Licensing Opportunity

An Artificial Neural System for SHM

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• Highly Distributed Nerves for Sensing
• Massively Parallel Signal Processing
• A Passive System
TECHNOLOGY DESCRIPTION:

• An Artificial Neural System (ANS) for Structural Health Monitoring (SHM) has been developed at the University of Cincinnati and North Carolina A&T State University and is available for licensing.

• The ANS architecture can be used with different types of sensors to continuously monitor the health of structures during operation to detect cracking, corrosion, strain, or vibration.

• The ANS architecture provides massively parallel processing and only four channels of data acquisition are needed to monitor tens to hundreds of neurons.

• Miniature continuous fiber sensors are used to sense along their entire length and provide highly distributed sensing.

• The ANS is highly distributed, massively parallel, passive, simple, wired, low cost, lightweight, redundant, and able to be retrofit to metallic and composite structures.

• Applications include aircraft, helicopters, spacecraft, civil infrastructure, naval, defense, and most types of structures that operate under dynamic loading.
THE ARTIFICIAL NEURAL SYSTEM (ANS):

Biological Neurons in the visual cortex

An orthogonal ANS on a panel
THE NERVE FIBER:

A short nerve fiber (AFCS) bonded onto a glass fiber panel and connected to copper wire

Response of the short nerve fiber due to a lead break to represent an acoustic emission
SIMULATION OF WAVES TO TEST THE ANS:

(a) time =9.9e-5 sec

(2) time =0.0010 sec

• Waves in a glass fiber panel due to a simulated acoustic emission.

• A 10x10 ANS with discrete nodes is located on the panel.
The figure indicates damage is located in the unit cell between column neurons 2, 3 and row neurons 18, 19 (not shown).

Simulation of the ANS architecture showing the combined output of the column neurons.
STRAIN ENERGY CAN PREDICT REMAINING LIFE:

Simulation of cumulative strain energy density due to one AE event

Notes:
1- The rate of change of Cumulative Strain Energy Density will be used to monitor the rate of damage growth.
2- The magnitude of the Cumulative Strain Energy Density will be used to predict the remaining life of a structure by referencing test data from a sample of the same material.
PRODUCT SUMMARY:

Simulation of large systems and testing of a small system have demonstrated the technology.

The technology can be licensed or a custom system can be developed through a cooperative Grant with the UC.

Licensing the technology
  • The Artificial Neural System (ANS)
  • The Active Fiber Continuous Sensor (AFCS)

Development of custom designed SHM Systems and Sensors
  • An ANS can be custom designed for use with the following sensor types:
    • Acoustic Emission detection or vibration level sensing using the directional AFCS
    • Quasi-static strain sensing using the directional AFCS
    • Special micron scale strain sensors
    • Corrosion sensing using a special sensor type
    • Other sensor types such as pressure sensors are possible