

CLAIMS:

1. A method of sleep stage detection, comprising:

receiving a first vital sign feature including a plurality of first feature values corresponding to respective ones of a plurality of epochs; and

5 performing a first logistic regression operation to calculate a first indication value for each intermediate one of the epochs based on the corresponding first feature value and those of preceding and succeeding ones of the epochs, the first indication value being descriptive of a sleep stage of the corresponding intermediate epoch.

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2. The method of claim 1, wherein the first vital sign feature relates to one of a heart rate, a pulse shape variability and a convoluted high frequency power of heart rate variability.

15 3. The method of claim 1 or 2, wherein the first logistic regression operation includes weighting and sigmoid operations.

4. The method of any one of claims 1 to 3, further comprising:

receiving a second vital sign feature including a plurality of second

20 feature values corresponding to respective ones of the epochs;

performing a second logistic regression operation to calculate a second indication value for each intermediate one of the epochs based on the

corresponding second feature value and those of the preceding and succeeding ones of the epochs, the second indication value being descriptive of the sleep stage of the corresponding intermediate epoch; and

performing a further logistic regression operation to determine the sleep
5 stage of each intermediate one of the epochs based on the corresponding first and second indication values.

5. The method of claim 4, wherein one of the logistic regression operations have weight values different from those of another one of the logistic regression
10 operations.

6. The method of claim 4 or 5, further comprising:

receiving a third vital sign feature including a plurality of third feature values corresponding to respective ones of the epochs; and

15 performing a third logistic regression operation to calculate a third indication value for each intermediate one of the epochs based on the corresponding third feature value and those of the preceding and succeeding ones of the epochs,

wherein the further logistic regression operation is performed to
20 determine the sleep stage of each intermediate one of the epochs further based on the corresponding third indication value if the corresponding third indication value is descriptive of the sleep stage of the corresponding intermediate epoch.

7. A method of creating a model for logistic regression, comprising:

receiving a vital sign feature in association with reference sleep stage information;

5 generating, from the vital sign feature and the reference sleep stage information, a cross validation set including a plurality of subsamples;

calculate each one of the subsamples with reference to other ones of the subsamples using a model with each of a plurality of machine learning parameter sets; and

10 associating the model with one of the parameter sets based on a comparison of the reference sleep stage information with a result of the calculation.

8. The method of claim 7, wherein the vital sign feature relates to one of a heart
15 rate, a pulse shape variability and a convoluted high frequency power of heart rate variability.

9. The method of claim 7 or 8, further comprising:

receiving another vital sign feature in association with the reference
20 sleep stage information,

wherein the cross validation set is further generated from the another vital sign feature.

10. The method of any one of claims 7 to 9, wherein the vital sign feature is sliced by at least three consecutive epochs.

5 11. The method of claim 10, wherein the at least three consecutive epochs include, with respect to an intermediate one of the epochs, a preceding one, the intermediate one and a succeeding one of the epochs.

12. The method of claim 10 or 11, wherein the at least three consecutive
10 epochs include 11 epochs.

13. The method of any one of claims 10 to 12, wherein the at least three consecutive epochs are configured to correspond to a total window period of at least 30 minutes.

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14. The method of any one of claims 1 to 13, wherein the vital sign feature is normalised.

15. The method of any one of claims 1 to 14, wherein the vital sign feature is
20 compensated for a missing portion.

16. The method of claim 15, wherein the missing portion is compensated for using max pooling.

17. A method of extracting a heart rate variability feature, comprising:

- 5 convolving a high frequency portion of a heart rate variability power spectral density with a convolution filter to generate a plurality of convolution values representing respective patterns of heart rate variability, the convolution filter relating to a convolutional neural network model; and
- selecting one of the convolution values based on a result of an activation
- 10 function operation performed on the convolution values.

18. The method of claim 17, wherein the selected convolution value corresponds to a largest value resulting from the performed activation function.

- 15 19. The method of claim 17 or 18, wherein the high frequency portion ranges from 0.15 Hz to 0.4 Hz.

- 20 20. The method of any one of claims 17 to 19, wherein the power spectral density is normalised across the high frequency portion and a low frequency portion thereof.

21. The method of any one of claims 17 to 20, wherein the activation function operation relates to one of a rectified linear unit, a soft relu and a sigmoid function.

5 22. A method of creating a model for extracting a heart rate variability feature, comprising:

receiving, in association with reference sleep stage information, a vital sign feature representing a heart rate variability power spectral density; and

creating a model including a convolution filter using machine learning
10 based on the vital sign feature with reference to the reference sleep stage information.

23. The method of claim 22, wherein the vital sign feature is derived from a physiological signal for an interval of three minutes within each interval of five
15 minutes.

24. The method of claim 22 or 23, wherein the vital sign feature is normalised.

25. The method of any one of claims 22 to 24, wherein the machine learning
20 includes a convolutional neural network.

26. A method of deriving a medical dosage, comprising:

receiving sleep stage information of a first time period;
receiving sleep stage information of a second time period for comparison
with that of the first time period; and
providing a medical dosage based on a result of the comparison.

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27. A method of assessing a responsiveness to a medical dosage, comprising:

receiving sleep stage information of a first time period;
receiving sleep stage information of a second time period for comparison
with that of the first time period; and

10 assessing a responsiveness to a medical dosage occurring between the
first and second time periods based on a result of the comparison.

28. The method of claim 26 or 27, wherein the prescriptive medical dosage
relates to at least one of anticonvulsant, benzodiazepines and emazepam.

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29. A computer-readable medium comprising instructions for causing a
processor to perform the method of any one of claims 1 to 28.

30. The computer-readable medium of claim 29, wherein the instructions are
20 adapted to be implemented in firmware.

31. A computing device comprising:

a processor; and

a storage device comprising instructions for causing the processor to perform the method of any one of claims 1 to 28.

5 32. The computing device of claim 31, wherein the storage device is a firmware chip.

33. A wearable device comprising:

10 a storage device comprising instructions for causing the processor to perform the method of any one of claims 1 to 28.

34. The wearable device of claim 33, wherein the storage device is a firmware chip.

15 35. The wearable device of claim 33 or 34, being in the form of a wristwatch.