CLAIMS

1. A computer-implemented method for identifying corrosion under insulation (CUI) in a structure using filters trained by a first machine learning system to a first threshold for CUI classification accuracy, comprising:

receiving a thermograph captured from the structure using an infrared radiation sensor and additional data related to the structure and environmental conditions;

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;

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 second threshold is reached, identifying CUI in the structure based on received thermograph and additional data using the first and second machine learning systems in coordination.

2. A computer-implemented method according to Claim 1, in which the first machine learning system includes a convolutional neural network.

3. A computer-implemented method according to Claim 2, in which 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. A computer-implemented method according to Claim 2, in which the second machine learning system includes a recurrent neural network.

5. A computer-implemented method according to Claim 4, in which the additional data includes ambient temperature, physical characteristics of the structure and weather conditions measured over time.

6. A computer-implemented method according to Claim 5, in which 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. A computer-implemented method according to Claim 1, in which identification of CUI includes identifying vulnerable areas of the structure under the insulation that confine moisture with a high likelihood.

8. A computer-implemented method according to Claim 1, further comprising:

validating an initial CUI classification by an inspection of the structure, in which validation is performed using at least two of pulsed eddy current evaluation, visual inspection, insulation removal and ultrasonic testing of wall thinning.

9. A computer-implemented method according to 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 using filters trained by a first machine learning system to a first threshold for CUI classification accuracy, comprising:

a computer system including a processor, memory and a communication module, the processor being configured to execute a program that performs steps of:

receiving a thermograph captured from the structure using an infrared radiation sensor and additional data related to the structure and environmental conditions;

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;

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. A system according to Claim 10, in which the first machine learning system includes a convolutional neural network.

12. A system according to Claim 11, in which 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. A system according to Claim 10, in which the second machine learning system includes a recurrent neural network.

14. A system according to Claim 10, in which the additional data includes ambient temperature, physical characteristics of the structure and weather conditions measured over time.

15. A system according to Claim 10, in which 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. A system according to Claim 10, in which identification of CUI includes identifying vulnerable areas of the structure under the insulation that confine moisture with a high likelihood.

17. A system according to Claim 10, in which the processor is configured to execute the program that performs a further step of:

validating an initial CUI classification by an inspection of the structure, in which validation is performed using at least two of pulsed eddy current evaluation, visual inspection, insulation removal and ultrasonic testing of wall thinning.

18. A system according to Claim 10, in which the computer system preprocesses the thermograph data and the additional data to encode categorical variables and normalize continuous variables.