Bayesian Network Inference and Information Fusion for Accurate Pipe Strength and Toughness Estimation

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Main Objective

This project was awarded to Arizona State University and Michigan State University to develop a novel Bayesian network tool to fuse detection information from multimodality diagnosis results for the probabilistic pipe strength and toughness estimation.

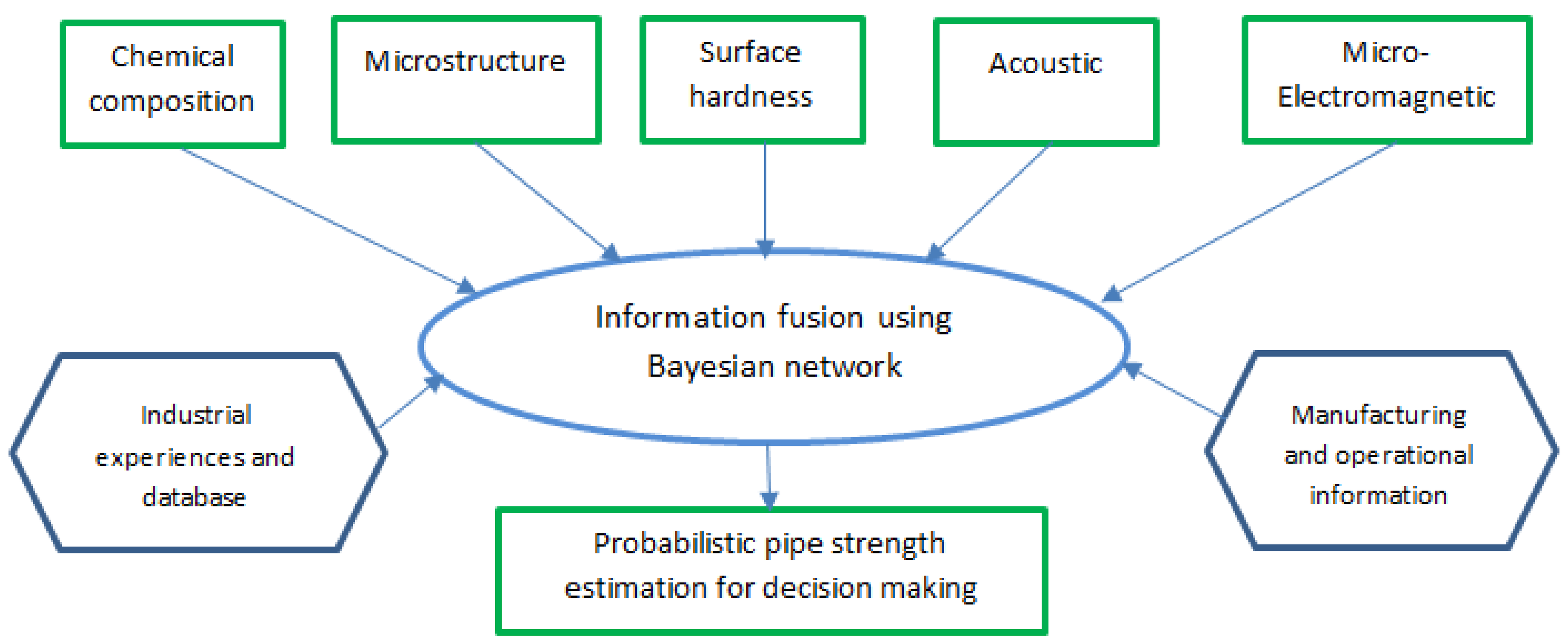

Figure 1. Schematic illustration of the proposed pipe strength estimation framework

Project Approach/Scope

- **Experimental testing and data analysis of chemical, metallurgical, and mechanical properties of pipe steel**
- **Experimental testing, data analysis and prototyping for acoustic and microelectromagnetic electromagnetic properties of pipe steel**
- **Integration of the information from the multimodal diagnosis into a Bayesian Network fusion model.**

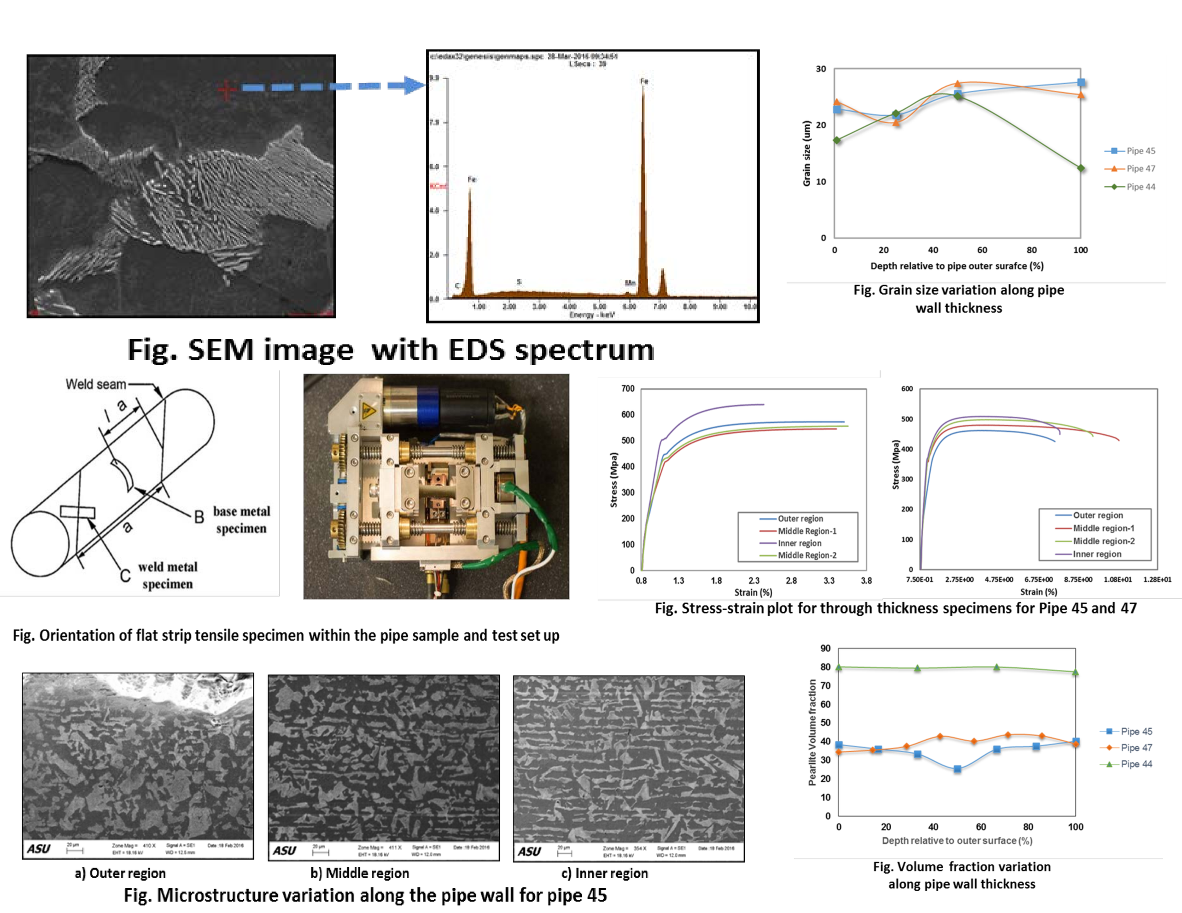

Figure 3. Experimental investigation of material properties

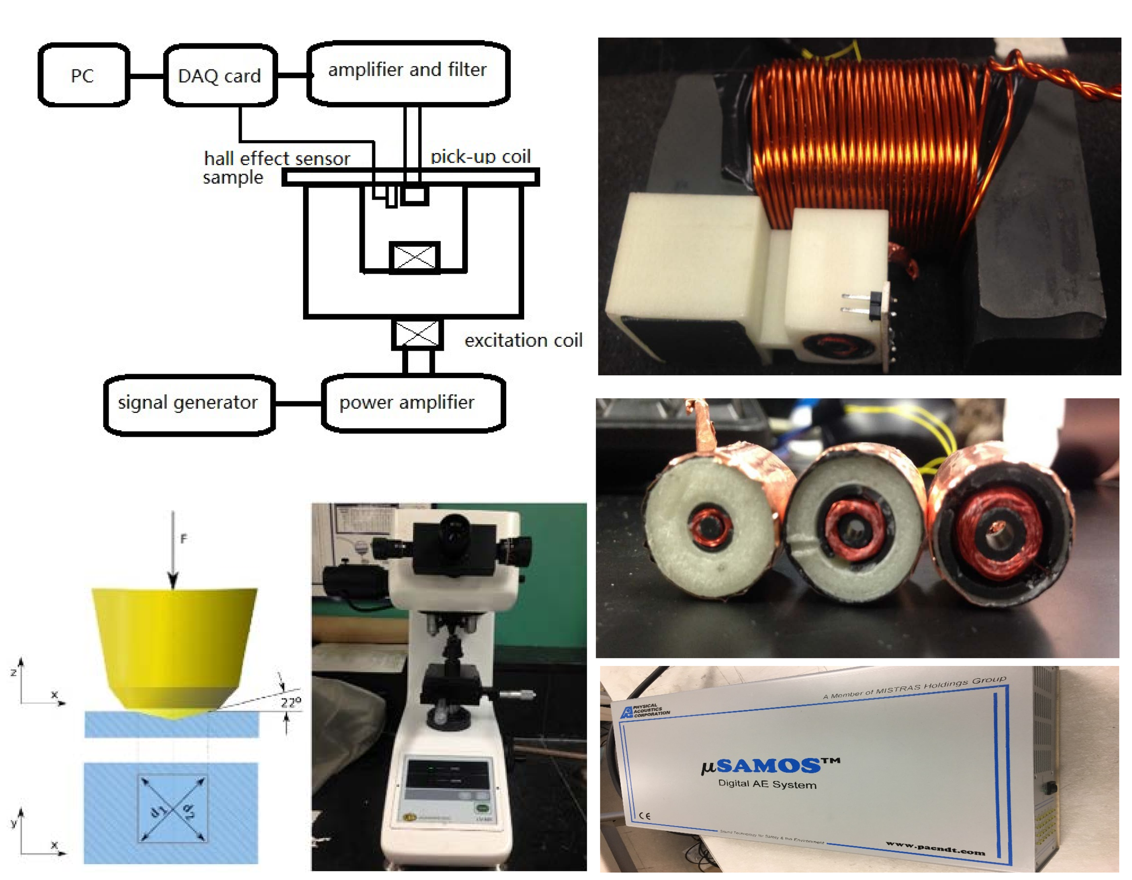

Figure 4. MBN and MAE experiments setup

Results to Date

The basic material properties including microstructure, composition, hardness, phase volume fraction are investigated from experimental analysis (SEM, EDS, Vicker's Hardness Tester). The various surface mechanical properties are studied and estimated with the use of acoustic and electromagnetic sensors. The tensile and fatigue properties are investigated using MTS Servo-Hydraulic machine.

Bayesian Network Model validation for prediction of yield strength; up to 30% improvement in prediction capability using the integrated model, compared to individual node prediction. Modification of likelihood regression coefficients; improvement in prediction by 4 – 13%. Node Hardness was observed to be most sensitive, volume fraction to be the least sensitive. Preliminary fatigue crack growth study shows a transgranular crack growth pattern.

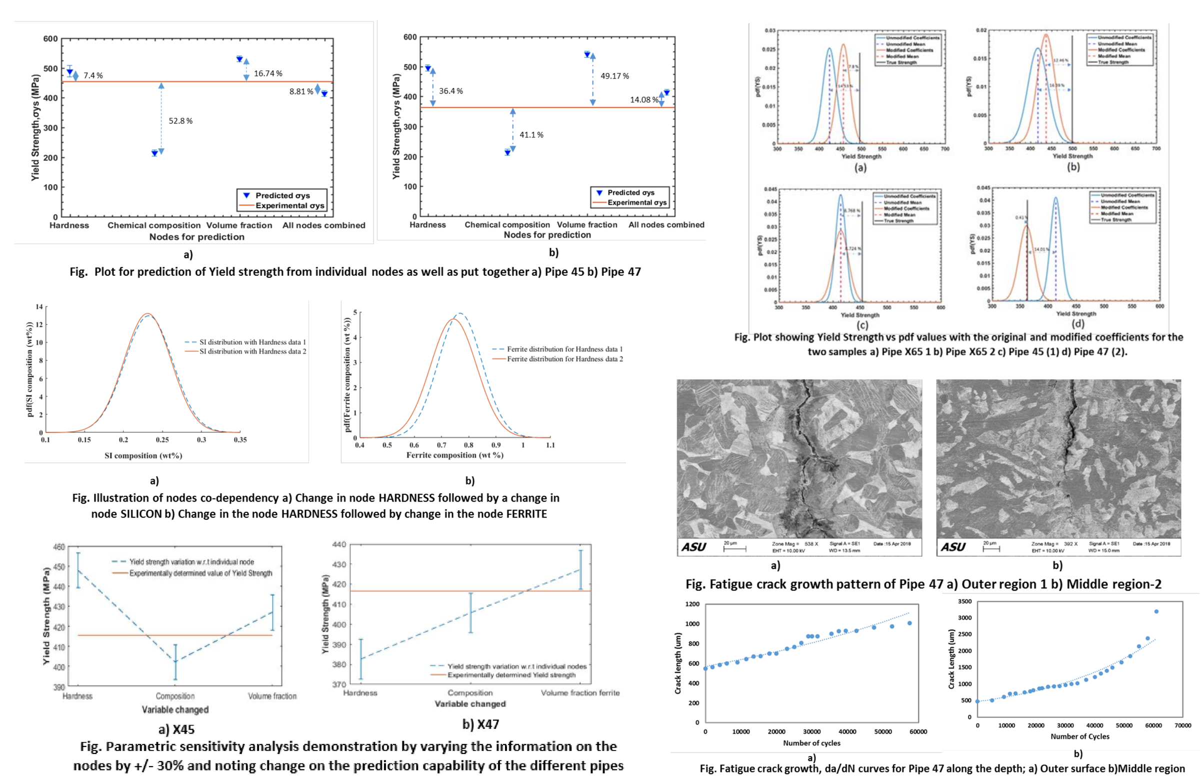

Figure 5. Results for BN model validation and updating, sensitivity analysis and fatigue study

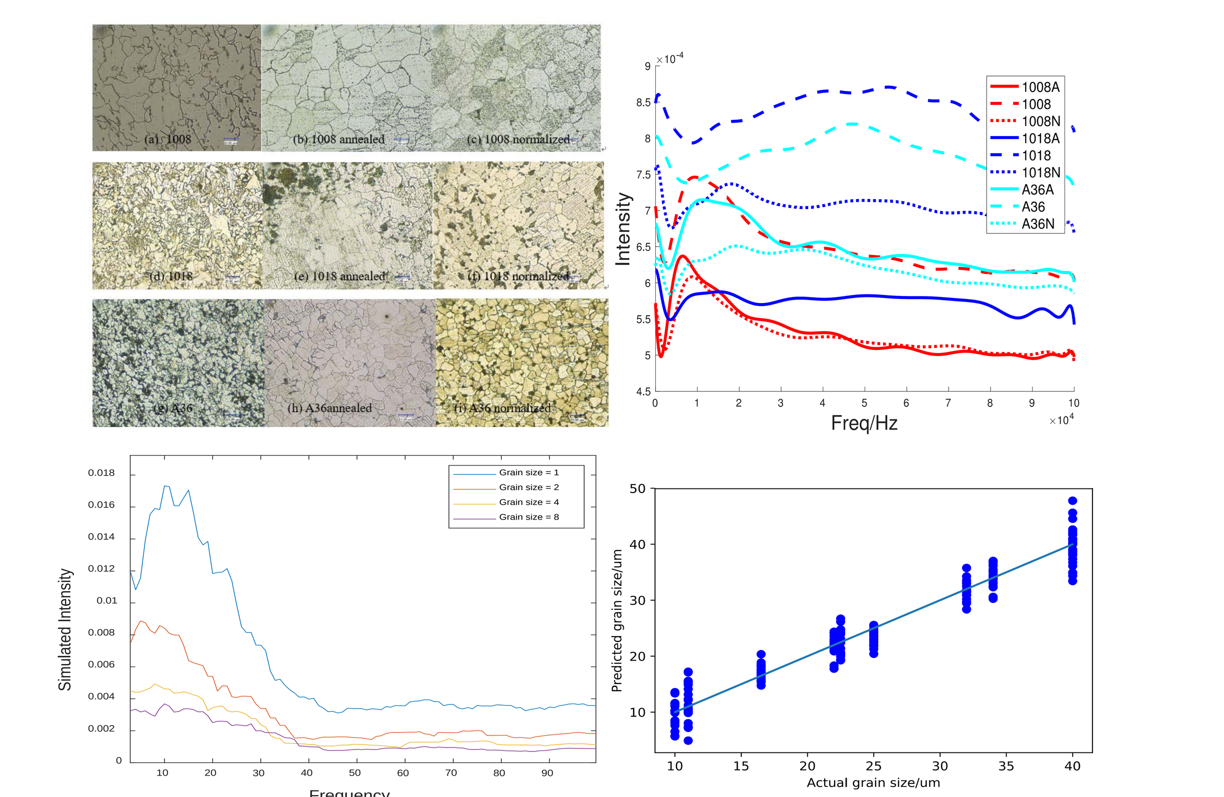

Figure 6. . MBN and MAE experiments results

Acknowledgments

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