Structural Health Monitoring (SHM)
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Lecture - 74
SHM design- 2 for BSLRP-Part2

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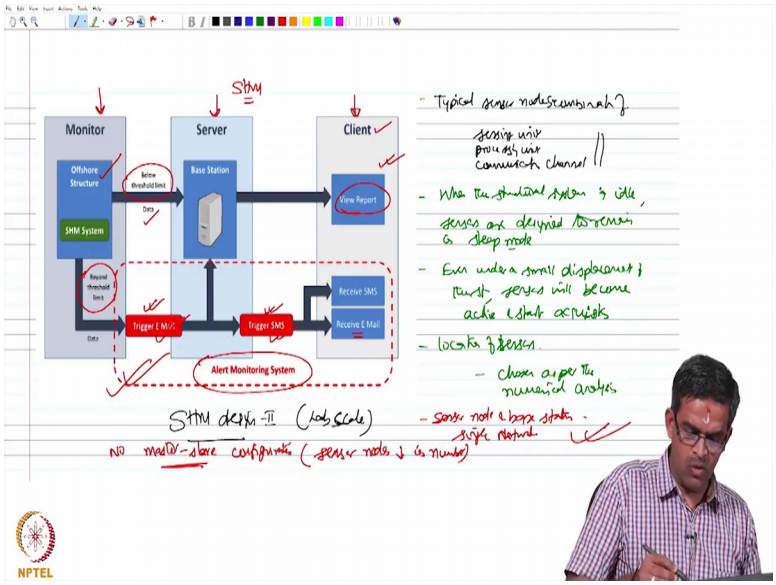

Now, the Structural Health Monitoring System what we have discussed also has an additional advantage, which is the alert monitoring system. So, look at the figure here this is actually the layout of SHM design to which we are discussing for the lab scale, that typical sensor node what we have here is a combination of is a combination of sensing unit, processing unit, and communication channel. It contains all.

Now interestingly, when the system is ideal when the structural system is ideal sensors or design to remind in sleep mode; even under a small displacement of the structure sensors will become active and start acquisition. Now, the location of sensors are very important in the design, the locations are chose as per the preliminary numerical analysis done, in the present study we have sensor nodes and base station connected to a single network.

So, there is no masters slave configuration, because in the lab scale the sensor nodes have a very small number or very small in number. Therefore, there is no need who have an expandability of master slave configuration.

So, the sensor nodes and the base station are connected to a single network. Now, if you look at this figure, which is talking about the layout there is an additional system what you have generated in this, which is the alert monitoring system. So, you monitor the system communicate to the server then get the report on the client server, this is standard system what we have for SHM which can be applicable to a real time monitoring also.

Now, more interestingly when you have a primary data of analyses of the off shore structure, you know what is the maximum displacement the structure is permitted to undergo you fix up what we call as a threshold value ok. When the acquired data on mapping with the existing data exceeds threshold value, then it has to trigger and email it has to also trigger and sms and the email as what we received in the client server showing that the data or the structures undergone a displacement or a response which is above or more than the threshold value.

So, the comparison of the acquired response with the threshold value is then communicated to the base station to indicate at what time, at what time frame, at what sensor, at what location on the structure this exceedance happened. So, there is a physical mapping of the exceeded data with that of the threshold value on to the real time structure. So, that the client server person looking at the report will know, at what location of the sensor on the other hand, at what location in the structure the exedents of the value has happened, at what time frame this has happened.

Now there is a common possibility that we can always ignore the statement by oversize therefore, the dual mode of alert monitoring happening in this design. One is by a SMS alert which tells you what happened and also by a standard email format, which is a legal document stating that the sensor has communicated to the client, that at a particular location at a particular time framework the threshold value of the structure has been exceeded. Whether it is exceeding and continuity exceeds is the different issue it gives me a trigger once when it is exceed ok.

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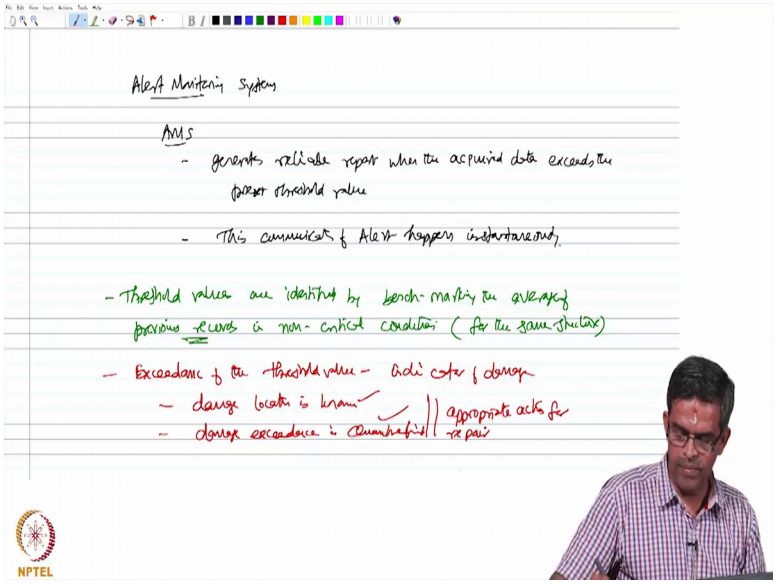

So, that is what we are adding now to the alert monitoring system to May SHM on let us discuss about this now. So, we are now entering into design of alert monitoring system, which is the part of the SHM in case of design 2. A alert monitoring systems has many advantages. It actually generates a reliable report when the acquired data exceeds the preset threshold value, that is first one second this communication of alert instantaneously that is very important. Now how do you identify the threshold values? The threshold values are identified by benchmarking the average of previous records in non-critical condition for the same structure. So, you keep on acquiring data in a non-critical stage the average of the previous records will be considered as a threshold value.

Now, exceedance of threshold value is an indicator of image. So, now, the question is damage location is known, because the sensor location is known damage exceedance is quantified, because it exceeded threshold value. Therefore, one can take appropriate action for repairing or reconstructing the structure ok.

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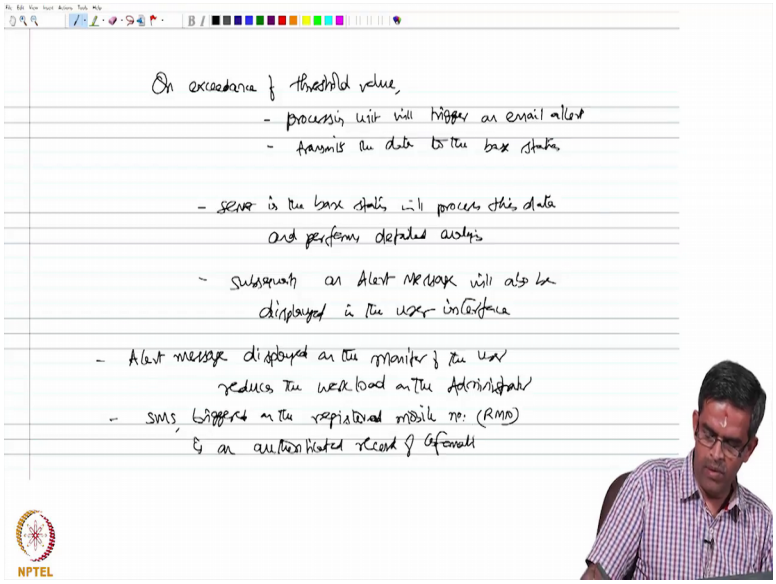

So on exceedance of the threshold value, the processing unit will trigger the processing unit will trigger an email alert and subsequently also transmits the data to the base station. Now server in the base station will process this data and performs detailed analysis, subsequently an alert message will also be displayed in the user interface. Now there are many advantages of this the alert message displayed on the monitor of the user of the user reduces the workload on the administrator ok.

Further, SMS trigger on the registered mobile number is an authentic information ok. It is an authenticated record of information which cannot be tampered.

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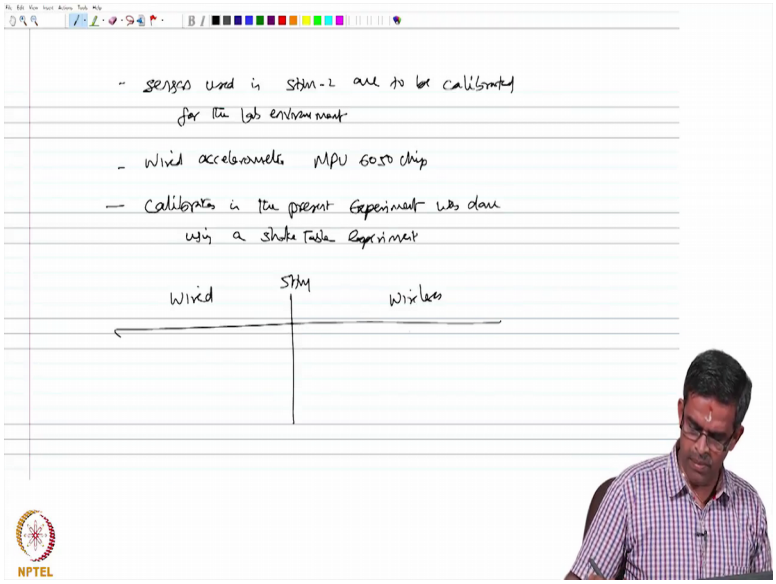

Now, the sensors used in SHM 2 design are also to be calibrated for the lab environment, because the real time monitoring in the right time monitoring will be different. So, we have use the wired accelerometer, which is MPU 6050 chip in the present study. The calibration the present test calibration in the present test in the present experiment was done using a shake table experiment I am not showing the results of the shake table experiments here. So now, we have 2 systems which is wired and wireless both are for structural health monitoring.

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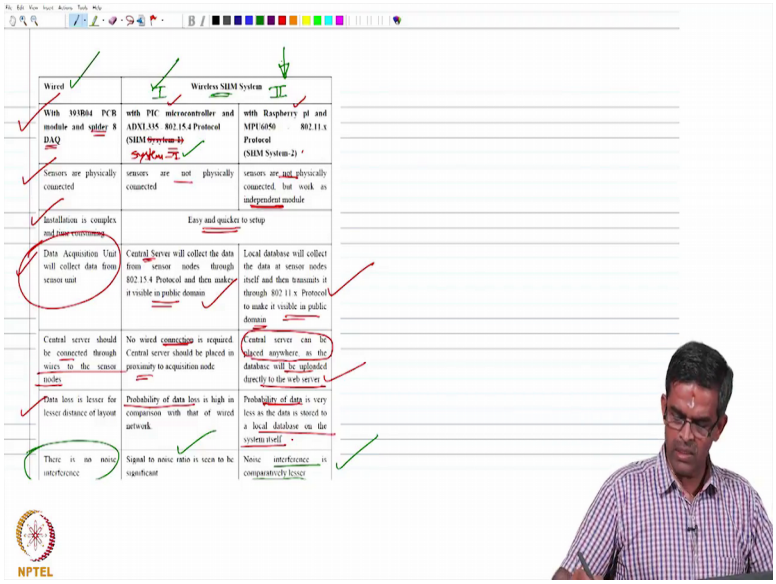

Let us compare them and see how was the result, wired sensors had 393B04 PCB module and spider 8 data acquisition system whereas, wireless system had PIC, PIC microcontroller and ADXL 335 802 15.4 Protocol for system 1, this is system 1 and system 2 had raspberry pi board with MPU 6050 802.11 x protocol for system 2. This we have explained.

Sensors are physically connected in this case whereas, in this case sensor not physically connected, but they work as an independent module, the installation is compressible because lot of wiring is required it is very easy and quick at state up the DAQ will collect data from the sensor unit. Whereas, in this case the central server will collect data from the sensor nodes through 804 15.4 protocol; whereas, in this case 80 to 11 x protocol and it makes it visible to the public domain as and when required.

So, the data acquire is available for checking whereas, in this case the data acquire is not known ok. The central server should be connected through wires, that is a cache here whereas, no wire connection is required the central server should be placed closely, because we have a distance restriction to the acquisition node, whereas in this case the central server can be placed anywhere; because we are having a different protocol for wireless communication system, because the database will be uploaded directly to the web server in system 2. The data loss is lesser, because it is a direct connection between the sensor and the DAQ. There is a high probability data loss in wireless sensor networking. However, system 2 this is greatly reduced by having a local database on the system itself.

In wired sensor the greatest advantage is there is no noise interference whereas, in wireless sensors signal to noise ratio seems to be very very high, because we generated white noise. In case of system one design as I showed you earlier, but in system 2 design the noise interference is comparatively lesson.

So now, this table shows very clearly the comparison between 3 systems wired system, wireless that is SHM design 1 design 1 and design 2 out of which one can see here the wireless system design 2, which has been recommended for (Refer Time: 16:12) investigating BSLRP under wave loads in the lab scale has been very successful.

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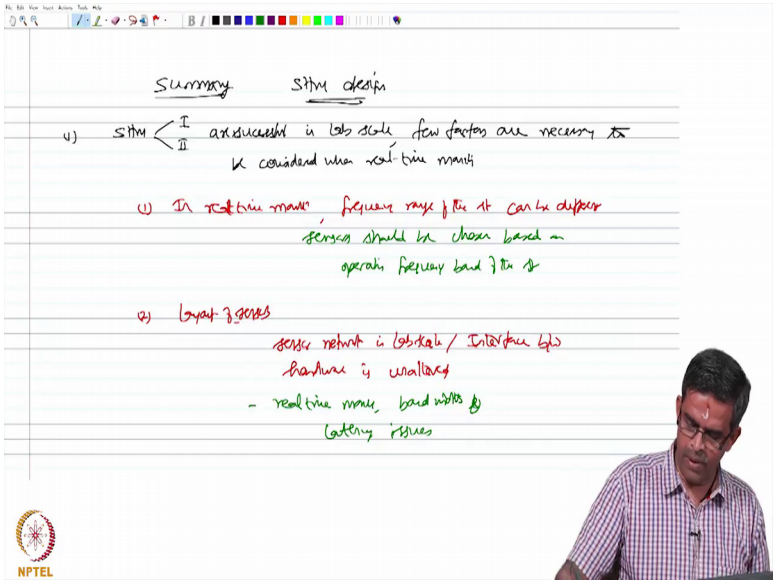

So, there are some challenges when you do this let us quickly see them what were the challenges in this system design, which we encountered, which we can share to the benefits of the viewer's. Even though this SHM system one and system 2 are successful in lab scale, few factors are necessary to be considered when you do a real time monitor.

The first issue is in real time monitoring, the frequency range of the structures can be different. Therefore, sensors should be chosen based on the operational frequency band of the structure. That is the first issue we have the second could be the layout of the sensors. The sensor network in lab scale that is the interface between hardware is unaltered, whereas in real time monitoring the bandwidth and latency issues should be covered.

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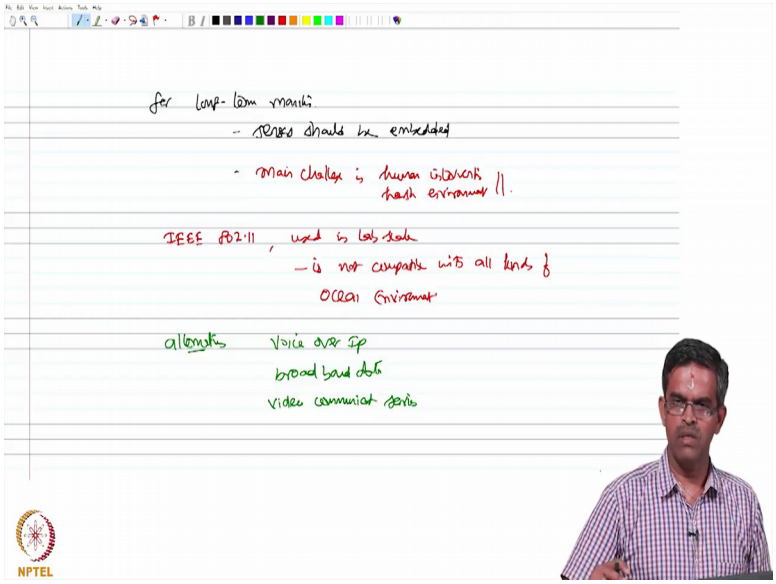

Now, when you go for long term monitoring sensor should be embedded in this structure. So therefore, here the main channels comes is human intervention and hash environment. Further, the IEEE protocol 802.11, which is used in the lab scale is not compatible with all kinds of ocean environment. So, there are alternatives. Alternatives could be voice over IP, broadband data, and video communication services.

So, friends in this lecture we discussed about the design of structural health monitoring on a lab scale appeared on to a new generation platform and showed you a each element of the SHM design, compared them with wired design and show them the advantages features or different elements, sensing unit, data acquisition, processing unit, communication channels and alert monitoring systems.

In the next lecture we will also talk about the structural health monitoring applied on purely within alert monitoring, by creating a post related failure on a lab scale on and offshore platform again. And see how the posted failure can be captured using the SHM design 2 on a lab scale.

Thank you very much. See you in the next lecture, till then bye.