

Artificial Immune System (AIS) for Damage Detection Under Variable Temperature Conditions

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Summary This work describes a structural health monitoring methodology which combines the advantages of guided ultrasonic waves together with artificial immune systems as a pattern recognition technique to determine the effects of the temperature in the damage detection process. In the methodology, the description of a sensor data fusion with the data from different temperature conditions to discard the resultant false positives by the changes in temperature is included.

BASIC CONCEPTS

Artificial Immune Systems (AIS)

Since the natural immune system has proved its effectiveness in the human body's defense, it can be used in the same way as a pattern recognition approach by means of a computational system. This is based on these principles:

Immune network theory: This explains how the immune memory is built by means of the dynamic behavior of the immune system cells

The negative selection: It is a process that allows identifying and removing cells that react to the own body cells giving to the system a tolerance to own cells..

The clonal selection: This is a process of adaptive immune responses in which the cells of the system are adapted to identify an invader element.

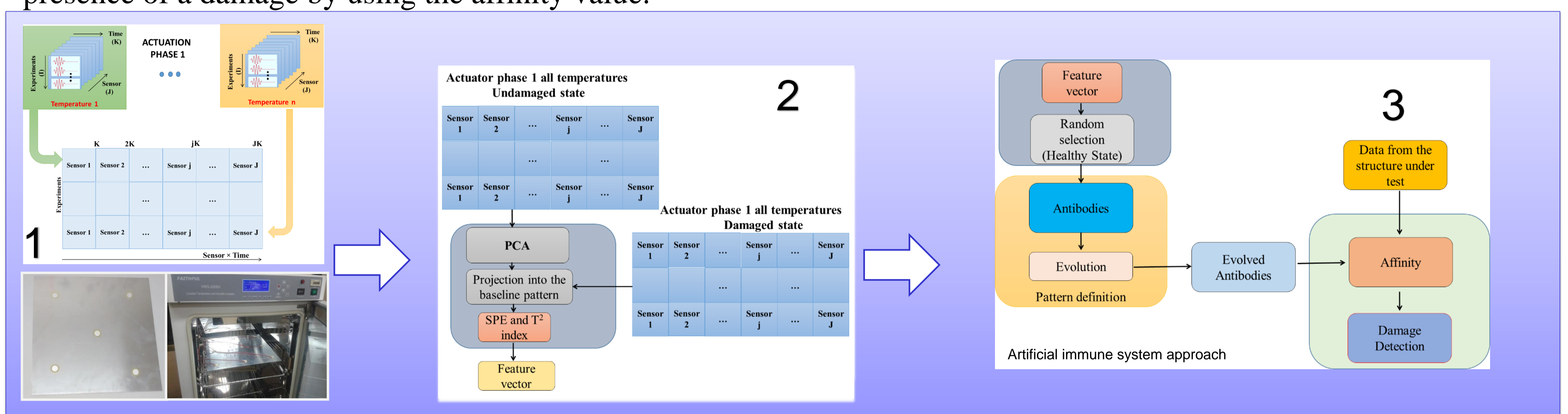
Methodology

Methodology

Uses Principal component analysis (PCA), damage indices (DI) and artificial immune systems (AIS) to determine the presence of a damage by using the affinity value.

Experimental setup

Aluminum plates with 5 piezoelectric sensors. 6 temperatures (25° - 50° C)

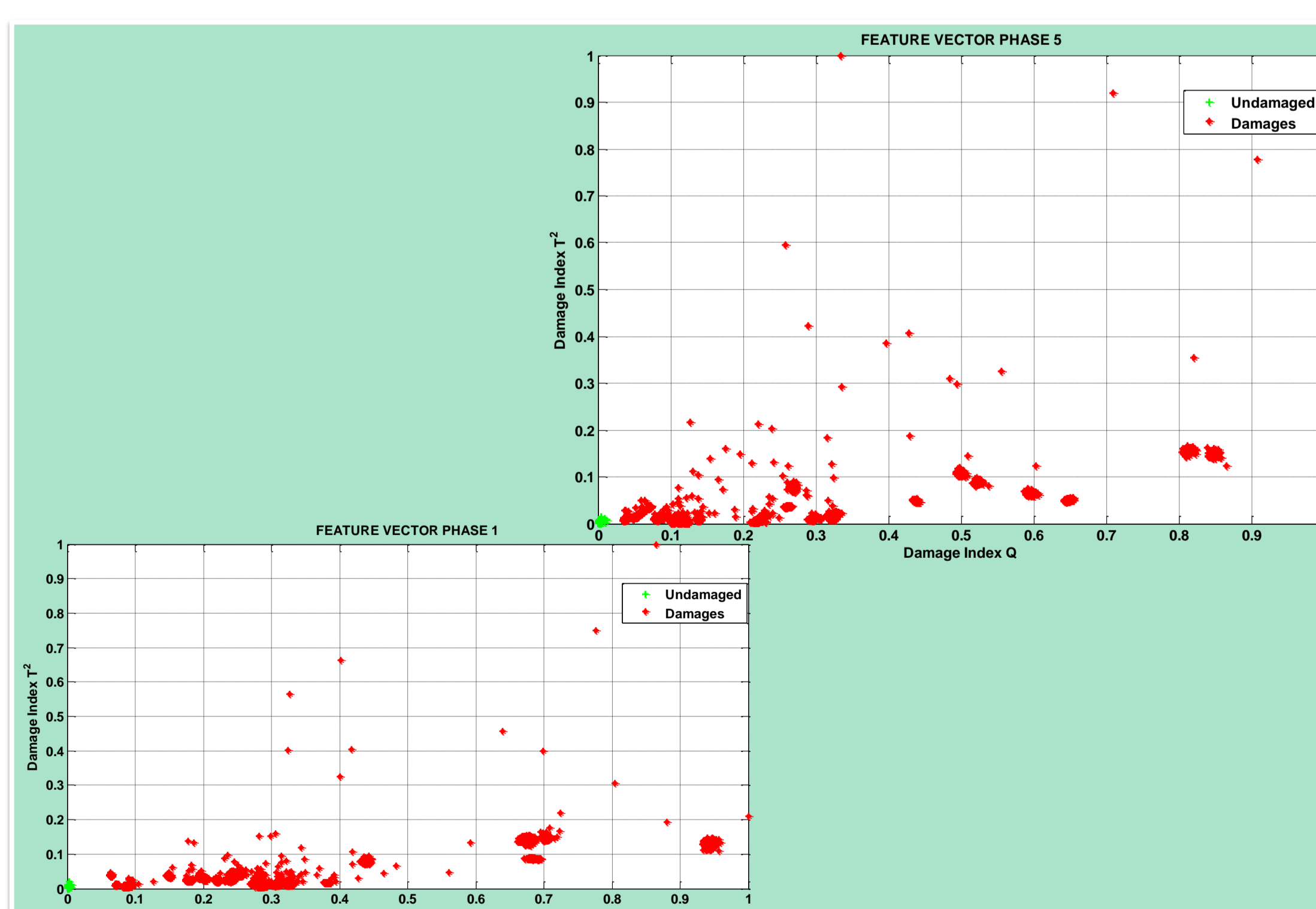


Damage detection methodology

RESULTS

FEATURED VECTOR

- Results from the damage indices are used to create the featured vector by each actuation phase

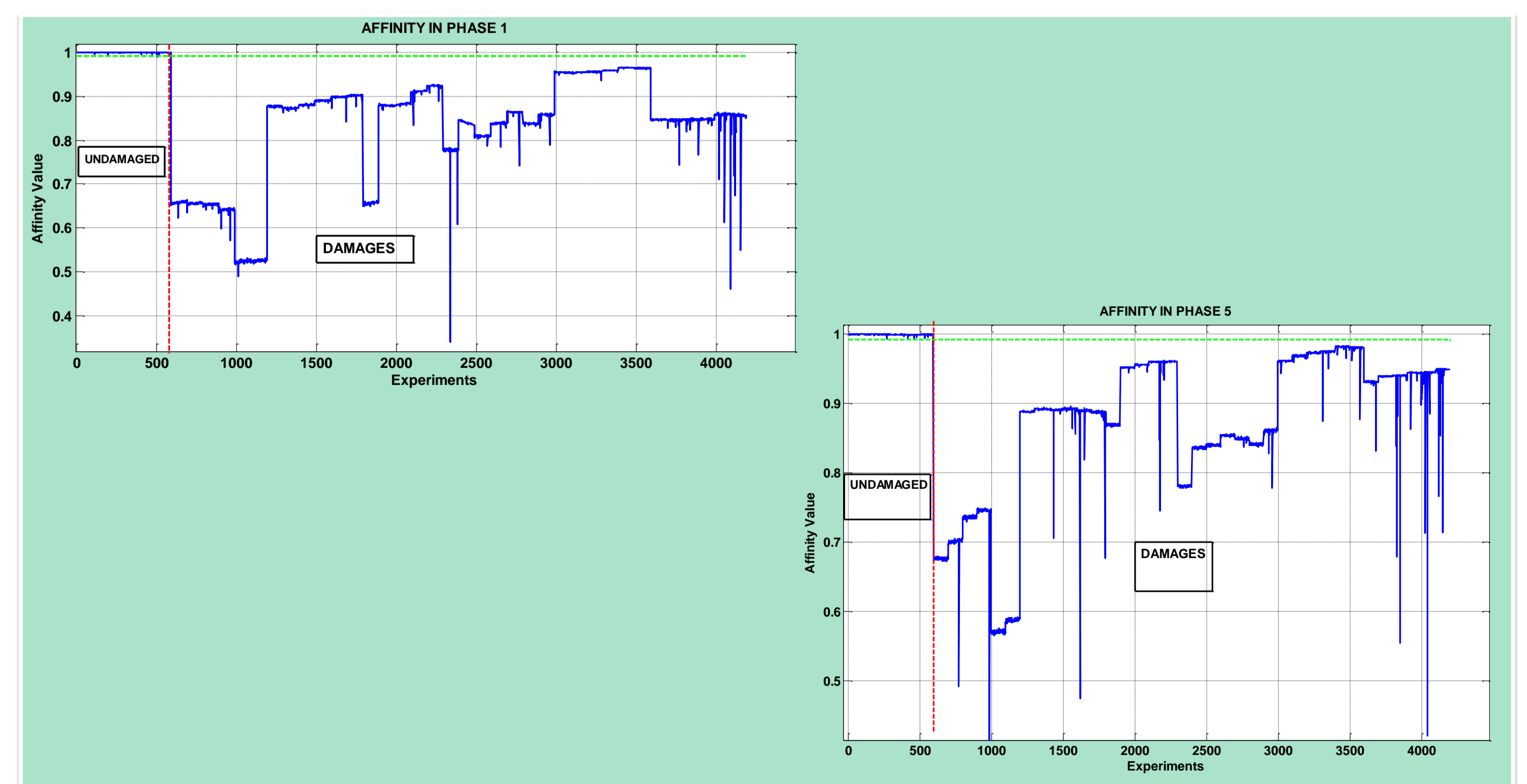


Damage Indices in two actuation phases

AFFINITY VALUE

-Is a measurement of similarity with the pattern.

-The pattern is the healthy state of the structure.



Affinity Values in two actuation phases

CONCLUSIONS

- Changes in temperature result in changes in the signal propagated through the structure.
- Results obtained with the introduced methodology showed that it is possible to detect all the damages in the structure under test, in spite of the changes in the temperature.
- The use of the affinity value allows to reduce the number of variables to analyze in the damage detection process and provides information about the similarity of each structural state with the healthy state and between them.