Claims

1. A method for determining a state of operation of a domestic appliance in a plurality of domestic appliances, comprising:

receiving, from the domestic appliance, a time series of data relating to the operation of the domestic appliance over a cycle of operation; and

determining the state of operation of the domestic appliance based on comparing the received time series with a model of time series of data corresponding to the operation of the plurality of domestic appliances over a cycle of operation.

2. The method according to claim 1, wherein the comparing comprises matching a pattern of the received time series of data to a pattern of a model of time series of data.

3. The method according to any one of claims 1 or 2, wherein the comparing comprises retrieving the model of time series of data from a database.

4. The method according to claim 3, wherein the retrieving is performed over a network.

5. The method according to any one of claims 1 to 4, wherein the plurality of domestic appliances is connected to a network, and wherein the receiving of the time series comprises receiving the data over the network.

6. The method according to any one of claims 1 to 5, wherein the plurality of domestic appliances comprises different types of domestic appliances, and wherein the model of time series of data corresponds to a type of domestic appliances.

7. The method according to claim 6, wherein determining the state of operation further comprises identifying the type of the domestic appliance in the plurality of domestic appliances, based on the received time series of data and/or on identification received from the domestic appliance.

8. The method according to any one of claims 1 to 7, further comprising assembling the model of time series of data based on time series of data relating to the operation of the plurality of domestic appliances, received from the plurality of domestic appliances.

9. The method according to any one of claims 1 to 8, further comprising storing a predetermined model of time series of data.

10. The method according to any one of claims 1 to 9, wherein the determining of the state of operation of the domestic appliance comprises diagnosing normal operation of the domestic appliance based on the comparing.

11. The method according to any one of claims 1 to 10, wherein the determining of the state of operation of the domestic appliance comprises diagnosing a fault of the domestic appliance based on the comparing.

12. The method according to claim 11, further comprising triggering diagnosing a fault of a component of the domestic appliance based on the diagnosing of the fault of the domestic appliance.

13. The method according to any one of claims 11 or 12, wherein diagnosing a fault comprises diagnosing heating operation of a domestic fluid heating system with a blocked condensate drain and/or heating operation of the domestic fluid heating system with a blocked flue intake.

14. The method according to any one of claims 11 to 13, wherein the diagnosing comprises:

using a timing of departure of the time series of data from a model of time series of data corresponding to a normal operation of the heating system over a cycle of operation and/or

displaying processed time series of data in an interface on a display screen of a device.

15. The method according to any one of claims 11 to 14, further comprising predicting a need for maintenance based on the diagnosing.

16. The method according to any one of claims 1 to 15, further comprising detecting a trend of operation of the domestic appliance, based on the determining of the state of operation of the domestic appliance over at least two cycles of operation.

17. The method according to claim 16, further comprising predicting a need for maintenance based on the detecting of the trend.

18. The method according to any one of claims 15 or 17, further comprising triggering maintenance of the domestic appliance based on the predicting.

19. The method according to claim 18, wherein triggering maintenance comprises outputting a maintenance instruction.

20. The method according to any one of claims 18 or 19, wherein triggering maintenance comprises maintaining the domestic appliance.

21. The method according to any one of claims 1 to 20, wherein the cycle of operation comprises a period of transient mode of operation and a period of steady mode of operation.

22. The method according to any one of claims 1 to 21, comprising defining a cycle of operation based on:

deriving from a duration taken from a first time series and from a portion of a second time series selected based on the first time series, and/or

using specific parameters in the data.

23. The method according to claim 22, wherein the duration taken from the first time series is:

a period taken from a power on signal to a power off signal; and/ the specific parameters in the data comprise:

a space heating status value; and/or

a flame detection value.

24. The method according to any one of claims 1 to 23, further comprising assembling the model of time series of data based on data received from the plurality of systems during a set up.

25. The method according to any one of claims 1 to 24, further comprising predefining the model of time series of data based on programming.

26. The method according to any one of claims 1 to 25, performed at least partly locally in the heating system.

27. The method according to any one of claims 1 to 26, wherein the domestic appliance is a domestic boiler and/or a washing machine.

28. The method according to any one of claims 1 to 27, wherein the received time series of data relates to the operation of a component of the domestic appliance over a cycle of operation.

29. The method according to any one of claims 1 to 28, wherein the time series of data comprises:

raw appliance data; and/or

enhanced data derived from the raw appliance data; and/or

at least a derived feature.

30. The method according to claim 29, wherein the derived feature comprises at least a feature derived from the raw data.

31. The method according to any one of claims 1 to 30, further comprising providing the time series of data in a line graph format.

32. The method according to claim 31, further comprising formatting and/or averaging the time series of data to display the data over a relevant cycle of operation of an appliance.

33. The method according to any one of claims 1 to 32, comprising enabling a user to navigate between different displays of time series of data.

34. The method according to any one of claims 1 to 33, comprising integrating input from external sources.

35. The method according to any one of claims 1 to 34, comprising regularly updating displays of the time series of data.

36. The method according to any one of claims 1 to 35, comprising validating and/or building reference data to train and/or develop an anomaly detector.

37. The method according to any one of the claims 1 to 36, comprising defining and/or configuring additional, new, derived features and/or any associated parameters.

38. The method according to any one of the claims 2 to 37, wherein the pattern matching comprises defining groupings of one or more derived features to use against the model time series data.

39. The method according to any one of the claims 1 to 38, wherein the comparing comprises comparison between processed data from multiple appliances in order to characterise common behaviours and/or differences.

40. A device configured to determine a state of operation of a domestic appliance in a plurality of domestic appliances, configured to:

receive, from the domestic appliance, a time series of data relating to the operation of the domestic appliance over a cycle of operation; and

determine the state of operation of the domestic appliance based on comparing the received time series with a model of time series of data corresponding to the operation of the plurality of domestic appliances over a cycle of operation.

41. The device according to claim 40, further configured to match a pattern of the received time series of data to a pattern of a model of time series of data.

42. The device according to any one of claims 40 or 41, wherein further configured to retrieve the model of time series of data from a database.

43. The device according to claim 42, further configured to retrieve the model over a network.

44. The device according to any one of claims 40 to 43, further configured to receive the time series of data over a network.

45. The device according to any one of claims 40 to 44, further configured to assign the model of time series of data to a type of domestic appliances.

46. The device according to claim 45, further configured to identify the type of the domestic appliance in the plurality of domestic appliances, based on the received time series of data and/or on identification received from the domestic appliance.

47. The device according to any one of claims 40 to 46, further configured to assemble the model of time series of data based on time series of data relating to the operation of the plurality of domestic appliances, received from the plurality of domestic appliances.

48. The device according to any one of claims 40 to 47, further configured to store a predetermined model of time series of data.

49. The device according to any one of claims 40 to 48, further configured to diagnose normal operation of the domestic appliance based on the comparing.

50. The device according to any one of claims 40 to 49, further configured to diagnose a fault of the domestic appliance based on the comparing.

51. The device according to claim 50, further configured to trigger diagnosing a fault of a component of the domestic appliance based on the diagnosing of the fault of the domestic appliance.

52. The device according to any one of claims 50 or 51, configured to diagnose heating operation of a domestic fluid heating system with a blocked condensate drain and/or heating operation of the domestic fluid heating system with a blocked flue intake.

53. The device according to any one of claims 50 to 52, configured to predict a need for maintenance based on the diagnosing.

54. The device according to any one of claims 50 to 53, further configured to detect a trend of operation of the domestic appliance, based on the determining of the state of operation of the domestic appliance over at least two cycles of operation.

55. The device according to claim 54, further configured to predict a need for maintenance based on the detecting of the trend.

56. The device according to any one of claims 53 or 55, further configured to trigger maintenance of the domestic appliance based on the predicting.

57. The device according to claim 56, configured to trigger maintenance by outputting a maintenance instruction.

58. The device according to any one of claims 56 or 57, configured to trigger maintenance by maintaining the domestic appliance.

59. The device according to any one of claims 40 to 58, further configured to assemble the model of time series of data based on data received from the plurality of systems during a set up.

60. The device according to any one of claims 40 to 59, further configured to predefine the model of time series of data based on programming.

61. The device according to any one of claims 40 to 59, configured to be connected to the plurality of domestic appliances via a communications network.

62. The device according to any one of claims 40 to 61, configured to be at least partly located in the heating system.

63. Apparatus comprising:

a monitoring device comprising a server;

a plurality of domestic appliances connected to the server of the device via a communications network and adapted to send one or more time series of data relating to the operation of the plurality of domestic appliances over a cycle of operation,

wherein the monitoring device is configured to:

receive, from a domestic appliance in the plurality of domestic appliances, a time series of data relating to the operation of the domestic appliance over a cycle of operation; and

determine the state of operation of the domestic appliance based on comparing the received time series with a model of time series of data corresponding to the operation of the plurality of domestic appliances over a cycle of operation.

64. Apparatus according to claim 63, wherein the domestic appliance is a domestic boiler and/or a washing machine.

65. Apparatus according to any one of claims 63 or 64, wherein the domestic appliance comprises a controller configured to:

receive data from sensors and/or from components of the domestic appliance; and

send data to the monitoring device over the network.

66. A device substantially as hereinbefore described with reference to and/or as illustrated in Figures 1, 2 and/or 3 of the accompanying drawings.

67. Apparatus substantially as hereinbefore described with reference to and/or as illustrated in Figures 1, 2 and/or 3 of the accompanying drawings.

68. A method substantially as hereinbefore described with reference to and/or as illustrated in Figures 4, 5 and/or 6 of the accompanying drawings.

69. A computer program product comprising program instructions to program a processor to carry out data processing of a method according to any one of claims 1 to 39 or 68, or to program a processor to provide a device of any one of claims 40 to 62 or 66, or to provide an apparatus of any one of claims 63 to 65 or 67.

Claims

1. A method for determining a state of operation of a domestic fluid heating system in a plurality of domestic fluid heating systems, comprising:

receiving, from the domestic fluid heating system, a time series of data relating to the operation of the domestic fluid heating system over a cycle of operation; and

determining the state of operation of the domestic fluid heating system based on comparing the received time series with a model of time series of data corresponding to the operation of the plurality of domestic fluid heating systems over a cycle of operation.

2. The method according to claim 1, wherein the comparing comprises matching a pattern of the received time series of data to a pattern of a model of time series of data, or wherein the comparing comprises retrieving the model of time series of data from a database, optionally wherein the retrieving is performed over a network.

3. The method according to claim 1 or claim 2, wherein the plurality of domestic fluid heating systems is connected to a network, and wherein the receiving of the time series comprises receiving the data over the network, or wherein the plurality of domestic fluid heating systems comprises different types of domestic fluid heating systems, and wherein the model of time series of data corresponds to a type of domestic fluid heating systems, optionally wherein determining the state of operation further comprises identifying the type of the domestic fluid heating system in the plurality of domestic fluid heating systems, based on the received time series of data and/or on identification received from the domestic fluid heating system.

8. The method according to any one of claims 1 to 3, further comprising assembling the model of time series of data based on time series of data relating to the operation of the plurality of domestic fluid heating systems, received from the plurality of fluid heating systems, or further comprising storing a predetermined model of time series of data.

5. The method according to any one of claims 1 to 4, wherein the determining of the state of operation of the domestic fluid heating system comprises diagnosing normal operation of the domestic fluid heating system based on the comparing, or wherein the determining of the state of operation of the domestic fluid heating system comprises diagnosing a fault of the domestic fluid heating system based on the comparing, optionally further comprising triggering diagnosing a fault of a component of the domestic fluid heating system based on the diagnosing of the fault of the domestic fluid heating system, optionally wherein diagnosing a fault comprises diagnosing heating operation of a domestic fluid heating system with a blocked condensate drain and/or heating operation of the domestic fluid heating system with a blocked flue intake, optionally wherein the diagnosing comprises:

using a timing of departure of the time series of data from a model of time series of data corresponding to a normal operation of the heating system over a cycle of operation and/or

displaying processed time series of data in an interface on a display screen of a device, optionally further comprising predicting a need for maintenance based on the diagnosing.

6. The method according to any one of claims 1 to 5, further comprising detecting a trend of operation of the domestic fluid heating system, based on the determining of the state of operation of the domestic fluid heating system over at least two cycles of operation, or further comprising predicting a need for maintenance based on the detecting of the trend.

7. The method according to any one of claim 5 or claim 6 when dependent on claim 5, further comprising triggering maintenance of the domestic fluid heating system based on the predicting, optionally wherein triggering maintenance comprises outputting a maintenance instruction, optionally wherein triggering maintenance comprises maintaining the domestic fluid heating system.

8. The method according to any one of claims 1 to 7, wherein the cycle of operation comprises a period of transient mode of operation and a period of steady mode of operation, or comprising defining a cycle of operation based on:

deriving from a duration taken from a first time series and from a portion of a second time series selected based on the first time series, and/or

using specific parameters in the data,

optionally wherein the duration taken from the first time series is:

a period taken from a power on signal to a power off signal; and/ the specific parameters in the data comprise:

a space heating status value; and/or

a flame detection value.

9. The method according to any one of claims 1 to 8, further comprising assembling the model of time series of data based on data received from the plurality of systems during a set up, or further comprising predefining the model of time series of data based on programming.

10. The method according to any one of claims 1 to 9, performed at least partly locally in the heating system.

11. The method according to any one of claims 1 to 10, wherein the domestic fluid heating system is a domestic boiler.

12. The method according to any one of claims 1 to 11, wherein the received time series of data relates to the operation of a component of the domestic fluid heating system over a cycle of operation, or wherein the time series of data comprises:

raw appliance data; and/or

enhanced data derived from the raw appliance data; and/or
at least a derived feature, optionally wherein the derived feature comprises at least a feature derived from the raw data, or further comprising providing the time series of data in a line graph format, optionally further comprising formatting and/or averaging the time series of data to display the data over a relevant cycle of operation of an fluid heating system.

13. The method according to any one of claims 1 to 12, comprising enabling a user to navigate between different displays of time series of data, or comprising integrating input from external sources, or comprising regularly updating displays of the time series of data, or comprising validating and/or building reference data to train and/or develop an anomaly detector, or comprising defining and/or configuring additional, new, derived features and/or any associated parameters.

14. The method according to any one of the claims 2 to 13, wherein the pattern matching comprises defining groupings of one or more derived features to use against the model time series data.

15. The method according to any one of the claims 1 to 14, wherein the comparing comprises comparison between processed data from multiple fluid heating systems in order to characterise common behaviours and/or differences.

16. A device configured to determine a state of operation of a domestic fluid heating system in a plurality of domestic fluid heating systems, configured to:

receive, from the domestic fluid heating system, a time series of data relating to the operation of the domestic fluid heating system over a cycle of operation; and

determine the state of operation of the domestic fluid heating system based on comparing the received time series with a model of time series of data corresponding to the operation of the plurality of domestic fluid heating systems over a cycle of operation.

17. The device according to claim 16, further configured to perform a method according to any one of claims 2 to 15.

18. The device according to claim 16 or claim 17, further configured to retrieve the model of time series of data from a database, optionally further configured to retrieve the model over a network.

19. The device according to any one of claims 16 to 18, wherein the domestic fluid heating system is a domestic boiler.

20. A computer program product comprising program instructions to program a processor to carry out data processing of a method according to any one of claims 1 to 15, or to program a processor to provide a device of any one of claims 16 to 19.