Claims

1. A system for use in analysis of electrograms, the system comprising:

a signal generator for generating an input signal;

an input electrode for applying an input signal to a driving region of a heart organ;

an output electrode for receiving an output signal at a driven region of the heart organ, so as to record a value thereof;

a processing system arranged to receive signals indicative of said recorded value from the output electrode for analysing conduction paths through the heart organ,

wherein the signal generator is arranged to generate an input signal comprising a plurality of pulses, individual said pulses being spaced from each other by a pacing interval;

and wherein the processing system is arranged to identify signal delay between the input signal and the output signal on the basis of the signal received by the output electrode in relation to the plurality of pulses,

characterized in that the processing system is arranged to identify a rate of variation in signal delay over a range of values of pacing interval; ~~.~~

~~2. A system according to claim 1,~~ wherein said processing system is arranged to identify first and second rates of variation in signal delay within the range of values of pacing interval; **and** ~~.~~

~~3. A system according to claim 2,~~ wherein said processing system is further arranged to compare the first and second rates of variation in signal delay so as to generate a parameter value indicative of a difference in said first and second rates of variation in signal delay.

24. A system according to claim ~~1-3~~, wherein said processing system is further arranged to compare said generated parameter value with at least one

known parameter value, so as to identify one of a plurality of physiological cardiac conditions.

35. A system according to claim 1 or 2 ~~3 or 4~~, wherein said processing system is arranged to use the output signal so as to construct a graphical representation of output potential against the pacing interval, and said first and second rates of variation in signal delay relate to said graphical representation.

46. A system according to claim 3 ~~5~~, wherein said first and second rates of signal delay relate to the gradient of a first portion of the graphical representation, and the gradient of a second portion of the graphical representation, respectively.

57. A system according to claim 4 ~~6~~, wherein said parameter value is given by an angle between the gradient of the first portion of the graphical representation, and the gradient of the second portion of the graphical representation.

68. A system according to claim 5 ~~7~~, wherein if said parameter value is lower than 150° a first physiological cardiac condition is identified and, if said parameter value is higher than 150°, a second physiological cardiac condition is identified.

79. A system according to claim 5 or 6 ~~7 or 8~~, wherein if said parameter value is between 115° and 135° a first physiological cardiac condition is identified and, if said parameter value is between 155° and 170°, a second physiological cardiac condition is identified.

810. A system according to any of claims 1 to 7 ~~3 to 9~~, wherein said processing system is further arranged to compare said parameter value with an average parameter value, and wherein, if said parameter value is lower than said

average parameter value, a first physiological cardiac condition is identified and, if said parameter value is higher than said average parameter, a second physiological cardiac condition is identified.

9~~11~~. A system according to any of claims **1 to 8** ~~3 to 10~~, wherein the processing system is arranged to identify a rate of variation in signal delay over a range of values of pacing interval for a plurality of heart organs, and wherein said processing system is further arranged to:

derive a respective said parameter value for each of said plurality of heart organs, to give a plurality of parameter values; and

derive an average of said plurality of parameter values, to give an average parameter value; and

compare said average parameter value to a parameter value from a heart organ,

wherein, if said parameter value is lower than said average parameter value, a first physiological cardiac condition is identified and, if said parameter value is higher than said average parameter value, a second physiological cardiac condition is identified.

10~~12~~. A system according to any of claims **6 to 9** ~~8 to 11~~, wherein the first physiological cardiac condition is long QT syndrome.

11~~13~~. A system according to any of claims **6 to 10** ~~8 to 12~~, wherein the second physiological cardiac condition is hypertropic cardiomyopathy.

~~14. A system according to claim 1, wherein the processing system is arranged to:~~

~~process the output signal by correlating the output signal with a first template to produce a first correlated trace;~~

~~process the output signal by correlating the output signal with a second template to produce a second correlated trace; and~~

~~compare said first correlated trace with said second correlated trace, so as to produce an output indicative of similarities in said first and second correlated traces, and thereafter utilise the produced output for identifying said signal delay, whereby to identify said rate of variation.~~

~~15. A system according to claim 1,~~

~~wherein the pacing interval between a first pulse of said plurality of pulses and a second pulse of said plurality of pulses is arranged to increase from a first value t_1 to a second value t_2.~~

~~16. A system according to claim 15, wherein t_1 is less than 350ms.~~

~~17. A system according to claim 15 or 16, wherein t_2 is greater than 350ms.~~

12 ~~18.~~ ~~A system according to claim 1,~~ **A system for use in analysis of electrograms, the system comprising:**

a signal generator for generating an input signal;

an input electrode for applying an input signal to a driving region of a heart organ;

an output electrode for receiving an output signal at a driven region of the heart organ, so as to record a value thereof;

a processing system arranged to receive signals indicative of said recorded value from the output electrode for analysing conduction paths through the heart organ,

wherein the signal generator is arranged to generate an input signal comprising a plurality of pulses, individual said pulses being spaced from each other by a pacing interval;

and wherein the processing system is arranged to identify signal delay between the input signal and the output signal on the basis of the signal received by the output electrode in relation to the plurality of pulses,

characterized in that the processing system is arranged to identify a rate of variation in signal delay over a range of values of pacing interval;

wherein the plurality of pulses comprises a first set of pulses, a second set of pulses and a third set of pulses, individual ones of the first set of pulses being spaced from individual ones of the second set of pulses by a first pacing interval, and individual ones of the first set of pulses being spaced from individual ones of the third set of pulses by a second pacing interval, **wherein the processing system is arranged to identify a rate of variation in signal delay over a range of values of the first pacing interval and the second pacing interval so as identify a rate of variation in signal delay over a range of values of the first pacing interval and the second pacing interval**.

13 ~~19~~. A system according to claim ~~18~~ **12**, wherein said first pacing interval is a constant value.

14 ~~20~~. A system according to claim ~~18 or 19~~ **13 or 12**, wherein said second pacing interval is a constant value.

15 ~~21~~. A system according to claim ~~18 or 19~~ **12 or 13**, wherein said second pacing interval varies.

16 ~~22~~. A system according to any of claims ~~18 to 21~~ **12-15**, wherein said second pacing interval is shorter than said first pacing interval.

~~23. A system according to any of claims 18 to 22, wherein the processing system is arranged to identify a rate of variation in signal delay over a range of values of the first pacing interval and the second pacing interval so as identify a rate of variation in signal delay over a range of values of the first pacing interval and the second pacing interval.~~

17 ~~24~~. A system according to **any of** claim**s** ~~23~~ **12-16**, wherein the processing system is further arranged to derive first and second rates of variation

in signal delay within the range, and to compare the first and second rates of signal delay so as to generate a function indicative of said variation in signal delay over a range of values of the first pacing interval and the second pacing interval.

18 ~~25~~. A system according to **any of** claim**s** ~~23 or 24~~ **12-17**, wherein said processing system is further arranged to use the output signal so as to construct a graphical representation of recorded output potential against the first pacing interval and the second pacing interval, wherein said graphical representation comprising a surface, and wherein said first and second rates of variation in signal delay relate to said graphical representation.

19 ~~26~~. A system according to claim ~~25~~ **18**, wherein said first and second rates of variation in signal delay relate to a first plane, parallel to a plane normal to the surface of a first portion of the graphical representation, and a second plane, parallel to a plane normal to the surface of the second portion of the graphical representation, respectively.

20 ~~27~~. A system according to claim ~~26~~ **19**, wherein said function is derived from a line of intersection between said first plane and said second plane.

21 ~~28~~. A system according to claim ~~27~~ **20**, wherein said processing system is further arranged to compare said function with a range of known functions, to identify one of a plurality of physiological cardiac conditions.

~~29. A system according to any preceding claim, wherein the system comprises at least four output electrodes for receiving an output signal at a respective plurality of driven regions of the heart organ.~~

~~30. A system according to claim 1, wherein~~

~~at least one of said driving region or driven region of the heart corresponds to a localized position of myocardial disarray.~~

~~31. A method of analysis of electrograms recorded from a heart organ, the method comprising the steps of:~~

~~evaluating signals indicative of a recorded value indicative of a signal output by a region of the heart organ generated in response to an input signal, the input signal comprising a plurality of pulses, the pulses being spaced from each other by a pacing interval,~~

~~wherein the method further comprises the step of identifying a signal delay between the input signal and the output signal on the basis of the output signal received in relation to the plurality of pulses,~~

~~characterized in that the method further comprises the step of identifying a rate of variation in signal delay over a range of values of pacing interval.~~

an output electrode for receiving an output signal at a driven region of the heart organ, so as to record a value thereof;

a processing system operable to receive signals indicative of said recorded value from the output electrode for analysing conduction paths through the heart organ,

wherein the signal generator is arranged to generate an input signal comprising a plurality of pulses, individual said pulses being spaced from each other by a pacing interval;

and wherein the processing system is arranged to identify signal delay between the input signal and the output signal on the basis of the signal received by the output electrode in relation to the plurality of pulses,

characterized in that the processing system is arranged to identify a rate of variation in signal delay over a range of values of pacing interval; ~~.~~

wherein said processing system is arranged to identify first and second rates of variation in signal delay within the range of values of pacing interval; and ~~.~~

wherein said processing system is further arranged to compare the first and second rates of variation in signal delay so as to generate a parameter value indicative of a difference in said first and second rates of variation in signal delay.

Thus, **the first aspect** ~~embodiments~~ of the present invention provide**s** a system adapted for determining a characteristic derivable from an electrogram indicative of a cardiac condition.

~~The processing system may be arranged to identify first and second rates of variation in signal delay within the range of values of pacing interval, thereby enabling different rates of variation in signal delay to be used in an analysis.~~

~~The processing system may be further arranged to compare the first and second rates of variation in signal delay so as to generate a parameter having a value indicative of a difference in said first and second rates of variation in signal delay, thereby allowing the different rates of variation in signal delay to be quantified.~~

The processing system may be further arranged to compare said parameter with at least one known parameter value, so as to identify one of a plurality of physiological cardiac conditions.

The processing system may be arranged to use the output signal so as to construct a graphical representation of output potential against the pacing interval. With such

arrangements the first and second rates of variation in signal delay typically relate to said graphical representation. More specifically, the

value is higher than said average parameter value, a second physiological cardiac condition is identified.

This allows a cardiac condition to be identified in a population of patients, and further, it allows the probability that a patient has a cardiac condition to be determined, relative to the population sampled.

The first physiological cardiac condition may be long QT syndrome and the second physiological cardiac condition may be hypertropic cardiomyopathy.

~~In another arrangement the processing system may be arranged to:~~

~~process the output signal by correlating the output signal with a first template to produce a first correlated trace;~~

~~process the output signal by correlating the output signal with a second template to produce a second correlated trace; and~~

~~compare said first correlated trace with said second correlated trace so as to produce an output indicative of similarities in said first and second correlated traces, and thereafter utilise the produced output for identifying said signal delay, whereby to identify said rate of variation.~~

~~This provides a means by which an electogram can be filtered using at least two templates, and is advantageously used to remove noise from a signal.~~

~~In another arrangement the pacing interval between a first pulse of said plurality of pulses and a second pulse of said plurality of pulses is arranged to increase from a first value t_1 to a second value t_2.~~

~~This provides a system which can perform an electrogram process which reduces the effect of altering the blood flow to the heart. In some arrangements t_1 may be less than approximately 350ms and t_2 may be greater than approximately 350ms.~~

In accordance with a second aspect of the invention, there is provided a system for use in analysis of electrograms, the system comprising:

a signal generator for generating an input signal;

an input electrode for applying an input signal to a driving region of a heart organ;

an output electrode for receiving an output signal at a driven region of the heart organ, so as to record a value thereof;

a processing system arranged to receive signals indicative of said recorded value from the output electrode for analysing conduction paths through the heart organ,

wherein the signal generator is arranged to generate an input signal comprising a plurality of pulses, individual said pulses being spaced from each other by a pacing interval;

and wherein the processing system is arranged to identify signal delay between the input signal and the output signal on the basis of the signal received by the output electrode in relation to the plurality of pulses,

characterized in that the processing system is arranged to identify a rate of variation in signal delay over a range of values of pacing interval;

~~In a yet further arrangement~~ **wherein** the plurality of pulses comprises a first set of pulses, a second set of pulses and a third set of pulses, individual ones of the first set of pulses being spaced from individual ones of the second set of pulses by a first pacing interval; and individual ones of the first set of pulses being spaced from individual ones of the third set of pulses by a second pacing interval**, wherein the processing system is arranged to identify a rate of variation in signal delay over a range of values of the first pacing interval and the second pacing interval so as identify a rate of variation in signal delay over a range of values of the first pacing interval and the second pacing interval.**

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In this arrangement, because a greater number of data are generated, the system allows greater scope for analysis of the electrograms produced. In terms of pacing intervals, any one, or a combination of, the following can be used: the first pacing interval may be a constant value; the second pacing interval may be a constant value or the second pacing interval may vary; the second pacing interval may be shorter than said first pacing interval.

~~The processing system may be arranged to identify a rate of variation in signal delay over a range of values of first pacing interval and second pacing interval so as identify a rate of variation in signal delay over a range of values of first pacing interval and second pacing interval.~~

The processing system may be further arranged to derive first and second rates of variation in signal delay within the range, and to compare the first and second rates of signal delay so as to generate a function indicative of said variation in signal delay over a range of values of first pacing interval and second pacing interval.

The processing system may be further arranged to use the output signal so as to construct a graphical representation of recorded output potential against the first pacing interval and second pacing interval; in view of the fact there are two pacing intervals, the graphical representation preferably comprises a surface, and said first and second rates of variation in signal delay relate to said graphical representation.

The first and second rates of variation in signal delay may relate to a first plane, positioned parallel to a plane normal to the surface of a first portion of the graphical representation, and a second plane, positioned parallel to a plane normal to the surface of the second portion of the graphical representation, respectively.

The function may be derived from a line of intersection between said first plane and said second plane.

The processing system is further arranged to compare said function with a range of known functions, to identify one of a plurality of physiological cardiac conditions.