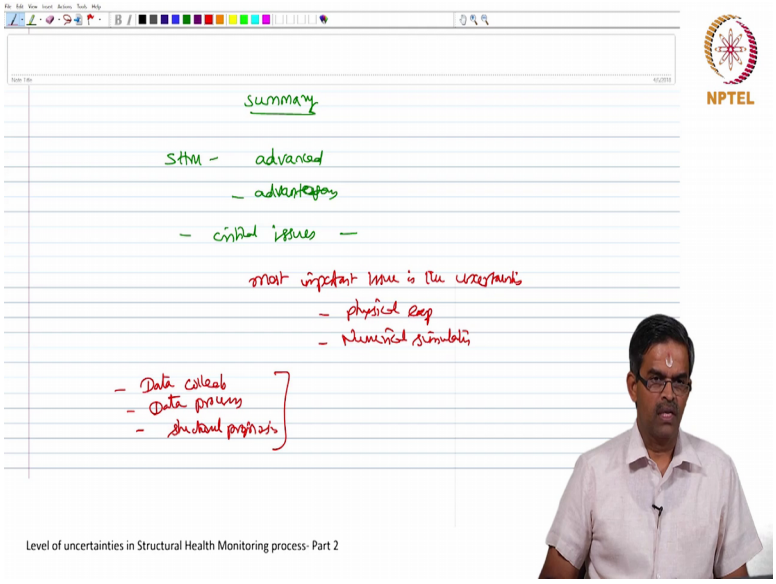

So friends, structural health monitoring process is advanced, is advantageous, but has a few critical issues, which we discussed in previous lectures. One of the most important critical issue is the uncertainties. They may arise even from physical experiments, even from numerical simulation, it can arise at any stage, it can arise at the data collection, data management and processing even during structural prognosis etcetera.

So, health monitoring though advices a very intelligent way of measuring the in situ condition of the structure; however, the outcome of this process also has certain level of disagreement in terms of it is non acceptance and non compliance the real time behavior which we must keep in mind. So, friends with this lecture we have competed the lectures in first module. I sincerely advise you to go through the tutorials and try to answer them in a more descriptive manner this particular lecture has future reading I would like to advice you on this future reading for a better understanding.

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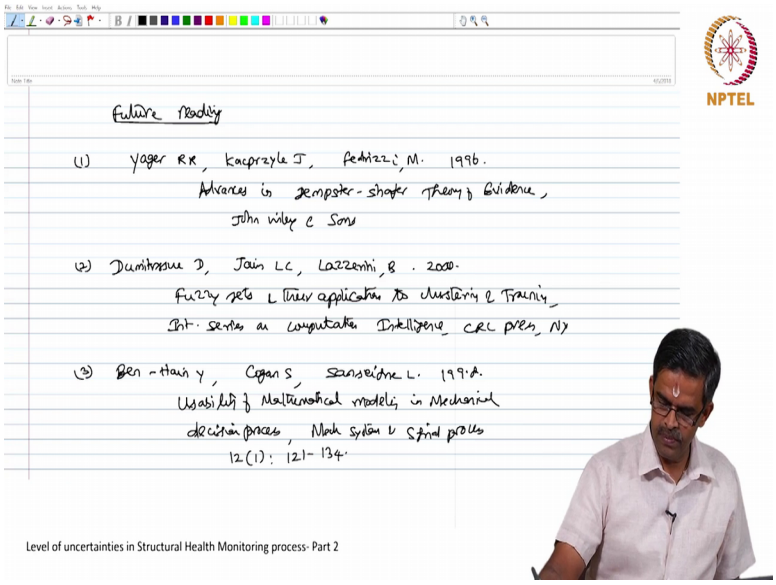

Advances in Dempster-Shafer theory of evidence, John Wiley and sons it is a book which talks about this kind of distribution. 2000 fuzzy sets and their application to clustering and training, international series on computational intelligence CRC press New York. The third could be a conference paper usability of mathematical modeling in mechanical decision process, mechanical systems and signal processing the journal 12 1: 121- 134.

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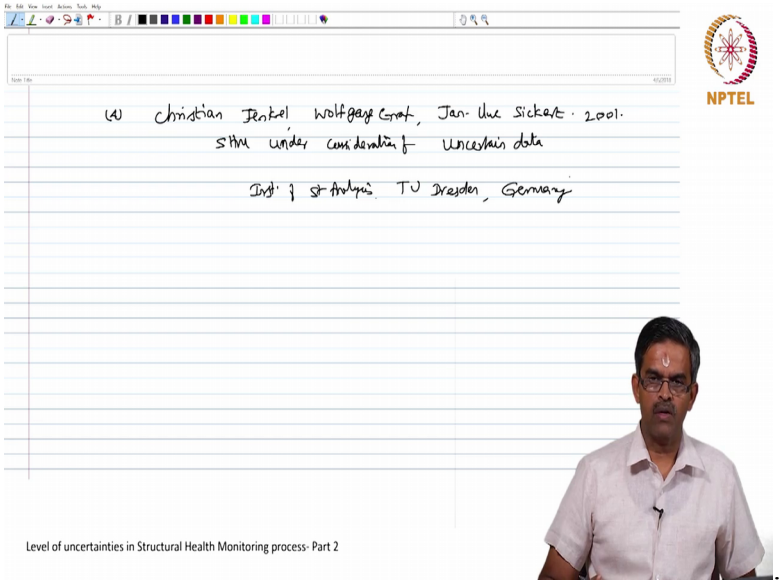

Christian Jenkel, Wolf and graph 2001 SHM under consideration of uncertain data from the institute of structural analysis T U Dresden Germany. So, there are many further

references has given to you for additional reading, I hope you understand and try to answer the questions in first module lectures.

Thank you very much and bye.