Structural Health Monitoring (SHM)
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Lecture - 62
Part - 2: Plausibility of errors in SHM

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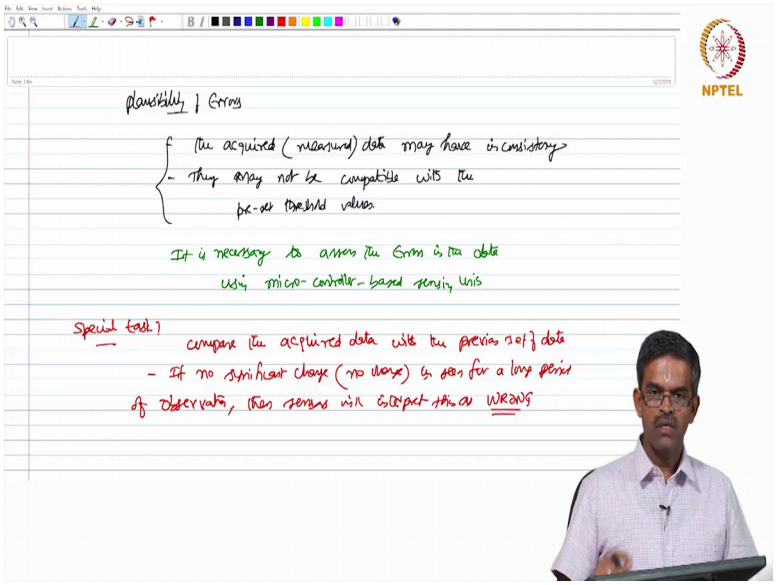

When you talk about plausibility of errors may have inconsistency they may not be compatible with the preset, threshold values. So, at this stage when such errors occur it is necessary to assess the errors in the data using microcontroller based sensing units. Now interestingly what special these units will do, what special task these units will perform? These units will compare the acquired data with the previous set of data, if no significant change or let us say no change is seen for a long period of observation then the sensors will interpret this as wrong data.

So, it takes a decision that the corresponding feed unit is idle maybe not working, maybe disconnected, maybe battery down; what are maybe the reason for the sensing unit not working, but somebody in the network or in the loop has to recognize this. This intelligent intervention is done possibly using artificial intelligence in structural health monitoring.

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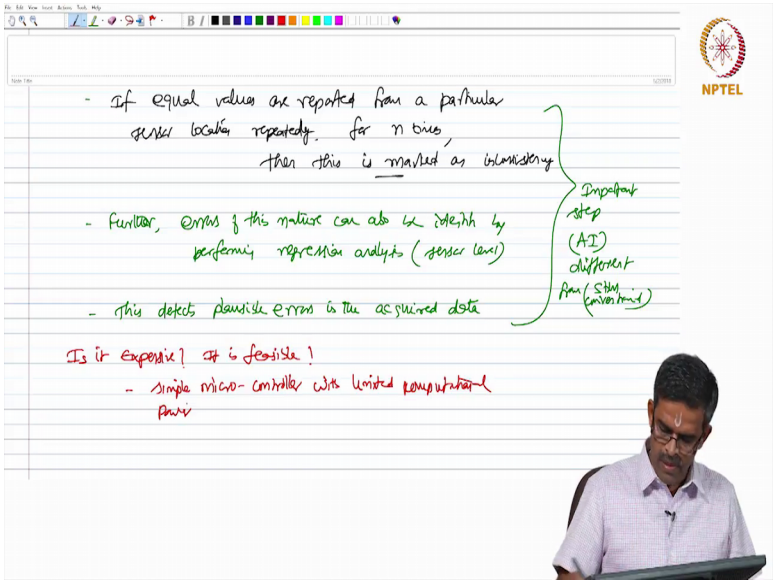

For example: if equal values are reported from a particular sensor location repeatedly for let us say n times this is marked as inconsistency, errors of this nature can also be identified by performing regression analysis which is also done by the sensor. So, this detects plausible errors in the acquired data. So, that is a very important step which makes artificial intelligence different from the conventional SHM.

Now is it expensive; is it expensive, is this process feasible? The answer is very simple: one can use a simple microcontroller with limited computational power to do this job.

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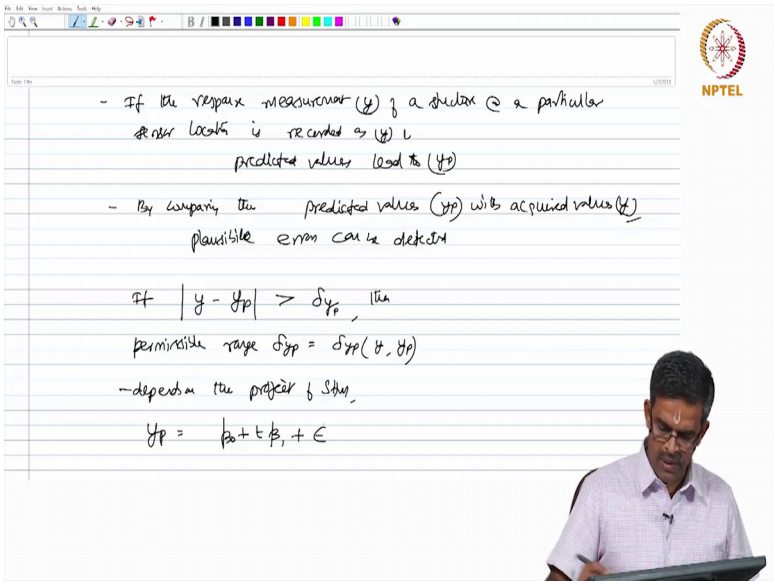

Let us say if the response measurement y of a structure at a particular sensor location is recorded as y and predicted values lead to let us say y p; p stands for predicted value. Now, by comparing the predicted values y p with acquired values y plausible errors can be detected if y minus y p mod is greater than delta y p. Then the permissible range delta y p will be a function of the measured value and the predicted value. It depends on the kind of project of SHM.

Therefore, I can say the predicted value can be some error function of beta 1 beta 0 beta 1 plus some error function.

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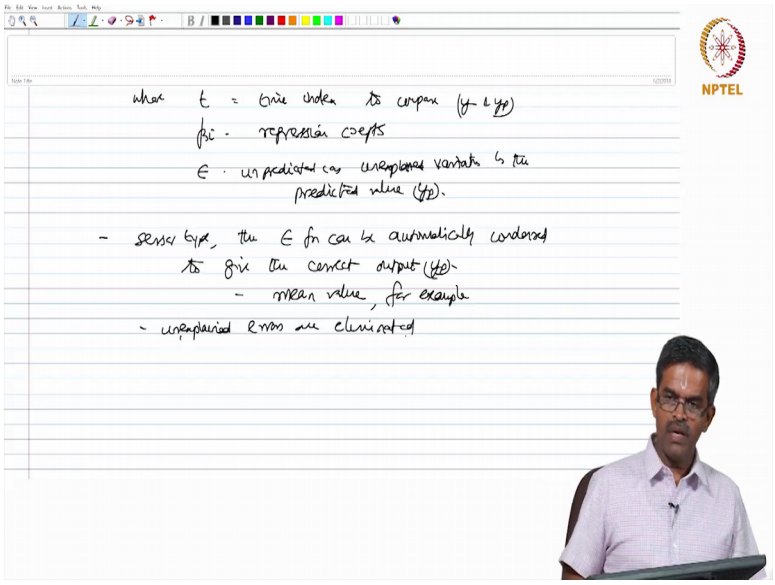

Where t is the time index used to compare y and y p. Beta i or the regression coefficients and epsilon represents the unpredicted or unexplained variation in the predicted value y p. So, depending upon the sensor type the error function can be automatically condensed output y p, which can be for example a mean value. So, the unexplained errors are eliminated.

So, this can be done by a simple microcontroller.

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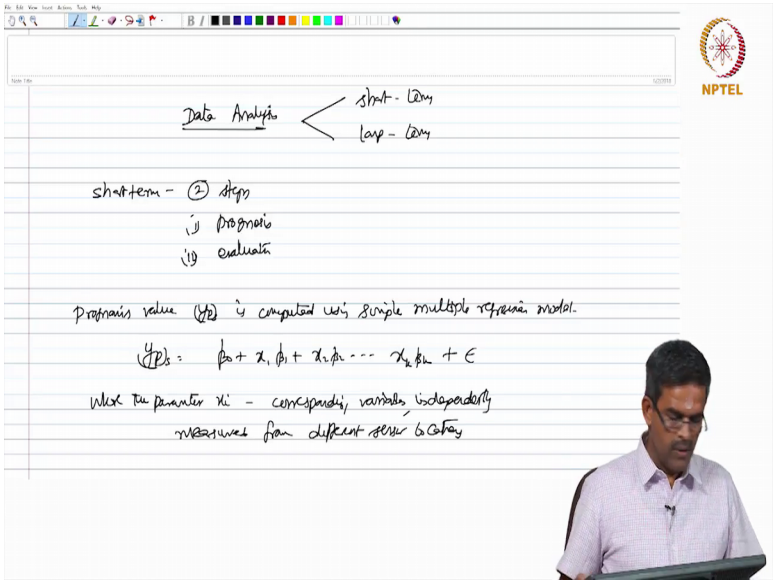

The next issue comes how do you do the data analysis. The data analysis can be done in two forms: one is short term, other is long term. Short term data analysis has two steps: one is the prognosis and second one is the evaluation. The prognosis value let us say y p of s is computed using simple multiple regression model; y p s can be calculated as beta 0 x 1 beta 1 plus x 2 beta 2 say x k beta k plus epsilon. Where, the parameters x i or the corresponding variables independently measured from different sensor locations.

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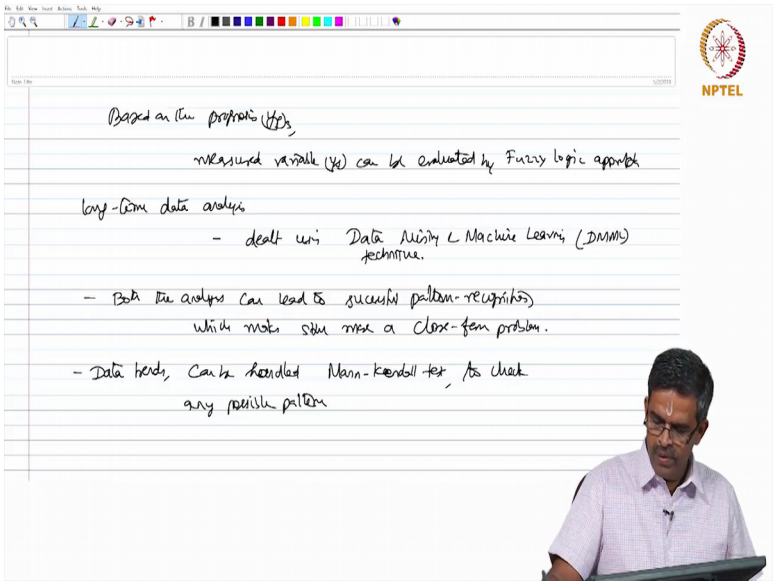

Now, based on the prognosis value y p s the measured variable y s can be evaluated by fuzzy logic approach. The long term data analysis is generally dealt using data mining and machine learning; this is DMML technique. Further, both the analysis can lead to a successful pattern recognition which makes SHM more a close form problem.

So, data trends which are different can be handled Mann-Kendall test to check any possible pattern.

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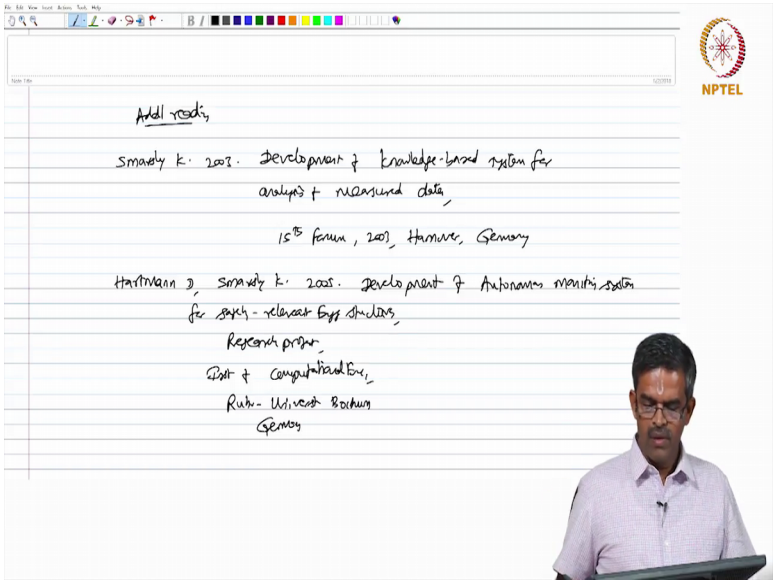

Friends, this lecture has additional reading which I recommend you can read Smarsly K 2003: development of knowledge based system for analysis of measured data; 15th forum 2003, Harnover, Germany. Hartmann D, and Smarsly K 2005: development of autonomous monitoring safety relevant monitoring system for safety relevant engineering structures; so research project done by Institute of Computational Engineering Ruhr University, Bochum, Germany.

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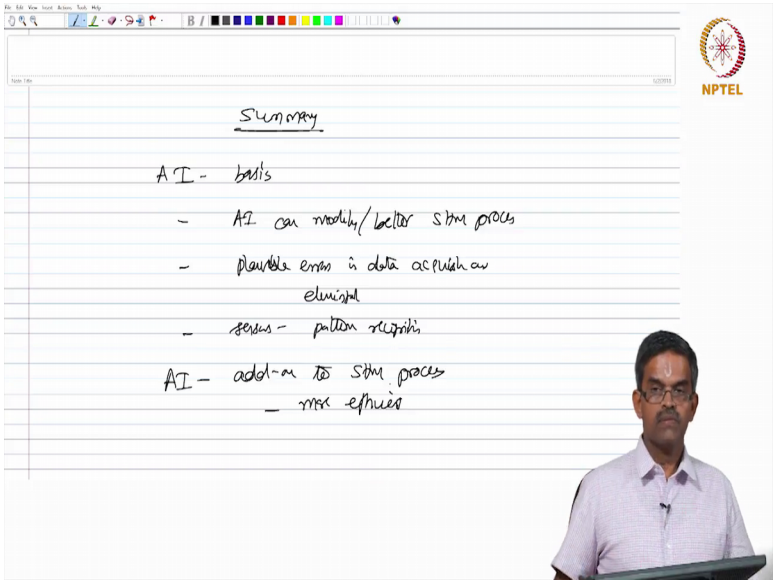

So friends, in this lecture we learnt basics of artificial intelligence, we also saw how AI can modify and make it better SHM process, we have also seen how the plausible errors in data acquisition are eliminated, and how sensors can also be used for pattern recognition. So, we have said that AI is a successful add on to SHM process to make it more efficient.

Thank you very much and bye.