Intelligent Strain Sensing on a Smart Composite Wing using Extrinsic Fabry-Perot Interferometric Sensors and Neural Networks.

By

Rohit Dua, Vicki M. Eller, Kakkattukuzhy M. Isaac,

Steve E. Watkins, and Donald C. Wunsch

Overview

- Motivation & Problem Description
- Fiber Optic Sensors
- Experimentation
- Neural Network Implementation
- Results
- Conclusion and Future Work

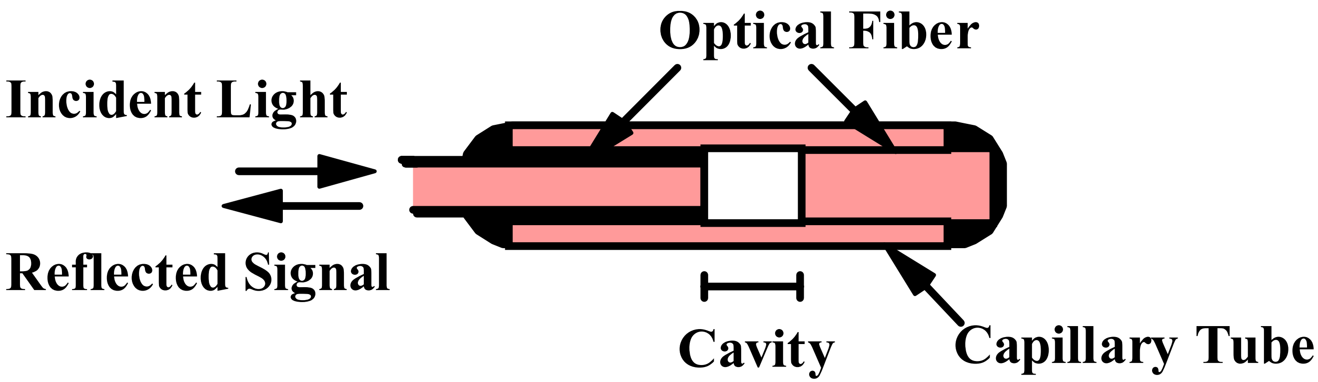
Motivation and Problem Description

- Aerodynamic parameter prediction
  - Strain: different points on wing
- Varying conditions
  - Angle-of-attack & air speed
- Neural network modeling
- Stall Prediction

Intelligent Sensing System

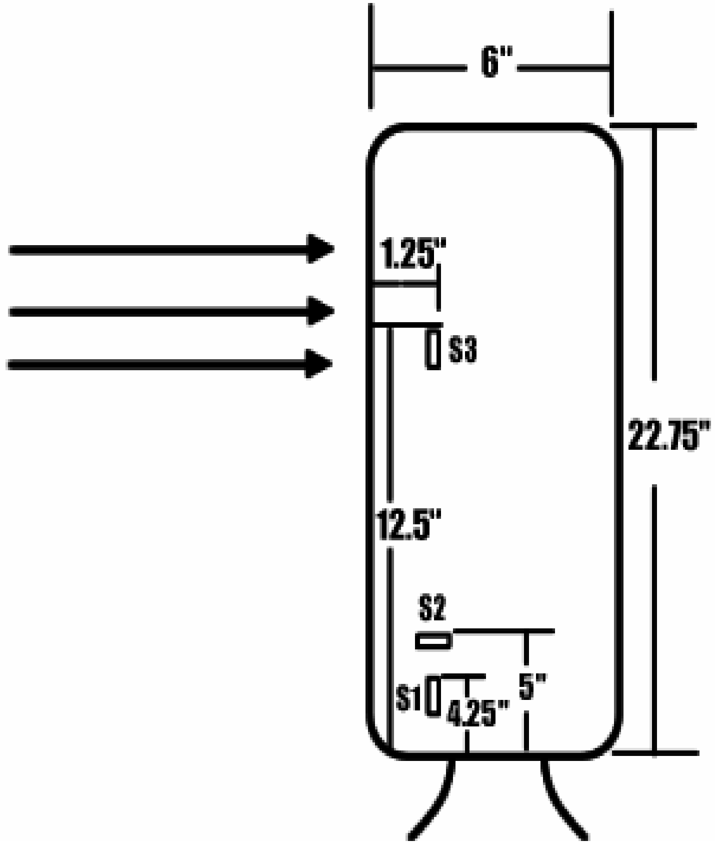
- Fiber Optic Sensing System:
  - Absolute strain measurement
  - Many advantages
- Neural Networks:
  - Function approximators
  - Intelligent system

Fiber Optic Sensors

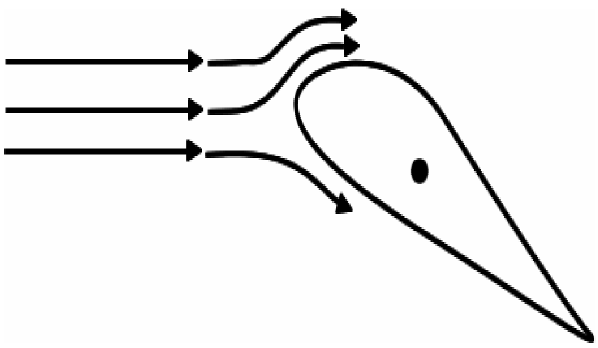


Extrinsic Fabry-Perot Interferometric (EFPI) Sensor

Experimentation

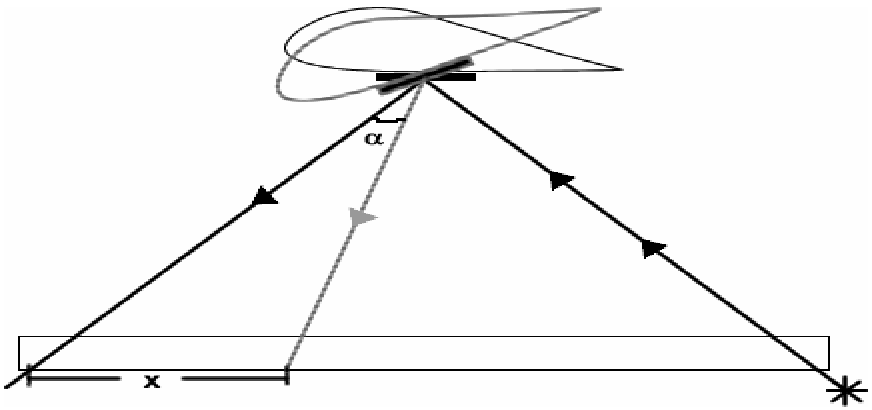


Sensor placement



Top View

Experimentation (Contd.)



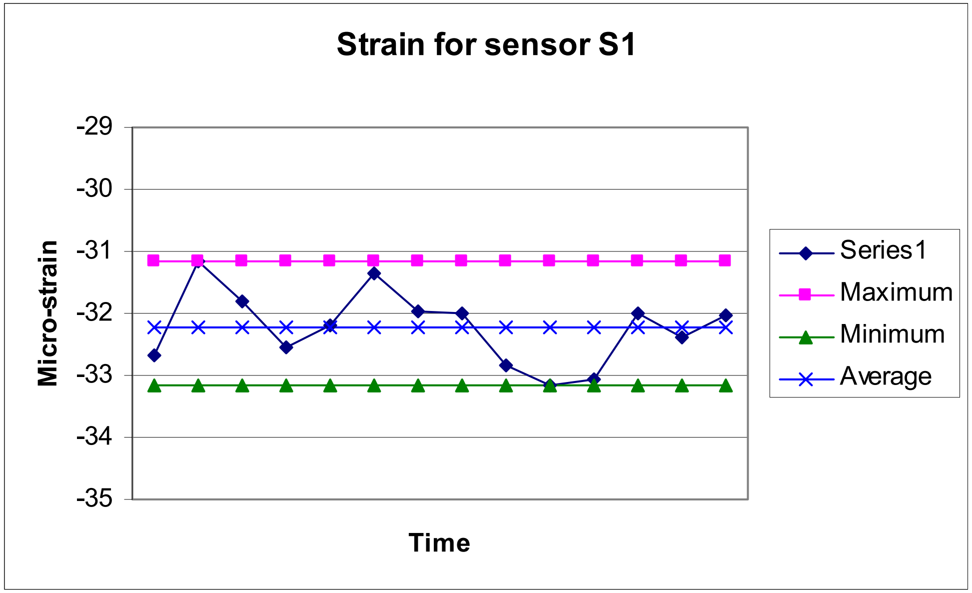
Measurement of angle-of-attack

- Key Strain points Measured
- Variation in Pressure: 0 to 460 Pa
- Variation in angle-of-attack: -1.627^0 to 4.31^0

Neural Network Modeling

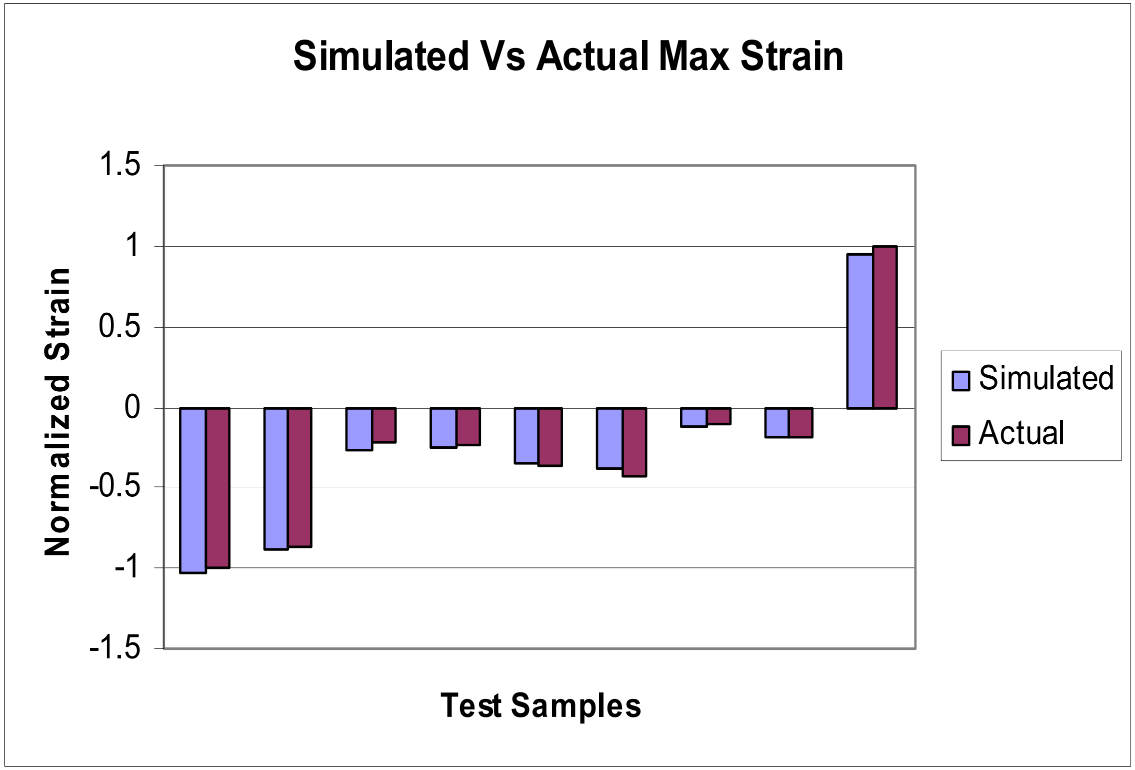
Neural network trained on two types of data

- Max and Min strain
- Average Strain

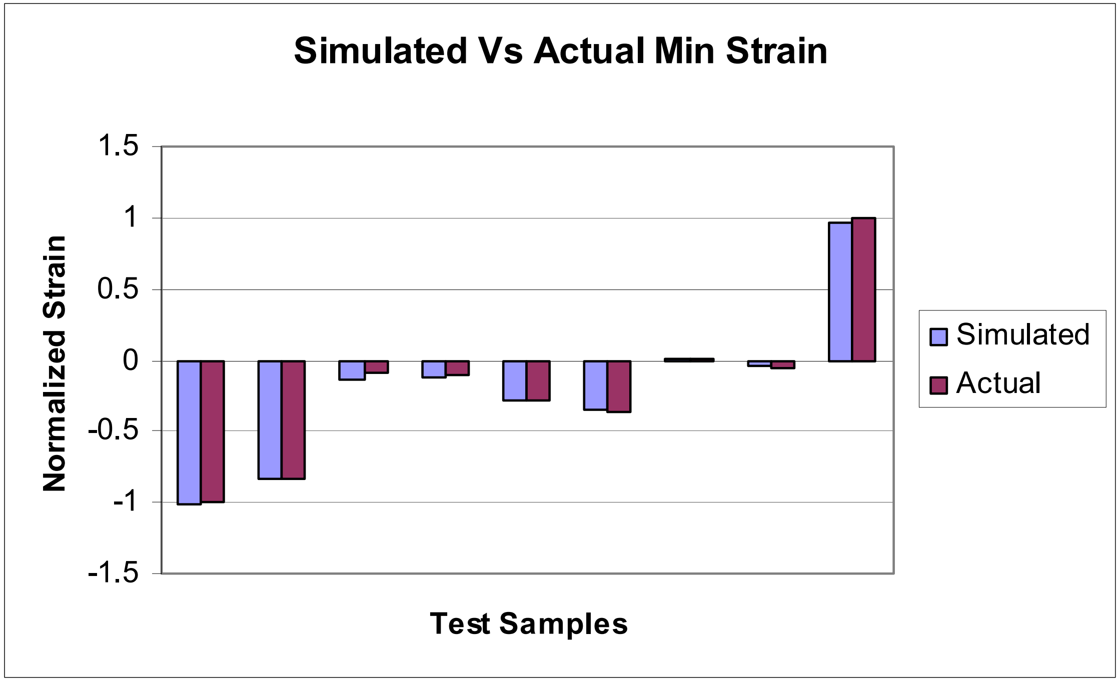


Typical Strain profile

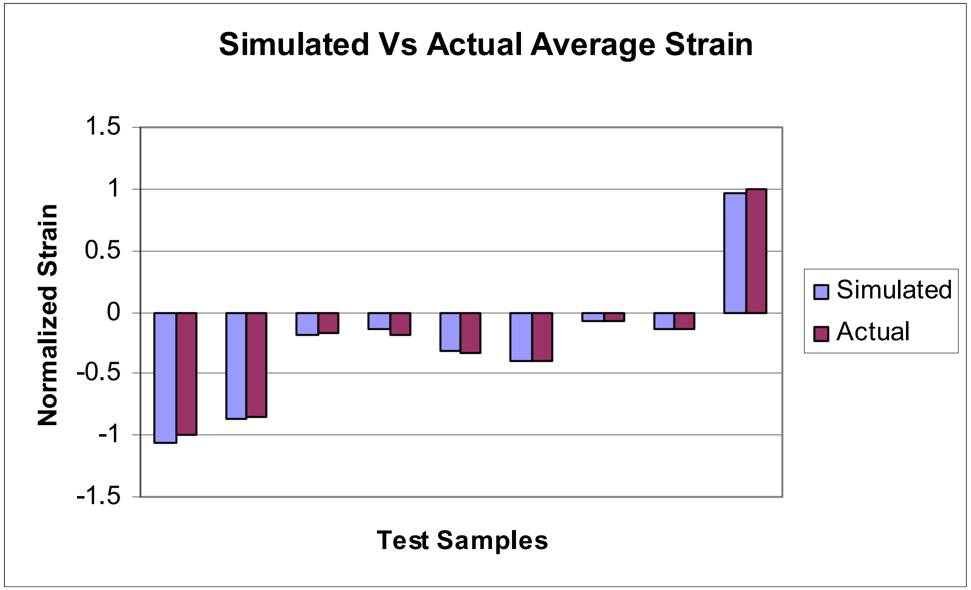
Training on Max Strain- Results



Training on Min Strain-Results



Training on Average Strain



Results: Contd.

Average errors in the test set

	Sensor		
	S1	S2	S3
Max Strain	4.05%	0.71%	2.08%
Min Strain	8.35%	1.92%	0.94%
Average Strain	3.70%	2.03%	1.05%

Conclusion and Future Work

- Predicted Strain compared with actual strain: tool to predict stall
- Neural network modeling: easy to implement and good accuracy
- Future work:
  - Improve accuracy in measurement techniques
  - Optimal sensor location algorithms
  - Simulation of stall condition