

Claims

1. A method of deriving mean arterial pressure of a subject, the method comprising:

5 (i) receiving data from an optical sensing module relating to at least one cardiac cycle of a bio-signal from the subject;

(ii) normalizing the received data relating to the at least one cardiac cycle;

10 (iii) calculating an area enclosed under a normalized waveform signal of the normalized received data to obtain a normalized area;

(iv) calculating a heart rate of the subject from the at least one cardiac cycle; and

(v) deriving the mean arterial pressure from the normalized area and heart rate.

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2. A method of claim 1, wherein the data relates to a plurality of cardiac cycles and the method includes normalizing respective data relating to each of the cardiac cycles; calculating respective areas enclosed by respective normalized data to obtain respective normalized areas; and obtaining an
20 average normalized area from the calculated normalized areas as the normalized area.

3. A method of claim 2, wherein the method further includes calculating respective heart rates from respective pairs of the cardiac cycles that are
25 arranged consecutively; and obtaining an average heart rate from the respective heart rates as the heart rate.

4. A method of any preceding claim, wherein the at least one cardiac cycle includes a pair of cardiac cycles, and wherein calculating the heart rate includes
30 calculating the heart rate according to the equation: $HR = 60/T$,

where HR is the heart rate; and

T is a time period determined between respective consecutive systolic peaks of the pair of cardiac cycles that are arranged consecutively.

5. A method of any of claims 1 to 3, wherein calculating the heart rate includes calculating the heart rate according to the equation: $HR = 60/T$,

where HR is the heart rate; and

5 T is a time period determined between respective consecutive valleys of the at least one cardiac cycle.

6. A method of any preceding claim, wherein calculating the area enclosed by the normalized received data includes calculating the area with respect to a time axis which defines the at least one cardiac cycle.

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7. A method according to claim 6, further comprising calculating an outlier area and subtracting the outlier area from the calculated area to obtain the normalised area.

15 8. A method according to claim 7, wherein the outlier area is disposed between a baseline of the at least one cardiac cycle and the time axis.

9. A method of claim 1, wherein the received data relating to the at least one cardiac cycle includes a waveform signal thereof, and

20 wherein normalizing the received data includes subtracting a minimum value of the waveform signal from the waveform signal to obtain a subtracted signal, and dividing the subtracted signal by a maximum value of the subtracted signal.

25 10. A method of any preceding claim, further comprising:
obtaining pulse pressure of the subject; and
deriving systolic blood pressure and diastolic blood pressure of the subject according to the respective equations: $DBP = MAP - (1/3) PP$, and $SBP = MAP + (2/3) PP$,

30 where MAP is the mean arterial pressure;
 DBP is the diastolic blood pressure;
 SBP is the systolic blood pressure; and
 PP is the pulse pressure.

11. A computer program for deriving mean arterial pressure of a subject, the computer program downloadable to an electronic device and includes a set of instructions, when executed, is arranged to control a processor of the electronic device to:

- 5 (i) receive data from an optical sensing module relating to at least one cardiac cycle of a bio-signal from the subject;
- (ii) normalize the received data relating to the at least one cardiac cycle;
- (iii) calculate an area enclosed under a normalized waveform signal of the normalized received data to obtain a normalized area;
- 10 (iv) calculate a heart rate of the subject from the at least one cardiac cycle; and
- (v) derive the mean arterial pressure from the normalized area and heart rate.

15 12. A computer program according to claim 11, wherein the computer program is downloadable over the internet.

13. A computer program stored in a memory of an electronic device, the computer program having a set of instructions, when executed, is arranged to control a processor of the electronic device to:

- 20 (i) receive data from an optical sensing module relating to at least one cardiac cycle of a bio-signal from a subject;
- (ii) normalize the received data relating to the at least one cardiac cycle;
- (iii) calculate an area enclosed under a normalized waveform signal of the normalized received data to obtain a normalized area;
- 25 (iv) calculate a heart rate of the subject from the at least one cardiac cycle; and
- (v) derive mean arterial pressure of the subject from the normalized area and heart rate.

30 14. A computer program according to any of claims 11 to 13, wherein the area enclosed by the normalized received data is calculated by calculating the enclosed area with respect to a time axis which defines the at least one cardiac cycle.

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15. A computer program according to claim 14, wherein the processor is further controlled to: calculate an outlier area and subtract the outlier area from the calculated area to obtain the normalised area.

5 16. A computer program according to claim 15, wherein the outlier area is disposed between a baseline of the at least one cardiac cycle and the time axis.

17. Apparatus for deriving mean arterial pressure of a subject, the apparatus
10 comprising:

(i) a receiver for receiving data from an optical sensing module relating to at least one cardiac cycle of a bio-signal from the subject;

(ii) a processor for:

15 (a) normalizing the received data relating to the at least one cardiac cycle;

(b) calculating an area enclosed under a normalized waveform signal of the normalized received data to obtain a normalized area;

(c) calculating a heart rate of the subject from the at least one cardiac cycle; and

20 (d) deriving the mean arterial pressure from the normalized area and heart rate.

18. Apparatus of claim 17, wherein the apparatus is in the form of an electronic device.

25 19. Apparatus of claim 18, wherein the electronic device is a telecommunications device or an optical measurement device.

30 20. Apparatus of claim 17, wherein the apparatus includes an optical measurement device and a telecommunications device having the receiver; and wherein the optical measurement device includes a signal sensing device for obtaining the bio-signal from the subject, and a data processing module for determining data relating to the bio-signal, wherein the receiver of the telecommunications device is arranged to receive the determined data of the
35 bio-signal.

- 5 21. Apparatus according to any of claims 17 to 20, wherein the area enclosed by the normalized received data is calculated by calculating the enclosed area with respect to a time axis which defines the at least one cardiac cycle.
- 10 22. Apparatus according to claim 21, wherein the processor is further configured to calculate an outlier area and subtract the outlier area from the calculated area to obtain the normalised area.
23. Apparatus according to claim 22, wherein the outlier area is disposed between a baseline of the at least one cardiac cycle and the time axis.