Predicting for new case :

UPISC UNIVERSITY OF PITTSBURGH INFRASTRUCTURE SENSING

COLLABORATION WORKSHOP

NATIONAL ENERGY TECHNOLOGY LABORATORY

Pipeline Defects Inspection Based Upon Distributed Acoustic Fiber Optic Sensing Data for Machine Learning Technology

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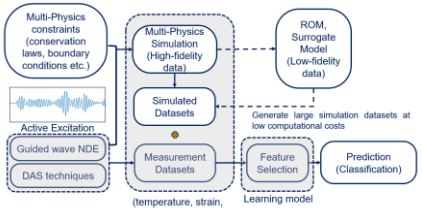
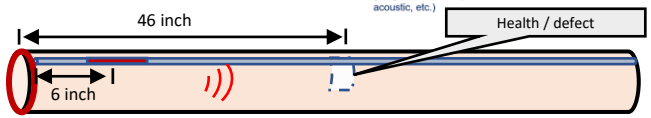
Motivation:

Current status: *Invisibility of underground pipelines prior to Failure and the requirement for long-range monitoring of the underground pipelines.*

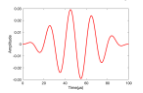
Improvement: *Combine guided wave ultrasonics and distributed fiber optics for structural health monitoring (SHM) and nondestructive evaluation (NDE) of pipeline conditions.*

Project Outline:



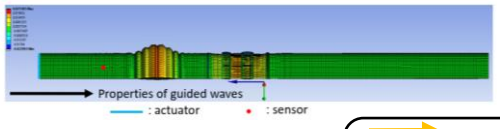


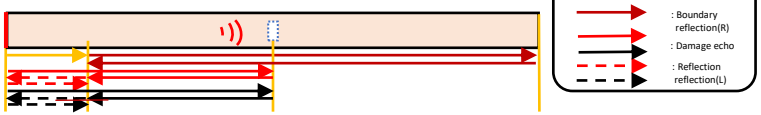
- Software: ANSYS, transient structural module;
- Method: Dynamic implicit analysis;
- Target: Guided wave propagation and simulated optical fiber sensing.

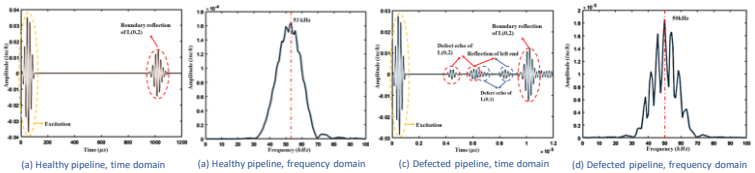


Excitation :

- Position: Left side of pipeline (yellow label)
- Signal: 50 kHz 5 cycle sinusoidal signal modulated with a Hanning window
- Loading method: Based on global coordinate system, load excitation in Z direction;

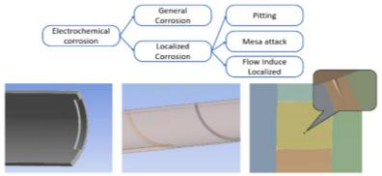




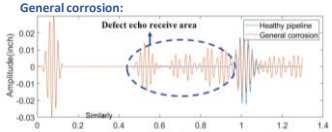


(a) Healthy pipeline, time domain (a) Healthy pipeline, frequency domain (c) Defected pipeline, time domain (d) Defected pipeline, frequency domain

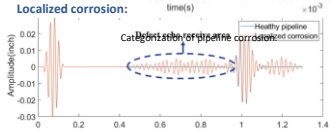
Categorization of pipeline corrosion:



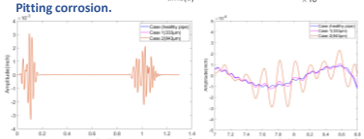
General corrosion:



Localized corrosion:

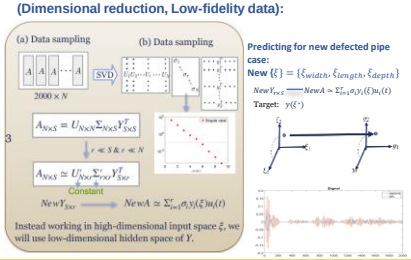


Pitting corrosion.



(Pitting corrosion signal from 0.7ms to 0.9ms.)

Surrogate Model
(Dimensional reduction, Low-fidelity data):

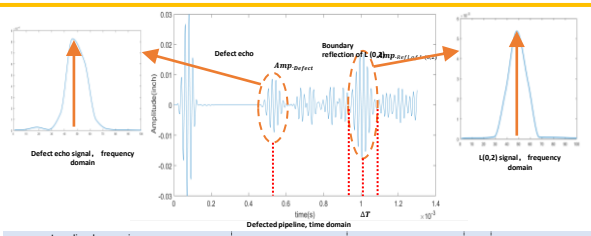


Predicting for new defected pipe case:

New $\{\xi\} = \{\xi_{width}, \xi_{length}, \xi_{depth}\}$

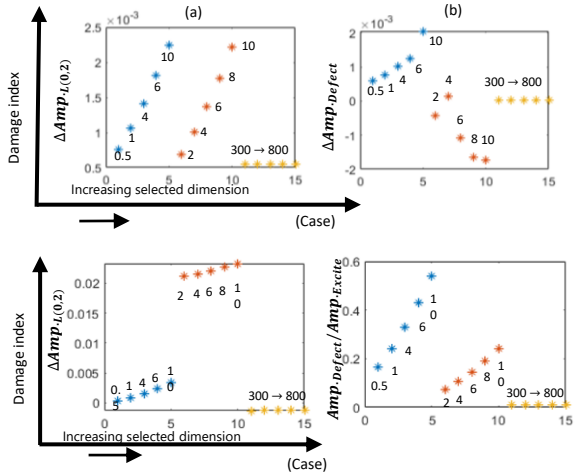
$NewY_{new} = NewA \simeq \Sigma_{i=1}^{r} \sigma_i y_i(\xi) u_i(t)$

Target: $y(\xi^*)$



Localized corrosion (inch/inch)	0.5	1	…	10
General corrosion (inch)	2	4	…	10
Pitting corrosion (μm)	300	425	…	800

- In the current study, we have chosen five examples in the study of each type of defected pipes corresponding to changes in the aspect ratio (length/width) for localized corrosion, the longitudinal length of generalized corrosion, and radius of the pits in the case of pitting corrosion.



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