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Module 4
Lecture 7

✓ STM design - TLP - Obstacle - II

Wireless sensor network design

- primary component of WSN - sensor node
- processor unit is connected to the external devices, GPIO pins

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To communicate with the external device,

i) inter Integrated circuits (I2C)

ii) serial peripheral Interface (SPI)

- I2C - communication protocol.

advantages

i) It has sufficient memory

ii) It has sufficient CPU cycles to program

iii) It controls & collect the logs from sensor unit

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- An extended, scalable 16 GB memory card
  - elevate / enhance data storage capacity
    - to store the data temporarily until this is transmitted for post-processing

- Pi board is powered with an external battery
  - extended period of time

- low-power consumption
  - ever operated from mobile stations
    - as offshore platforms are mostly inaccessible

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alternative methods of power source

(1) Energy harvesting techniques.

solar power
wind power
wave energy

(2) Ultra-power circuit boards

- nano-watts power for WSN

(Vahid et al. 2016, Lee et al. 2016)

- Sensing unit - MPU 6050

  - tri-axial gyroscope
  - tri-axial accelerometer
  - digital-motion processor

  } MPU 6050 combination of these

- It can measure both
  - acceleration
  - rotation

  about all the (3) axes

- It also has 16-bit ADC to collect/process the output from the sensor

1 kg (with a full rack is 12 g

sensitivity - 16,384 CSB/g

- Transmitter used is connected to Pi board
  - which acts as transceiver unit

- Sensor nodes act as independent module
  - They measure & send data directly to the server through transmitter

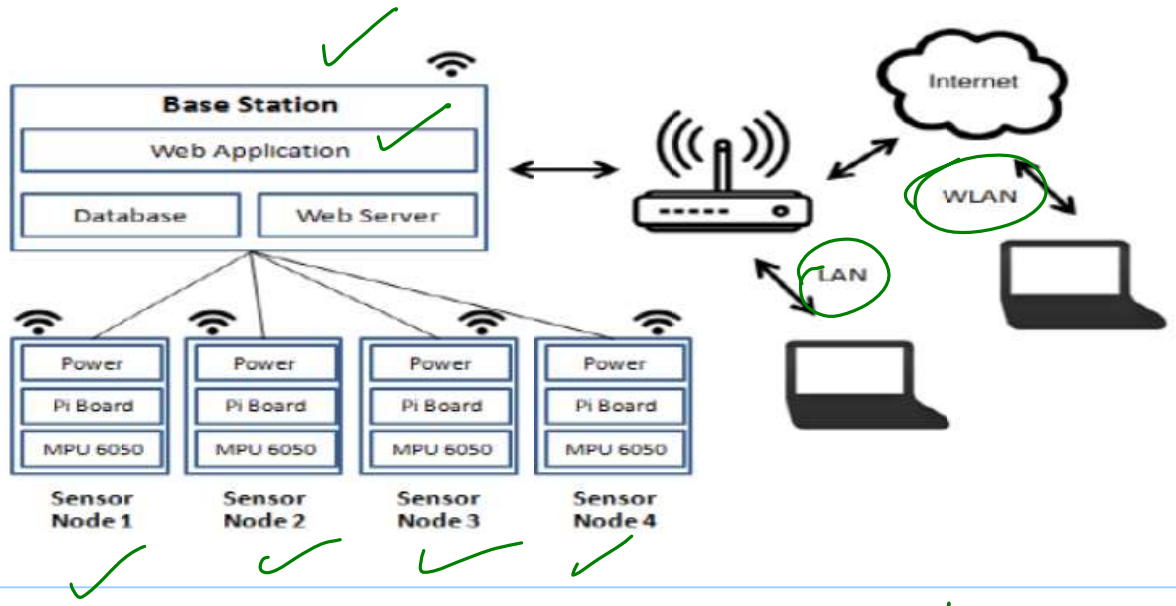
④ steps basis for sensor nodes

(1) Acquire
(2) Transmit
(3) Store
(4) Repeat

- another important feature is self-diagnosis & self organization of the sensors.

- Adv.

(1) no need to use large # of sensors.
- intermediate nods will participate in forwarding the data packets b/w the source & destinatn



WSN Architecture

STM architecture used has the following features

- Component-level integration of multiple software & hardware units
- important features of the design

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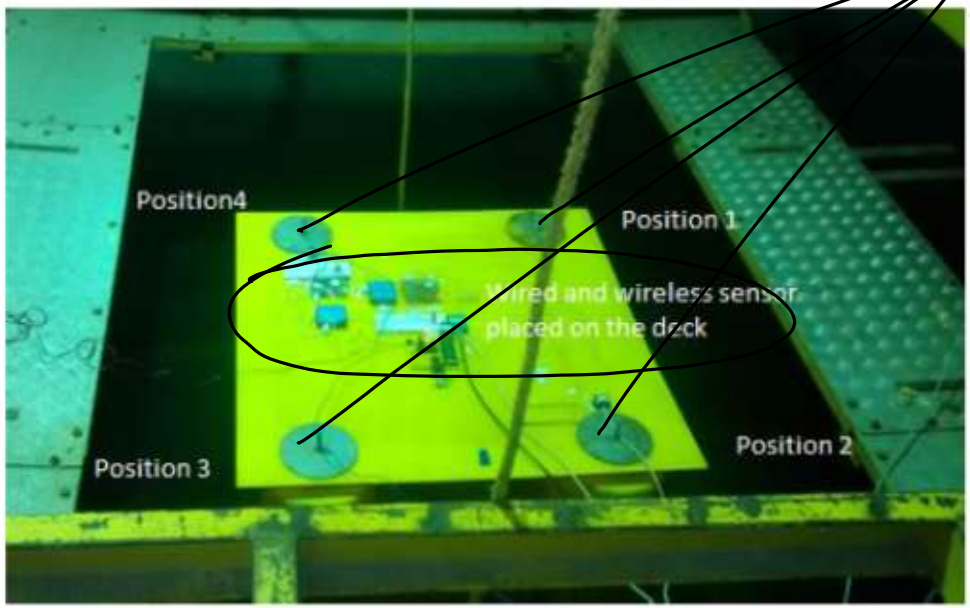
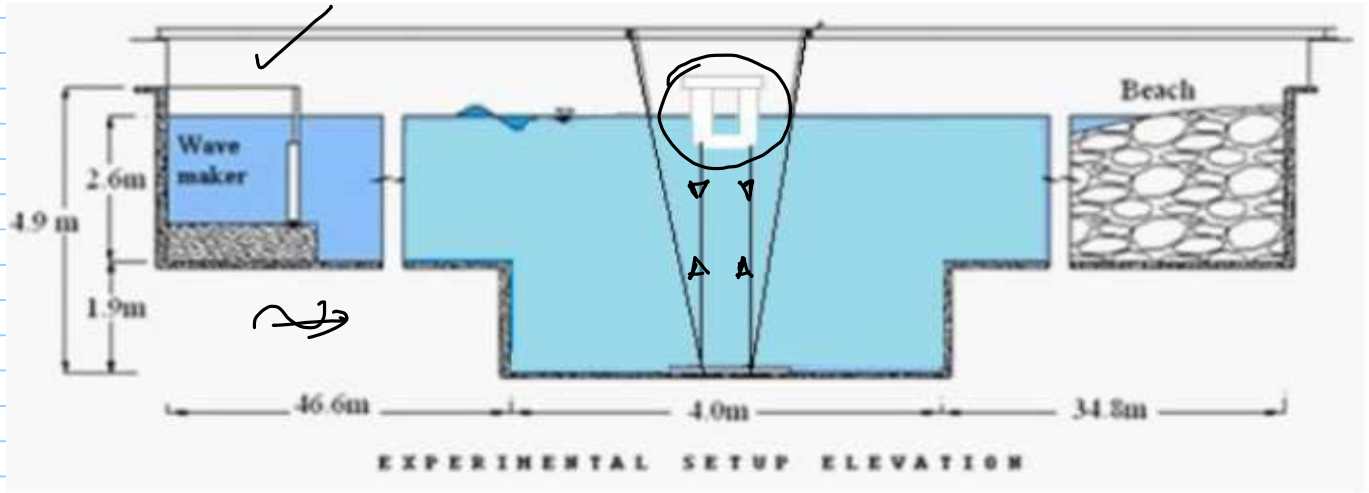


location of buoyant legs
- connected to tethers.

- deck houses
  - bolts
  - wired
  - wireless

- acceleration
- inclination (rotation)
- axial force - tethers.

Typ. - square deck (green)


Beach
Wave maker
2.6m
4.9 m
1.9m
46.6m
4.0m
34.8m
EXPERIMENTAL SETUP ELEVATION

SHM system - is installed on the deck of TP
- Lab scale

- IEEE 802.11 protocol is used to transmit the data through the transmitter (WSN)

- All sensors and base station are connected to the same network

- Server @ the base station receives data
- stores the data in local MySQL database

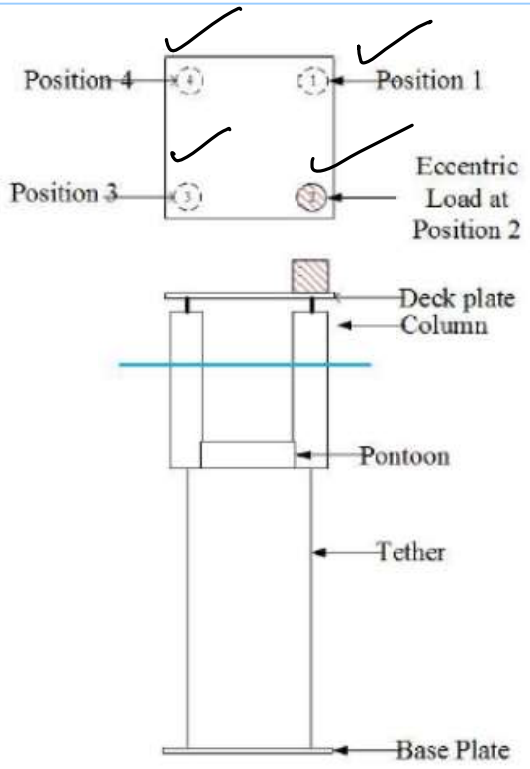
A webpage is designed to access the collected data as a report

- web application is hosted through a static IP address.
  - This can be accessed globally by all authenticated users

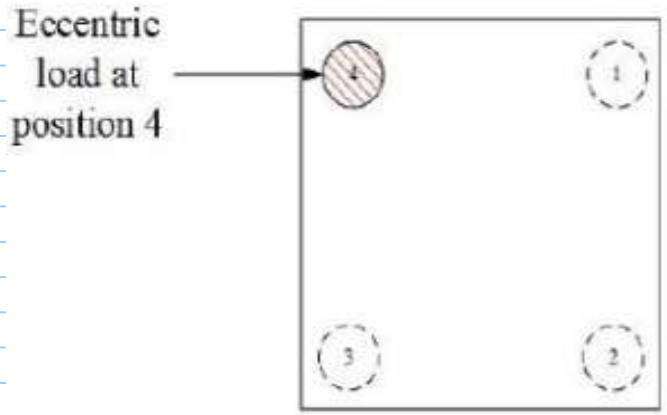
- AMS — message / damage is communicated then all authorized users should access
  - i) SMS
  - ii) email

  || damage caused on the platform.

- postulated failure — AMS — communicate this successfully.



TLP (plan, elevation)



plan of the platform

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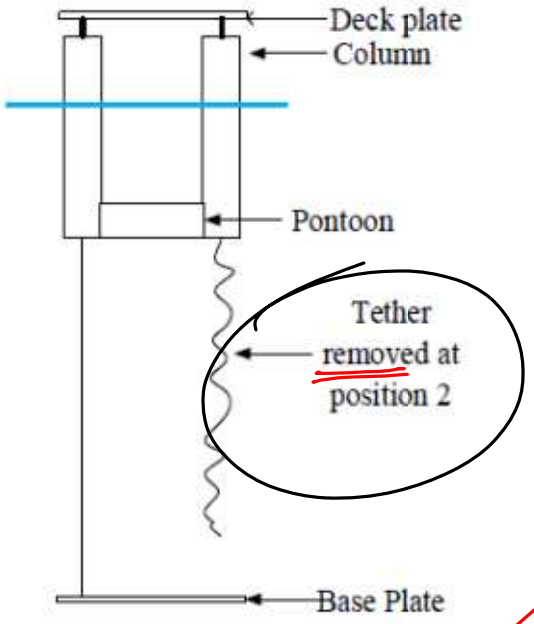

Newly developed webpage is used as a reporting tool to

read
analyze
generate alert messages

- When the sensor acquired data exceeds a threshold value (pre-set in the sensor)

- In the real-time monitoring, transmitting to this frequency is a challenge

- alternatives : Voice over IP, video conferencing, broadband data

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WSN design aims to perform the following

(1) to monitor the integrity of the structure

(2) acquire the data

(3) transmit the data to base station

- Server at the base station will process the received data
- in Wireless system (which is absent in wired system) it is important to limit the transfer of data packets - data which are not related to monitoring (noise) ✗

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- If platform experiences large displacement will above the threshold value, system architect should enable this transfer

- How to manage sensor waking during non-required Standards.

  - keep mode - data doesn't exceed threshold limit
  - active - data exceeds the limit - should be communicated

(1) power

(2) Memory space

- no redundant data / allowed to store
- data is acquired. it is compared (processed) with the exists set of limit values
- when the stored data exceed the limit value it's stored/ communicated

→ Auto mode / idle state
- exit once displacement of the system is acts
- acquisition starts immediately

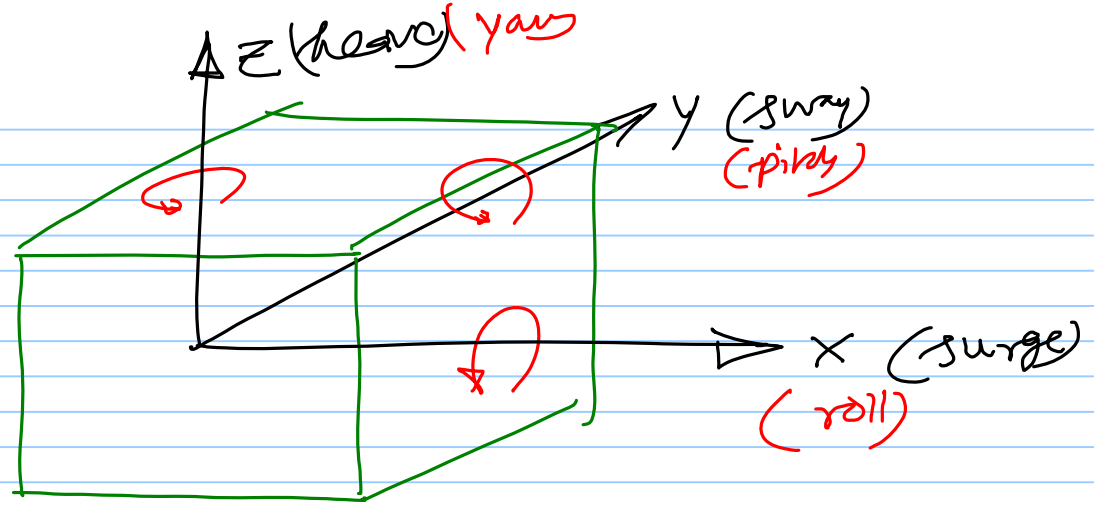
Threshold values

- limiting values, which on exceedance indicate damage

- frequency (ω_n) — vibration-based damage detection

- TLP — (2) distinct set of degrees-of-freedom.

✓ surge (x)	Roll (about x) rotation
✓ sway (y)	pitch (about y)
yaw (about z)	heave (z) displacements



Rigid
- vertical plane (YZ) / (XZ)
  - heave
  - Roll
  - pitch
  - T (<<)
  - 3-5 s
  - freq ↑

flexible
- Horizontal plane (XY)
  - surge
  - sway
  - yaw
  - T (>>)
  - (90-120s)
  - freq ↓.

Chandrasekaran et al. (2016)

- NPTEL - offshore structures — analysis
  — design
  — materials etc
  — Risk/reliability

(i) Advanced Marine Structures - IITM
(ii) Ocean st & Material - IIT M
(iii) Reliability of offshore A - IITM
(iv) Analysis & design of st - IITM
(v) Safety, HSE - IITM

} Chandrasekaran NPTEL website

Summary

- modules / sensors
  - DAQ
  - TCP behavior
  - communication protocol
  - postulated failure (AMS)
- power saving
- memory overflow || active?