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(54) **Title**: A MONITORING OR PREDICTING SYSTEM AND METHOD OF MONITORING OR PREDICTING

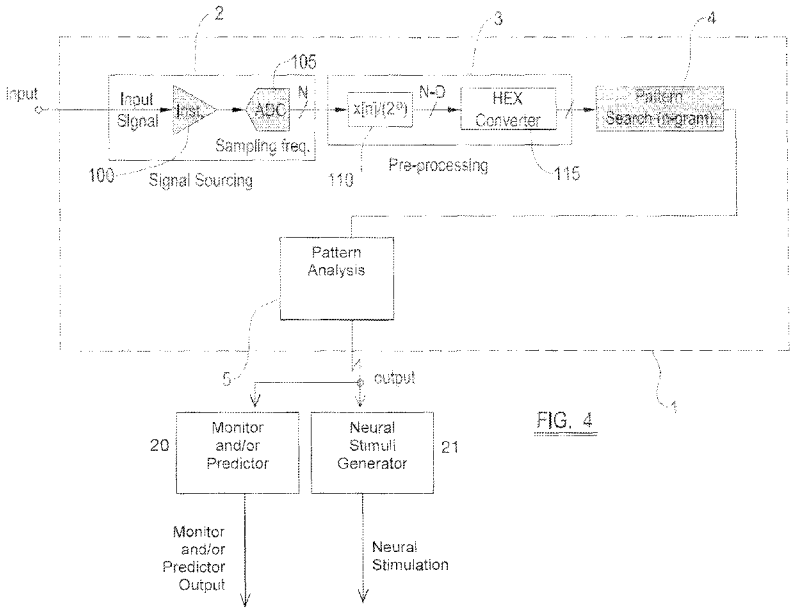

FIG. 4

(57) **Abstract**: A monitoring or predicting system to detect the onset of a neurological episode, the system comprising :a neurological electrical input, the input being a digital representation of a neurologically derived signal; a converter to convert the digital signal into a digital data string; a pattern analyser to identify recurring patterns in the digital data string; and a monitor to measure a pattern-derived parameter, wherein an output from the monitor gives an indication of the onset or occasion of a neuronal activity in dependence on the pattern-derived parameter.

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Title: **A MONITORING OR PREDICTING SYSTEM AND METHOD OF MONITORING OR PREDICTING**

Description of Invention

Field of the invention

This invention relates to a monitoring or predicting system and to a method of monitoring or predicting neurological electrical signals.

Background

Major attempts are constantly being made to monitor and predict epileptic seizures. Most predictive methods analyse electrical signals representing neuronal activity in the brain using electrode pickups located at the level of the scalp, externally, under the scalp or deep within the brain.

An electroencephalogram (EEG) is a system for recording electrical activity in the brain produced by the firing of neurons within the brain. Multiple electrodes are placed around the scalp but electrodes can also be placed in direct contact with the brain or within the brain. The EEG signal is composed of different wave patterns operating in a spectrum going from below 4Hz to over 100Hz. There are other mechanisms for detecting and recording neuronal activity such as an electrocorticogram (ECoG) where the signal is derived directly from the cerebral cortex or functional magnetic resonance imaging (FMRI).

Epilepsy is just one example of a potential neurological episode.

In order that the present invention may be more readily understood, embodiments thereof will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 shows a first set of potential electro positions for use with a device or system embodying the present invention;

Figure 2 shows another potential set of electro positions for use with a device or system embodying the present invention;

Figure 3 is a graph showing a relationship between seizure risk and neuronal activity signal anomalies;

Figure 4 is a block diagram of a monitoring or predicting device embodying the present invention;

Figure 5 is a schematic block diagram showing a system embodying the present invention for gather and analysing neuronal activity signals embodying the present invention;

Figure 6 is a table of anomaly results achieved using an embodiment of the system of figure 5;

Figure 7 shows an example of the pattern count during pre-itcal and ictal periods, the ictal period being shaded;

Figure 8 is a graph showing an example of the pattern count varying over time;

Figure 9 shows a graphical user interface designed to analyse neuronal activity data signals in accordance with an embodiment of the invention;

Figure 10 is another block diagram representation of a monitoring or predicting device embodying the present invention.

Table I shows a 10 nibble pattern matrix;

Table II shows an example of a first part of a 9 nibble pattern matrix;

Table III shows an example of a first part of an 8 nibble pattern matrix;

Table IV shows an example of a first part of a 7 nibble pattern matrix;

Table V shows an example of a first part of a 6 nibble pattern matrix;

Table VI shows some initial results distinguishing pre-ictal from ictal periods;

Table VII shows historical results related to pattern count changes when analysing full data sets;

Figure 11 is a snap-shot of over 12000 electronic readings taken from a single patient, the bold trace reflecting normal state and the fainter trace representing readings taken from the same patient during seizure;

Figure 12 is a detail of the electronic readings from figure 11 running from electronic readings 4000 to 5200;

Figure 13 is a detail of the electronic readings from figure 11 running from electronic readings 4800 to 5040;

Figure 14 shows a case list of available data for different patients;

Figure 15 shows raw data and process data for case 7;

Figure 16 gives a pattern count for 10 nibble patterns identified during seizure conditions – run 13 and a summary of the anomaly percentage; and

Figure 17 gives the same information as the pattern count shown in figure 16 but for run 14 taken from the same patient during a normal state.

Figure 18 shows a second graphical user interface designed to analyse neuronal activity data signals in accordance with an embodiment of the invention.

One embodiment of the present invention is a neurological signal monitoring or predicting device. The device receives input from one or more sensors which are suitable for receiving signals indicative of neuronal activity from the brain.

Electrodes or electrical contacts are the preferable form of sensors to detect neuronal activity from the brain, i.e. neuronal activity sensors. For the sake of convenience, this specification refers to neuronal activity sensors as electrodes or electrical contacts but non-electrical sensors to detect or derive neuronal activity are possible alternatives or equivalents to electrical sensors. As well as being used as inputs, the electrical contacts may also be configured as outputs to provide neuronal stimulation to a part or parts of the brain.

There are conventions for positioning and fixing of EEG electrodes (see figures 1 and 2) so that aspect will not be discussed further here.

The electrical signals from the brain comprise rhythmic patterns and anomalies. By anomalies, we are referring to electrical signals which are random in nature and do not conform to rhythmic signal patterns. It is one premise of the invention that as the proportion of anomalies to rhythmic patterns in the electrical signal increases, then the likelihood of a neurological

episode such as an epileptic fit also increases. This relationship is shown graphically at figure 3.

Specific identification of individual anomalies, such as signatures, is not necessary to provide useful information to predict or monitor the likelihood of a neurological event such as an epileptic seizure. Some specific anomalies are, however, indicators of the onset of a neurological event.

As well as detecting patterns using signal processing techniques and creating pattern ratios to identify threshold between patterns indicating a normal state and using those patterns to distinguish from a seizure state, one can also use more observational techniques to distinguish between the different classes of signal pattern.

The electrical signals received from EEGs are received as floating point data. The floating point data is then digitised and weighted in accordance with predetermined characteristics which can be pre-set or controlled by a user. Figure 11 shows such a weighted graph derived from the floating point data. In figure 11 the electronic readings are taken at a rate of 256 per second. The bolder line in figure 11 represents a floating point data which has been digitised and weighted, taken from the patient when in a normal state. The fainter trace represents electronic readings taken from the same patient pre-seizure and during seizure. Exactly the same scaling and weighting has been applied to the processed floating point data. It is clear from figure 11 that there is an almost rhythmic nature to the electronic reading when in the normal state. When in the seizure state, the electronic reading is clearly more erratic. An observation can be made looking at this data that the rhythmic electronic readings are characteristic of a normal state and the almost pseudorandom electronic readings are characteristic of a seizure state. These characterisations can be used through electronic processing/signal processing to determine a likelihood of the patient being in the normal state

or in the seizure state. Usefully, when the electronic reading characteristics decay from the almost rhythmic pattern, observance of this decay can be used as a trigger to provide an alert that the patient is moving from a normal state towards a seizure state.

Embodiments of the invention use a number of different measures to make threshold decisions and some of those measures are discussed below. The invention bases decisions on pattern-derived parameters which may involve thresholding or reacting to a profile of a particular pattern-derived parameter. Thus, if a pattern derived parameter exceeds or falls below a predetermined or learned threshold, then a decision can be taken in response to that and an indicator given. Similarly, pattern-derived parameters can be profiled so when a parameter follows a particular trend such as decaying, then a decision can be taken in response to that and an indicator given. A pattern-derived parameter is a parameter derived from an observation of or operation on a digital data string which gives information about one or more patterns that recur in the digital data string. Examples of pattern-derived parameters are: the number of patterns identified in a data run; the proportion of patterns of a certain length compared to the total data payload; and combinations of these and including profiles or signatures of pattern-derived parameters such as monitoring the rate of change of a particular pattern-derived parameter.

The thresholds or profiles of pattern-derived parameters can be learnt by the monitoring or predicting system and varied according to individual characteristics of the user being monitored. Monitor learning uses known heuristics, neural network and artificial intelligence techniques.

A basic embodiment of a signal gathering and analysing system takes a neuronal activity signal either in digital form or converts it from analog to digital and then presents the signal as a character string. The character string may be in binary, hexadecimal or other base. The character string is

preferably of the characters 0…9; A…F making up the hexadecimal character set. What is important is that the characters can provide a pattern of characters.

A sliding window of predetermined bit length or nibble length is placed over the data string and the data characters sitting within the window are considered to be a pattern. The pattern and the number of further occurrences of that pattern are logged as the window is slid over the entire data string. The window may be stepped incrementally through the data string bit by bit, in steps of multiple bits or potentially even pseudo-randomly. In basic terms, the system counts the number of occurrences of each pattern and creates various parameters or characterisations of the data based on pattern count. Variations in pattern count have been shown to provide an indication of whether or not the brain is in a pre-ictal or ictal period. The system also includes an output giving an indication of the onset of an ictal state based on the parameters derived from or characterisation of the pattern count.

The most basic embodiment of a monitoring or predicting system makes use of this relationship between pattern count and changes in neuronal activity to provide a monitoring or predicting system to provide a warning to a user based on an analysis which determines whether there has been a change in pattern count indicative of a change in neuronal activity indicative of onset of a seizure or the like. The analysis is based on internally stored historical ratios of pattern counts or can be processed by the monitoring or predicting device on the fly and compared with predetermined thresholds given the different parameters for the incoming data and the user.

The output of the monitoring or predicting system can be a wired output, a wireless output, a Bluetooth™ output, an optical output, an audio output or any other mechanism of alerting a user or reporting to a user. A particularly

preferred method is the use of a traffic light indicator giving an alert status continually. The status of the indicator goes from green where there is no indication of onset of an ictal period, through amber where there is a potential risk of onset of an ictal period; to red where an ictal period is indicated as being imminent or ongoing.

The monitoring or predicting device is configured as a piece of electronic hardware with input connections to one or more neuronal activity sensors such as EEG electrodes which form part of a skull cap or an array of electrodes positioned on and attached to the skull. The device is preferably located on headgear or attached to the skull so that the path or distance from the or each sensor to the monitoring or predicting device is as short as possible. The device preferably has an internal power source but can be connected to an external power source.

The monitoring or predicting device 1 in one embodiment of the invention shown in figure 4 comprises a number of modules defined by their functionality. In various embodiments, the modules are: either all held in a common housing of the monitoring or predicting device; or some modules are remote from the skull or body-located monitoring or predicting device and connected thereto by a wired or wireless connection.

There are four basic modules making up the monitoring or predicting device 1: a signal sourcing module 2 which receives input signals representing neuronal activity from sensors; a pre-processing module 3 which takes a sampled signal and creates a data string; a pattern search module 4 which analyses the data string and shows repeated patterns; and a pattern monitor module 5 which analyses the patterns and generates a monitor and/or predictor output in dependence on the analysed patterns.

Figure 14 shows a case list of available historical EEG data taken from patients in various conditions, usually either normal or abnormal, abnormal indicating pre-ictal or ictal state.

In a further embodiment of the device, as shown in figure 4, a neural stimulator is provided to furnish electrical or other stimuli to a part or parts of the brain. The stimuli are preferably furnished in response to the monitor and/or predictor output of the device.

Figure 15 shows the raw data and the process data for case 7. The raw data comprises the original floating point data from the EEG before it has been digitised and weighted. The process data shows the hexadecimal characters representing the digitised and weighted data from which patterns can be derived.

Figure 16 shows the patterns identified in case 7 in run 13 for which the data was captured during seizure. The size of the file is 40732 bits and for a 10 nibble pattern 4156 patterns were identified leaving 36576 anomalies giving an anomaly density or ratio of 89.8%.

Figure 17 shows the results for run 14 of case 7 which is data captured when the same patient in case 7 was in a normal state. Again, the file size is 40732 bits but the number of patterns identified is 39090 leaving only 1642 anomalies, giving an anomaly density or ratio of 4.03%. This conveys an immediate distinction between the pattern/anomaly density or ratio allowing immediate characterisation of the data signals as being either captured during a normal state or during a seizure state. The percentage of anomalies present during a seizure state is vastly greater than the percentage of anomalies present during a normal state. A threshold can be determined or even learned by the monitoring or predicting device which can constantly monitor, for example 10 second readings in real time and make a judgement on

whether the pattern ratio or pattern threshold has been decayed or passed and provide an alert or prediction in response to monitoring of this pattern–derived parameter. Conventional pattern analysis and pattern derivation mechanisms can be used to derive, identify, count and monitor patterns.

Figure 5 shows the modules 2,3,4 and 5 of a monitoring or predicting device 1 as part of a larger and more detailed network which includes the facility to stream live data or run stored data through the modules.

Referring to figure 4, the signal sourcing module 2 has an amplifier 100 or pre-amplifier to receive neuronal activity input signals (an analog signal) preferably from EEG electrodes. Downstream of the amplifier there are one or more analog to digital converters 105 (or a multiplexed analog to digital converter) operating at a sampling frequency fs and having as their input the respective amplified EEG signals from the electrodes 10.

The sampled output of the analog to digital converters 110 is a binary string which is preferably converted to hexadecimal by HEX converter 115. The use of hexadecimal is particularly helpful to gain a visible and direct appreciation of the presence of patterns in the signal being monitored.

An analog-to-digital converter is used with typical sampling frequencies (fs) of 128-512Hz for EEG and ECoG to 10-30KHz for single neuron and local field potential (LFP) signals. The conversion, depending upon the application can result in 8-16bit data. When stored for software (and microcontroller hardware) this information is represented at its lowest level in binary, but in a higher level of abstraction in hexadecimal (HEX). Hence, the data is already available in an alphanumeric format.

The hexagonal output is fed to the pattern search module 4 which is configured in this example as an n-gram model.

Additionally, we can adjust the level of lossiness of the data representation by dividing the data (an N bit number) by 2^D where D is an integer, to result in a reduced data format - i.e. reducing a 16bit number to an 8bit one by dividing down with D = 8.

The n-gram process in the pattern search module 4 extracts any patterns in the signals. Once patterns are extracted the number of significant patterns are counted. A significant pattern is a pattern that has occurred more than 2 times but other threshold limits can be selected and may be usefully varied for different pattern sizes. The greater the pattern size, i.e. string length, the less repeating patterns there will be.

The pattern count is monitored and when the pattern count drops below a historically derived threshold stored in the pattern monitor, the pattern monitor outputs a change of status. A significant pattern count is quantified in two ways: (1) to count out of the number of significant patterns the total number of occurrences of all these patterns and (2) out of the patterns found what percentage were significant. The former is shown in the below results, the latter method quantified similar results so is not shown here. These pattern counts can then be quantified as a ratio between a current window of analysis and a previous window during an inter-ictal state (ictal refers to the state during a seizure).

The hexadecimal output is sampled and patterns identified and counted.

In figure 6, there are four sets of results 6A,6B,6C and 6D. The “NC” columns are data taken in the time prior to a neurological event (pre-ictal). The “ANC2” columns are data taken during a seizure onset and during the event (ictal) – see also the timing diagram at the foot of the table in figure 6.

6A gives the raw results. 6B recognises that certain patterns occur very frequently particularly those patterns representing a saturated signal for a null signal which in hexadecimal terms would equate to "00" or "FF". These patterns are therefore excluded from the list of patterns. 6C removes all repeat patterns from the list of patterns. A repeat pattern is a sub-set of a pattern which occurred in a larger pattern size pattern list.

The other figures give similar pattern matrices for 9, 8, 7 and 6 nibbles taken for the same data string. Tables I to V show the first page of patterns and frequency of occurrence for the five pattern sizes of 10 to 6 nibbles.

Preferably the data is sampled as 6, 7, 8, 9 or 10 nibbles from a sliding window applied to the hexadecimal data output string and the occurrence of each individual distinct nibble pattern is logged. In the 10 nibble pattern matrix shown in Table I, the two most popular occurring 10 nibble patterns in the "NC" data acquisition period are 020100FFFE and 20100FFFEF which patterns both occur 5 times in the "NC" data acquisition period. Many other 10 nibble patterns occur during the "NC" period.

The signal sourcing module receives input signals S1-S7 representing neuronal activity from one or more EEG sensors 10 (see figures 1 and 2) attached to the skull in a conventional manner (of both attachment and/or array). The input signals in this example are electrical signals S1-S7 direct from EEG sensors 10. In other embodiments, the input signals may be remotely streamed from a live feed or a recorded data set.

In the preferred embodiment, the number of repeated patterns in NC is compared to the number of repeated patterns in ANC2. There are usually more repeated patterns in NC rather than ANC2 during the actual seizure. As a consequence, there are less patterns identifiable during a seizure, meaning that there are also more anomalies occurring during seizure hence the

premise of the invention that an increase in the proportion of anomalies to repeated patterns is an indicator or predictor of the onset of a neurological event such as an epileptic seizure.

A relative increase in the number of repeated patterns is a direct indicator of the onset of a neurological episode and is useful information to allow the device to perform an episode prediction function. The likelihood of the onset of a neurological episode increases as the number of repeated patterns increases.

Aspects of the invention deal with one of the bottlenecks of analysis of epileptic seizure activity. An aspect of the invention allows the ability to work with consistent data which is well annotated and databased to establish a framework for future work and storage of results into the same framework. The system shown at figure 5 provides this framework.

Figure 5 shows data acquisition, user interface and processing blocks. In theory each of these components could be placed in a different technological implementation, such as the acquisition being an implantable neural monitoring or predicting device, the user interface being on a mobile phone or PC and the processing units being a web-accessed cloud (such as the Amazon Elastic Compute Cloud). The distribution of these elements will vary depending upon the signal processing requirements (computational complexity) and application space.

Pattern analysis of historical data yields sets of parameters concerning the patterns. Predictions or decisions on whether a neural event is upcoming can be taken by comparing in either relative or absolute terms real-time patterns with stored parameters, pre-determined patterns and thresholds. The monitoring or predicting device provides an output indicative of whether a

neural event is unlikely, likely or imminent, much like a traffic light output: red, amber and green.

The electrodes or electrical contacts that are used to detect neuronal activity from the brain are the inputs to the monitoring or predicting device. These inputs may be reversed to provide a stimulus output. The present invention also includes the provision of neuronal stimulation to a part or parts of the brain.

The stimulus may be provided in response to any of the parameters measured or monitored by the monitoring or predicting device, such as a change in pattern count indicative of a change in neuronal activity, an onset, a seizure or the like. Thus, the traffic light output from the device can be used to trigger a neural stimulation, perhaps targeted stimulation, in an attempt to ameliorate, offset, delay or avoid entirely a neurological episode such as an epileptic seizure. The neural stimulation is provided by a neural stimuli generator 21 which can be a part of the device or connectable to a device output, potentially wirelessly, or wired.

Referring to figure 6, this data was obtained from the University Hospital of Freiburg Epilepsy Centre, Germany. The data used were pre-sampled at 256Hz and quantised using a 128 channel 16-bit data acquisition. All 21 patients' first seizure was used from this data set. There is a pre-ictal period of up to 1 hour in most cases with seizure durations varying from 15-170 seconds. There were multiple types of seizures present including: simple partial, complex and general tonic-clonic.

Conventional pattern analysis techniques were used. The invention does not relate to the analysis technique but in the identification that patterns and pattern ratios of the digitised and sampled data are characteristic of a patient being in normal, pre-ictal and seizures states.

Two sets of tests were conducted with this data. The first set aimed to quantify whether there were pattern differences between seizure/ictal areas when compared against inter and pre-ictal periods. To do this, sample pre-ictal periods equal in size to the seizure period were extracted. The average pattern count between each of 10 sections of pre-ictal data is computed in order to compare against the seizure pattern count. For this analysis we used D = 8 and analysed the data for n-gram sizes of 12 and 14, where one token was one electrical reading in 1byte or 2HEX characters. These results (shown in Table VI) show that in most cases the pattern count (P) compared to the seizure count (S) was considerably different; 18 out of 21 cases showed a ratio that indicated a greater than 25% change in pattern count. These results aim to distinguish pre-ictal from ictal periods.

The second set of tests analysis used the full pre-ictal period, segmented into 5 and 10 second windows. We analysed the data using D = 8 and with n-gram sizes 10 and 14. A typical pattern count found in these data sets is shown in figure 7. The results for all 21 patients are shown in Table VII. Table VII shows heuristic results (related to pattern count changes) when analysing the full data sets. The descriptions refer to the changes that occur that are visible changes compared to the pre-ictal period.

It is clear patterns exist and interestingly some patterns change or exist for certain n-gram sizes but not for others. An interesting pattern was an increase followed by a slow decrease over several minutes – see sharp increase at 60 minutes in figure 8. These findings conclude that out of the 21 patients, 18 can be detected using the features outlined in figure 6. Table VII shows patterns at different n-gram sizes. Patterns are identical using different n-gram sizes while making sure that patterns in an n-gram of 12 are not replicated in an n-gram size of 10, i.e. making sure that patterns are unique and not a subset of a larger pattern in the data. Also, one needs to

identify data parameters (e.g. types of seizure) to identify if certain patterns correlate with patient-specific information.

To gather further historical data and develop pattern parameters and thresholds there is disclosed a modular analysis framework as shown in figure 5.

The system of figure 5 is an open online and/or real-time analysis tool (www.winam.net) with an SQL database that is used to examine multiple cases and runs of data sets and presents in a webpage form as shown I figure 9. As in figure 5 the structure is such that the data sourcing can be through an RSS feed, or offline data source. The processing (n-gram) is implemented through a separate processing cluster allowing multiple parallel processing efficiently. This is an open system that allows users to freely access and carry out the algorithmic techniques described in this paper. The database structure itself is designed to allow users to input multiple patient cases, and for each case run particular data sets (EEG, ECoG, ECG etc...) or parts of these data sets.

Figure 18 shows a second graphical user interface designed to analyse neuronal activity data signals in accordance with an embodiment of the invention. This interface is used to set the parameters, in real-time or offline, of the logics module 4 and/or the downstream analysis module.

In Figure 18, a number of parameters may be monitored and/or adjusted and applied to the data in real time (and not just post-analysis). The listed parameters are not exclusive and other parameters or sub-parameters can also be modified.

The “weighting” parameter refers to the rounding of the EEG signal. For example, the EEG signal may be sampled at 5Hz, and then the number of

samples may be divided by 128 to remove noise - effectively "zooming in" on the results. The signal then needs to be rounded as a 5Hz sample frequency divided by 128 will not give an integer number of samples. In a preferred embodiment, the signal is rounded up.

The "interval" parameter is the window length the user wishes to process cycles in. In one embodiment, the interval length may be 1 minute.

The "frequency" parameter is a frame frequency and relates to the number of frames to be processed. If, for example, the user has 1 hour of data and the 11th to 20th minutes are of interest, the user can skip to the 11th minute and select how many frames will be read – e.g. 20 frames at a 30s interval length.

The "optimiser" parameter determines the optimum pattern length to determine a suitable anomaly ratio. For example, with a pattern length of 2 bits it is likely there will be very few or no anomalies, but with a pattern length of 20 bits, it is likely there will be several anomalies. The optimiser effectively sets a benchmark for the anomaly ratio. In a preferred embodiment, the optimiser parameter determines the pattern length of each pattern type A, B, C, D, (see, for example, Figure 17, where the length of pattern A is 10 nibbles, and patterns B,C and D are 0) such that anomaly ratio is less than 10%. The optimiser can automatically determine the ideal settings for each of the pattern groups (shown as GNBP(A-D) on the user interface). The pattern group settings may be overridden manually by adjusting, respectively, GNBP(A-D) individually or jointly.

The "SD" parameter control relates to the threshold standard deviation of the results.

Other importing functionality is readily implemented as is reporting documentation to further visualise, analyse the results and further develop

pattern-based parameters on which to base neuronal event monitoring or predicting decisions.

When used in this specification and claims, the terms "comprises" and "comprising" and variations thereof mean that the specified features, steps or integers are included. The terms are not to be interpreted to exclude the presence of other features, steps or components.

The features disclosed in the foregoing description, or the following claims, or the accompanying drawings, expressed in their specific forms or in terms of a means for performing the disclosed function, or a method or process for attaining the disclosed result, as appropriate, may, separately, or in any combination of such features, be utilised for realising the invention in diverse forms thereof.

Annex:
WiNam
Core Logic
Jamil El-Imad
May 2010

Neural Binary Pattern Storage Table
(NBPST)

Each pattern group from(A, B, C or D) has a length defined by Pattern_n_length (where n = a, b, c or d) will have a storage table where'unique' patterns are stored. Each pattern stored has an associated count and the last offset (from the start of frame).

Pattern A - (validation A>B>C>D)
Pattern_a_name: xxxxxxxx (Key)
Pattern_a_count: 32,768 (16bit / 2byte)
Pattern_a_last_offset: 32,768 (16bit / 2byte)

Sample:

Pattern_A_name	A1 10 7F 33	3F 51 A2 9F	....	75 00 D1 01
Pattern_A_count	1	3	....	1
Pattern_A_last_offset	1	11	....	23

Pattern B
Pattern_b_name: xxxxxxxx (Key)
Pattern_b_count: 32,768 (16bit / 2byte)
Pattern_b_last_offset: 32,768 (16bit / 2byte)

Pattern C
Pattern_c_name: XXXXXX (Key)
Pattern_C_count: 32,768 (16bit / 2byte)
Pattern_c_last_offset: 32,768 (16bit / 2byte)

Pattern D
Pattern_d_name: XXXXXX (Key)
Pattern_d_count: 32,768 (16bit / 2byte)
Pattern_d_last_offset: 32,768 (16bit / 2byte)

NBP Working Storage

(NBPWS)

Pattern_a_length:	*As per user input:*	2-24 byte patterns
Pattern_b_length:		2-24 byte patterns
Pattern_c_length:		2-24 byte patterns
Pattern_D_length:		2-12 byte patterns

Each data value is 1 byte in length (8bits). Pattern_N_length determines the number of 1 byte patterns that constitute a pattern – example: Pattern_A_length = 3 refers to 'XX XX XX', such as '10 7F 33'.

Offset:	32,768 (16bit / 2byte), initial value -1
LLA:	32,768 (16bit / 2byte), initial value 0

NBP Process

1. **Open Input File** -> Apply weight factor (*user input: Pattern Weight, Weight Range,*) to 1 or 2 byte (2 Character Hex)-

2. **Read Input File** -> *Using user inputs: Skip to, Frame Length, Frame Frequency, Frame Gap*

3. **Write** unformatted data to input_storage_table

4. **Open Exclude List File** (*Using user input: Exclude List*):
   Write to Exclude List Storage Table (ELST)

1. **Start_logic**
   Offest = Offset+1

   If LLA = 0 skip to **Update Pattern Table Routine**

   Compare LLA with Offset range A-D

   Overlap? Y: **Start Logic**
   N: Continue

2. **Update Pattern Table Routine**
   IF Pattern_d_Length > 0 *then*

Compare offset + Pattern_d_Length of input_storage_table to Pattern_d_name table in NBPST.

Duplicate key? Yes: Set duplicate_flag to d, continue
No: Continue

IF Pattern_c_Length > 0 *then*
Compare offset + Pattern_c_Length of input_storage_table to Pattern_c_name table in NBPST.

Duplicate key? Yes: Set duplicate_flag to c, continue
No: Continue

IF Pattern_b_Length > 0 *then*
Compare offset + Pattern_b_Length of input_storage_table to Pattern_b_name table in NBPST.

Duplicate key? Yes: Set duplicate_flag to b, continue
No: Continue

IF Pattern_a_Length > 0 *then*
Compare offset + Pattern_a_Length of input_storage_table to Pattern_a_name table in NBPST.

Duplicate key? Yes: Set duplicate_flag to a, continue
No: Continue

Duplicate_flag = ON? (will equal a, b, c or d)

a. **NO**
Move offset to pattern_a_last_offest
Move 1 to pattern_a_count
Move offset + Pattern_a_length of input_storgae_table to Pattern_a_name

If Pattern_name in ELST **Return to Start_logic**
Else Write table entry into NBPST

Move offset to pattern_b_last_offest
Move 1 to pattern_b_count
Move offset + Pattern_b_length of input_storgae_table to Pattern_b_name

If Pattern_name in ELST **Return to Start_logic**
Else Write table entry into NBPST

Move offset to pattern_c_last_offest
Move 1 to pattern_c_count
Move offset + Pattern_c_length of input_storgae_table to Pattern_c_name

If Pattern_name in ELST **Return to Start_logic**
Else Write table entry into NBPST

Move offset to pattern_d_last_offest
Move 1 to pattern_d_count
Move offset + Pattern_d_length of input_storgae_table to Pattern_d_name

If Pattern_name in ELST **Return to Start_logic**
Else Write table entry into NBPST

Return to Start Logic Loop Till EOF

b. YES
Move offset to pattern_n_last_offest (n = a, b, c or d – found from Duplicate_flag)
Move offset to LLA
Add 1 to pattern_count
Re-Write table entry

If Pattern_count not > ELST count **Return to Start_logic**
Else Update correlation bit map table

Return to Start Logic Loop Till EOF

Claims

1. A monitoring or predicting system to detect the onset of a neurological episode, the system comprising:

a neurological electrical input, the input being a digital representation of a neurologically derived signal;

a converter to convert the digital signal into a digital data string;

a pattern analyser to identify recurring patterns in the digital data string; and

a monitor to measure a pattern-derived parameter, wherein an output from the monitor gives an indication of the onset or occasion of a neuronal activity in dependence on the pattern-derived parameter.

2. A system according to claim 1, wherein the pattern-derived parameter is related to a count or a proportion of recurring patterns in the digital data string.

3. A data acquisition and analysis system comprising:

a neurological electrical input comprising a digital representation of a neurologically derived signal;

a converter to convert the digital signal into a digital data string;

a pattern analyser to identify recurring patterns in the digital data string; and

a monitor to measure a pattern-derived parameter related to a count or a proportion of recurring patterns in the digital data string, wherein an output from the monitor gives an indication of the onset or occasion of a neuronal activity in dependence on the pattern-derived parameter.

4. A system according to any preceding claim, wherein the digital data string is a character data string, a binary data string or a hexadecimal data string.

5. A system according to any preceding claim, wherein the system further comprises a neural stimuli generator for stimulating a part of a brain.6. A method of detecting the onset of a neurological episode comprising:

receiving a neurological electrical input comprising a digital representation of a neurologically derived signal;

converting the digital signal into a digital data string;

identifying recurring patterns in the digital data string;

monitoring a pattern-derived parameter related to a count or a proportion of recurring patterns in the digital data string; and

providing an output giving an indication of the onset or occasion of a neuronal activity in dependence on the pattern-derived parameter.

7. The method of claim 6, further comprising:

weighting the digital signal when converting the digital signal into a digital data string.

8. The method of claim 6 or 7, further comprising:

sampling the digital data string with a bit length of 6, 7, 8, 9 or 10 bits.

9. The method of any of claims 6 to 8, further comprising:

monitoring the rate of change of the pattern-derived parameter.

10. The method of any of claims 6 to 9, further comprising:

counting significant recurring patterns.

11. The method of any of claims 6 to 10, further comprising:

excluding patterns in the data string that are identified as null signals from the significant recurring pattern count.

12. The method of any of claims 6 to 11, further comprising:

detecting or identifying the type of neurological episode.

13. The method of any of claims 6 to 12, wherein the output giving an indication of the onset or occasion of a neuronal activity is determined based on either:

analysing internally stored historical ratios of pattern counts; or

processing by a monitoring device and comparing with a predetermined threshold.

14. The method of claim 13, wherein the predetermined threshold is learned from the user profile using known heuristics, neural network and/or artificial intelligence techniques, or determined by the total number of significant patterns and/or a percentage of significant patterns found.

15. The method of any of claims 5 to 14, further comprising:

stimulating a part of a brain using a neural stimuli generator.

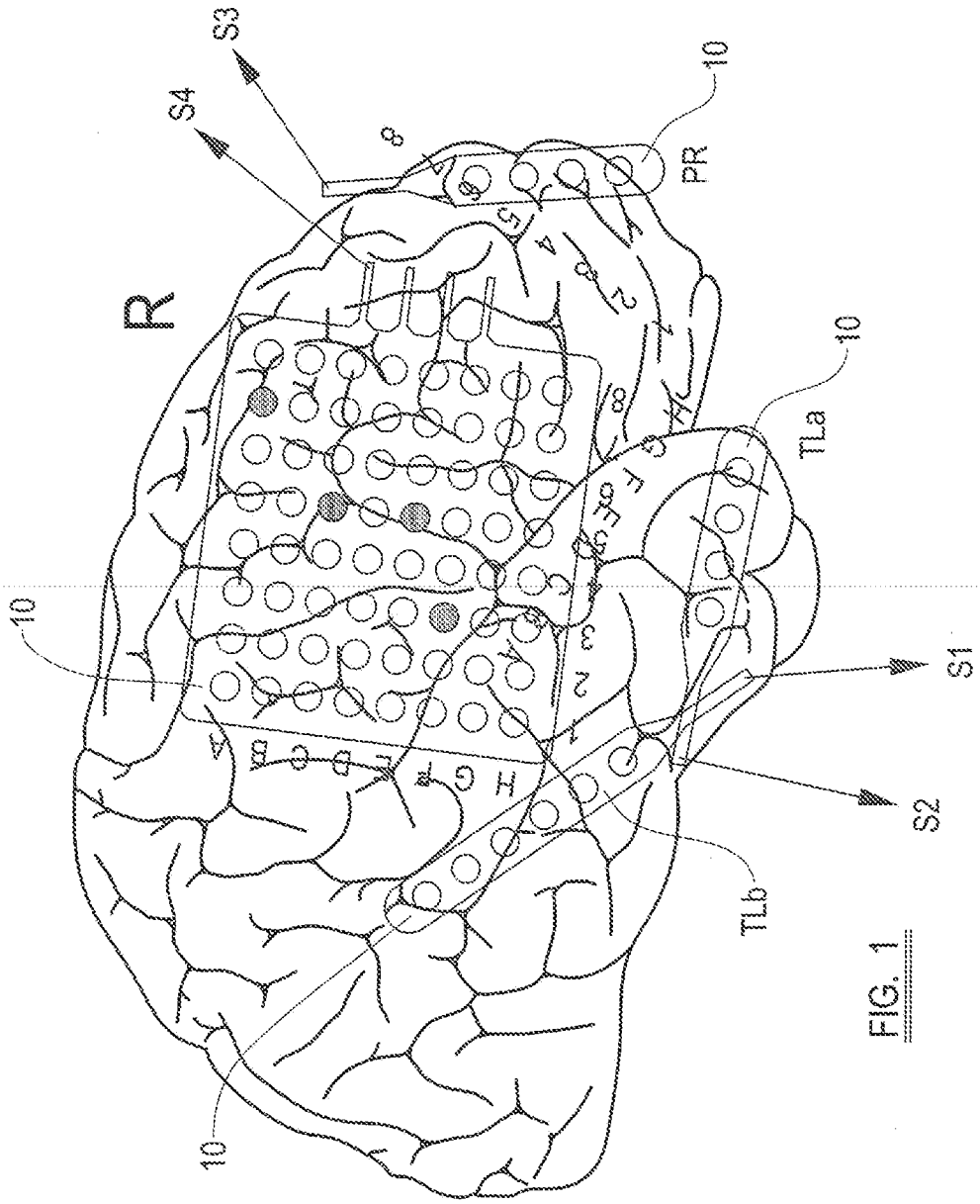


FIG. 1

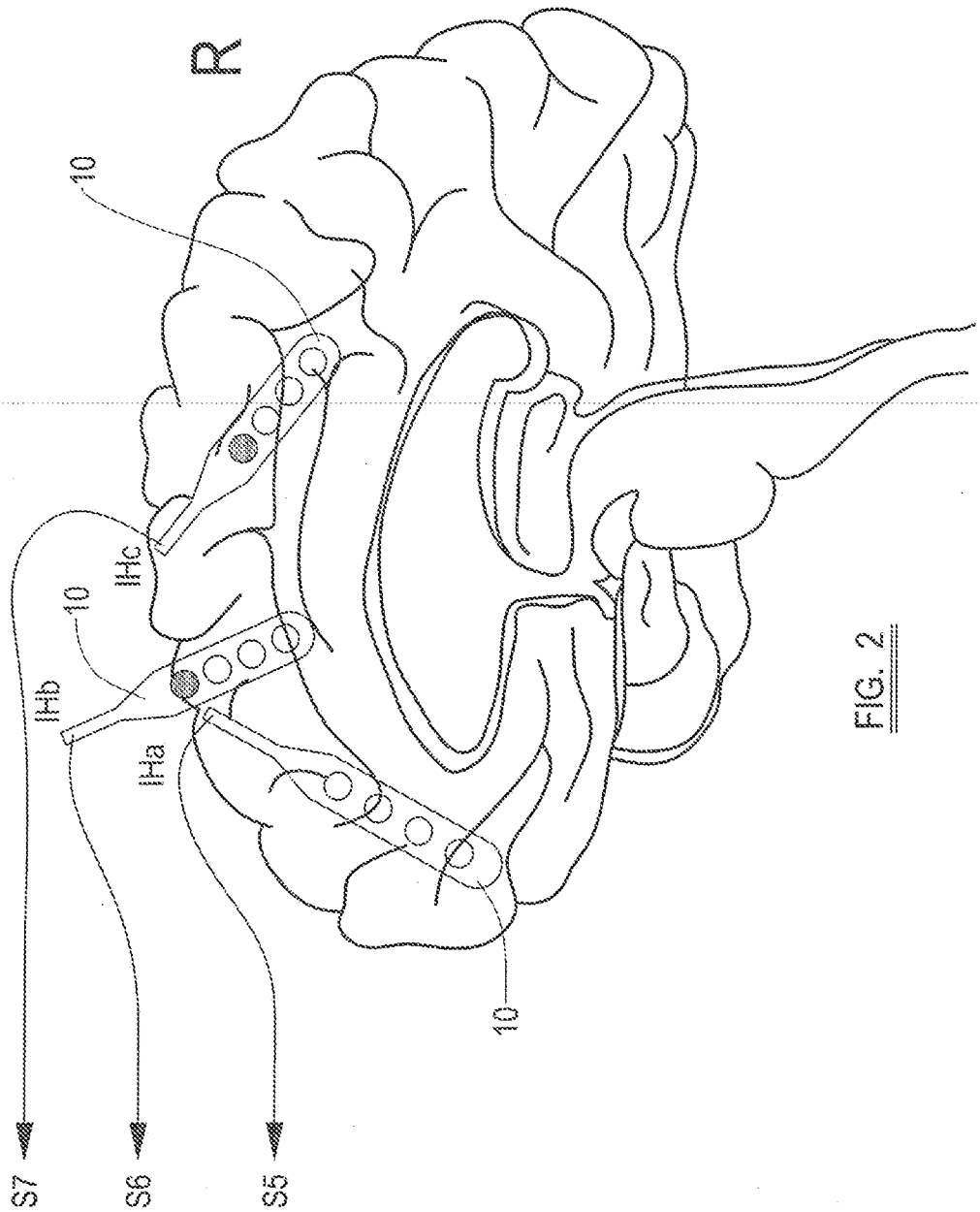


FIG. 2

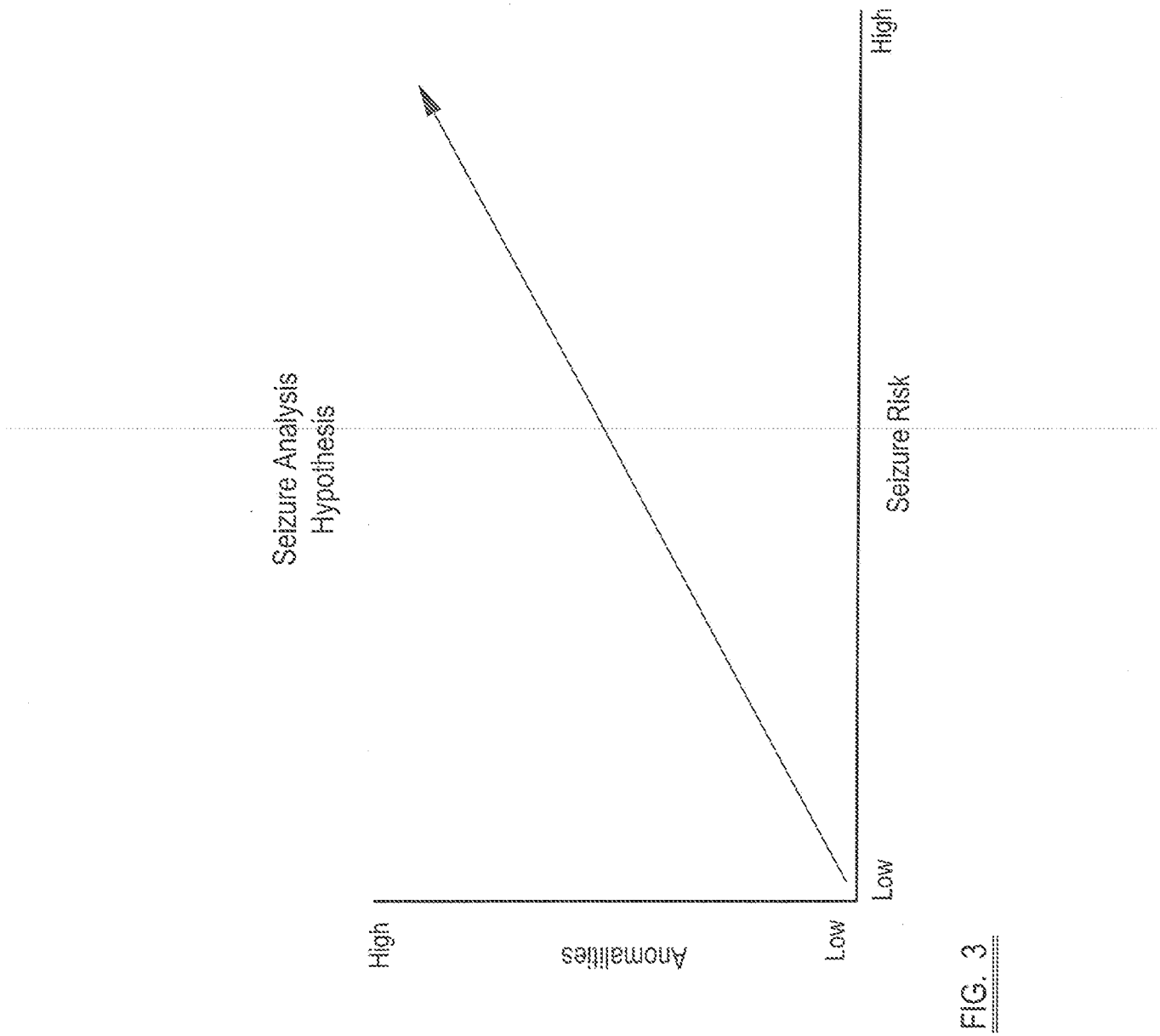

Seizure Analysis
Hypothesis
High
Seizure Risk
Low
High
Anomalities
Low

FIG. 3

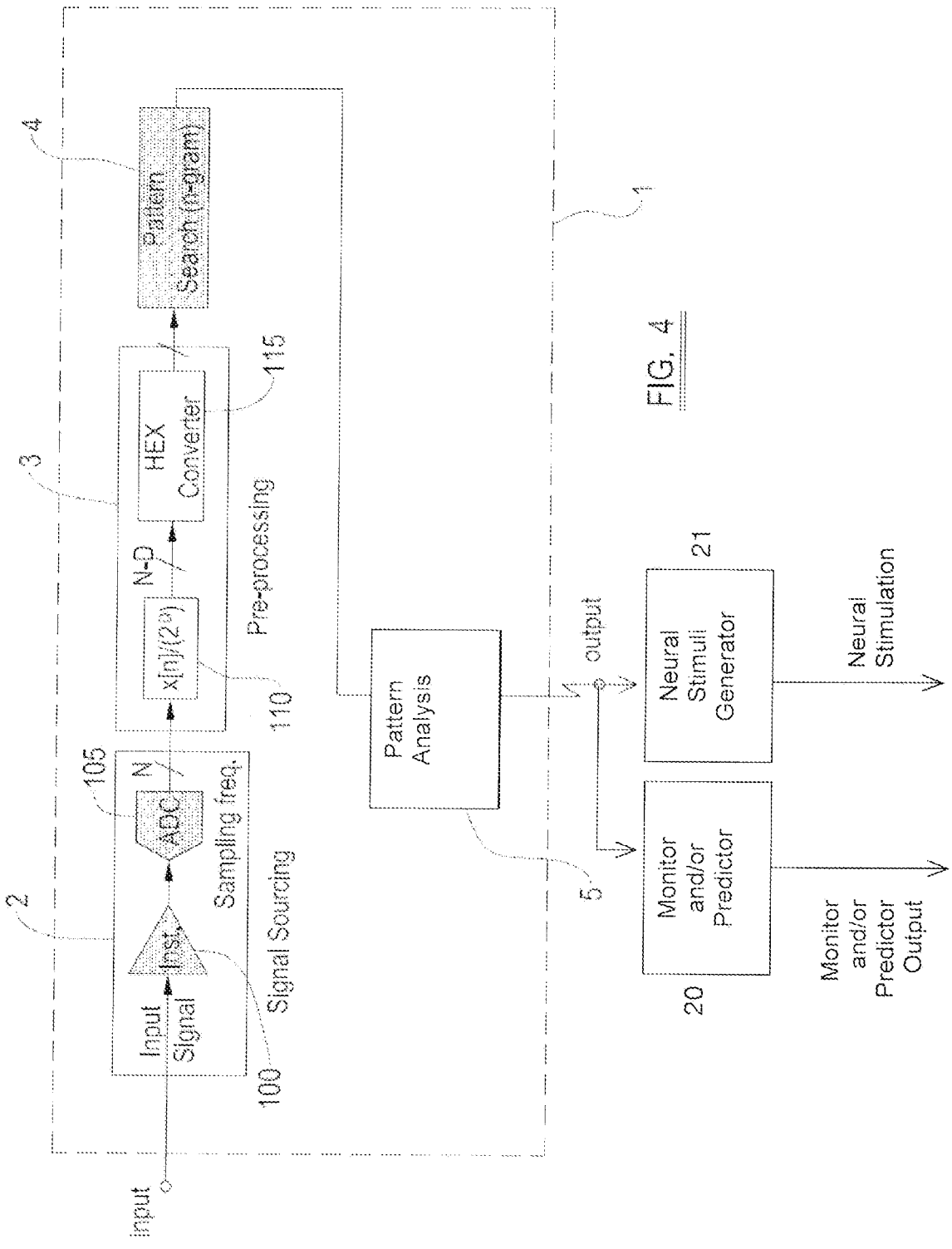
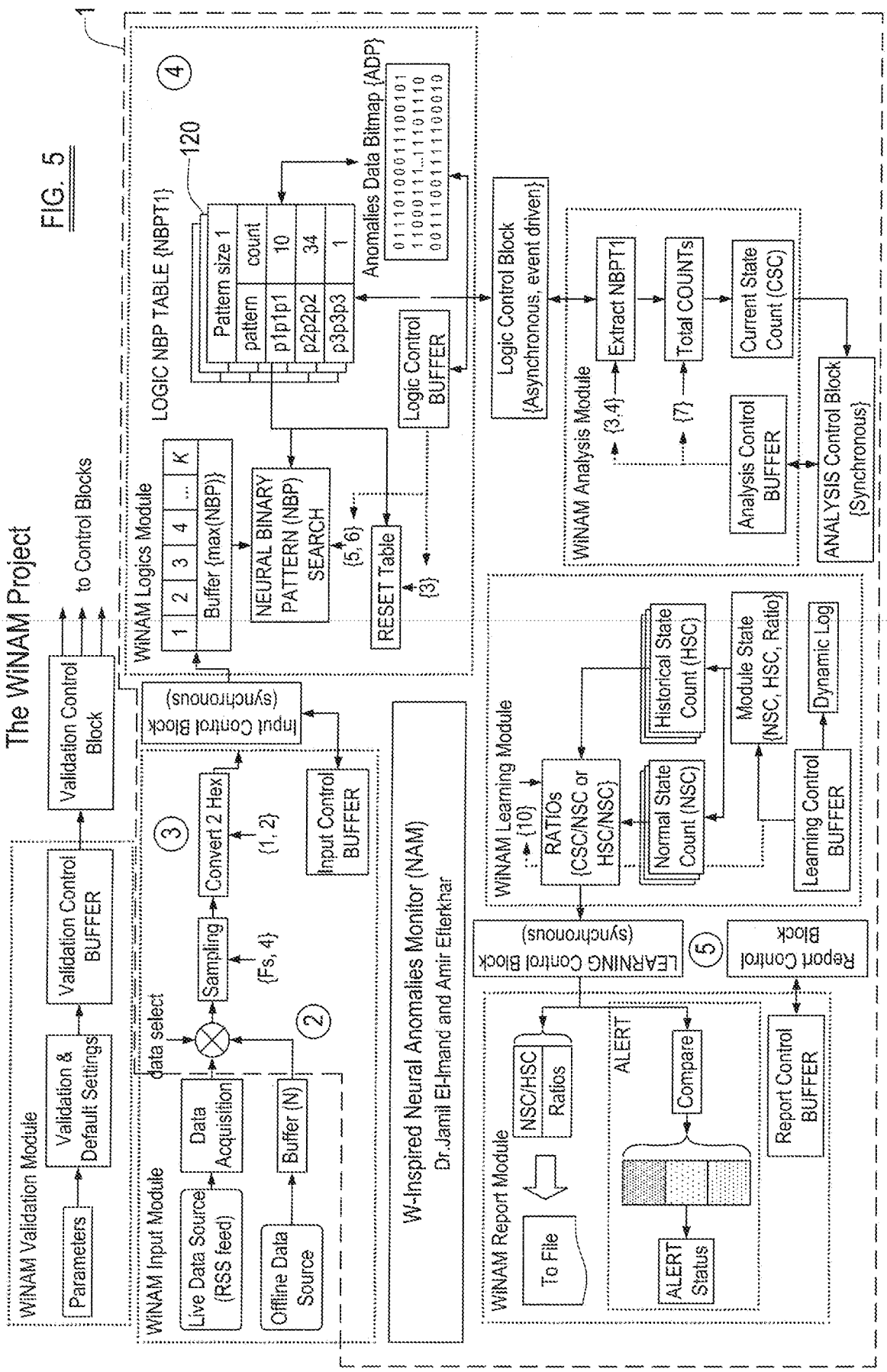

input
Input Signal
Inst
ADC
N
105
Sampling freq.
Signal Sourcing
100
2
x[n]/(2^n)
N-D
HEX Converter
115
Pre-processing
110
3
Pattern Search (n-gram)
4
1
Pattern Analysis
5
output
Neural Stimuli Generator
21
Neural Stimulation
Monitor and/or Predictor
20
Monitor and/or Predictor Output

FIG. 4

FIG. 5


The WiNAM Project
1
WiNAM Validation Module
Parameters
Validation & Default Settings
Validation Control BUFFER
Validation Control Block
to Control Blocks
WiNAM Input Module
Live Data Source (RSS feed)
Offline Data Source
Data Acquisition
Buffer (N)
data select
Sampling
{Fs, 4}
Convert 2 Hex
{1, 2}
Input Control BUFFER
Input Control Block (synchronous)
3
2
WiNAM Logics Module
LOGIC NBP TABLE {NBPT1}
120
4
1 2 3 4 ... K
Buffer (max(NBP))
NEURAL BINARY PATTERN (NBP) SEARCH
{5, 6}
RESET Table
{3}
Pattern size 1
pattern count
p1p1p1 10
p2p2p2 34
p3p3p3 1
Logic Control BUFFER
Anomalies Data Bitmap {ADP}
01110100011100101
11000111...11101110
00111001111100010
Logic Control Block {Asynchronous, event driven}
W-Inspired Neural Anomalies Monitor (NAM)
Dr.Jamil El-Imand and Amir Eftekhar
WiNAM Analysis Module
Extract NBPT1
{3,4}
Total COUNTs
{7}
Current State Count (CSC)
Analysis Control BUFFER
ANALYSIS Control Block {Synchronous}
WiNAM Learning Module
{10}
RATIOs {CSC/NSC or HSC/NSC}
Historical State Count (HSC)
Normal State Count (NSC)
Module State {NSC, HSC, Ratio}
Dynamic Log
Learning Control BUFFER
LEARNING Control Block (synchronous)
5
Report Control Block
WiNAM Report Module
NSC/HSC Ratios
To File
ALERT
Compare
ALERT Status
Report Control BUFFER

Patient	Sex	Age	Seizure Type	H/NC	Origin	Seizure Duration (ANC2) / seconds	NC Location before seizure / hours	6A ANC2 Patterns	6A NC Patterns	6A Ratio	6B ANC2 Patterns	6B NC Patterns	6B Ratio	6C ANC2 Patterns	6C NC Patterns	6C Ratio	6D ANC2 Patterns	6D NC Patterns	6D Ratio
								Seizure onset Normal											
1	f	16	SP, CP	NC	Frontal	19.49	6.16	538	1756	0.3064	519	1716	0.3024	482	1579	0.3053	482	1658	0.258
2	m	38	SP, CP, GTC	H	Temporal	147.35	0.89	12310	34201	0.3599	12299	34166	0.36	12256	34041	0.36	12256	34249	0.3579
3	m	14	SP, CP	NC	Frontal	108.63	1.67	13578	26721	0.5081	13130	26393	0.4975	10705	19481	0.5495	10705	19945	0.5367
4	f	28	SP, CP, GTC	H	Temporal	77.30	1.03	903	6763	0.1375	933	6783	0.1375	343	6783	0.0506	343	9792	0.035
5	f	16	SP, CP, GTC	NC	Frontal	14.98	0.99	1703	3340	0.5099	1616	2873	0.5629	1012	2058	0.4917	1012	1936	0.5227
6	f	31	CP, GTC	H	Tempero/Occipital	107.94	1.80	7319	22996	0.3183	7050	22886	0.308	6361	16569	0.3839	6361	19231	0.3489
7	f	42	SP, CP, GTC	H	Temporal	79.55	1.70	2404	18879	0.1289	2356	18309	0.1287	1885	12061	0.1563	1885	12397	0.1532
8	f	32	SP, CP	NC	Frontal	178.87	1.10	34388	39070	0.8802	33373	37118	0.8994	32437	35957	0.9021	32437	35965	0.9019
9	m	44	CP, GTC	NC	Tempero/Occipital	38.56	1.04	1739	9428	0.2383	1719	7269	0.2365	1139	6961	0.1632	1139	6751	0.1687
10	m	47	SP, CP, GTC	H	Temporal	87.07	1.18	20999	20466	1.0259	16773	17763	0.9439	15060	16163	0.9311	15060	15598	0.9649
11	f	40	SP, CP, GTC	NC	Parietal	41.55	1.05	4140	4467	0.9227	4085	4409	0.9265	3867	4234	0.9133	3867	4507	0.858
12	f	42	SP, CP, GTC	H	Temporal	61.33	1.06	10711	14731	0.7271	10504	12064	0.8707	8862	9092	0.9747	8862	9663	0.9171
13	f	22	SP, CP, GTC	H	Tempero/Occipital	76.13	1.18	6214	11946	0.5245	6214	11848	0.5245	6214	11848	0.5245	6214	13654	0.4551
14	f	41	CP, GTC	B, NC	Fronto/Temporal	79.77	1.34	16860	16163	1.0431	14868	13698	1.0708	12872	11545	1.1106	12822	12028	1.066
15	m	31	SP, CP, GTC	H, NC	Temporal	31.51	0.94	7086	7418	0.9552	6409	557 1	1.1504	5026	4903	1.0251	5026	4706	1.0682
16	f	60	SP, CP, GTC	H	Temporal	173.61	1.36	35452	38797	0.9136	34315	37655	0.9113	33871	37282	0.9112	33871	36486	0.9311
17	m	28	SP, CP, GTC	NC	Temporal	56.87	1.81	1747	12878	0.1357	1282	11475	0.1126	591	10726	0.0551	591	10582	0.0558
18	f	25	SP, CP	NC	Frontal	17.93	1.20	36	1133	0.0318	36	1133	0.0318	36	1133	0.0318	36	963	0.0374
19	f	28	SP, CP, GTC	NC	Frontal	23.17	1.01	1716	3716	0.4618	1508	3668	0.4226	1278	3427	0.3729	1278	3516	0.3635
20	m	33	SP, CP, GTC	NC	Tempero/Parietal	25.09	1.84	2931	5549	0.5282	2723	4911	0.5545	2276	3455	0.6588	2276	3169	0.7182
21	m	13	SP, CP	NC	Temporal	89.91	0.93	26018	19761	1.013	18159	17999	1.009	16182	16329	0.991	16182	15825	1.0226
								ORIGINAL NGRAM SIZE = 10			FF and 00 Patterns Removed			All Repeat Patterns removed		Different NC part		

FIG. 6

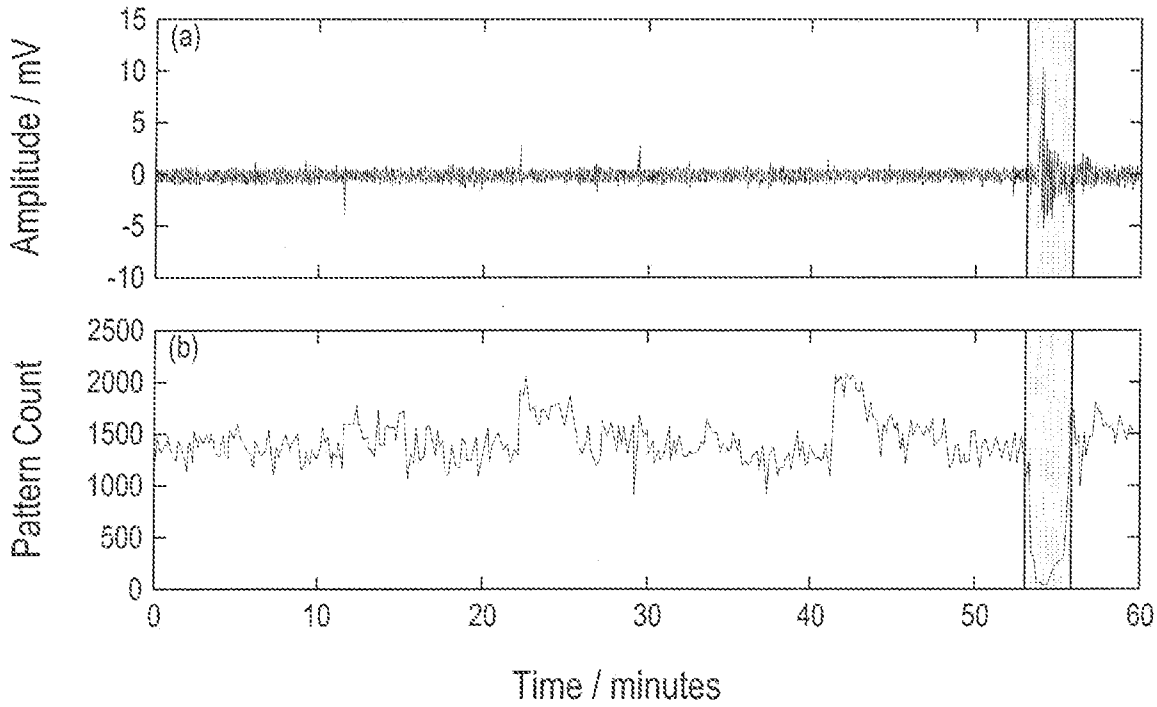

(a)
(b)
Amplitude / mV
Pattern Count
Time / minutes
15
10
5
0
-5
-10
2500
2000
1500
1000
500
0
0
10
20
30
40
50
60

FIG. 7

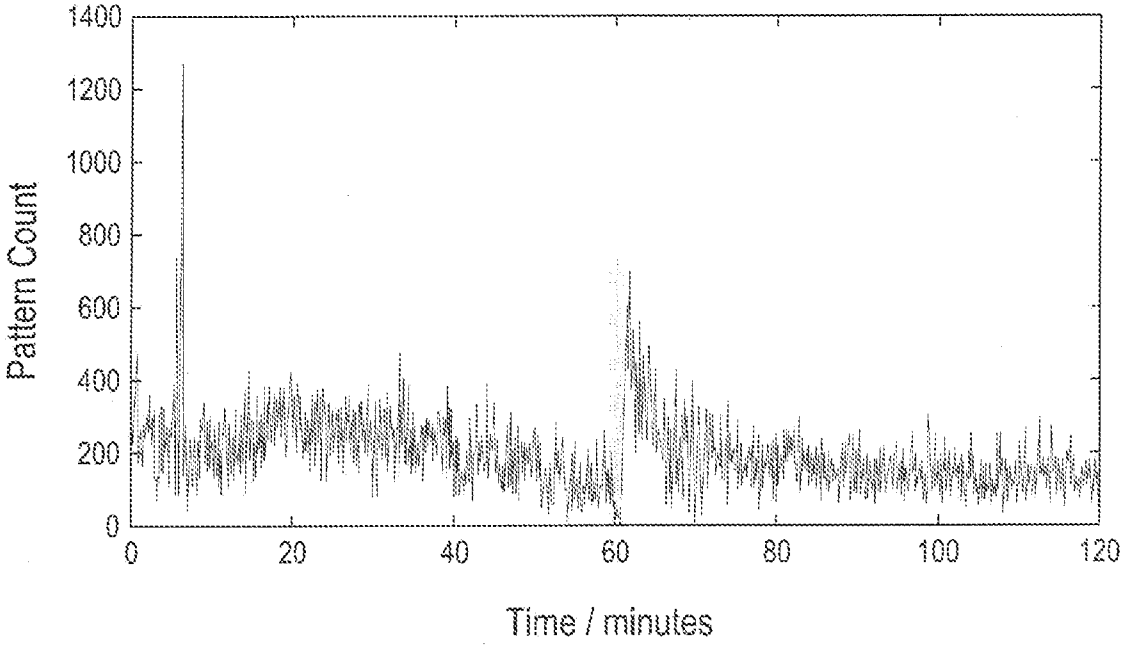

1400
1200
1000
800
600
400
200
0
Pattern Count
0
20
40
60
80
100
120
Time / minutes

FIG. 8

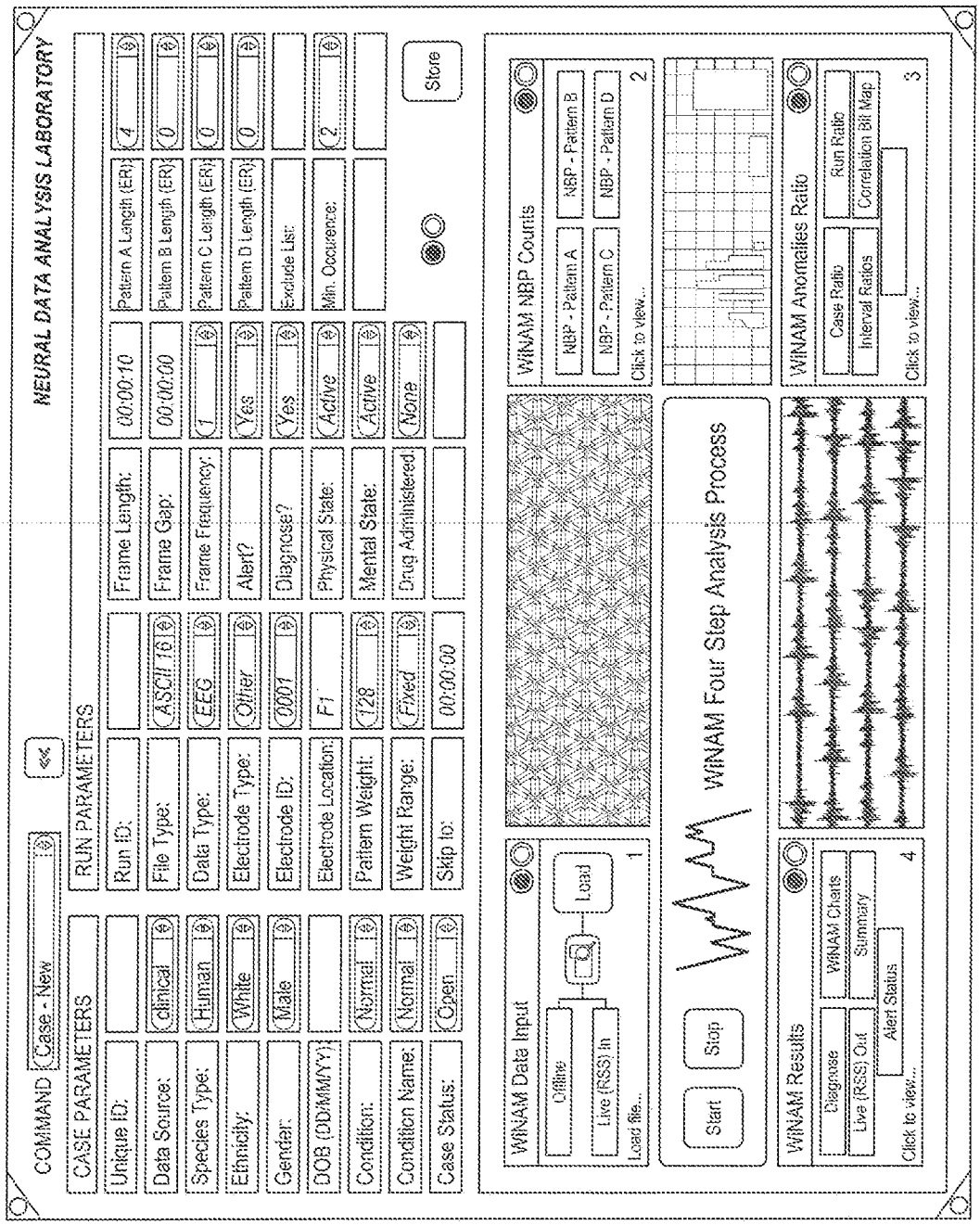

NEURAL DATA ANALYSIS LABORATORY
COMMAND
Case - New
CASE PARAMETERS
Unique ID:
Data Source:
Clinical
Species Type:
Human
Ethnicity:
White
Gender:
Male
DOB (DD/MM/YY):
Condition:
Normal
Condition Name:
Normal
Case Status:
Open
RUN PARAMETERS
Run ID:
File Type:
ASCII 16
Data Type:
EEG
Electrode Type:
Other
Electrode ID:
0001
Electrode Location:
F1
Pattern Weight:
128
Weight Range:
Fixed
Skip to:
00:00:00
Frame Length:
00:00:10
Frame Gap:
00:00:00
Frame Frequency:
1
Alert?
Yes
Diagnose?
Yes
Physical State:
Active
Mental State:
Active
Drug Administered
None
Pattern A Length (ER):
4
Pattern B Length (ER):
0
Pattern C Length (ER):
0
Pattern D Length (ER):
0
Exclude List:
Min. Occurence:
2
Store
WiNAM Data Input
Offline
Live (RSS) In
Load file...
Load
1
WiNAM Four Step Analysis Process
Start
Stop
WiNAM NBP Counts
NBP - Pattern A
NBP - Pattern B
NBP - Pattern C
NBP - Pattern D
Click to view...
2
WiNAM Anomalies Ratio
Case Ratio
Run Ratio
Interval Ratios
Correlation Bit Map
Click to view...
3
WiNAM Results
Diagnose
Live (RSS) Out
WiNAM Charts
Summary
Alert Status
Click to view...
4

FIG. 9

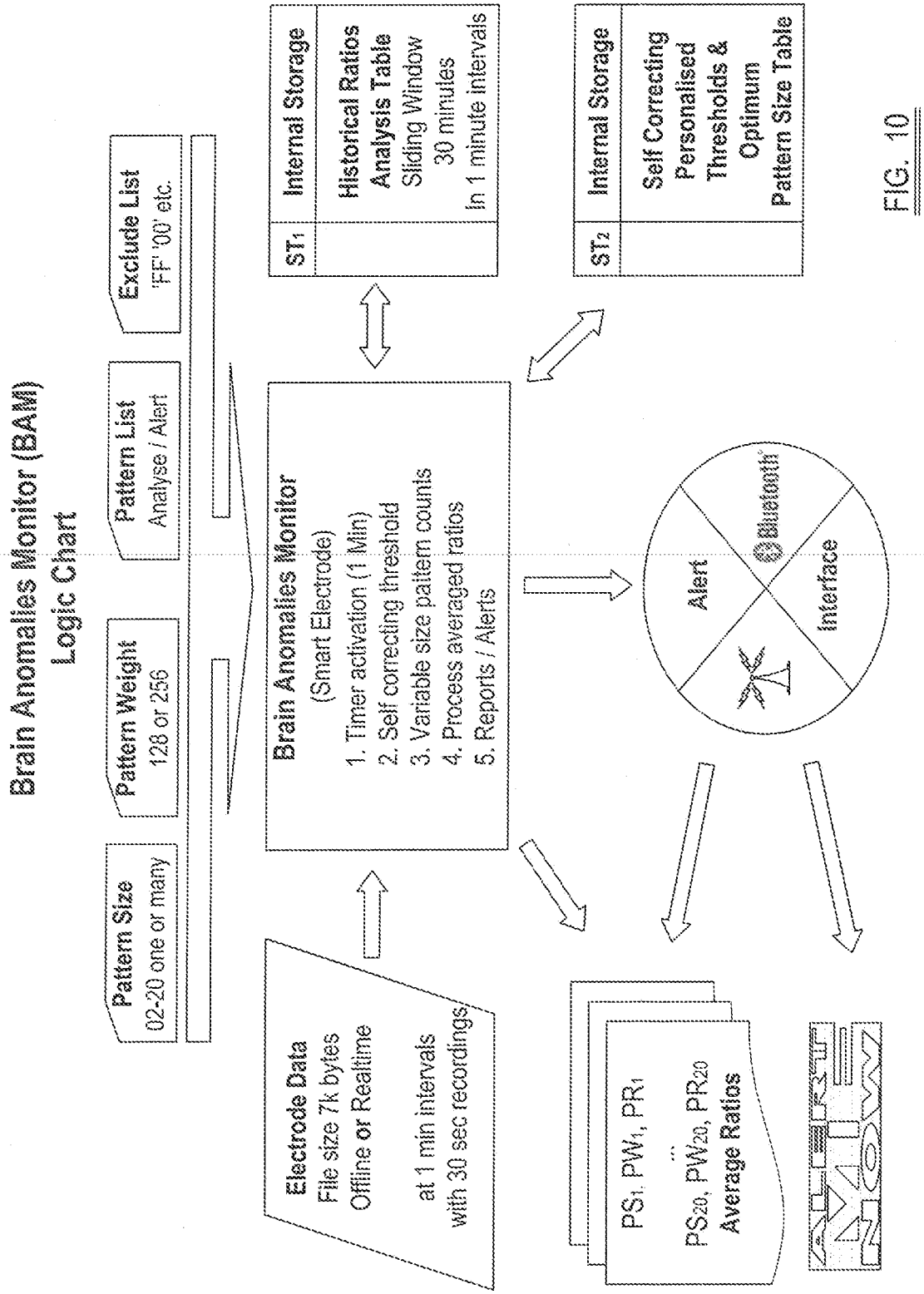

Brain Anomalies Monitor (BAM)
Logic Chart
Pattern Size
02-20 one or many
Pattern Weight
128 or 256
Pattern List
Analyse / Alert
Exclude List
'FF' '00' etc.
Brain Anomalies Monitor
(Smart Electrode)
1. Timer activation (1 Min)
2. Self correcting threshold
3. Variable size pattern counts
4. Process averaged ratios
5. Reports / Alerts
ST1
Internal Storage
Historical Ratios
Analysis Table
Sliding Window
30 minutes
In 1 minute intervals
ST2
Internal Storage
Self Correcting
Personalised
Thresholds &
Optimum
Pattern Size Table
Alert
Bluetooth
Interface
Electrode Data
File size 7k bytes
Offline or Realtime
at 1 min intervals
with 30 sec recordings
PS1, PW1, PR1
...
PS20, PW20, PR20
Average Ratios

FIG. 10

Table I

16 Nibble (half byte) pattern Matrix																		
	Data One								Data Two									
	ANC1			ANC2		NC			ANC1			ANC2						
Sno	NC	5	7060505050	4	0101010101	15	E0E0E0E0E0	18	FE3E1E2E2E	4	E2E2E2E2E2	18						
1	02D100FFFE	5	07060505060	4	1010101010	15	1E0E0E0E0E	5	DFE0E1E2E2	4	2E2E2E2E2E	18						
2	2010XFFFEF	5	0705050505	4	1010101010	15	7E7E7E7E7E	4	DEDDDCDBDA	3								
3	F6F7FAFAF9	4	8D0E0F101101	3			E7E7E7E7E7	4	3E1E1E2E2E	3								
4	6F7FAFAF9F	4	5D6040202B	3			1E1E1E1E2E	3	E1E2E2E3E4	3								
5	4040404040	4	2040403010	3			E0E0E0E0E0	3	DBDBDCDCDDE	3								
6	0404040404	4	0020302000F	3			E1E1E1E1E2	3	E8E3E1E0DF	3								
7	FFEFCFBFAF	3	F4F4F4F4F5	3			D8D8D7D8D8	3	DFDEDEDEDF	3								
8	0C0A090806	3	F5F6F6F6F5	3			6E0E0E0E0D	3	DCDDDFE2E2	3								
9	EFEFFF01030	3	5F6F6F6F5F	3			E1E0E0E0E0	3	EAE9E9E9E8	3								
10	0304070706	3	5F4F4F4F4F	3			E9E6E7E7E7	3	E2E1E1E2E2	3								
11	BFCFCFCFCF	3	4F4F4F4F5F	3			9E4E4E6E7E	3	9E6E4E3E3E	3								
12	0100FFFEFF	3	8D0202020D	3			E5E4E4E6E7	3	DBDDE0E1E1	3								
13	7060506070	3	6606040202	3			9E9E7E7E7E	3	EDDDCDBDAD	3								
14	0202030306	3	F5F4F4F4F4	3			D6D6D9DADB	3	E2E2E2E2E2	3								
15	DFEFDFCFCF	3	0506060303	3			5D6D6DADBD	3	E3E6E4E3E3	3								
16	6060606060	3	0E0E0E0E0E	3			9D8D7D8D9D	3	DEDCDDDFE2	3								
17	2020305060	3	0102020202	3			1E0E1E0E0E	3	1E0DEDCDCD	3								
18	F1F1F1F2F3	3	8F7F6F7F8F	3			DFDFDFDFDF	3	2E2E2E2E2E	3								
19	FBFCFCFCFC	3	0202040301	3			DCDCDCDCDC	3	EDCDDDFE2E	3								
20	0606080808	3	0B0E0F1010	3			CDCDCDCDCD	3	E1E0DFE0E0	3								
21	FEFEFF0103	3	0F0E0C0907	3			9D8D7D8D9D	3	DEDCDDDFE2	3								
22	100FFFEFFF	3	1020202020	3					AEBEBEBEBE	3								
23	0102020306	3	8060304030	3					E1E0DEDCDC	3								
24	FDFEFDFCFC	3	F0E0C030070	3					1E2E2E3E4E	3								
25	0706050807	3	F8F7F6F7F8	3														
26	C0A0908060	3																
27	0606060606	3																
28	F0F6F5F6F7	3																
29	8080808060	3																
30	6F6F5F6F7F	3																
31	FFFEFCFBFA	3																
32	F5F5F4F2F0	3																
33	1020203060	3																
34	1F1F1F2F3F	3																
35	3040707060	3																

Table II

8 Nibble (half byte) pattern Matrix																				
	Data One								Data Two											
Sno	NC		ANC1		ANC2		NC		ANC1		ANC2									
1	010DFFFEEF	7	F4F4F4F4F	7	1D1010101	16	E0E0E0E0E	8	DCDCDCDCD	8	E3E2E2E2E	19								
2	0403404040	7	0202020202	8	0101010101	16	0E0E0E0E0	8	E2E2E2E2E	8	2E2E2E2E2	16								
3	F8F9F9F8F	8	0605050605	8	1414141414	3	E7E7E7E7E	8	E0E0EDCDCD	8	E9EAEBECE	3								
4	FAFBFBFAF	8	0705050705	8	0E0C0C0C0D	3	DBD7D7D7D	8	E3E1E0DFE	8	ECEBEAE9E	3								
5	FCFDFDFDF	8	F8F8F7F8F	4	191A1B1C1	3	EFEEECECBE	8	E8E8E8E8E	8	E4E5E5E5E	3								
6	0606060606	8	7060506060	4	0201FFFDF	3	E1E1E1E2E	8	E7E6E6E6E	8	D8D8D8D8D	3								
7	2010DFFFE	8	F9F3F9FAF	4	1816191817	3	E6E6E6E5E	8	DEDDDCDBD	8	EEEFEFEFE	3								
8	FAFAFAFAF	8	FBFCFCFCF	4	0101010100	3	D8D8D7D8D	8	EBDFDFDED	8	ECEBE8E8E	3								
9	02011DFFFF	8	0505060705	4	0104040301	3	DFDFDFDFD	8	E1E0E0DFD	8										
10	FFFEFDFDF	4	0706050605	4	1818181818	3	DEDDDDDCD	4	E3E4E5E5E	8										
11	F6F5F6F7F	4	0E0C0D0E07	3	FFF8020302	3	DCDCDCDCD	4	E9E9E9E8E	8										
12	FBFBFAF7F	4	0602034040	4	0403030302	3	E9E8E7E7E	4	E4E3E2E1E	4										
13	FAFAFBFCF	4	F6F6F6F5F	4	1310F0E0D	3	EFEEEEBEAE	4	DDDDDDDDD	4										
14	FFFEFCFBF	4	0302030FDF	4	0306060A0	3	DDDCDBDAD	4	E7E8EAEAECE	4										
15	0504A0C0C0	4	0000000000	4	3B3B3B3B3	3	E8E7E7E7E	4	DFDFDFDED	4										
16	FEFDFCFBF	4	0FDF0F0E0	4	1B1B1A191	3	E3E2E1E1E	4	E4E5E5E3E	4										
17	0DC0A050B0	4	0304060B03	4	0E0C0B0B0	3	E8E3E1DFD	4	DDCCBBDAD	4										
18	FFFFFEFFFD	4	FAF9F8F9F	4			E0E0E0E0D	4	F7F7F7F7F	4										
19	FCFCFCFCF	4	0B07060050	4			7E7E7E7E7	4	DEDEDDDDD	4										
20	EDFCFCFCF	4	0B0B090B0	4			E1E1E3E3E	3	DEDFEGE1E	4										
21	F6F7FAFAF	4	0B06050500	4			DDDCDDDDD	3	CCDBDBDCD	4										
22	FAF8F8F9F	4	0604032020	4			1E0E0E0E0	3	FEGE1E2E2	4										
23	FCFCFE0000	4	0303030B60	4			E1E0E0E0E	3	E5E5E7EAE	4										
24	F9F8F8F8F	4	0404060706	4			E3E4E4E6E	3	E1E2E2E3E	4										
25	FDFDFDFCF	4	0404030101	4			E2E1DFDFD	3	DFEDE1E3E	4										
26	0605060706	4	0605030303	3			DCDBDAD8D	3	E6E6E6E6E	4										
27	FEFEFEFFD	4	0E0E0D0CCD	3			F0EFEEECE	3	E9EAE9E7E	4										
28	FCFCFAF9F	4	F8F6F5F3F	3			E2E3E2E1E	3	E2E2E2E3E	4										
29	0304070706	4	F4F4F5F6F	3			D5D3D1CFC	3	E2E3E4E5E	4										
30	0F7FAFAFB	4	0302FFFEF	3			9D8D7D8D9	3	EAE8E6E5E	4										
31	4040404040	4	F8F7F6F7F	3			D6D3DADBD	3	E5E3E3E0D	4										
32	FFFFFFFEF	4	1010100FD	3			E3E3E2E2E	3	E6E7E7E5E	4										
33	0A0B0B0B0	4	0303020B0F	3			F3EFEBE9E	3	DDDDDDDCD	4										
34	FEFDFCFCF	4	0204040301	3			9E8E7E7E7	3	E0D7DFDFD	4										
35	F7FAFAF8F	4	0306060CC0	3			E6E6E5E5E	3	E2E2E3E3E	4										
36	0402504020	4	0200FD3FBF	3			DEE1E2E2E	3	EAE9E8E8E	4										

Table III

8 Nibble (half byte) pattern Matrix																				
	Data One								Data Two											
Sno	NC		ANC1		ANC2		MC		ANC1		ANC2									
1	40404040	7	F4F4F4F4	7	01010101	8	E0E0E0E0	13	DCDCDCDC	7	2E2E2E2E	19								
2	04040404	7	4F4F4F4F	7	10101010	8	0E0E0E0E	9	CDCDCDCD	7	E2E2E2E2	19								
3	0100FFFE	7	3B3B3B3B	6	01010100	4	DFDFDFDF	6	E3E1E0DF	7	EEEEFEFF	4								
4	100FFFEF	7	3B3B3B0A	8	0909090A	3	7E7E7E7E	6	E1E0E0DF	6	EEEBEAE8	3								
5	FAFBFBFA	6	2020202D	6	2B3B3B2B	3	E7E7E7E7	8	EZE2E2E2	6	CEBEAE9E	3								
6	3F9F9F8F	6	0D0D0D0D	6	2D1FFFDF	3	EFEEEDCEB	5	DFDEDEDF	6	EEFEFEFE	3								
7	F8F9F9F8	6	02020202	6	1A1A1B1C	3	E8E8E8E5	5	2E2E2E2E	6	ECE8E8E8	3								
8	AFBFBFAF	6	07060605	5	81819181	3	E1E1E1E3	5	DDDDDDDD	6	CEBE9E8E	3								
9	020100FF	5	706060D0	5	0B0C0C0D	3	FEEECEBE	5	EDDDCDBD	5	E5E5E5E5	3								
10	FCFDFDFD	6	FFFFFFFF	5	FDFDFCFE	3	8D7D7D7D	5	0DEDCDCD	5	EEEEFEEF	3								
11	FAFAFAFA	5	FAF9F9F8	4	04030303	3	D8D8D7D8	5	E0DFDFDE	5	9EAEBECE	3								
12	AFAFAFAF	5	04040301	4	40303030	3	D8D7D7D7	5	DEDEDEDE	5	5E5E5E5E	3								
13	06060605	5	06070605	4	81818181	3	6E6E5E5E	5	E0DFEDED	5	D8D8D8D8	3								
14	FEFEFEFF	5	01010101	4	FFFFFF00	3	FDFDFDFD	5	EDDEDCDC	5	EZDCDADB	3								
15	20100FFF	5	05060607	4	FF000203	3	E5E3E1DF	5	9E9F9E8E	5	BDBDBDBD	3								
16	CFDFDFDF	5	40403010	4	01000000	3	9D8D7D8D	5	E3E4E5E5	5	E9EAEBEC	3								
17	60504040	5	F0F0F0E0	4	0E0D0B06	3	1E1E1E2E	5	0DFDFDED	5										
18	FFFFFFEF	4	80402020	4	41414141	3	F2F1F1F1	4	6E6E5E5E	5										
19	FFFEFCF8	4	C0C03060	4	E0C0B0B0	3	DCDCDCDC	4	E7E6E6E6	5										
20	EFDFCFBF	4	80706050	4	01040403	3	E3E2E1E1	4	E8E8E5E5	5										
21	DFDFDFDF	4	F9F9F9FA	4	10404030	3	3E2E1E1E	4	E9E9E9E8	5										
22	FAFAFBFC	4	E0C03070	4	3B3B3B3B	3	EDDDDDCD	4	3E1E0DFE	5										
23	FAF9F8F9	4	0F0F0F0E	4	18181918	3	9E9E7E7E	4	DEDDDCDB	5										
24	FFEFDFDF	4	0E0C0907	4	3100E0D0	3	DDCDBDAD	4	EDEDEDED	5										
25	F9F9F8F6	4	20200FDF	4	B1B1A191	3	EFEEEBEA	4	1E0E0CFD	5										
26	AF8F8F8F	4	00204040	4	0301FFFD	3	E9E8E7E7	4	3E4E5E5E	5										
27	FFFEFDFD	4	FBFCFCFC	4	80809040	3	CDCDCDCD	4	7E6E6E6E	5										
28	FDFDFDFC	4	70605050	4	2D1D1B1A	3	8E7E7E7E	4	DFDFDFDE	5										
29	FFEFCFBF	4	02020AFD	4	1B1B1A19	3	DDDCDBDA	4	DCDBDBDC	4										
30	FCFCFCFC	4	FFFF0000	4	1A141414	3	DDDDDDDD	4	7E6EAECE	4										
31	06060607	4	10101010	3	F0002030	3	CEDDDDDC	4	DDDDDDCD	4										
32	04050402	4	30402080	4	16181816	3	E2E1DFDF	4	DFDFDFDF	4										
33	0C0A0908	4	6F6F3F3F	4	03020100	3	9E3E1DFD	4	0E1E2E2E	4										
34	6F5F6F7F	4	8F8F7F6F	4	10101D3F	3	E0E0E1E1	4	E4E3E2E1	4										
35	F7FAFAF9	4	0E0F1010	4	B0D0C0D0	3	E0E1E1E1	4	2E2E3E3E	4										
36	FEFDFCFB	4	30303040	4	13130E0C	3	E8E7E7E7	4	CDBDBDCD	4										

Table IV

7 Nibble (half byte) pattern Matrix

Sno	NC	Data One ANC1		ANC2		NC		Data Two ANC1		ANC2	
		15	14	13	12	17	16	15	14	13	23
1	FDFDFDF	02020202	01010101	01010101	E0E0E0E	E3E2E2E	E2E2E2E				
2	04040404	05050505	10101010	01010101	0E0E0E0	13	E4E5E5E	14	2E2E2E2	19	
3	00FFFFEF	13	F4F4F4F	0A0A0A0	7	E1E1E1E	11	E6E6E6E	14	E0E0E0E	7
4	FCFCFCF	12	F9F9F9F	0B0B0A0	7	E7E7E7E	11	DFDFDFD	13	DFE0E2E	6
5	FEFDFCF	12	FDFCFCF	1818181	6	DFDFDFD	10	DCDCDCD	12	D8D80B0	6
6	FAFAFAF	11	04040404	0B0C0C0	6	D8D807D	10	DFE0E1E	12	E5E5E5E	6
7	FBFBFAF	11	F8F7F8F	1414141	6	DEDDDDD	9	E0E1E2E	12	ECEBEAE	6
8	F8F9F9F	11	FCFCFCF	04040B0	6	E6E9E9E	9	DDDCD8D	12	EDEDECE	5
9	08080B0	10	07050B0	191A1B1	5	E3E3E2E	9	E5E5E3E	11	EBEBECE	5
10	FEFEFEF	10	03030B0	0303030	5	D7D7D7D	9	DEDEDED	11	E8E8E9E	5
11	FDFCFCF	10	05050B0	FDFDFCF	5	E8E3E5E	9	DFDFDED	11	DCDCDCD	5
12	FAFBFCF	10	04080B0	0403030	5	EAE9E9E	8	DDDDDDD	11	E6E4E3E	5
13	06060B0	10	06070B0	090A0B0	5	DFDEDDD	8	E3E4E5E	11	EFEFEFE	4
14	01020202	10	F6F5F5F	0E0E0E0	5	E1E1E2E	8	E0DFDFD	10	E4E8E9E	4
15	08080B0	10	04040B0	0302010	5	E8E6E5E	8	DEDDDDD	10	E5E7E8E	4
16	04040302	10	03040A0	100E0D0	5	E6E9E8E	8	E1E1E2E	10	F3F2F2F	4
17	FAFBFBF	9	FBFBFBF	01040A0	5	DBDBDBD	8	E6E6E5E	10	E9E9E9E	4
18	08070B0	9	0F0F0E0	0A0B0C0	5	DA0A0AD	8	E3E3E4E	10	E9E9E9E	4
19	F5F5F5F	9	04040302	1818191	5	EDEDEDE	8	E1E2E3E	10	EAE9E8E	4
20	0A0C0C0	9	07060504	1111111	5	DADADBD	8	E9E9E9E	10	F6F7F8F	4
21	F9F9F8F	9	00000000	0C0B0B0	5	D7D8D9D	8	E7E7E7E	10	EEECEBE	4
22	FAF9F8F	9	04030201	0706160	5	E8E8E6E	8	DFDDDCD	10	EEFEFEF	4
23	0100FFF	9	F7F7F8F	1010111	4	E8E8E8E	8	E2E2E3E	10	E6E7E9E	4
24	07080A0	9	08050504	04050403	4	E3E3E2E	7	E4E3E3E	10	E9E8E8E	4
25	06070B0	9	F7F7F7F	04060B0	4	D8D7D7D	7	E2E3E3E	9	E8E7E5E	4
26	FFFEFF0	8	FFFFFFF	100E0D0	4	DCDCDCD	7	E3E3E2E	9	D8DADBD	4
27	08090A0	8	F8F5F5F	00FEFEF	4	E0E0E1E	7	DCDDDDD	9	ECECECE	4
28	FEFCFBF	8	09090B0	0E0D0D0	4	E3E7E7E	7	E1E2E2E	9	E8EAE9E	4
29	F9F8F9F	8	FCFDFDF	0B06050	4	D7D7D8D	7	EAEAE9E	9	E9E9EAE	4
30	04030201	8	05040403	0103040	4	DADADAD	7	CDCDCDC	9	ECEAE9E	4
31	02020202	8	06060403	0E0F101	4	DEDFE1E	7	E0E0E1E	9	E9EAEBE	4
32	FDFDFCF	8	FCFCFDF	0B0A0A0	4	E2E1E1E	7	DDDDDCD	9	D8D8D9D	4
33	FCFBFAF	8	01002040	00FF020	4	E2E2E3E	7	E6E5E4E	9	EFEEECE	4
34	F8F8F7F	8	02030403	01010403	4	FDFDFDF	7	DADAD9D	9	EEEFEFE	4
35	FEFEFFD	8	03060B0	0B0B0C0	4	E2E3E2E	7	DFDFDDD	9	F8F7F8F	4
36	FFFEFDF	8	F6F5F6F	3B3B3B3	4	EFEEECE	7	E9EAE9E	9	E5E3E3E	4
37	F8FAF9F	8	07090B0	08050403	4	E3E2E1E	7	E3E2E1E	9	E8E9EAE	4

Table V

Sno	NC		Data One ANC1		ANC2		NC		Data Two ANC1		ANC2	
	FFFFFF	16	FFFFFF	15	010101	14	E0E0E0	22	DDDDDD	19	E3E2E2	23
2	FDFDFD	16	202020	14	101010	14	0E0E0E	17	FDFDFD	15	2E2E2E	23
3	DFDFDF	15	020202	14	000000	8	E1E1E1	13	E2E2E2	15	CECECE	7
4	404040	15	000000	13	111111	8	DFDFDF	12	E1E0E0	15	EFEFEF	7
5	040404	15	505050	13	ACA0A0	7	FDFDFD	11	DFDFDF	15	EDECEB	7
6	0F0F0F	13	050505	13	040403	7	DEDEDE	11	2E2E2E	15	DFEDE2	6
7	000000	13	9F9F9F	12	0B0B0A	7	E7E7E7	11	E1E0DF	15	E1E0E0	6
8	0F0F0E	13	F8F8F9	12	0A0A0A	7	1E1E1E	11	8E8E8E	14	CEBEAE	6
9	FEFDFC	12	F4F4F4	12	B0B0A0	7	7E7E7E	11	E0E0E0	14	BD6D8D	6
10	FCFCFC	12	F4F4F4	12	FFFFFF	7	D0D8D7	10	DEDEDE	14	FE0E2E	6
11	EFCFCF	12	0F0F0F	12	818181	6	6D8D7D	10	CDCDCD	14	5E5E5E	6
12	CFCFCF	12	FDFCFC	11	0E0E0E	6	9E9E9E	9	DCDCDC	14	E5E5E5	6
13	FEFEFE	11	404040	11	030302	6	8E8E8F	9	4E5E5E	14	D8D8D8	6
14	F8F9F9	11	111111	11	141414	6	EDDDDD	9	E2E1E0	14	DDDCDD	6
15	FBFBFA	11	DFCFCF	11	030201	6	CECCCD	9	E4E5E5	14	ECEBEA	6
16	BFBFAF	11	040404	11	BDCDCD	6	E9E9E9	9	EDEDED	14	DECDDE	5
17	FEFEFE	11	303030	10	181818	6	E5E3E1	9	DFE0E1	13	CDCDCD	5
18	EFEFEF	11	0F0F0E	10	0F1010	5	7D7D7D	9	E0DFDF	13	EEEFEF	5
19	AFAFAF	11	F8F7F8	10	0B0CAC	6	3E2E2E	9	EEEEEE	13	E8E8E9	5
20	FAFBFC	11	040403	10	404030	6	E3E2E1	9	DFDFDE	12	E8E9E	5
21	EFEFF0	11	8F7F8F	10	0A0A08	6	E3E2E2	9	0E1E2E	12	DEDECE	5
22	FAFAFA	11	030303	10	414141	5	E6E5E5	9	DCDCDD	12	DCDCDC	5
23	8F9F8F	11	505050	10	FDFDFC	5	D7D7D7	8	FE0E1E	12	CECECE	5
24	808080	10	050606	10	303030	5	DEDEDD	9	EGE1E2	12	BEBECE	5
25	FEFEFF	10	101010	10	191A1B	5	E1E2DED	9	DDDCDB	12	FEFEFE	5
26	040403	10	FCFCFC	10	040504	5	DFDFEG	8	E5E5E3	11	6E4E3E	5
27	010202	10	FFFF00	10	100E0D	5	4D4D4D	8	3E4E3E	11	E3E1E0	5
28	080808	10	705060	10	0D6D0	5	E0E0E8	8	E0DFE0	11	E6E4E3	5
29	FDFCFC	10	070505	10	403030	5	6E6E6E	8	DEDFDF	11	EBEBEC	5
30	090306	10	CFCFCF	10	818181	5	DADADB	8	E3E2E1	11	EDEDEC	5
31	060606	10	080705	9	C0B0B0	6	E6E6E6	8	E3E1E0	11	1E0E0E0	5
32	102020	10	304040	9	040303	5	AE9E9E	8	DEDEDF	11	EDEDED	5
33	040302	10	F0F0E0	9	104040	5	DDDDDD	8	E4E4E3	11	EFEEED	4
34	404030	10	FBFBFB	9	302010	5	E8E8E8	8	E3E4E5	11	6E7E5E	4
35	606060	10	040609	9	706060	5	BEBDD0	8	FDFDED	11	2F2F2F	4
36	808080	10	040406	9	A0B0C0	5	EDEDE1	8	5E5E3E	11	D6D8D9	4
37	DFCFCF	10	6F6F5F	9	181819	5	D4D4D4	8	DEDDDD	11	CECBEBBE	4

Table VI

			NGRAM = 12			NGRAM = 14		
Patient	Sdur/s	Pdur/hrs	S	P	Ratio	S	P	Ratio
1	19.49	6.10	514	778.9	0.66	269	393.3	0.684
2	147.35	0.89	6000	28727.5	0.209	2805	21811.3	0.129
3	108.63	1.67	11029	25517.8	0.432	8150	23742.1	0.343
4	77.30	1.03	743	324.6	2.289	577	83.2	6.935
5	14.98	0.99	1455	3246.8	0.448	1138	2991.8	0.38
6	107.94	1.80	2974	13409.7	0.222	1606	9053.5	0.177
7	79.55	1.70	938	16917.8	0.055	719	14890.9	0.048
8	178.87	1.10	27969	34800.6	0.804	19923	27931.6	0.713
9	38.56	1.04	990	6939.9	0.143	702	5465.6	0.128
10	87.07	1.18	14260	19114.6	0.747	10639	17416.9	0.611
11	41.55	1.05	2241	2216.3	1.011	981	861.8	1.14
12	61.33	1.00	2032	12806.2	0.159	1091	11541.4	0.095
13	76.13	1.18	4214	4809.5	0.876	1791	2451.3	0.731
14	70.77	1.34	14268	13165.1	1.084	12212	11027.6	1.11
15	31.51	0.94	5326	5523.1	0.964	4305	4452.6	0.97
16	170.61	1.36	29278	37282.8	0.785	21912	33935.4	0.646
17	58.87	1.81	1256	11120.3	0.113	988	9095.3	0.109
18	17.93	1.20	0	401.6	0	0	154.9	0
19	23.17	1.01	850	2688.7	0.316	469	1679.1	0.279
20	25.09	1.64	1323	4629	0.286	946	4098.1	0.231
21	89.91	0.93	17693	20965.5	0.844	15120	19932.2	0.759

Table VII

	NGRAM = 10		NGRAM = 14
Patient	10s	5s	5s
10	increase/decrease	increase/decrease	increase/decrease
11	none	none	none
12	decrease	decrease	increase/decrease
13	none	none	none
14	none	none	none
15	none	none	none
16	decrease/increase	decrease/increase	decrease/increase
17	decrease	decrease	increase
18	reduce variance	reduce variance	reduce variance
19	decrease/increase	decrease/increase	increase
1	decrease	none	none
20	decrease	decrease	decrease
21	none	decrease	decrease
2	decrease	decrease	decrease
3	decrease	decrease	decrease
4	none	increase	increase
5	decrease	decrease	decrease
6	decrease	decrease/increase	increase
7	decrease	decrease	increase/decrease
8	decrease	decrease	none
9	decrease	decrease	increase

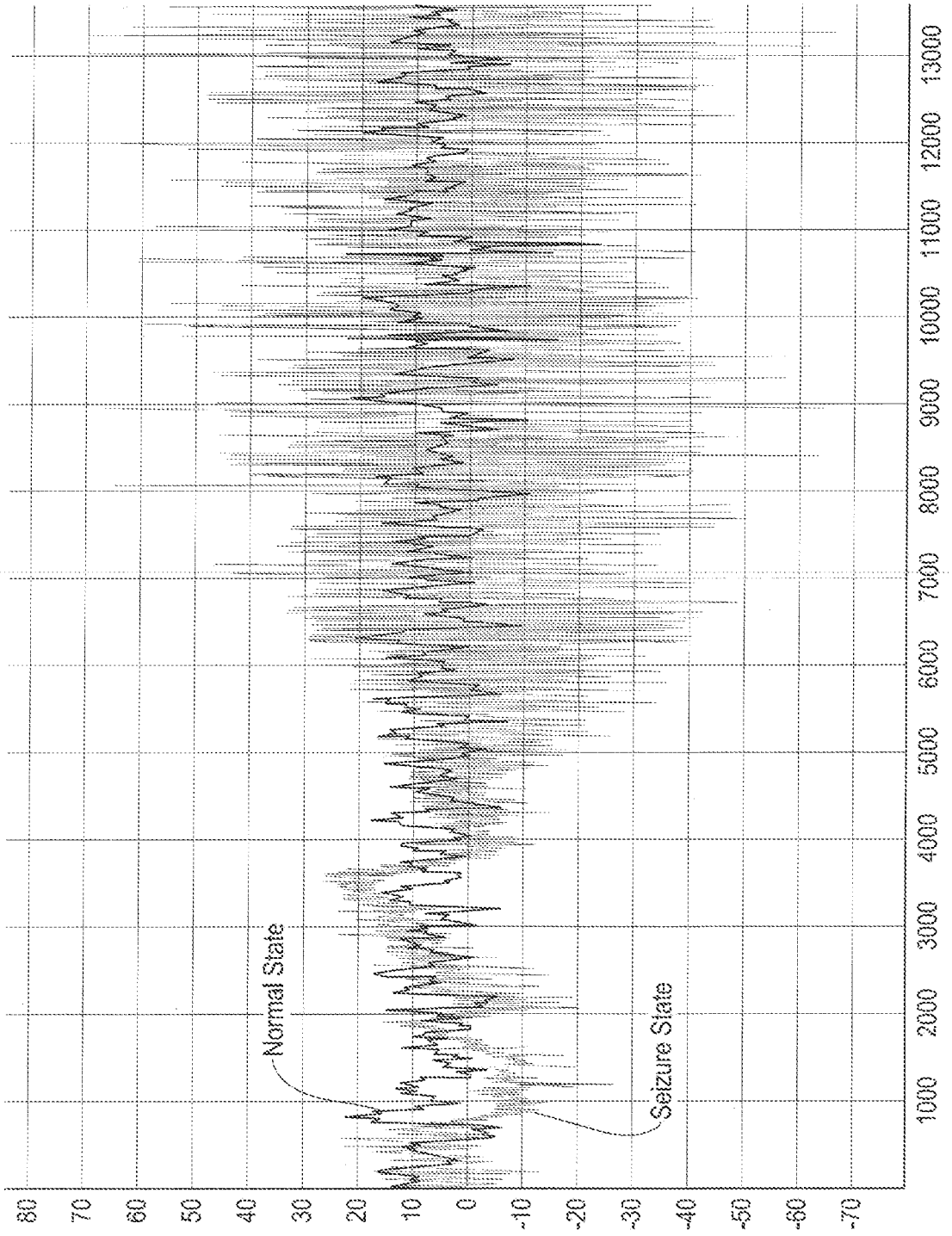

Normal State
Seizure State
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000
12000
13000

FIG. 11

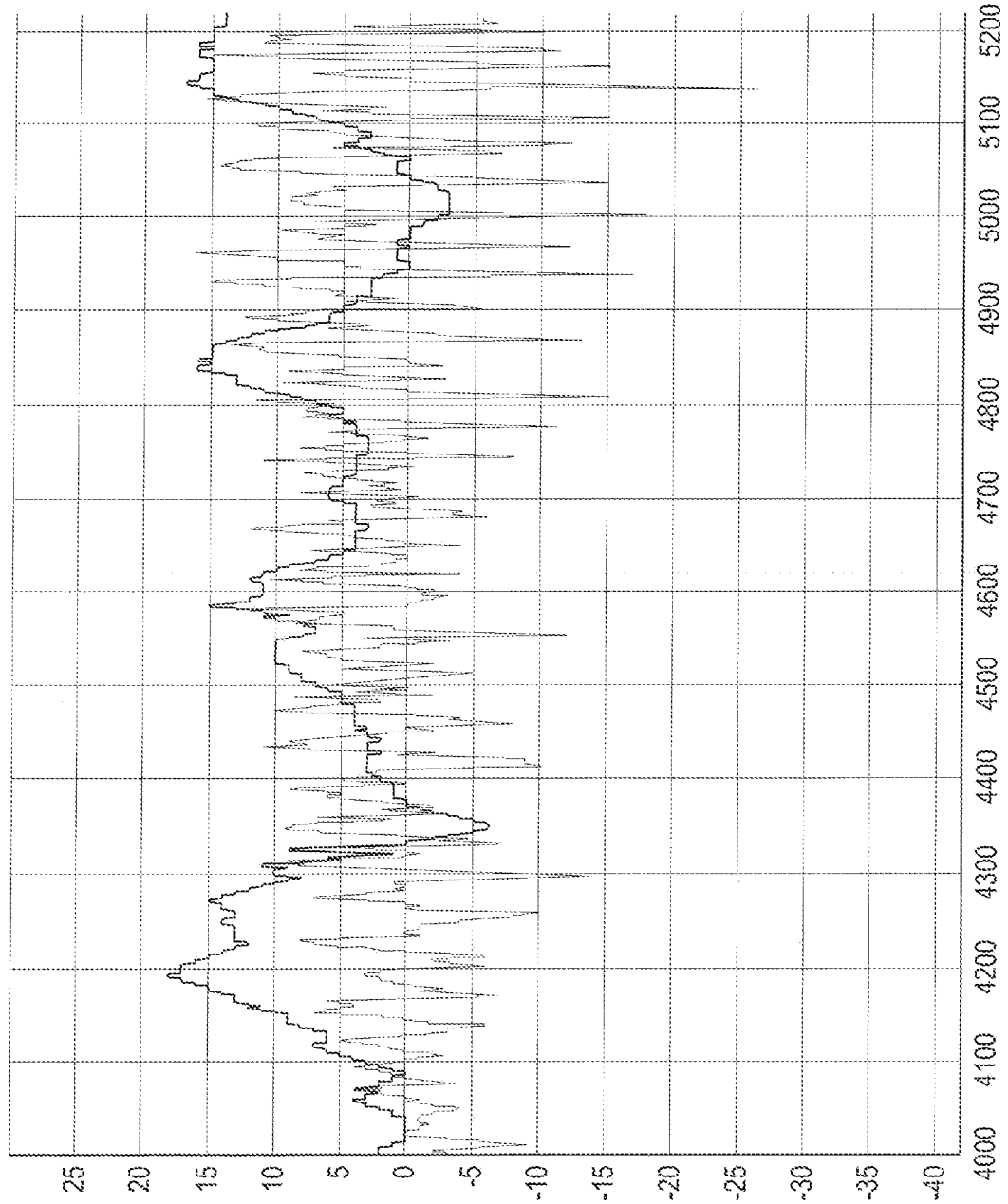

25
20
15
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
4000
4100
4200
4300
4400
4500
4600
4700
4800
4900
5000
5100
5200

FIG. 12

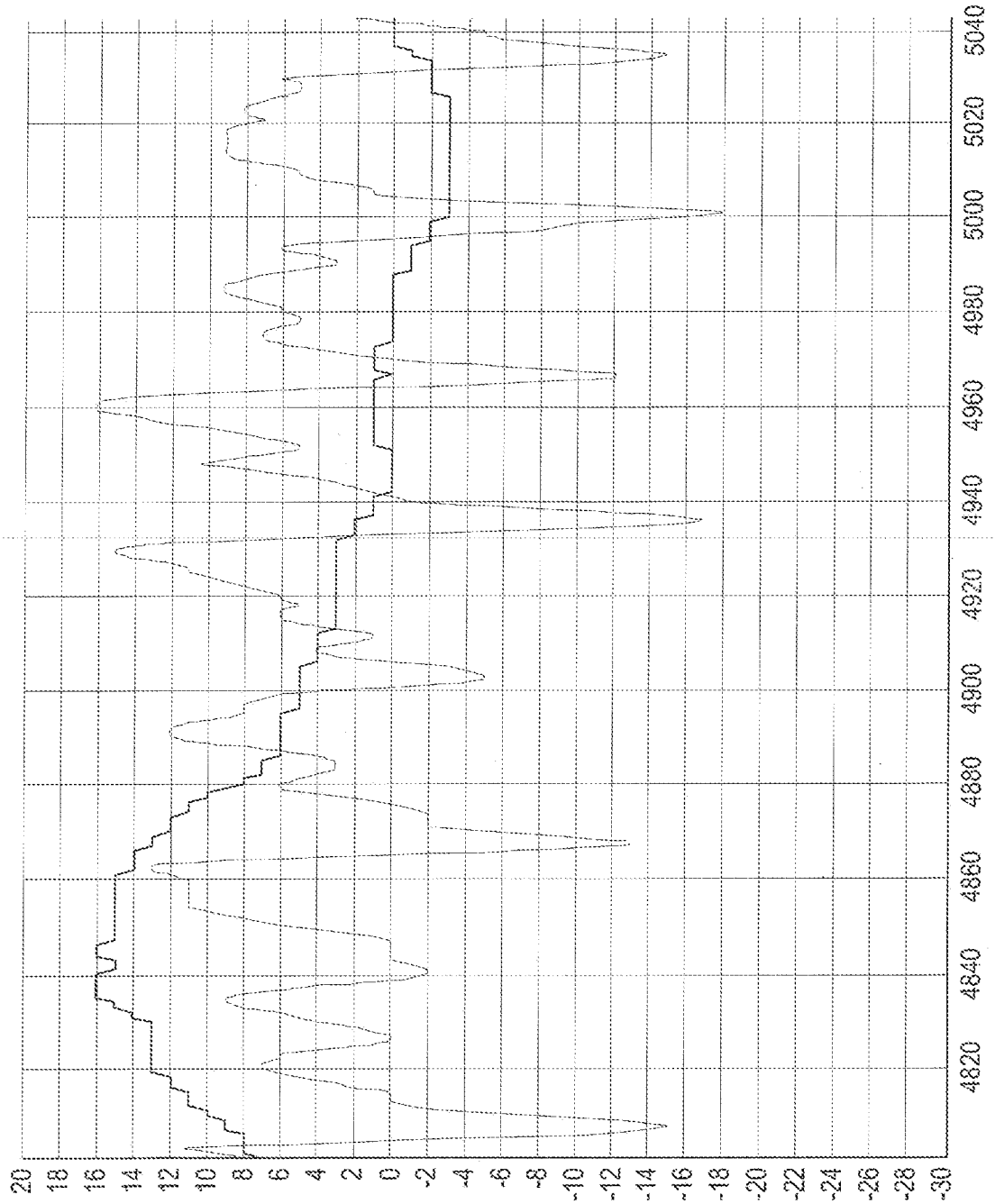

20
18
16
14
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-22
-24
-26
-28
-30
4820
4840
4860
4880
4900
4920
4940
4960
4980
5000
5020
5040

FIG. 13

										+
0001	Clinical	Human	Unknown	Female	05/1/1995	Abnormal	Open			Select Command
0002	Clinical	Human	Unknown	Male	11/1/1972	Abnormal	Open			Select Command
0003	Clinical	Human	Unknown	Male	05/1/1996	Abnormal	Open			Select Command
0004	Clinical	Human	Unknown	Female	08/1/1984	Abnormal	Open			Select Command
0005	Clinical	Human	Unknown	Female	05/1/1994	Abnormal	Open			Select Command
0006	Clinical	Human	Unknown	Female	09/1/1979	Abnormal	Open			Select Command
0007	Clinical	Human	Unknown	Female	12/1/1968	Abnormal	Open			Select Command
0008	Clinical	Human	Unknown	Female	09/1/1978	Abnormal	Open			Select Command
0009	Clinical	Human	Unknown	Male	12/1/1966	Abnormal	Open			Select Command
0010	Clinical	Human	Unknown	Male	13/1/1963	Abnormal	Inconclusive			Select Command

FIG. 14

Case Parameters

Case ID:	0007	Data Source:	Clinical
Species:	Human	Gender:	Female
DOB:	12/01/1968	Condition:	Abnormal

Run Parameters

Run ID:	0013	Filename:	sample_data.txt
File Type:	ASCII 16	Data Type:	Deep Brain
Pattern Weight:	256	Weight Range	Fixed
Pattern A Length (ER)	10	Pattern B Length	0
Pattern C Length (ER)	0	Pattern D Length	0

Raw Data

-3.5116000e+002	-2.3880000e+002	-1.0580000e+002	-3.2000000e+001	-1.2000000e+001	FFFF	FFFF	0000	0000	0000	0000	0000	0000	0000
1.5030000e+001	7.1050000e+001	1.6100000e+002	3.2200000e+002	5.1400000e+002	0000	0000	0001	0001	0001	0001	0001	0001	0002
6.5360000e+002	7.1600000e+002	7.1050000e+002	6.6400000e+002	5.9700000e+002	0003	0003	0003	0003	0003	0003	0003	0003	0002
5.1600000e+002	4.7600000e+002	4.4700000e+002	4.4700000e+002	4.4700000e+002	0002	0002	0002	0002	0002	0002	0002	0002	0002
5.0800000e+002	6.1500000e+002	3.8800000e+002	7.4200000e+002	7.2200000e+002	0002	0002	0003	0003	0003	0003	0003	0003	0003
6.2600000e+002	8.0700000e+002	6.3300000e+002	0.8300000e+002	7.6800000e+002	0002	0002	0002	0002	0002	0002	0003	0003	0003
7.9700000e+002	6.5600000e+002	9.2100000e+002	1.0830000e+003	1.3030000e+003	0003	0003	0003	0004	0004	0004	0004	0004	0005
1.5540000e+003	1.8000000e+003	1.9300000e+003	1.9730000e+003	1.9540000e+003	0006	0007	0007	0008	0008	0008	0008	0008	0008
1.9360000e+003	1.8650000e+003	1.8510000e+003	1.7920000e+003	1.5760000e+003	0008	0007	0007	0007	0007	0007	0007	0007	0006
-2.4870000e+003	-2.1130000e+003	-1.7090000e+003	-1.4010000e+003	-1.2160000e+003	FFF6	FFF8	FFF9	FFFB	FFFB	FFFB	FFFB	FFFB	FFFB
-1.0830000e+003	-9.6900000e+002	-8.0800000e+002	-8.2600000e+002	-7.6800000e+002	FFFC	FFFC	FFFC	FFFD	FFFD	FFFD	FFFD	FFFD	FFFD
-5.7300000e+002	-4.1300000e+002	-2.9600000e+002	-1.8500000e+002	-1.2500000e+002	FFFE	FFFE	FFFF	FFFF	FFFF	FFFF	FFFF	FFFF	0000
-7.6000000e+001	-6.7000000e+001	-5.8000000e+001	-2.8000000e+001	-3.1000000e+001	0000	0000	0000	0000	0000	0000	0000	0000	0000
1.4200000e+002	1.8700000e+002	2.3300000e+002	2.3300000e+002	2.3300000e+002	0001	0001	0001	0001	0001	0001	0001	0001	0001
2.4500000e+002	2.2700000e+002	1.2800000e+002	1.6000000e+001	-1.0800000e+002	0001	0001	0001	0000	0000	0000	0000	0000	0000
-1.4100000e+002	-1.8700000e+002	-1.8700000e+002	-1.7500000e+002	-1.2100000e+002	FFFF	FFFF	FFFF	FFFF	FFFF	FFFF	FFFF	FFFF	0000
3.0600000e+000	1.4500000e+002	3.3600000e+002	5.1300000e+002	6.8600000e+002	0000	0001	0001	0001	0002	0002	0002	0002	0003
9.6130000e+002	1.0220000e+003	1.1080000e+003	1.0360000e+003	9.6300000e+002	0003	0004	0004	0004	0004	0004	0004	0004	0004

FIG. 15

Case Parameters

Case ID:	0007	Data Source:	Clinical
Species:	Human	Gender:	Female
DOB:	12/01/1988	Condition:	Abnormal

Run List

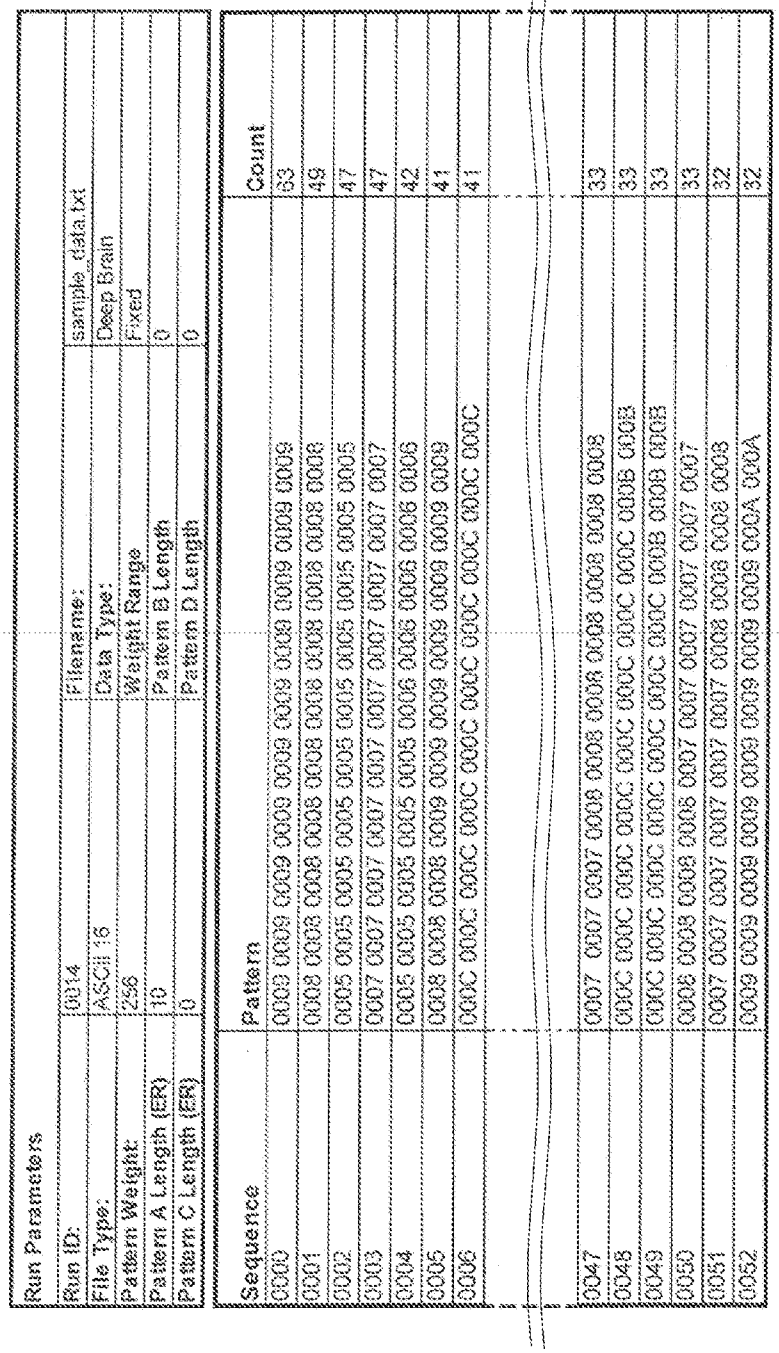
Seq.	RunID	File Name	Comment	Size File	Size Pattern	Size Anomalies	Anomalies %
0001	0013	sample_data.txt	Seizure	40, 732	4, 168	36, 576	89.80%
0002	0014	sample_data.txt	Normal	40, 732	39, 090	1, 642	4.03%

Run Parameters

Run ID:	0013	Filename:	sample_data.txt
File Type:	ASCII 16	Data Type:	Deep Brain
Pattern Weight:	256	Weight Range	Fixed
Pattern A Length (ER)	10	Pattern B Length	0
Pattern C Length (ER)	0	Pattern D Length	0

Sequence	Pattern	Count
0000	0005 0005 0005 0005 0005 0005 0005 0004 0004 0004	7
0001	0005 0005 0005 0005 0005 0005 0004 0004 0004 0004	6
0002	0006 0006 0006 0005 0005 0005 0005 0005 0005 0005	5
0003	0005 0005 0005 0005 0006 0006 0006 0006 0006 0006	5
0004	0006 0006 0006 0006 0006 0006 0006 0006 0006 0006	5
0005	0002 0002 0002 0002 0002 0002 0002 0003 0003 0003	5
0006	0003 0003 0003 0003 0003 0003 0003 0003 0003 0003	5
...	...	...
0036	0006 0006 0006 0006 0006 0007 0007 0007 0007 0007	3
0037	000D 000D 000D 000D 000D 000D 000D 000C 000C 000B	3
0038	0003 0003 0003 0003 0002 0002 0002 0002 0002 0002	3
0039	0007 0007 0007 0007 0007 0007 0007 0007 0006 0006	3
0040	0001 0000 0000 0000 0000 0000 0000 0000 0000 0000	3
0041	000E 000E 000E 000E 000E 000F 000F 000F 000F 000F	3

FIG. 16



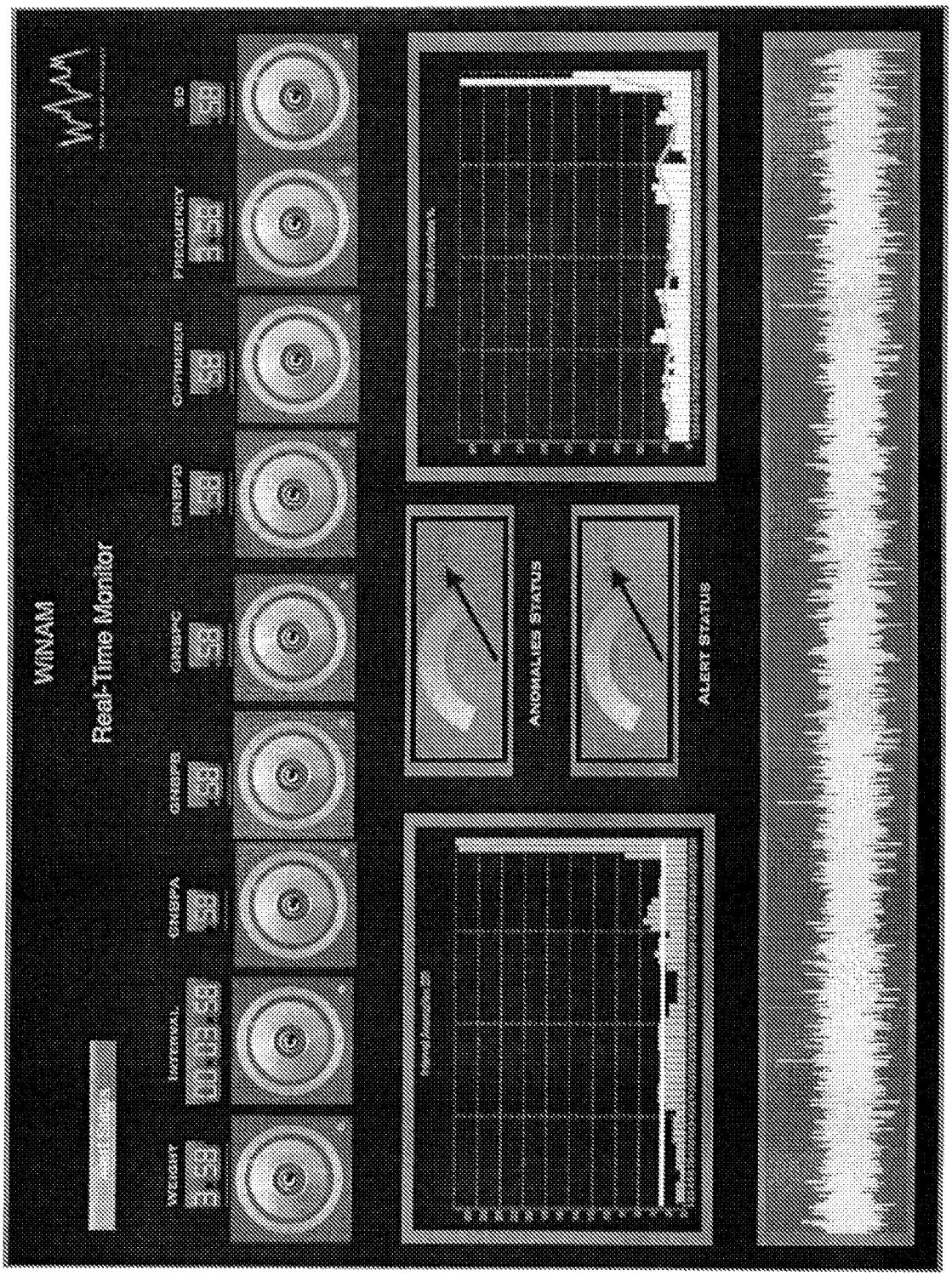
Run Parameters

Run ID:	0014	Filename:	sample_data.txt
File Type:	ASCII 16	Data Type:	Deep Brain
Pattern Weight:	256	Weight Range	Fixed
Pattern A Length (ER)	10	Pattern B Length	0
Pattern C Length (ER)	0	Pattern D Length	0

Sequence	Pattern	Count
0000	0009 0009 0009 0009 0009 0009 0009 0009 0009 0009	53
0001	0008 0008 0008 0008 0008 0008 0008 0008 0008 0008	49
0002	0005 0005 0005 0005 0005 0005 0005 0005 0005 0005	47
0003	0007 0007 0007 0007 0007 0007 0007 0007 0007 0007	47
0004	0005 0005 0005 0005 0005 0005 0005 0005 0005 0005	42
0005	0008 0008 0008 0009 0009 0009 0009 0009 0009 0009	41
0006	000C 000C 000C 000C 000C 000C 000C 000C 000C 000C	41
...	...	...
0047	0007 0007 0007 0008 0008 000A 0008 0008 0008 0008	33
0048	000C 000C 000C 000C 000C 000C 000C 000C 000B 000B	33
0049	000C 000C 000C 000C 000C 000C 000C 000B 000B 000B	33
0050	0006 0008 0008 0006 0007 0007 0007 0007 0007 0007	33
0051	0007 0007 0007 0007 0007 0007 0008 0008 0008 0008	32
0052	0009 0009 0009 0009 0009 0009 0009 0009 000A 000A	32

FIG. 17

FIG. 18



INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2011/051616

A. CLASSIFICATION OF SUBJECT MATTER
INV. A61B5/0476 G06F19/00
ADD. A61N1/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A61B G06F A61N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X,P	WALID JUFFALI ET AL: "The WiNAM project: Neural data analysis with applications to epilespy", BIOMEDICAL CIRCUITS AND SYSTEMS CONFERENCE (BIOCAS), 2010 IEEE, IEEE, 3 November 2010 (2010-11-03), pages 45-48, XP031899695, DOI: 10.1109/BIOCAS.2010.5709567 ISBN: 978-1-4244-7269-7 the whole document	1-14
A	US 6 658 287 B1 (LITT BRIAN [US] ET AL) 2 December 2003 (2003-12-02) abstract; claims 1,21; figures 1-4 column 1, line 50 - column 2, line 11 column 5, lines 29-60 column 5, line 62 - column 7, line 10	1-14

-/--

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
19 January 2012	25/01/2012

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Medeiros Gaspar, Ana

3

Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/GB2011/051616

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☒ Claims Nos.: 15
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

see FURTHER INFORMATION sheet PCT/ISA/210

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

Continuation of Box II.2

Claims Nos.: 15

The method claim 15 contains the step of "stimulating a part of a brain using a neural stimuli generator", said method step being described in the description of the application as being carried out, subsequent to the monitoring and predicting steps, "in an attempt to ameliorate, offset, delay or avoid entirely a neurological episode such as an epileptic seizure" (page 14 lines 10-15). The presence of such a step renders the methods of claim 15 methods of therapy practised on the human body, with the aim of maintaining or restoring the health. It is furthermore pointed out that the above mentioned additional step of the dependent claim 15 also appears to encompass methods involving different kinds of physical interventions practised on the human body considered to be of surgical nature, by means of which the claimed methods are also seen as methods for treatment of the human body by surgery, thereby also for that reason falling within the provisions of Rule 39.1(iv)/67.1(iv) PCT. Consequently, no search has been carried out and no opinion will be formulated by this Authority with respect to novelty, inventive step or the industrial applicability on the subject-matter of claim 15 (Article 34(4)(a)(i) PCT).

The applicant's attention is drawn to the fact that claims relating to inventions in respect of which no international search report has been established need not be the subject of an international preliminary examination (Rule 66.1(e) PCT). The applicant is advised that the EPO policy when acting as an International Preliminary Examining Authority is normally not to carry out a preliminary examination on matter which has not been searched. This is the case irrespective of whether or not the claims are amended following receipt of the search report or during any Chapter II procedure. If the application proceeds into the regional phase before the EPO, the applicant is reminded that a search may be carried out during examination before the EPO (see EPO Guideline C-VI, 8.2), should the problems which led to the Article 17(2) declaration be overcome.

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2006/111644 A1 (GUTTAG JOHN V [US] ET AL) 25 May 2006 (2006-05-25) abstract; claims 58,63,64,99; figures 22,23 paragraphs [0006] - [0010] -----	1-14
A	US 5 995 868 A (OSORIO IVAN [US] ET AL) 30 November 1999 (1999-11-30) abstract; figures 1,5 column 4, line 41 - column 6, line 63 column 10, line 57 - column 12, line 64 -----	1-14
A,P	WO 2010/115939 A2 (NAT UNIVERSITY OF IRELAND CORK [IE]; FAUL STEPHEN DANIEL [IE]; TEMKO A) 14 October 2010 (2010-10-14) abstract; figure 4 page 10, line 5 - page 11, line 16 -----	1-14

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/GB2011/051616

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 6658287 B1	02-12-2003	NONE	
US 2006111644 A1	25-05-2006	US 2006111644 A1	25-05-2006
		US 2011257517 A1	20-10-2011
		WO 2005117693 A1	15-12-2005
US 5995868 A	30-11-1999	AU 1752897 A	20-08-1997
		DE 69736592 T2	14-12-2006
		EP 0898460 A1	03-03-1999
		JP 3769023 B2	19-04-2006
		JP 2002502270 A	22-01-2002
		US 5995868 A	30-11-1999
		US 6549804 B1	15-04-2003
		WO 9726823 A1	31-07-1997
WO 2010115939 A2	14-10-2010	EP 2416703 A2	15-02-2012
		WO 2010115939 A2	14-10-2010