

Structural Health Monitoring (SHM)
Prof. Srinivasan Chandrasekaran
Department of Ocean Engineering
Indian Institute of Technology, Madras

Lecture - 54
Acquisition system and Networking for SHM -Part 2

(Refer Slide Time: 00:17)

WSN - Wired network

- centralized data acquisition units
- sensors are used to measure physical parameters as analog values
- these sensors are connected to a centralized data server through wires
- DAQ will convert analog to digital signals (ADC) and then process the data
- wired sensor - give high quality measurements & input to SHM scheme
- therefore no transmission delay/ no data loss

Let us see the origin of this wireless sensor networking. Essentially, origin from wired network with centralized data acquisition units, sensors are used to measure physical parameters as analog value. Then these sensors are connected to a centralized data server through wires, then the data acquisition unit converts analog to digital signals that is called ADC; analog digital conversion and then process the data.

See the steps involved in wired network which actually made or given birth to wireless sensor networking that is a point what we are discussing here. Of course, wired sensors are expected to give high quality measurements and input to the SHM scheme, there was no transmission delay and no data loss, but all these were true when you do it on a lab scale.

(Refer Slide Time: 03:02)

All these were true, lab scale

- real-time monitoring, many issues arise
- dependency/reliability of sensors, wires for long run
- power exploitation
- network congestion
- fail to work on demand (no self-diagnosis)

They cannot be implemented on large structures

- bridges
- dams
- offshore platforms

On a real time monitoring, there were many problems. One of the foremost issue is dependency or reliability of sensors and wires for a long run power exploitation network congestion, fail to work on demand that is there was no self diagnosis of the sensor, that was a big issue. So, they cannot be implemented, they cannot be implemented on large structures like bridges, dams, offshore platforms because they have extensive length of cables.

(Refer Slide Time: 04:45)

If cable is damaged, data will be lost

- low efficiency of system.

Electro-mechanical systems

- induce m/c vibrations
- cross interference of power signals

measurements of sensor

- created additional complexities
- wireless sensors
 - self-adaptability
 - self-stabilization

If there would have been a damage to the cable, if the cable is damaged, data will be lost and that will lead to loss of efficiency of the whole system, further the electromechanical systems which induce machine vibration which induce cross interference of power signals with that of the measurements of the sensor created additional complexities.

Now, one can ask me a question; how these complexities can be controlled in a wireless sensor. Wireless sensors are essentially smart sensors, they have self adaptability and self scalability to monitor on their own.

(Refer Slide Time: 06:26)

Wired sensors

- do not have capability to process data
- central server is responsible for
 - collection
 - aggregation
 - storage of data
 - processing
- whole concept of data management is centralized
- X sharded/replicated/high-jacked

negative deal

NPTEL

So, in nutshell, wired sensors do not have capability to process data. So, the centralized server is responsible for collection, aggregation, storage and processing of data.

So, the whole concept of data management is centralized ok; that is a negative deal in wired sensors because if the centralized unit is shutdown or repaired or let us say, for example, high jacked ok, you lose a complete data. Whereas, in wired sensors, this problem was face will be made and corrected in wireless sensor networking, now various examples, we can give for example: let us say the wired sensors were installed for Golden Gate bridge at San Francisco.

(Refer Slide Time: 08:11)

1) Golden Gate Bridge (San Francisco)
- Abdul Ghaffar & Scanlon, 1985
- frequencies, mode shapes & damping ratio

2) Bill Emerson Memorial Bridge, Cape Girardeau
SHM scheme
- 84 Accelerometer channels
- anemometers to wind vel
- to analyze the seismic response
- behavior of a cable-stayed bridge
(Casado et al. 2004)

You can have a very interesting study on this referred by Abdul Ghaffar and Scanlon; 1985, we have used wired sensors, they measured frequencies, mode shapes and damping ratio of the bridge, the second application was also proudly presented in the Bill Emerson memorial bridge in Cape Girardeau. People have used structural health monitoring scheme which consists of 84 accelerometers; accelerometer channels. There are n number of anemometers to measure wind velocity. The system was to analyze the seismic response to understand behavior of a cable stayed bridge which was a new design, then at the time. So, the details can be seen in Casaido at al; 2004

(Refer Slide Time: 10:31)

length of cables - 75% of total installation bill of complete SHM system

- SHM - wired network - very expensive
- bulky (Celebi, 2002)

So, they clearly say that length of the cables consumed about 75 percent of the total installation time of the complete SHM system. They also said that SHM system using wired network can be very expensive when you do it for buildings, you can see the reference from Celebi 2002 who clearly states about the cost of SHM if it is wire.

(Refer Slide Time: 11:37)

Sensor Network - Wired

- many complexities
- tried
- disadvantages
- large structures
- increasing complexity

- WSN - many overruling advantages

WSN - design evolved from wired network design

So, in nutshell, we can very clearly understand that the sensor network, if wired has many complexities, though they have been tried, but there have been some disadvantages which researchers clearly highlighted and they were tried on large structures like bridges which showed increasing complexities.

So, wireless sensor networking on the other hand had many overruling advantages. We now see how this wireless sensor networking design slowly evolved from the wired design which component was replaced and how wireless sensor networking became very popular and effective in comparison to wired networking though wired networking had no data loss, no transmission loss, etcetera, there were advantages also. But they have been forbidden completely and in the recent past, people have successfully if deployed violations in networking for structural health monitoring, in different types of structures all over the world.

We will discuss this detail in the next lecture.

Thank you very much.