Module 3

Lecture 6 : Acquisition system
and Networking for

SHM

- Type of data, need to be monitored should be defined to
design the sensor network.

- Major types of data : ②

i, kinematic
(i) Environmental

Quantities

Kinematic Quantities

- displacement
- velocity
- acceleration
- strain

Traditional types) related to
measure these Quantities

- accelerometer $\big\langle$ uniaxial
  $\quad\quad\quad\quad\quad\quad\quad\quad$ biaxial

- LVDT - displacement

- strain gauge

- displacement transducer
- force transducer
- load sensor.

Environmental Conditions

- temperature variations
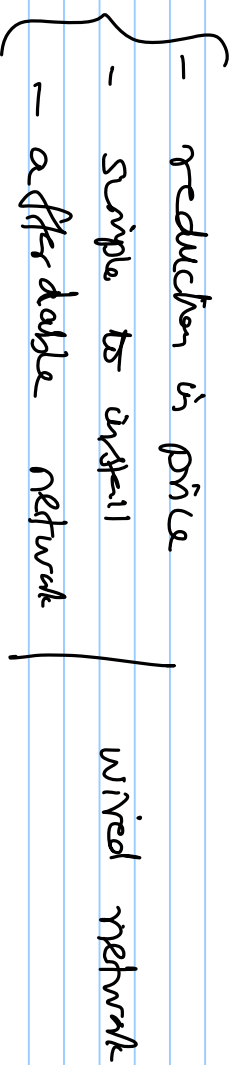- pressure
- moisture content
- Relative Humidity (RH)

— Specific, dedicated
type of sensor

— moisture dispersion

— water - design issues

- These parameters not only affect the damage level of the system
but also have impact on the operation of sensors

Wireless sensor Networks (WSN)

— Smart sensor

— automatic, continuous monitoring

- reduction in price
- simple to install
- affordable network

wired network

Wireless system
↓ System cost (Networkisation)
↓↓ installation time (commissioning time)

Wired network
- { Avoid complexity (weight of wires)
  - no complexities (arise from their wiring & service maintenance)

Wired sensors depend a central server
to communicate
- wireless sensors do not need
  a central server

  — They convert the measured
  data into digital form
  and transmit them directly

  — wireless sensor network makes online
    monitory max simple, low cost
  - simple, low cost
    processor to handle the
    data

Advantages of SHM - Strategic Structures

- Insures serviceability of the structure (long-term monitoring)
- Increase safety & knowledge about performance of the structure
- Validate the design of the structure and its performance
- Can monitor & control the construction process, during operation
- Assess load capacity & verify role of the structure
- Assess any requirement of emergency response efforts

automati
ty

- NSN

WSN —   Wired network
- centralized data acquisition units
- sensors are used to measure physical quantity
   as analog value

- These sensors are connected to a centralized
   data server through wires

- DAQ unit convert analog to digital signal
   (ADC) and then process the data

- Wired sensor — give high quality measurement
   & input to SHM scheme

- therefore no transmission delay/ no data loss

- All these were true, but to scale

  - real-time monitoring, may have extra

- dependency/reliability & trust, basis for
  long run

  - power exploitation
  - network congestion
  - fail to wak a demand (no self-diagnosis)

They cannot be implemented on large structures

  - bridges
  - dams
  - alpha path

If cable is damaged, data will be lost

— loss of efficiency of STM.

Electro-mechanical systems

    — reduce m/c vibrations

    — can interference of power signals ||

            measurement & sensor

  — Created additional complexities

      — wireless sensors

         — self-adaptivity

         — rbt — isolasity || to

           mainly a tra em

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 !!

  ✗ shutdown / repaired / high-fault

  ⟨ Negative dear ⟩

(1) Golden Gate Bridge (San francisco)

— Abdel-Ghaffar & Scanlan, 1985)

— frequencies, mode shapes & damping rates

(2) Bill Emerson Memorial Bridge, Cape Girardeau
SHM sensors

— 84 Accelerometer channels

— 14 accelerometers to measure

— to analyze the seismic response

— behaviour of a cable-stayed bridge

(Caicedo et al. 2004)

Length of Cable — 75% of total installation cost of complete SHM System

- SHM — Wired Network — very expensive
  — faulty (Celebi, 2002)

Sensor Network - Wired

- Many Complexities
- bied
  - disadvantages
  - long structures
    - increasing Complex

- WSN - many overuly advantages

WSN - design evolved from wired Network design