

# Module 3

lecture 5:

Sensor requirements and  
data acquisition

## Example: offshore structures

- offshore structures operate under high risk factors
  - due to kind of process (exploration & production)
- They need to be monitored
  - novel in their type
  - topside mechanical systems designed
- Their failure (even down-time, for repair) cause economic loss.
- Statistically in offshore

STM is

- preventive maintenance approach

①

- dependent on continuous monitoring of the structure, under time-varying loads

② It is difficult to carry out traditional inspection network

NOT (a) visual inspection

- structure is huge

- partially submerged is (seen) under

- certain members of the structure, cannot be inspected

An automated, continuous STM scheme is necessary

- damage analysis can be carried out to either operational (and functional) safety

In areas where VI is not possible (piles, foundation members etc), one should examine the merits of using simulated numerical model

- a few scaled models of the same platform can be examined experimentally

- There is a correlation, needs to be established b/w the observations made @ lab scale and that of the real scale.

Numerical modelling of offshore platform for deepwater STM system.  
certain assumptions and approximations are adopted

— procedure max contentions

i) Varying mass is not linked with marine growth, equipment & fluid storage (which, otherwise is temporary)

ii) Variable submergence, loading to change is buoyant, & mass of the members is not included

— this will influence the energy dissipation to the system, significantly

Brinker et al. (1995), certain factors user given the design & maintaining system for offshore platform (Loland & Dodd, 1974)

- i) sensors should be able to withstand environmental uncertainties
- ii) proposed STM scheme should have financial advantages over the manual inspection method (handinspect)
- iii) Vibration spectrum should remain stable over a period of time
- iv) Manual sea state and wind exults should be used to extract the natural frequency of the system
- v) Acoustic wave measurements should be used to identify the mode shapes

## Various vibration-based monitoring sensors & technology (other applications)

Physical parameter

Principle to the sensor

Technology

(1) Acceleration, ✓  
Velocity ✓  
displacement ✓

Inductive sensors

Conventional

capacitive sensors

MEMS technique

piezo-electric sensors

(2) Magnetic field ✓

Magneto-resistance

Magnetic resistivity ✓

(large size)

(3) optical properties ✓

photo-electric sensors  
optical fibre sensors

• Fibre-Bragg Grating

- Fabry-perot

interferometer

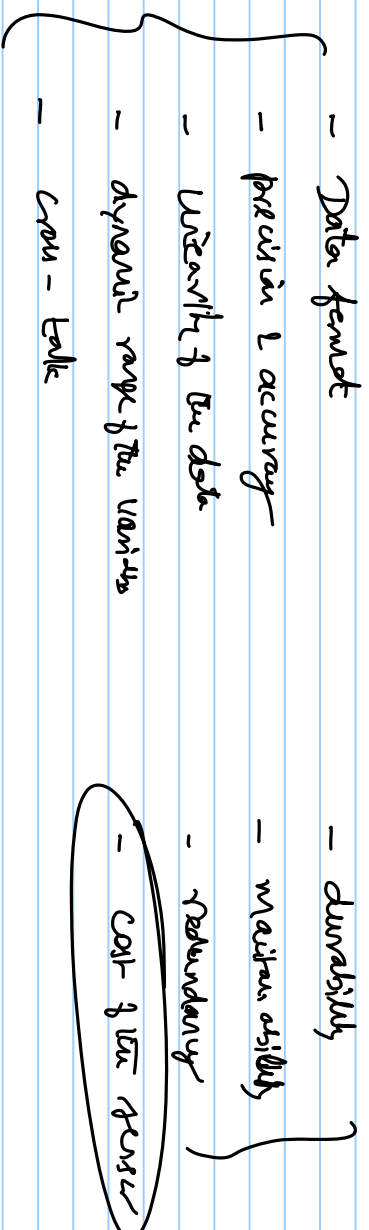
- Intensity-based sensors

(4) Acoustic ✓

ultrasonic probes

### Sensor performance

- Quality of data is highly dependent on the performance of the sensors
- Common factors that govern the reliability of sensors





## STW involves

— detection & tracking

During detection, sensor is prepared to read the data, and correlate the data with the sensitivity & demand.

② approaches to carry out the above work

(1) Most common:

Deploy sensors (or) array of sensors is a network with commercially available components in the market

— Major disadvantage is that "existence of the structure will be limited to range & frequency of the array of sensors"

physical Quantities are measured without any definition of damage

- assumption here is that measured data will be sensitive to the damage (Farrar et al. 1994)

- It also has an assumption that damaged & undamaged structures are subjected to a similar kind of excitations (very tedious limited)

- The same strategy is employed is real time which will measure the data and analyze the data for damage-sensitive features.

Alternately,

Quantify the damage before developing the gender system

How do you quantify the damage?

Through Numerical simulation, model is prepared and results available from the simulation, prior to the occurrence of damage are noted

- type of damage
- possible extent of damage
- location of damage

design the gender system  
based on the simulation results

- vital parameter, to design the sensing system
- Extract domain features from the data
  - Statistical pattern recognition (SPR)
  - It's the governing factor to design the acquisition system (Flynn, 2010)

Additional requirements are updated

- Changing condition of the environment
  - operational condition
- 
- helpful to predict the in-link detection & damage (simulation)
- Improves the ability to detect & damage detection process is strong

## Acquisition system

Types of data to be acquired

- defined to design the sensor network

### ② types of data

- kinematic
  - environmental
- Quantities

## Summary

- Sensing requirement for seismic studies
  - offshore platforms (ocean studies)
- design of sensing system is done based on the anticipated damage level in a given structure