

WHAT IS CLAIMED IS:

1. A computer-implemented method for identifying corrosion under insulation (CUI) in a structure, comprising:
 - a) receiving a thermograph captured from the structure using an infrared radiation sensor and additional data related to the structure and environmental conditions;
 - b) applying one or more filters to the thermograph and the additional data using a first machine learning system;
 - c) initially determining a CUI classification based on output from the one or more filters;
 - d) validating the initial CUI classification by an inspection of the structure;
 - e) training the filters of the first machine learning system based on results of the validation;
 - f) repeating steps a) through e) with additional thermograph data until a first threshold for CUI classification accuracy is reached;
 - g) inputting outputs of the first machine learning system and additional data related to the structure and environment conditions into a second machine learning system that incorporates information from earlier states into current states;
 - h) training the second machine learning system to identify CUI according to changes in the outputs of the first machine learning system and the additional data over time until a second threshold for CUI classification accuracy is reached; and
 - i) after the first and second thresholds are reached, identifying CUI in the structure based on current thermograph and additional data using the first and second machine learning systems in coordination.
2. The computer-implemented method of claim 1, wherein the first machine learning system includes a convolutional neural network.
3. The computer-implemented method of claim 2, wherein the convolutional neural network includes a plurality of hierarchical layers, each hierarchical layer including a convolutional stage, a non-linear function stage and a pooling stage.
4. The computer-implemented method of claim 2, wherein the second machine learning system includes a recurrent neural network.

5. The computer-implemented method of claim 4, wherein the additional data includes ambient temperature, physical characteristics of the structure and weather conditions measured over time.
6. The computer-implemented method of claim 5, wherein the first and second machine learning systems are trained to recognize false positive findings relative to reflection of infrared radiation from objects external from the structure.
7. The computer-implemented method of claim 1, wherein identification of CUI includes identifying vulnerable areas of the structure under the insulation that confine moisture with a high likelihood.
8. The computer-implemented method of claim 1, wherein validation is performed using at least two of pulsed eddy current evaluation, visual inspection, insulation removal and ultrasonic testing of wall thinning.
9. The computer-implemented method of claim 1, further comprising preprocessing the thermograph data and the additional data to encode categorical variables and normalize continuous variables.
10. A system for identifying corrosion under insulation (CUI) in a structure, comprising:
 - An infrared camera including a communication module, the infrared camera positioned so as to capture infrared radiation emitted from the structure and adapted to communicate thermographs of the captured radiation via the communication module;
 - a computer system including a processor, memory and a communication module, the processor being configured to execute a program that performs steps of:
 - i) applying one or more filters to thermographs received from the infrared camera via the communication module and additional data related to the structure and environmental conditions, using a first machine learning system;
 - ii) initially determining a CUI classification based on output from the one or more filters;
 - iii) validating the initial CUI classification by an inspection of the structure;

iv) training the filters of the first machine learning system based on results of the validation;

v) repeating steps i) through iv) with additional thermograph data until a first threshold for CUI classification accuracy is reached;

vi) inputting outputs of the first machine learning system and additional data related to the structure and environment conditions into a second machine learning system that incorporates information from earlier states into current states;

vii) training the second machine learning system to identify CUI according to changes in the outputs of the first machine learning system and the additional data over time until a second threshold for CUI classification accuracy is reached; and

after the first and second thresholds are reached, identifying CUI in the structure based on current thermograph and additional data using the first and second machine learning systems in coordination.

11. The system of claim 10, wherein the first machine learning system includes a convolutional neural network.

12. The system of claim 11, wherein the convolutional neural network includes a plurality of hierarchical layers, each hierarchical layer including a convolutional stage, a non-linear function stage and a pooling stage.

13. The system of claim 11, wherein the second machine learning system includes a recurrent neural network.

14. The system of claim 13, wherein the additional data includes ambient temperature, physical characteristics of the structure and weather conditions measured over time.

15. The system of claim 14, wherein the first and second machine learning systems are trained to recognize false positive findings relative to reflection of infrared radiation from objects external from the structure.

16. The system of claim 10, wherein identification of CUI includes identifying vulnerable areas of the structure under the insulation that confine moisture with a high likelihood.
17. The system of claim 10, wherein validation is performed using at least two of pulsed eddy current evaluation, visual inspection, insulation removal and ultrasonic testing of wall thinning.
18. The system of claim 10, wherein the computer system preprocesses the thermograph data and the additional data to encode categorical variables and normalize continuous variables.