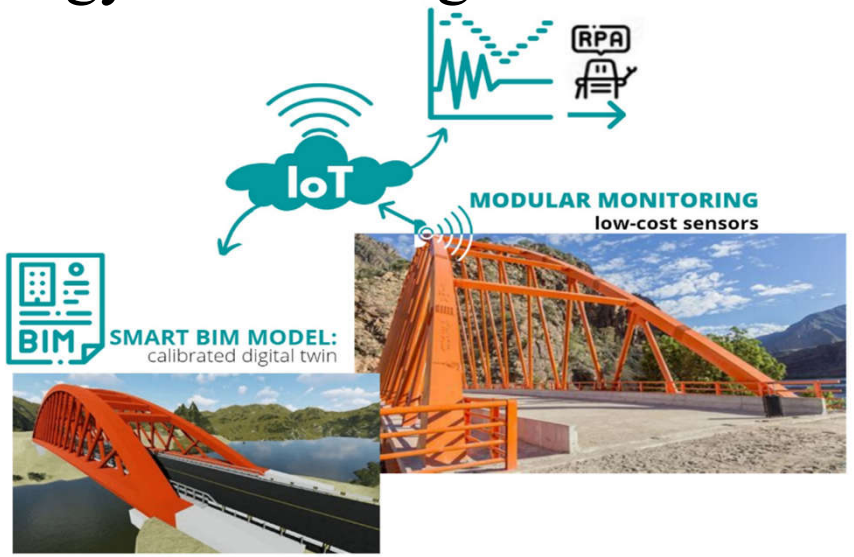
EUCEET 2025: European Civil Engineering Education and Training Association

Enhancing Steam Education in Engineering Through the Integration of AI and Smartphone Technology in Teaching Practices



School of Civil Engineering

Universitat Politècnica de Catalunya
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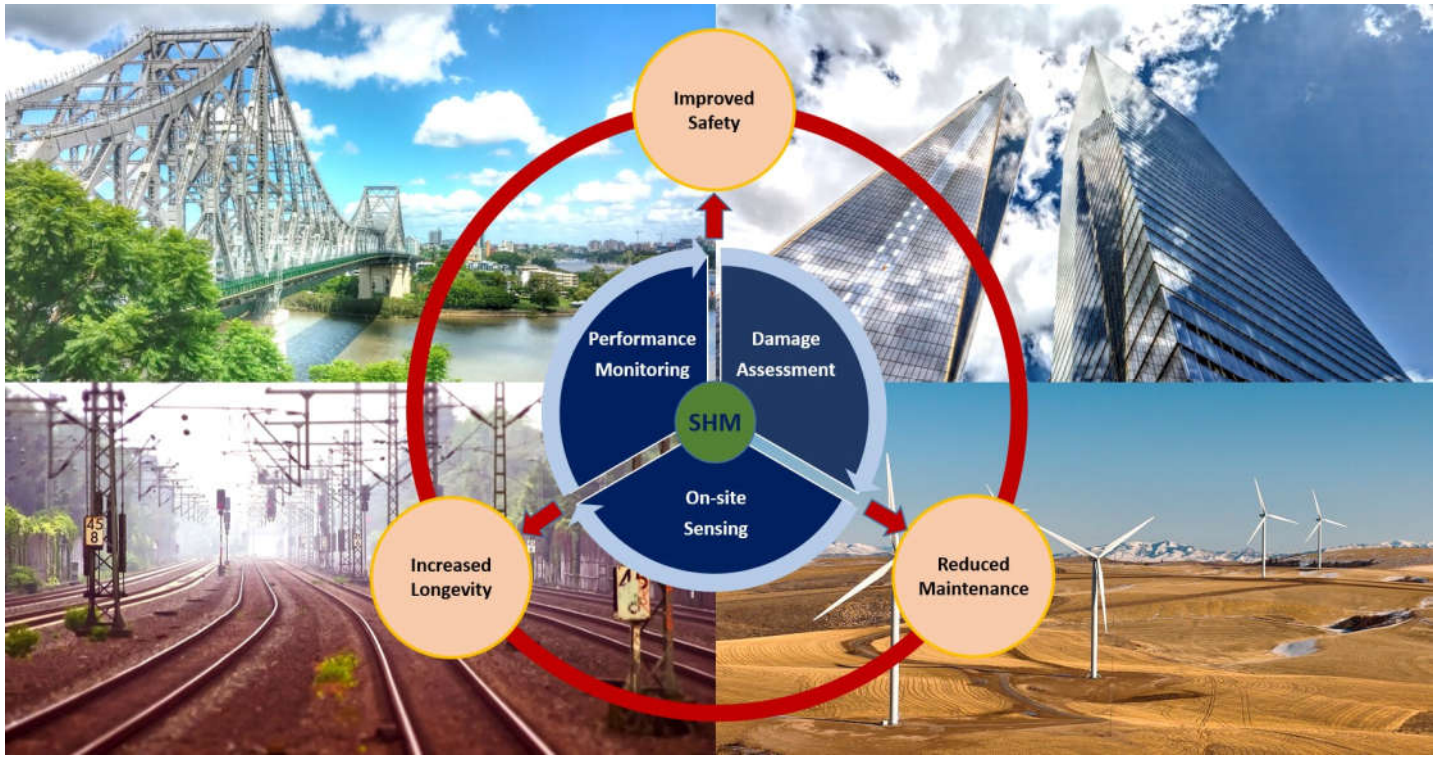
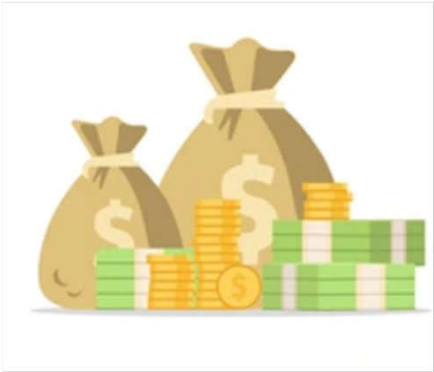
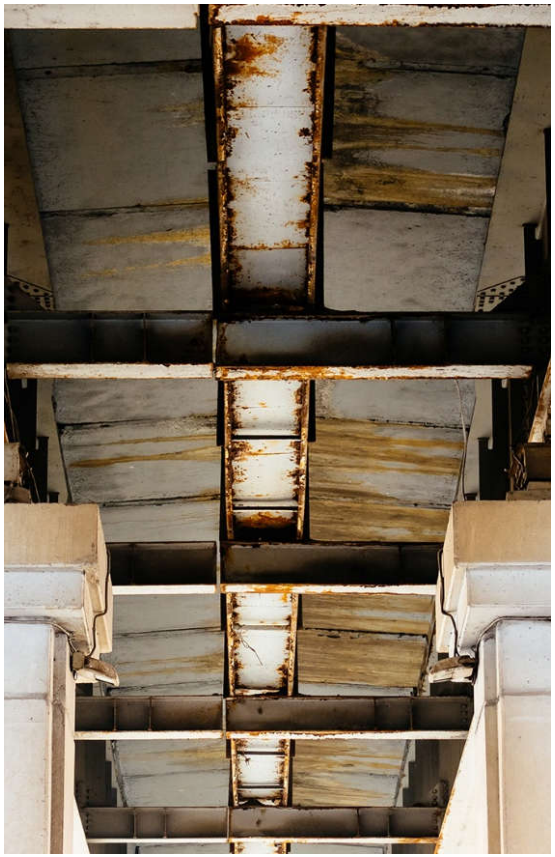
Introduction



Inspections



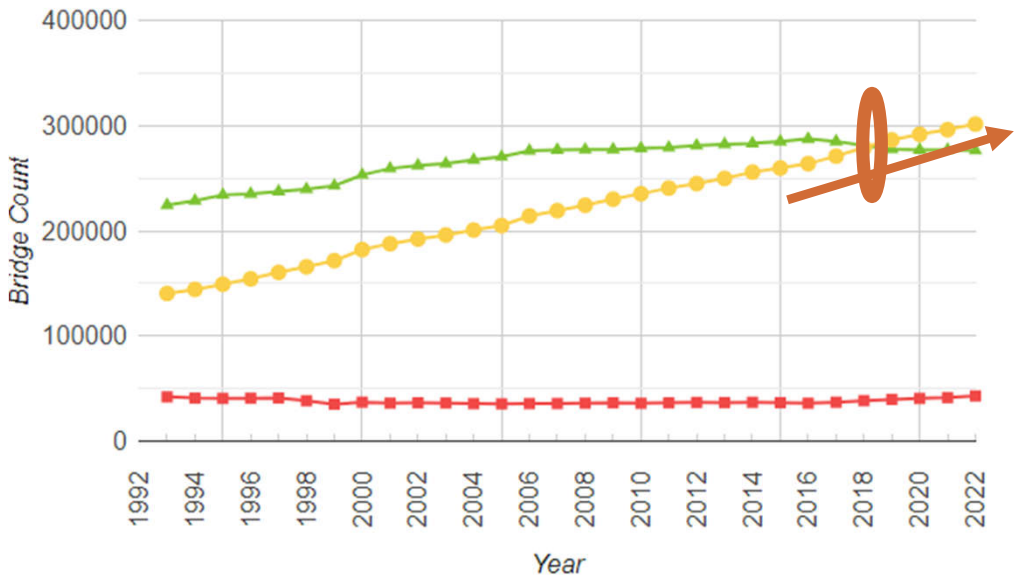
Current State of Infrastructures



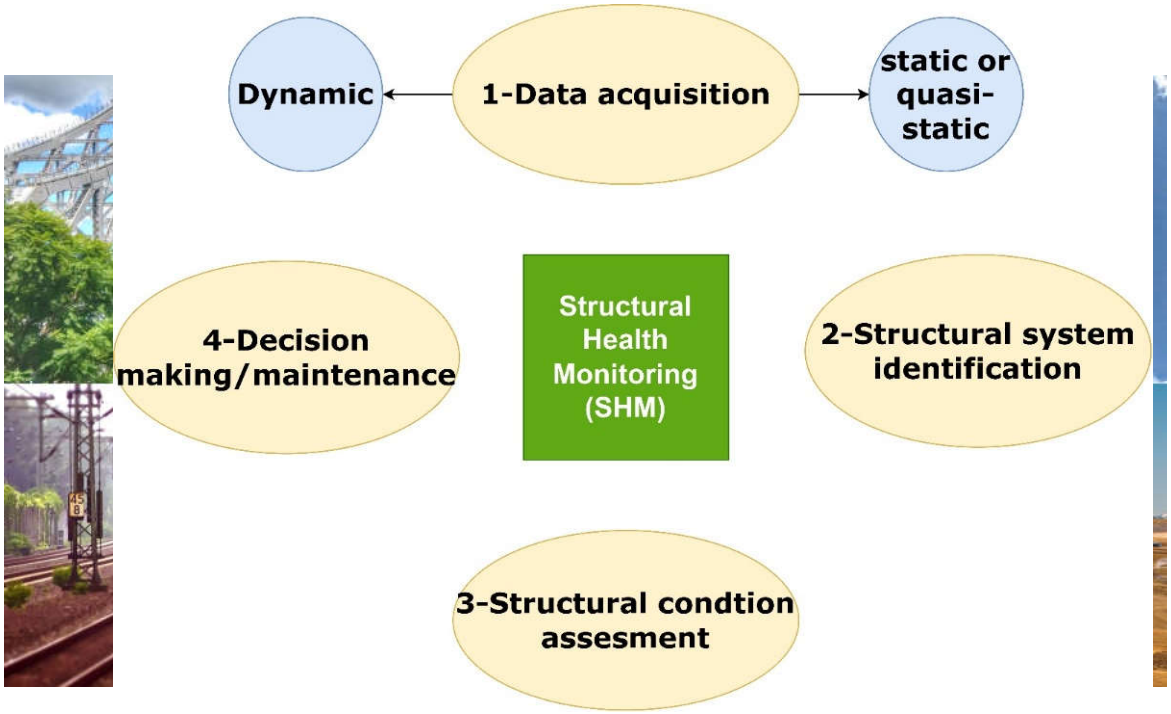
Current State of Infrastructures

- ASCE infrastructure report on 2021 **$125 billion repair costs**

	Good	Fair	Poor
All Bridges	276,309 (44.52%)	301,394 (48.56%)	42,966 (6.92%)
	Total: 620,669		



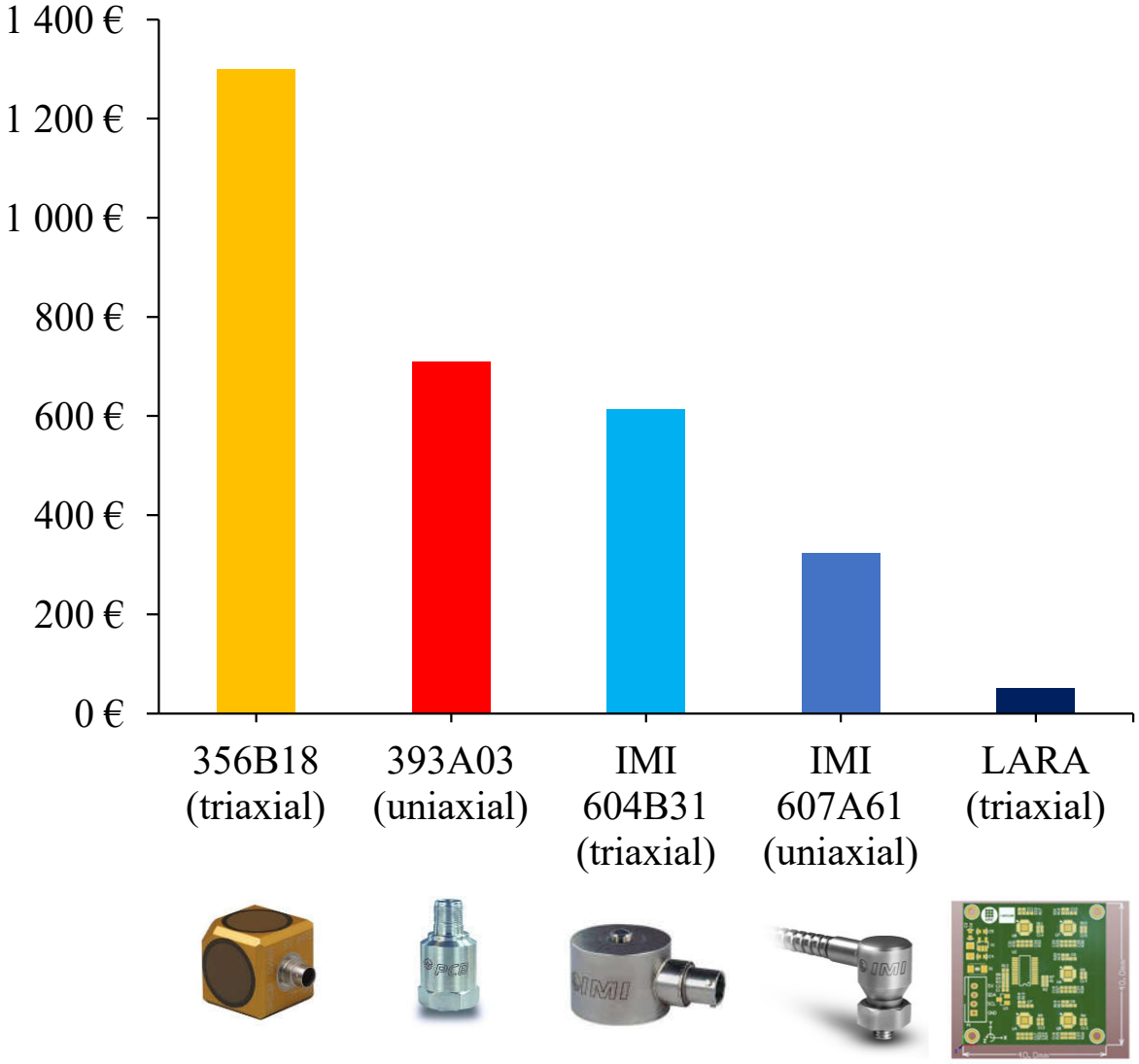
Structural Health monitoring of Bridges

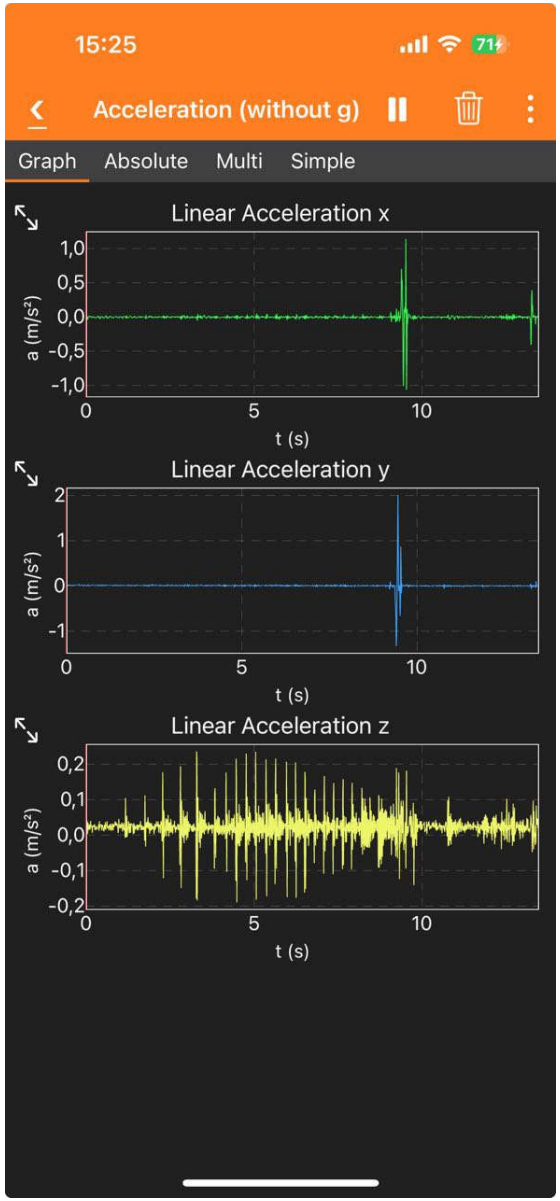


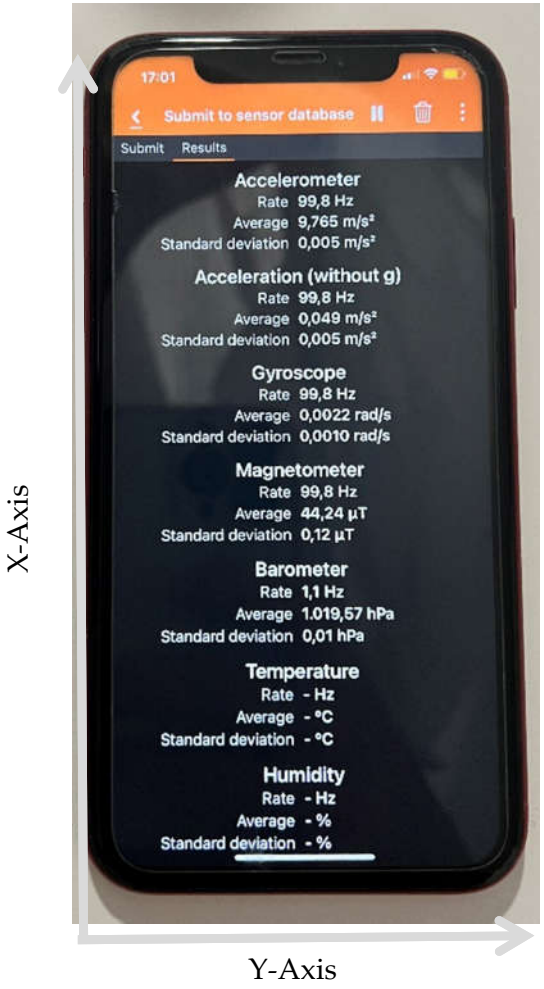
Price Comparison

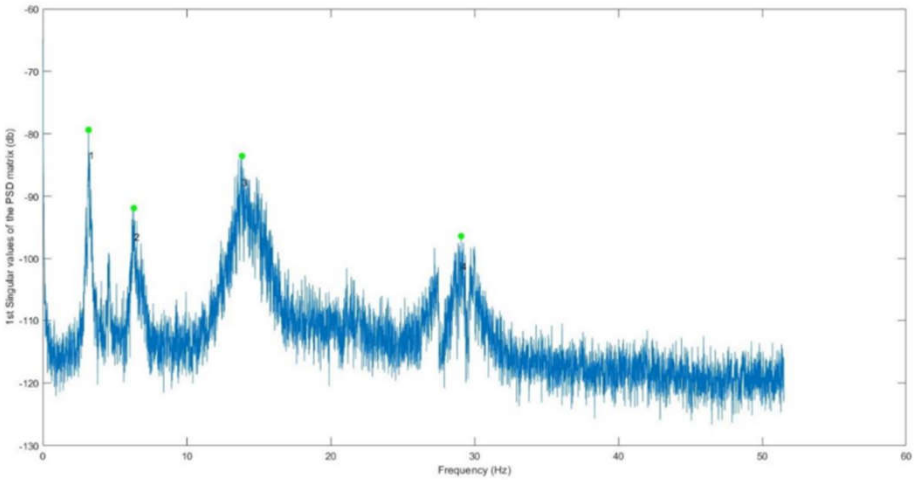
Data Acquisition Average Price

- Commercial = 738 €/ Channel
- LARA= 100 €/ Channel



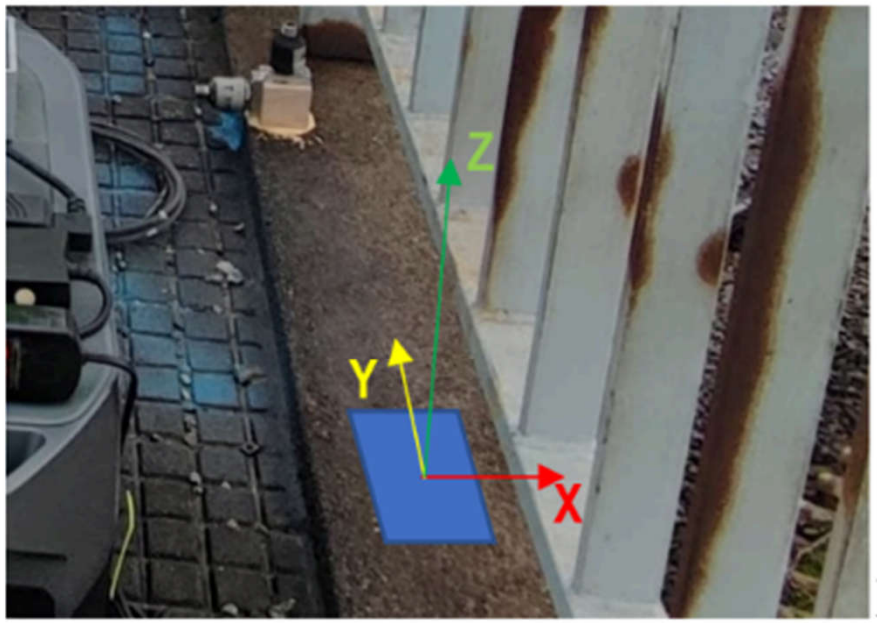

15:25
Acceleration (without g)
Graph
Absolute
Multi
Simple
Linear Acceleration x
a (m/s²)
t (s)
Linear Acceleration y
a (m/s²)
t (s)
Linear Acceleration z
a (m/s²)
t (s)


17:01
Submit to sensor database
Submit
Results
Accelerometer
Rate 99,8 Hz
Average 9,765 m/s²
Standard deviation 0,005 m/s²
Acceleration (without g)
Rate 99,8 Hz
Average 0,049 m/s²
Standard deviation 0,005 m/s²
Gyroscope
Rate 99,8 Hz
Average 0,0022 rad/s
Standard deviation 0,0010 rad/s
Magnetometer
Rate 99,8 Hz
Average 44,24 µT
Standard deviation 0,12 µT
Barometer
Rate 1,1 Hz
Average 1.019,57 hPa
Standard deviation 0,01 hPa
Temperature
Rate - Hz
Average - °C
Standard deviation - °C
Humidity
Rate - Hz
Average - %
Standard deviation - %
X-Axis
Y-Axis

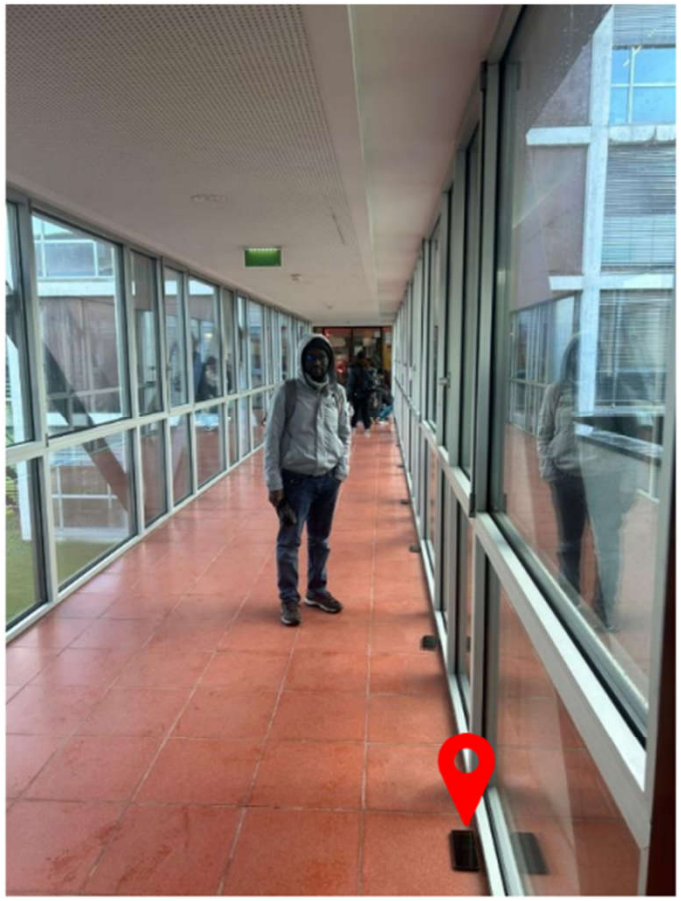

1st Singular values of the PSD matrix (db)
Frequency (Hz)


Location of the smartphone

A)


Z
Y
X

B)



4. **Calculate Damping Ratios:** Use these singular values to calculate the damping ratios.

Here's how you might implement these steps, assuming you can access or recompute the PSD matrices for the identified frequencies:

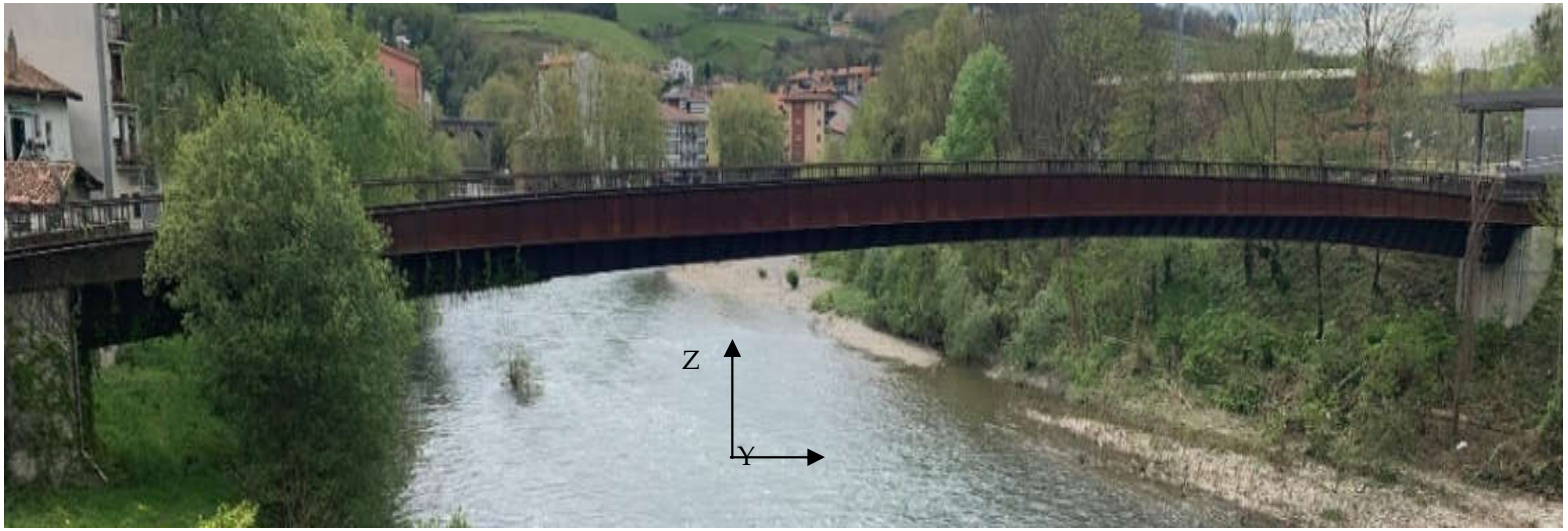
Step 1: Define a Function to Calculate Damping Ratios

matlab Copy code

```
function dampingRatios = CalculateDampingRatios(PSD, identifiedFrequencies, Fs)
    dampingRatios = [];
    for freq = identifiedFrequencies
        % Find the index in the PSD corresponding to the identified frequency
        freqIndex = round(freq / (Fs/size(PSD, 3)));

        % Perform SVD on the PSD matrix at the identified frequency
        [U, S, ~] = svd(squeeze(PSD(:,:,freqIndex)));

        % Calculate damping ratio assuming you can extract s1 and s2 from S
        if size(S,1) >= 2 && S(2,2) > 0
            dampingRatio = (1/(2*pi)) * (S(2,2)/S(1,1));
        else
            dampingRatio = NaN; % Assign NaN if s2 is not valid
        end

        dampingRatios = [dampingRatios, dampingRatio];
    end
end
```

Step 2: Recompute PSD (if necess[illegible]) and Calculate Damping Ratios

Methodology



Mode Number	LARA 1-Z (Hz)	iPhone XR-Z (Hz)	LARA 1-X (Hz)	iPhone XR-X (Hz)	LARA 1-Y (Hz)	iPhone XR-Y (Hz)
1	2.39	2.38	2.39	2.38	2.39	2.38
2	-	-	3.25	3.24	3.25	-
3	5.27	5.28	-	-	5.27	5.28
4	9.14	9.16	9.14	9.16	9.14	-
5	10.02	10.07	-	-	10.02	10.07

Thank you for your attention!

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October 2025