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(54) **METHODS FOR AUTOMATIC GENERATION OF EEG MONTAGES**

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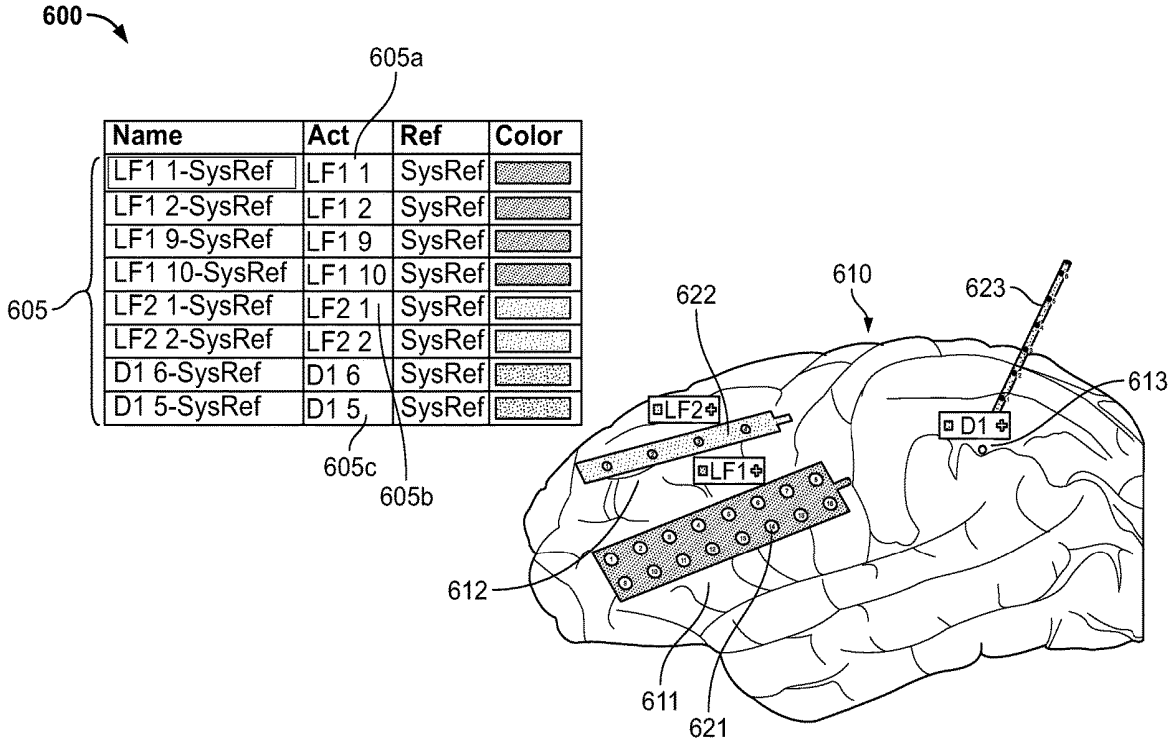
(57) **ABSTRACT**

Computer-implemented methods of enabling an on-the-fly generation of at least one user-defined montage from EEG electrodes positioned in a patient's brain, on the patient's brain and/or on the patient's scalp. The methods includes generating a graphical interface to display a view of the patient's brain and/or scalp overlaid with the EEG electrodes, each of which is uniquely identified with reference to its position in the patient's brain, on the patient's brain and/or on the patient's scalp, displaying a tool within the graphical interface for selecting at least one electrode from the displayed EEG electrodes, indicating a reference electrode corresponding to the selected electrode, accessing EEG signals corresponding to the electrode and the reference electrode, and generating another graphical interface to display an EEG trace indicative of a comparison of EEG signals of the electrode and the reference electrode.



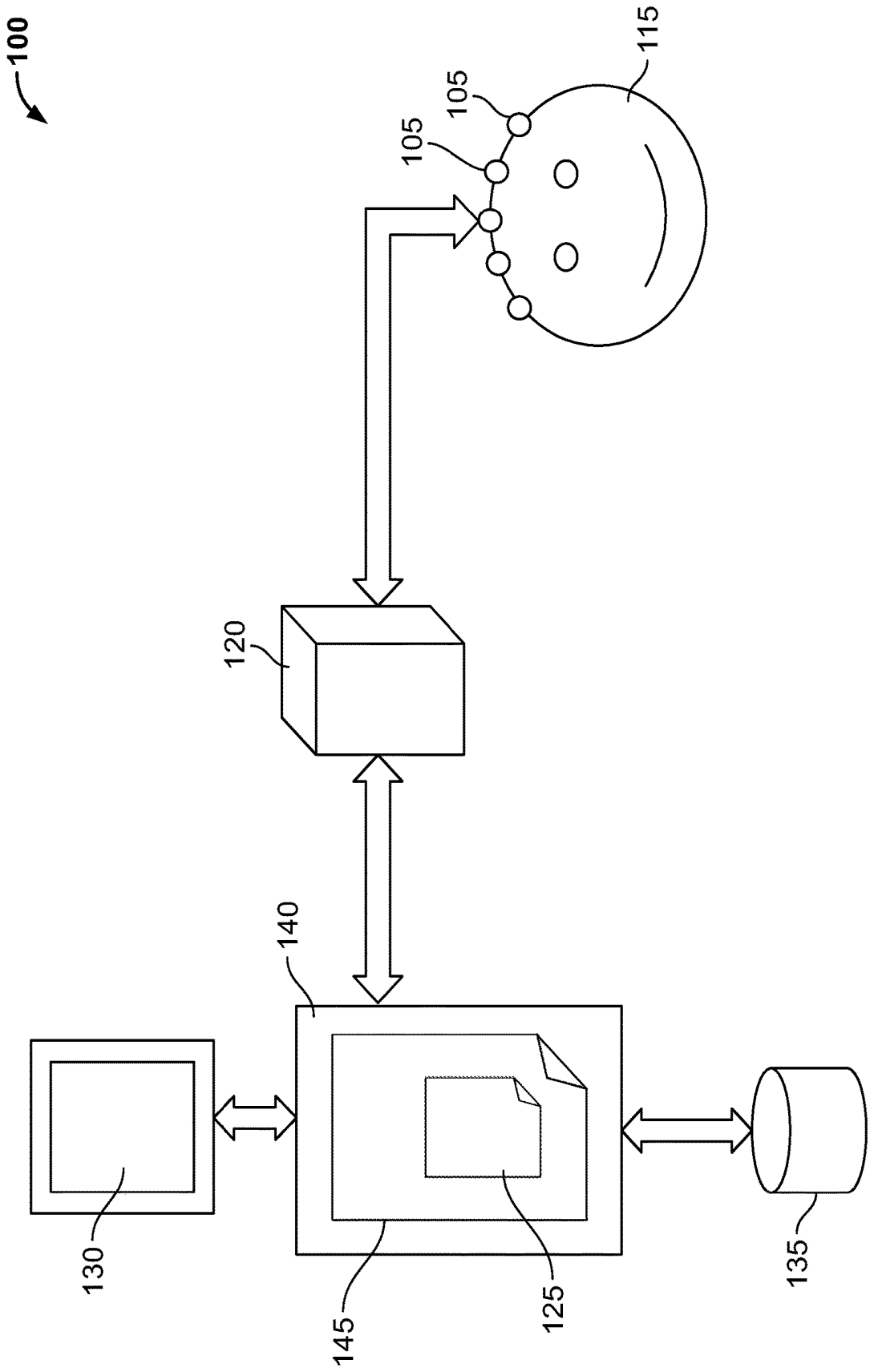


FIG. 1

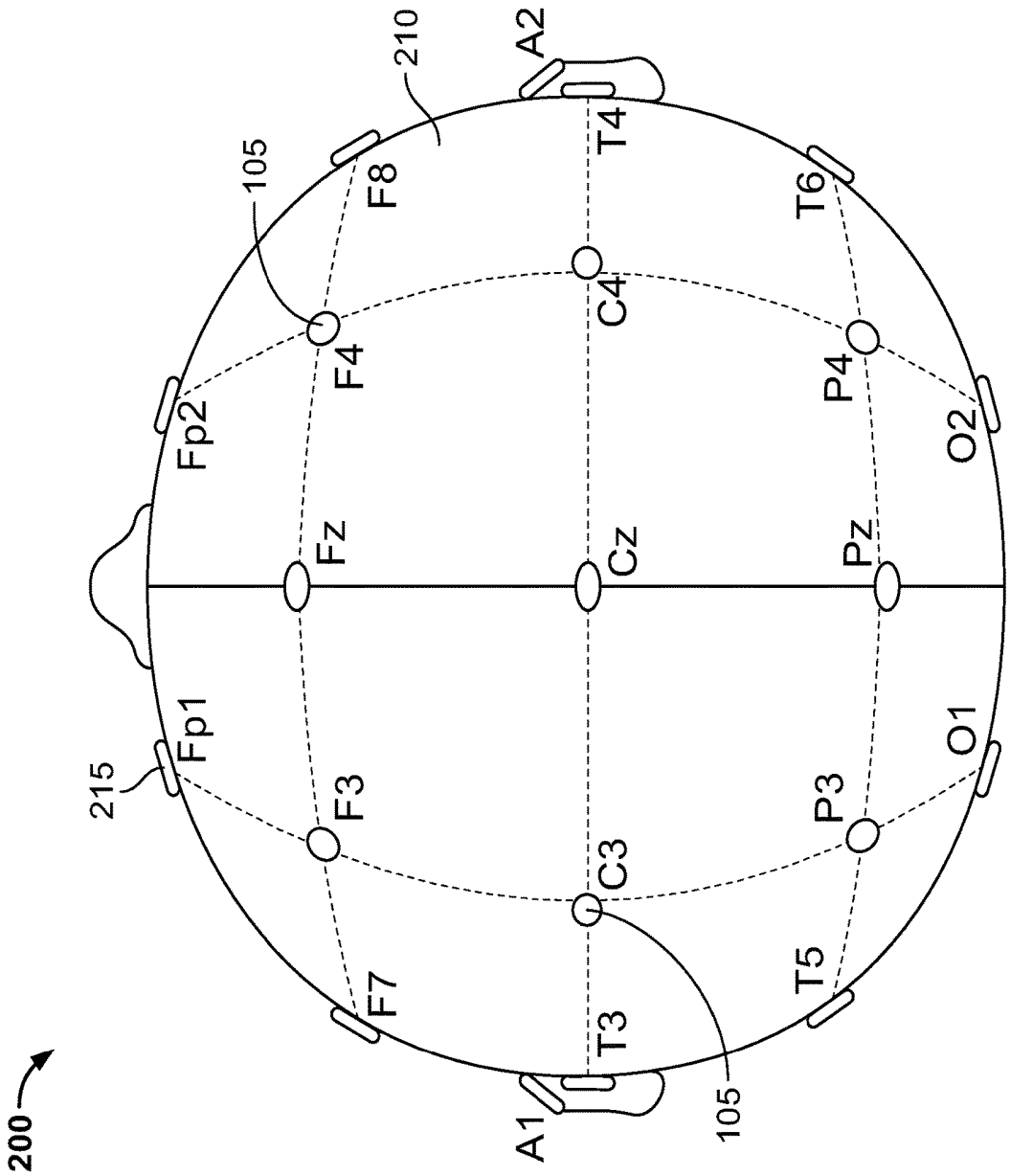

200
210
215
105
105
A1
A2
T3
T4
T5
T6
F7
F8
F3
F4
C3
C4
P3
P4
Fp1
Fp2
O1
O2
Fz
Cz
Pz

FIG. 2

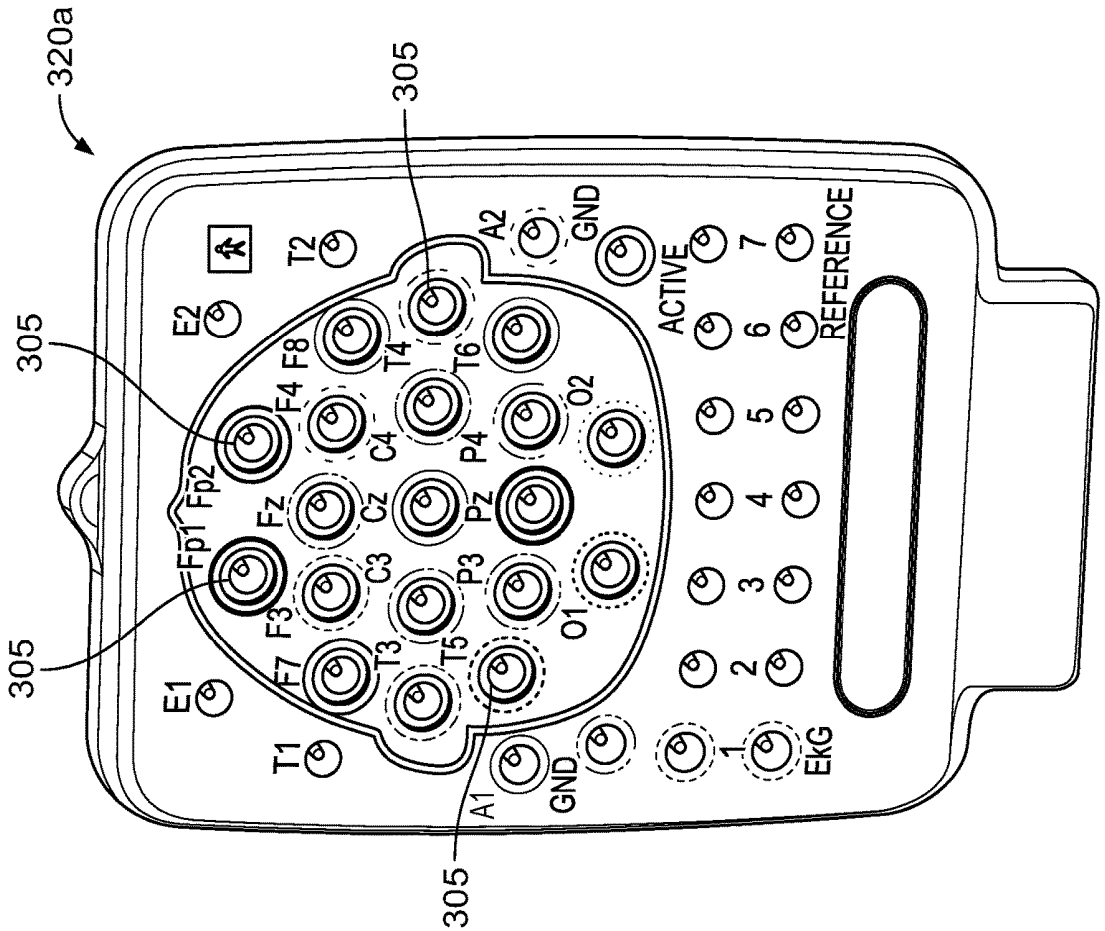

320a
305
305
305
305
E2
T2
A2
GND
ACTIVE
7
6
REFERENCE
F8
T4
T6
F4
C4
P4
O2
5
Fp2
Fz
Cz
Pz
4
Fp1
C3
P3
O1
3
F3
T3
T5
F7
2
E1
T1
A1
GND
1
EkG

FIG. 3A

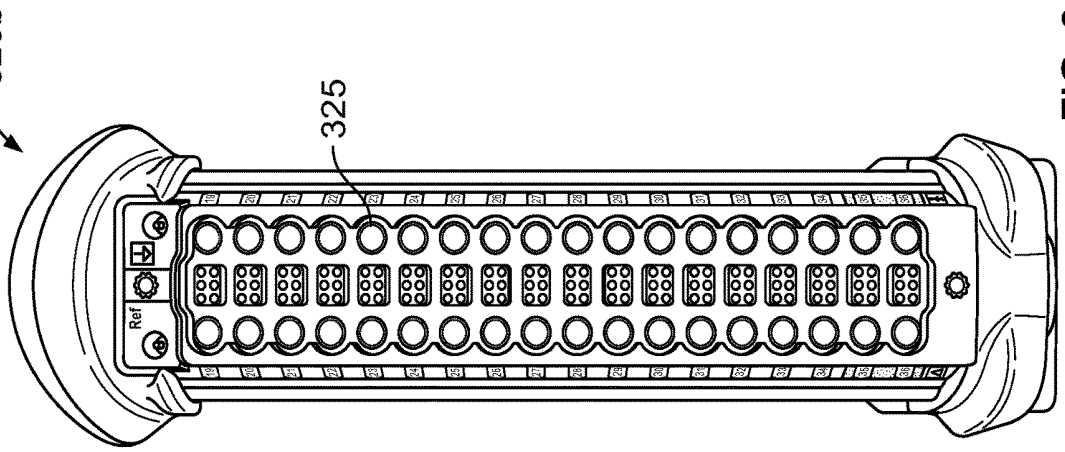


FIG. 3C

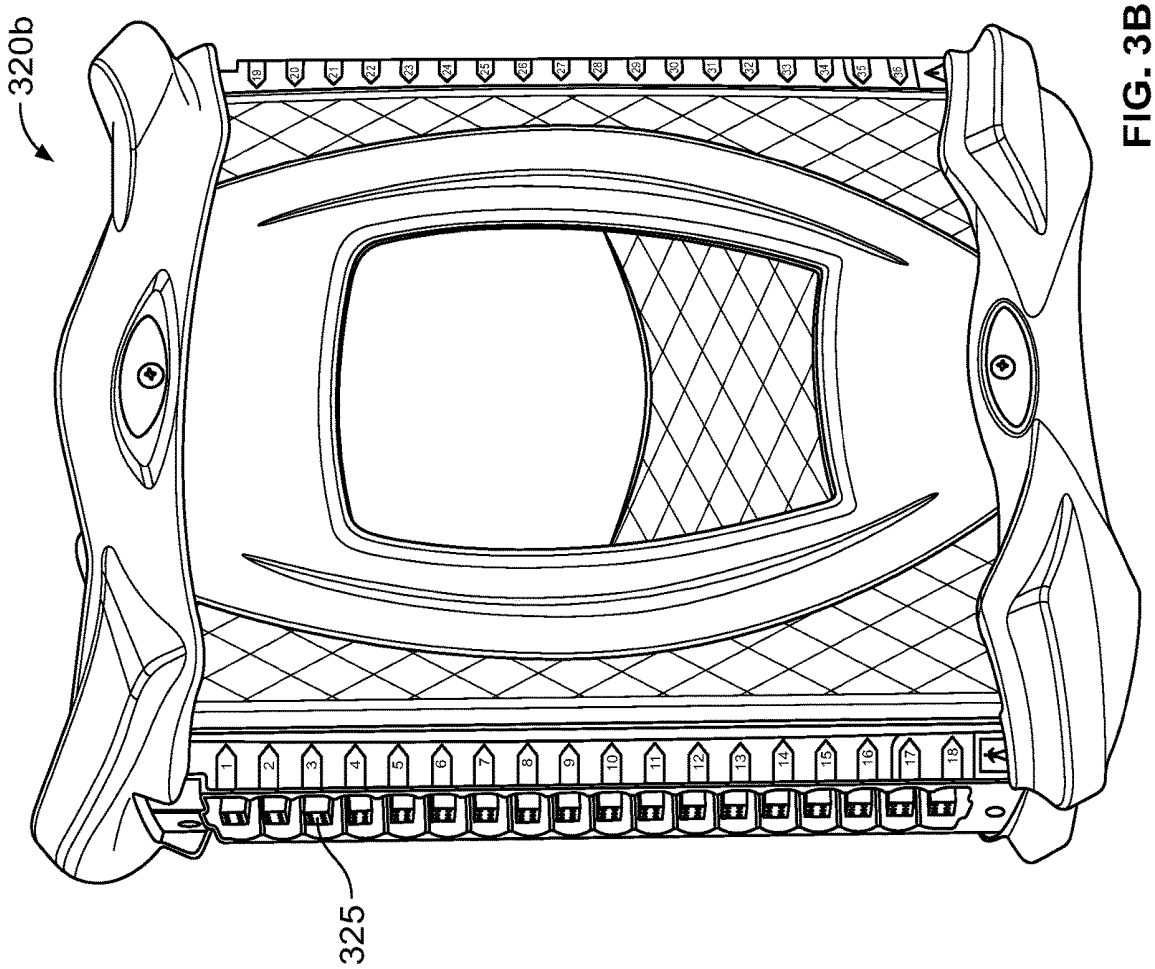


FIG. 3B

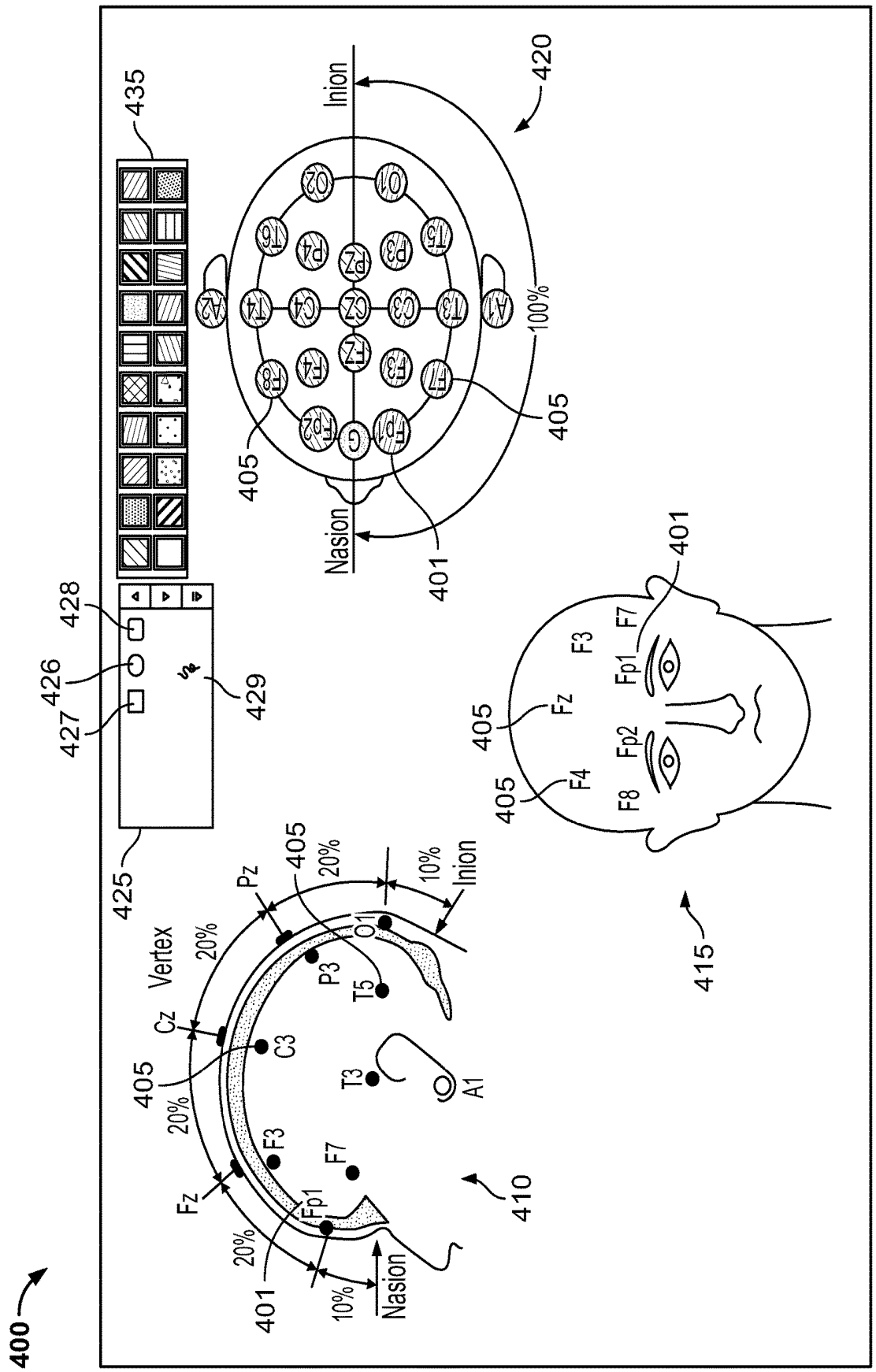

400
410
415
420
425
426
427
428
429
435
401
405
Nasion
Inion
Vertex
Fz
Cz
Pz
Fp1
F3
F7
C3
T3
A1
T5
P3
O1
Fp2
F4
F8
Fz
Fp1
F7
F3
Fp2
F4
F8
Fp1
F7
F3
Fz
Fp2
F4
F8
T3
C3
C4
T4
A2
T6
P4
O2
T5
P3
O1
A1
Fp2
G
Fp1
Fz
Cz
Pz
20%
10%
100%

FIG. 4A

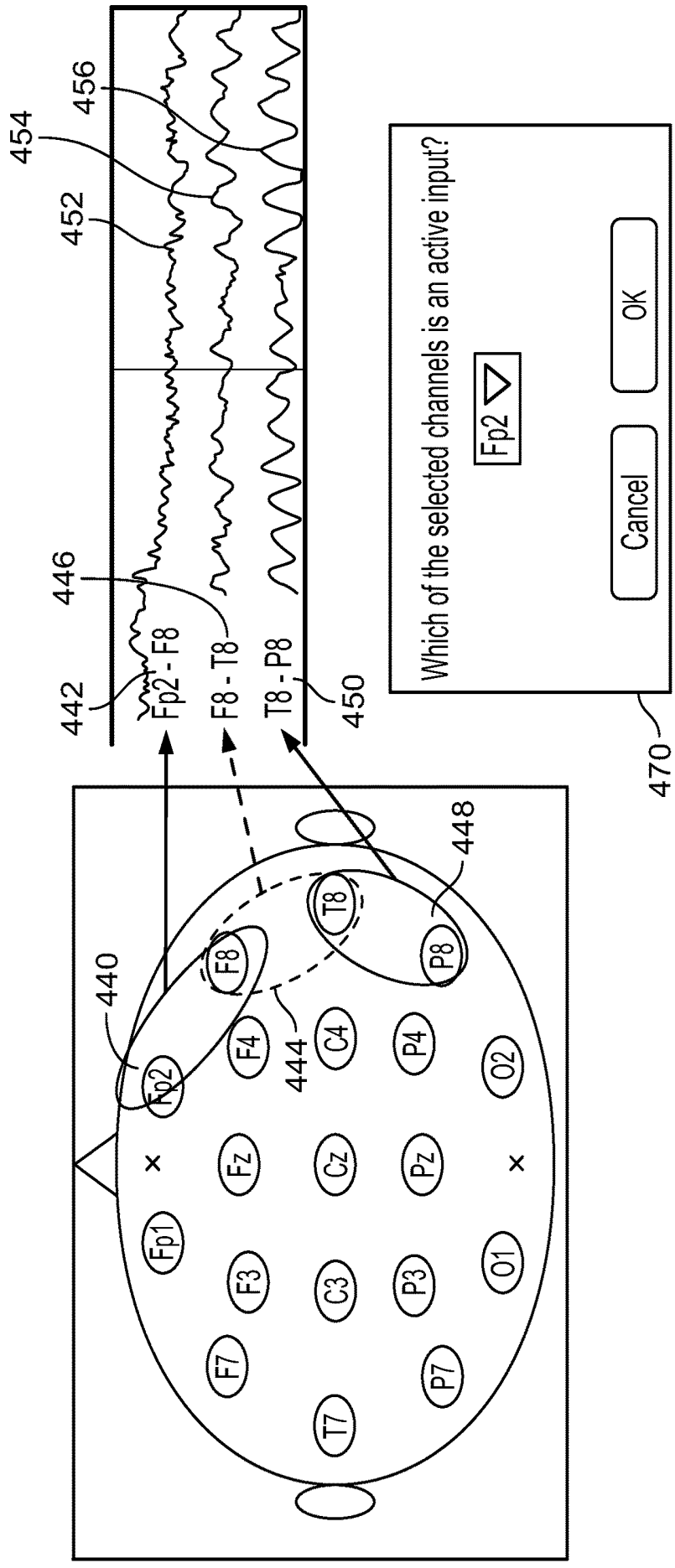

454
456
452
446
442
Fp2 - F8
F8 - T8
T8 - P8
450
Which of the selected channels is an active input?
Fp2
Cancel
OK
470
440
448
444
Fp1
Fz
Cz
Pz
F3
C3
P3
O1
F7
T7
P7
Fp2
F4
C4
P4
O2
F8
T8
P8

FIG. 4B

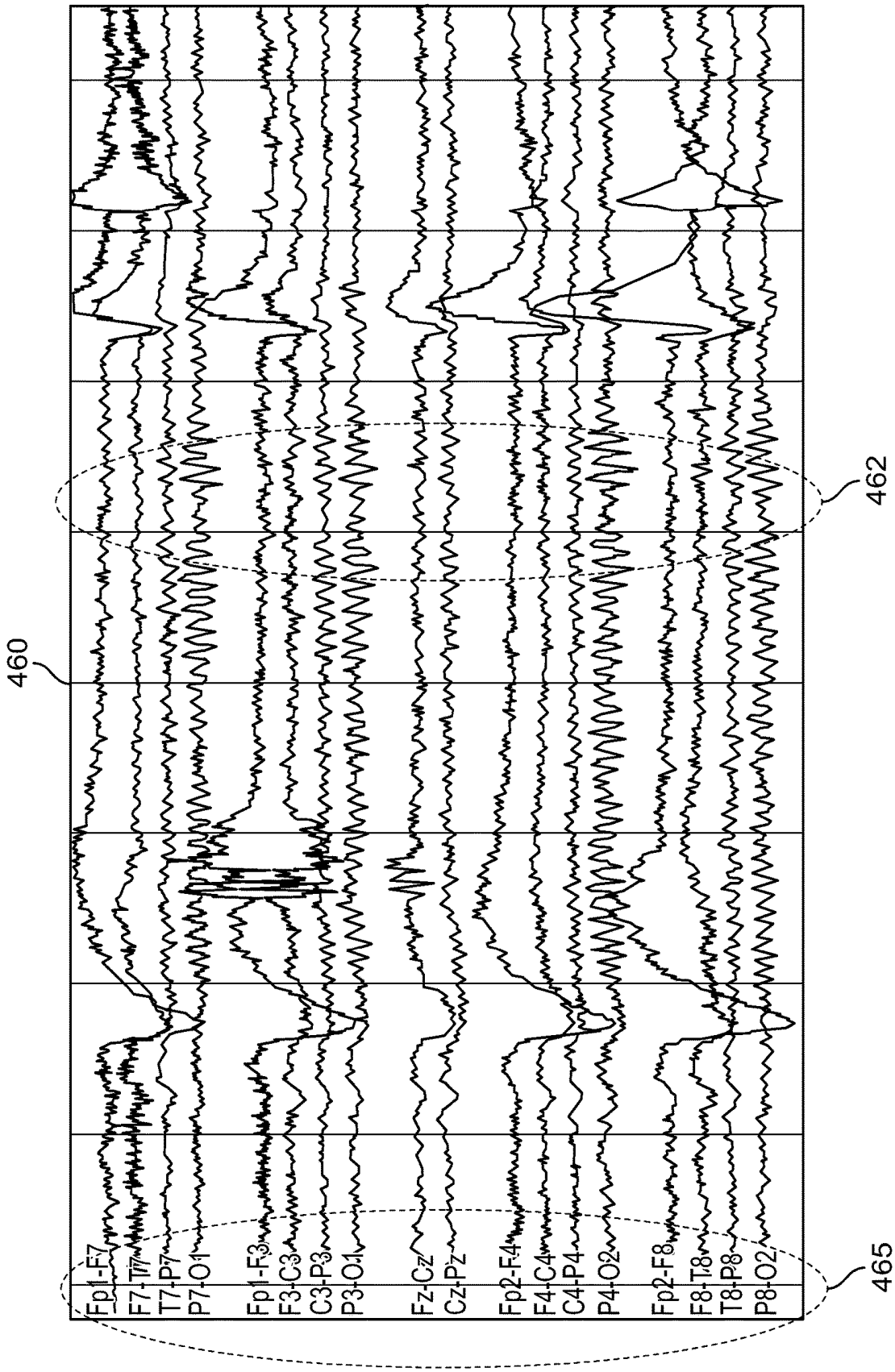

460
462
465
Fp1-F7
F7-T7
T7-P7
P7-O1
Fp1-F3
F3-C3
C3-P3
P3-O1
Fz-Cz
Cz-Pz
Fp2-F4
F4-C4
C4-P4
P4-O2
Fp2-F8
F8-T8
T8-P8
P8-O2

FIG. 4C

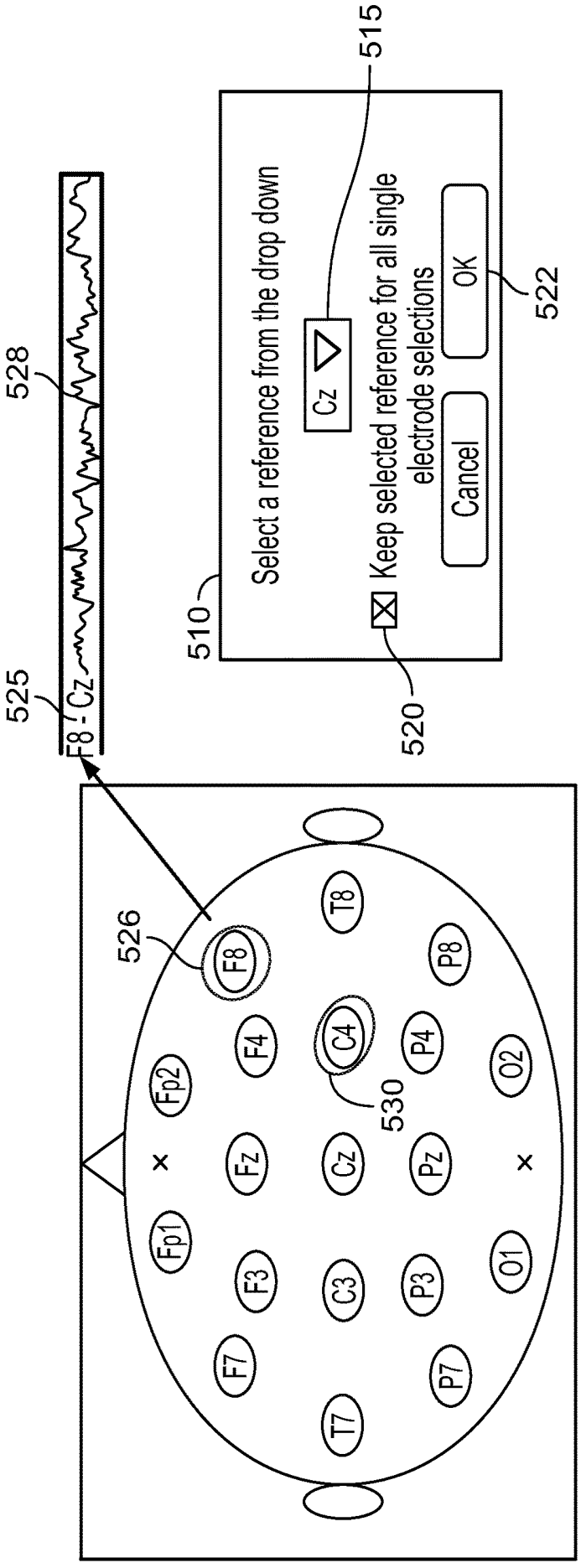

515
Select a reference from the drop down
Cz
Keep selected reference for all single electrode selections
Cancel
OK
522
510
520
528
525
F8 - Cz
526
530
Fp1
Fp2
F7
F3
Fz
F4
T7
C3
Cz
C4
P7
P3
Pz
P4
T8
P8
O1
O2

FIG. 5A

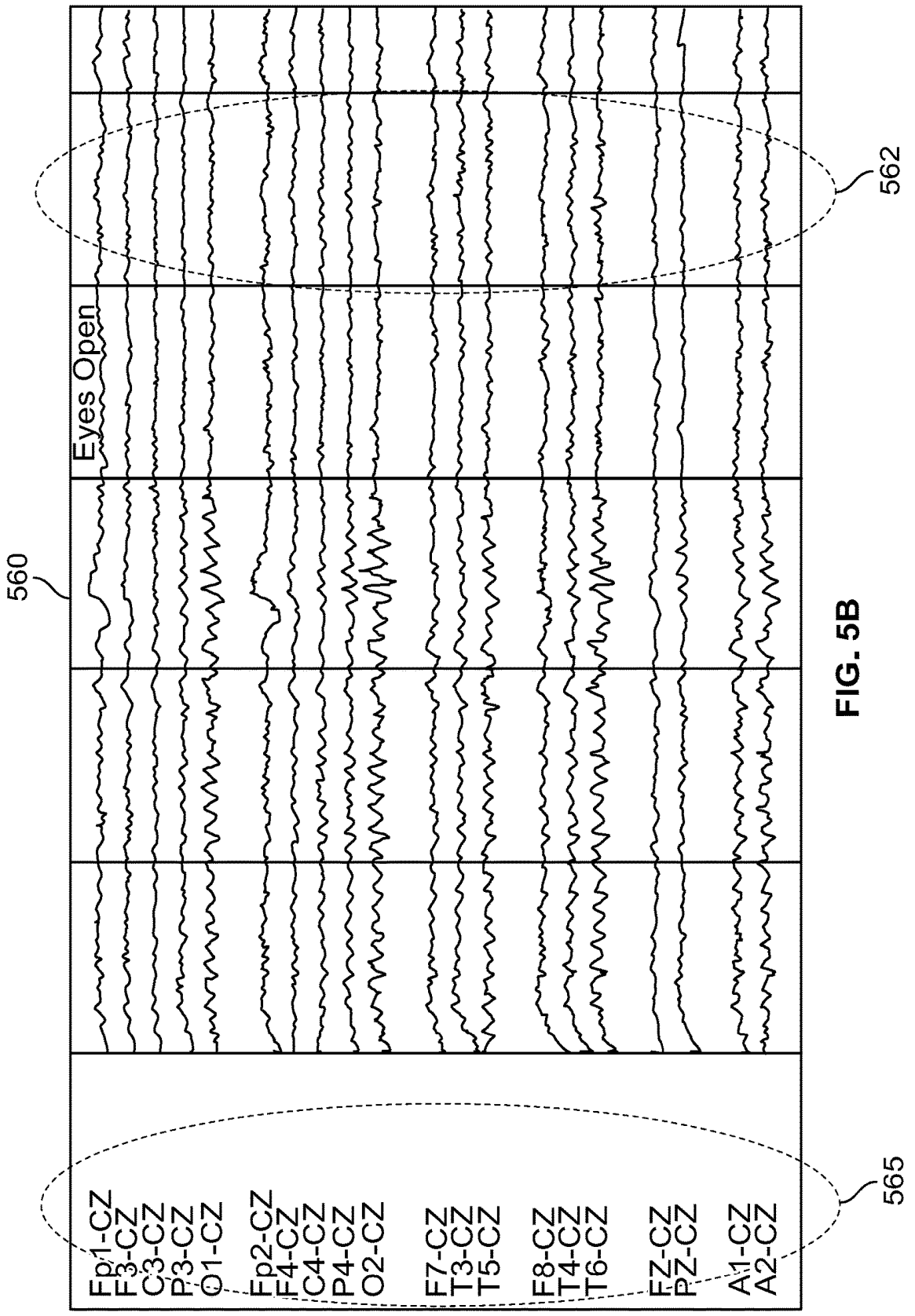

560
562
565
Eyes Open
Fp1-CZ
F3-CZ
C3-CZ
P3-CZ
O1-CZ
Fp2-CZ
F4-CZ
C4-CZ
P4-CZ
O2-CZ
F7-CZ
T3-CZ
T5-CZ
F8-CZ
T4-CZ
T6-CZ
FZ-CZ
PZ-CZ
A1-CZ
A2-CZ

FIG. 5B

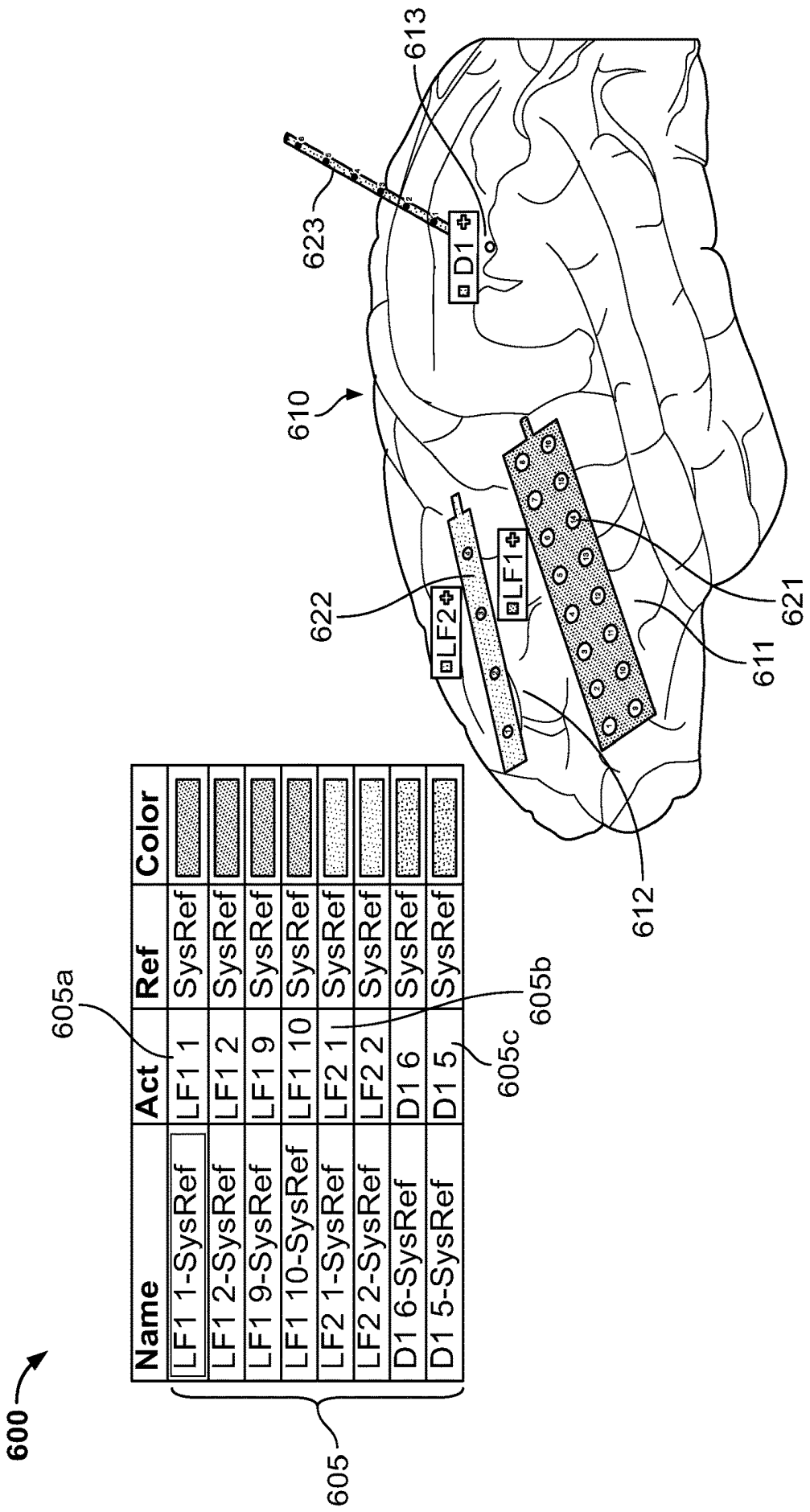

600
605
605a
605b
605c
Name
Act
Ref
Color
LF1 1-SysRef
LF1 1
SysRef
LF1 2-SysRef
LF1 2
SysRef
LF1 9-SysRef
LF1 9
SysRef
LF1 10-SysRef
LF1 10
SysRef
LF2 1-SysRef
LF2 1
SysRef
LF2 2-SysRef
LF2 2
SysRef
D1 6-SysRef
D1 6
SysRef
D1 5-SysRef
D1 5
SysRef
610
611
612
613
621
622
623
D1
LF1
LF2

FIG. 6A

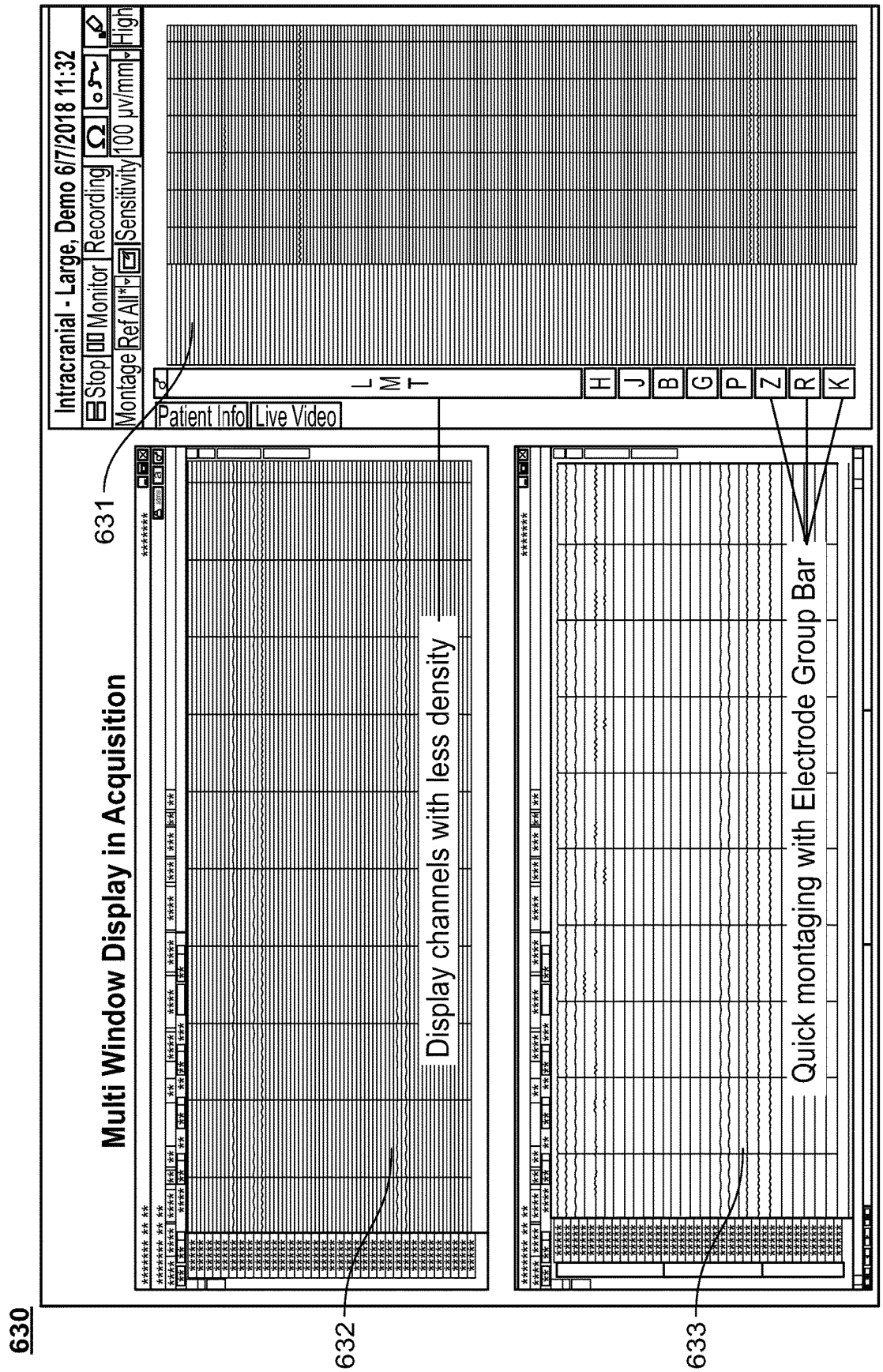

630
Intracranial - Large, Demo 6/7/2018 11:32
Stop
Monitor
Recording
Montage
Ref All*
Sensitivity
100 µv/mm
High
Patient Info
Live Video
L
M
T
H
J
B
G
P
Z
R
K
631
Multi Window Display in Acquisition
Display channels with less density
Quick montaging with Electrode Group Bar
632
633

FIG. 6B

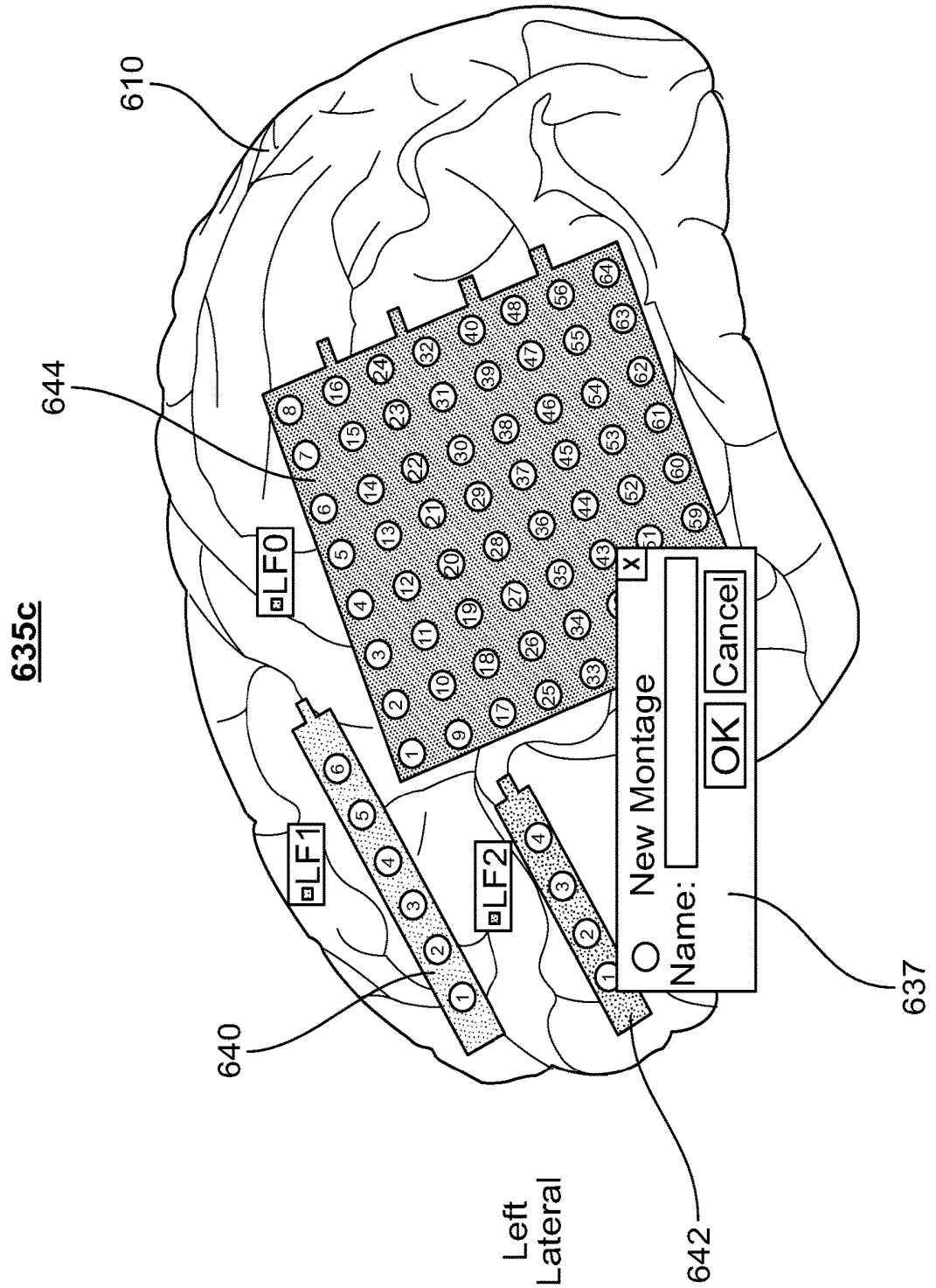

635c
610
644
LF0
LF1
LF2
640
642
637
New Montage
Name:
OK
Cancel
Left
Lateral

FIG. 6C

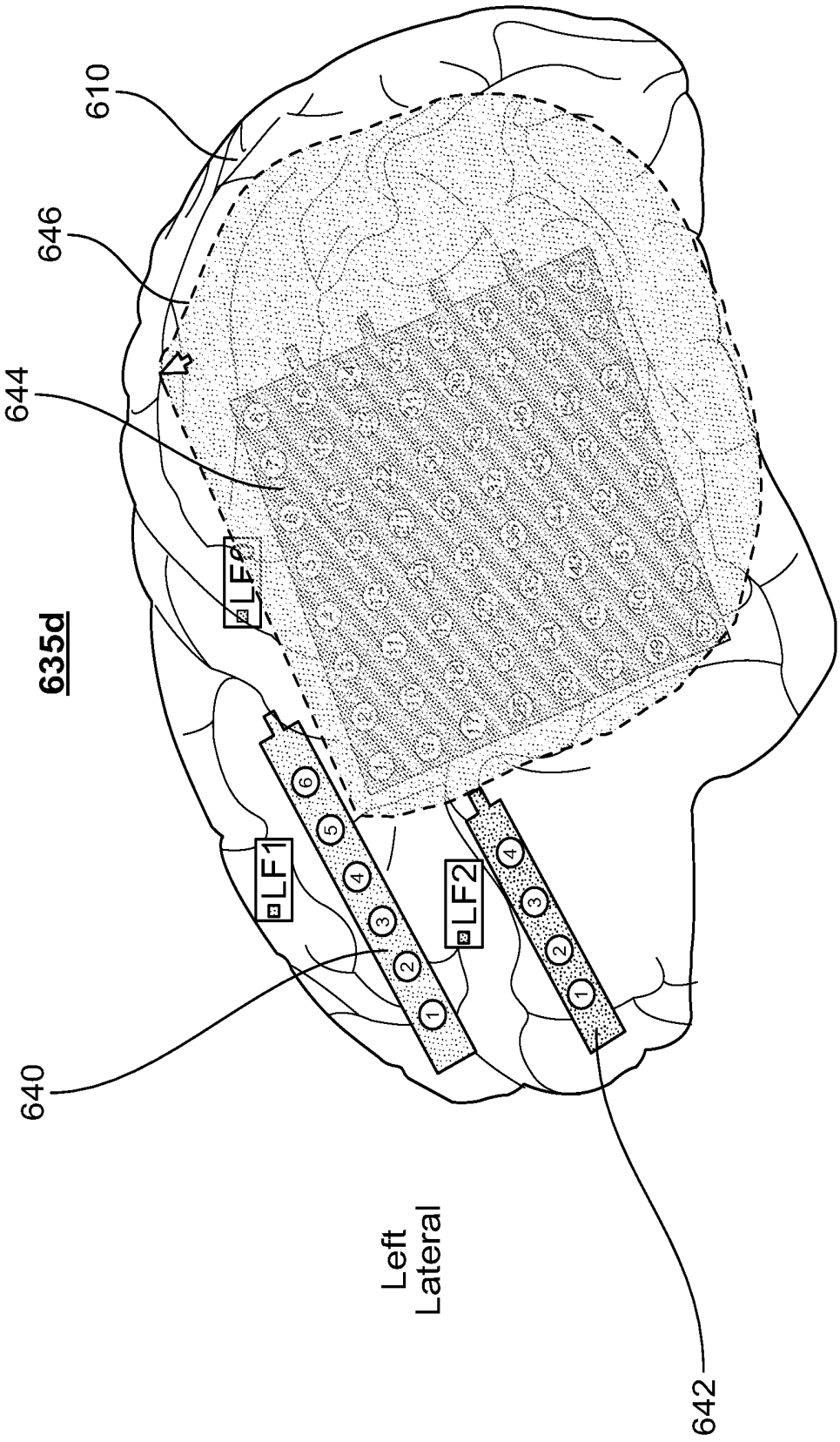


FIG. 6D

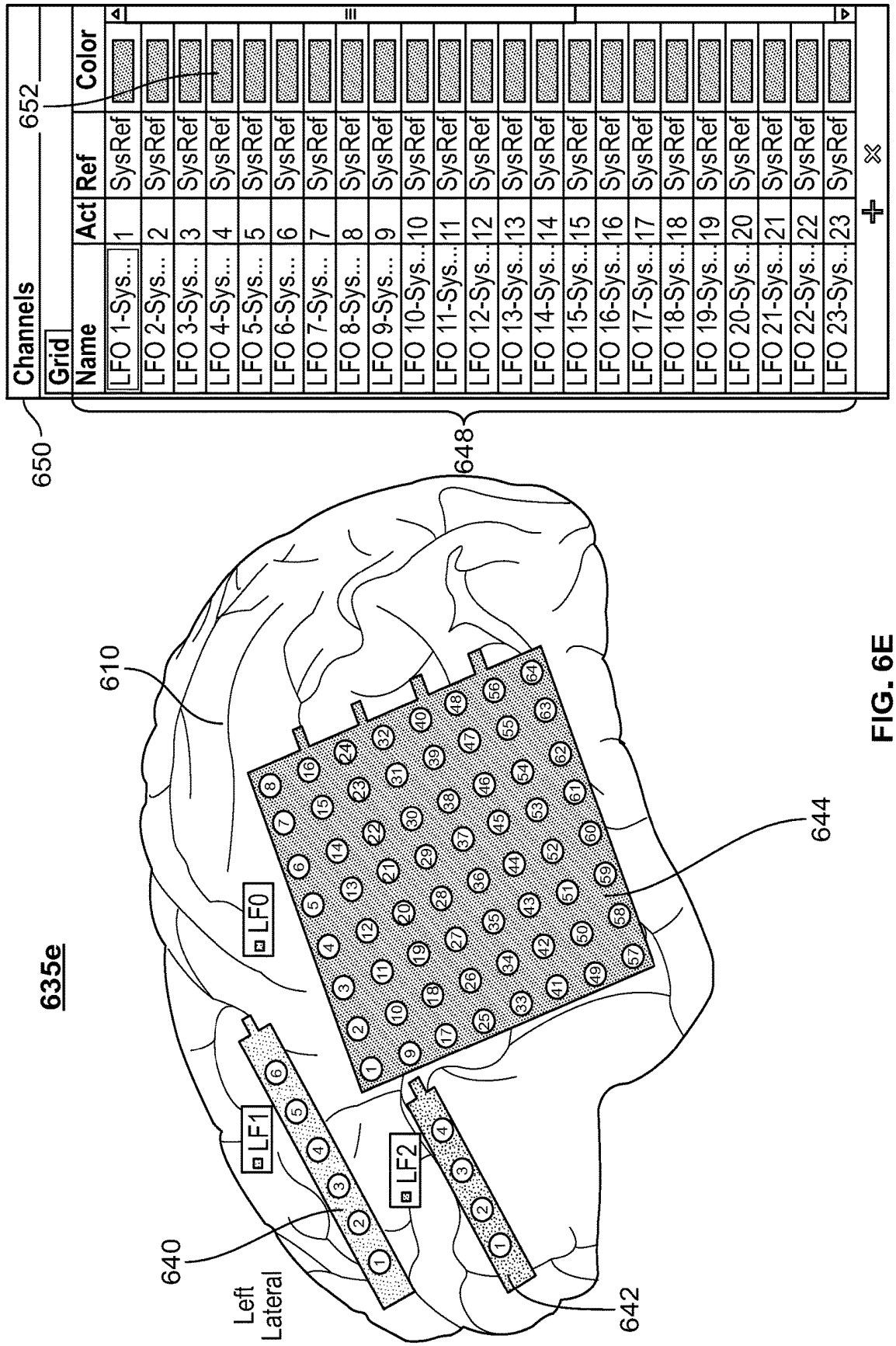

Channels
652
Grid
Name
Act
Ref
Color
LFO 1-Sys... 1 SysRef
LFO 2-Sys... 2 SysRef
LFO 3-Sys... 3 SysRef
LFO 4-Sys... 4 SysRef
LFO 5-Sys... 5 SysRef
LFO 6-Sys... 6 SysRef
LFO 7-Sys... 7 SysRef
LFO 8-Sys... 8 SysRef
LFO 9-Sys... 9 SysRef
LFO 10-Sys... 10 SysRef
LFO 11-Sys... 11 SysRef
LFO 12-Sys... 12 SysRef
LFO 13-Sys... 13 SysRef
LFO 14-Sys... 14 SysRef
LFO 15-Sys... 15 SysRef
LFO 16-Sys... 16 SysRef
LFO 17-Sys... 17 SysRef
LFO 18-Sys... 18 SysRef
LFO 19-Sys... 19 SysRef
LFO 20-Sys... 20 SysRef
LFO 21-Sys... 21 SysRef
LFO 22-Sys... 22 SysRef
LFO 23-Sys... 23 SysRef
650
648
610
635e
LF0
LF1
LF2
640
642
644
Left
Lateral

FIG. 6E

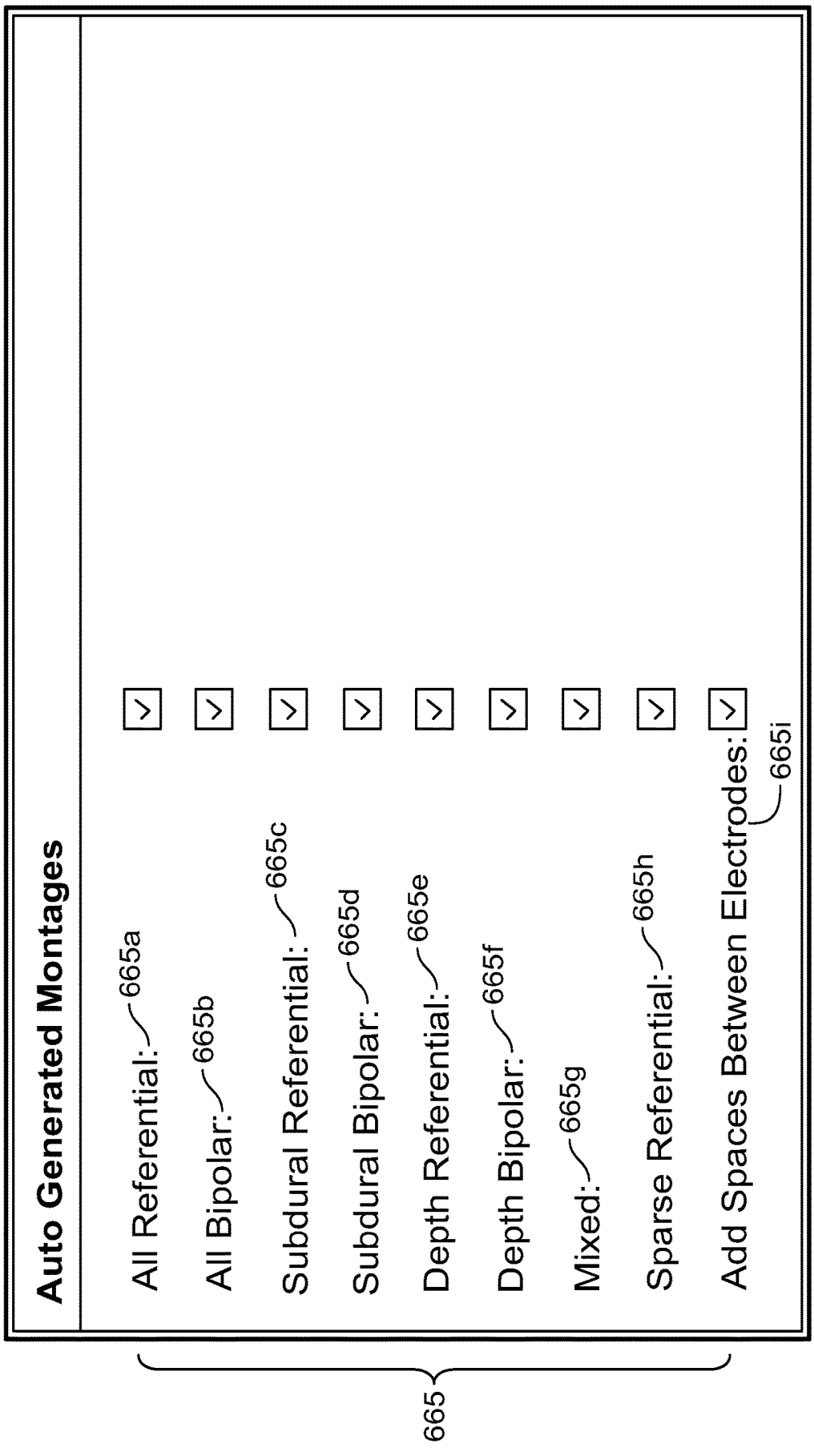

660f
Auto Generated Montages
All Referential:
665a
All Bipolar:
665b
Subdural Referential:
665c
Subdural Bipolar:
665d
Depth Referential:
665e
Depth Bipolar:
665f
Mixed:
665g
Sparse Referential:
665h
Add Spaces Between Electrodes:
665i
665

FIG. 6F

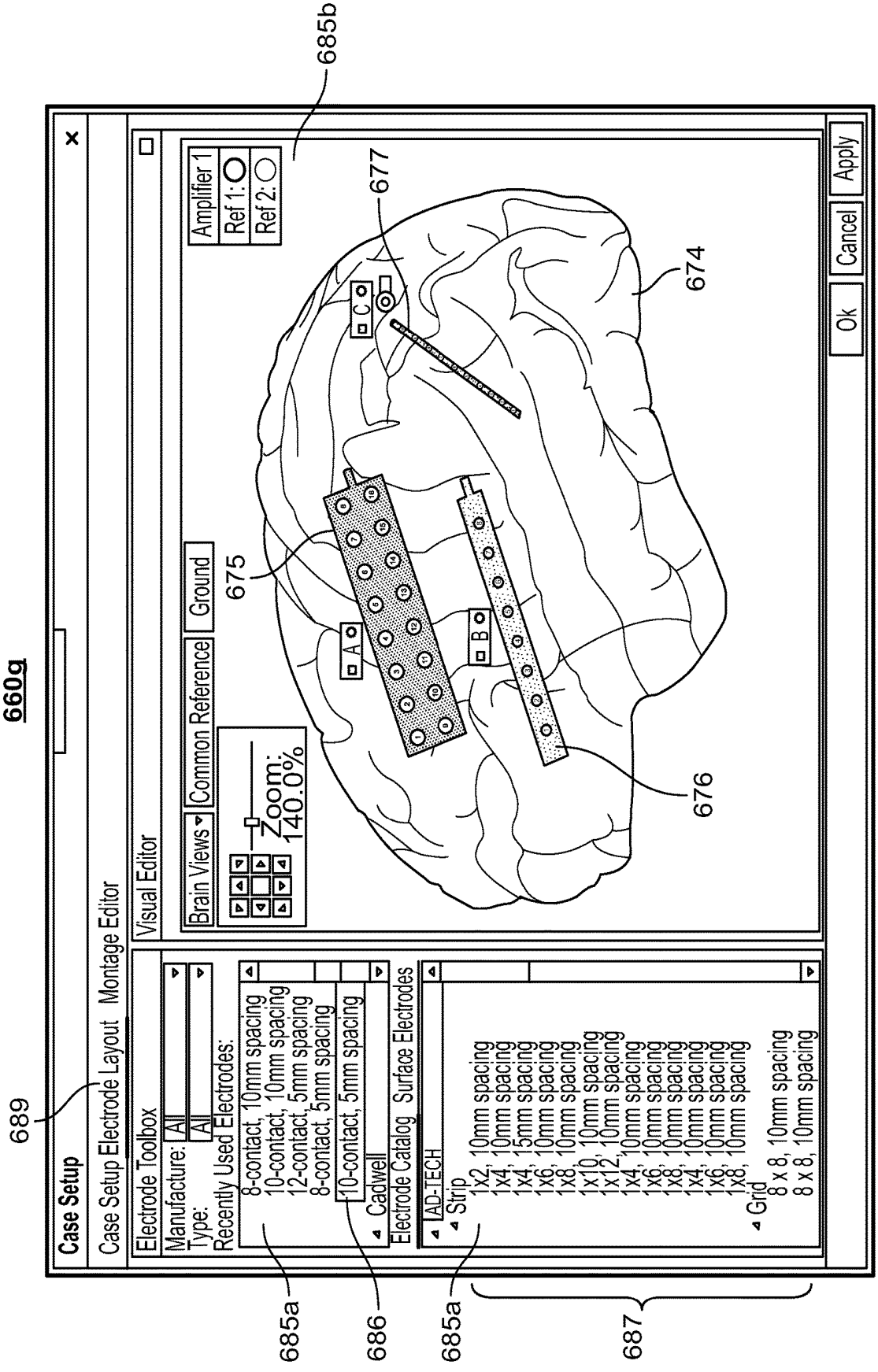

660g
689
685b
677
674
675
676
685a
686
685a
687
Case Setup
Case Setup Electrode Layout Montage Editor
Electrode Toolbox
Manufacture: All
Type: All
Recently Used Electrodes:
8-contact, 10mm spacing
10-contact, 10mm spacing
12-contact, 5mm spacing
8-contact, 5mm spacing
10-contact, 5mm spacing
Cadwell
Electrode Catalog Surface Electrodes
AD-TECH
Strip
1x2, 10mm spacing
1x4, 10mm spacing
1x4, 15mm spacing
1x6, 10mm spacing
1x8, 10mm spacing
1x10, 10mm spacing
1x12, 10mm spacing
1x4, 10mm spacing
1x6, 10mm spacing
1x8, 10mm spacing
1x4, 10mm spacing
1x6, 10mm spacing
1x8, 10mm spacing
Grid
8 x 8, 10mm spacing
8 x 8, 10mm spacing
Visual Editor
Brain Views
Common Reference
Ground
Zoom: 140.0%
Amplifier 1
Ref 1:
Ref 2:
A
B
C
Ok
Cancel
Apply

FIG. 6G

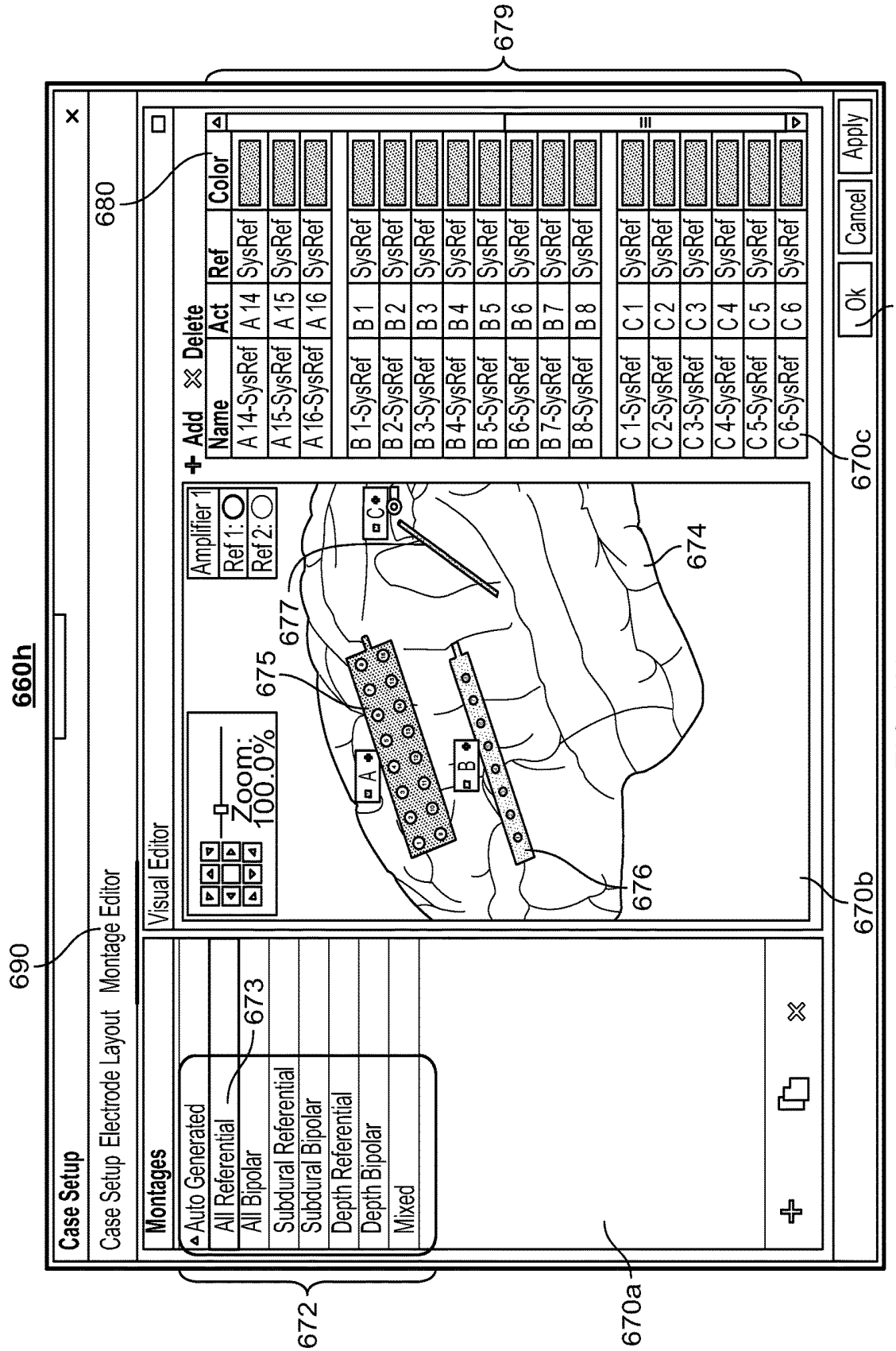

660h
690
Case Setup
Case Setup Electrode Layout Montage Editor
Montages
Auto Generated
All Referential
All Bipolar
Subdural Referential
Subdural Bipolar
Depth Referential
Depth Bipolar
Mixed
673
672
670a
Visual Editor
Zoom: 100.0%
Amplifier 1
Ref 1:
Ref 2:
675
677
676
674
670b
680
679
Add
Delete
Name
Act
Ref
Color
A 14-SysRef
A 15-SysRef
A 16-SysRef
B 1-SysRef
B 2-SysRef
B 3-SysRef
B 4-SysRef
B 5-SysRef
B 6-SysRef
B 7-SysRef
B 8-SysRef
C 1-SysRef
C 2-SysRef
C 3-SysRef
C 4-SysRef
C 5-SysRef
C 6-SysRef
670c
Ok
Cancel
Apply
681

FIG. 6H

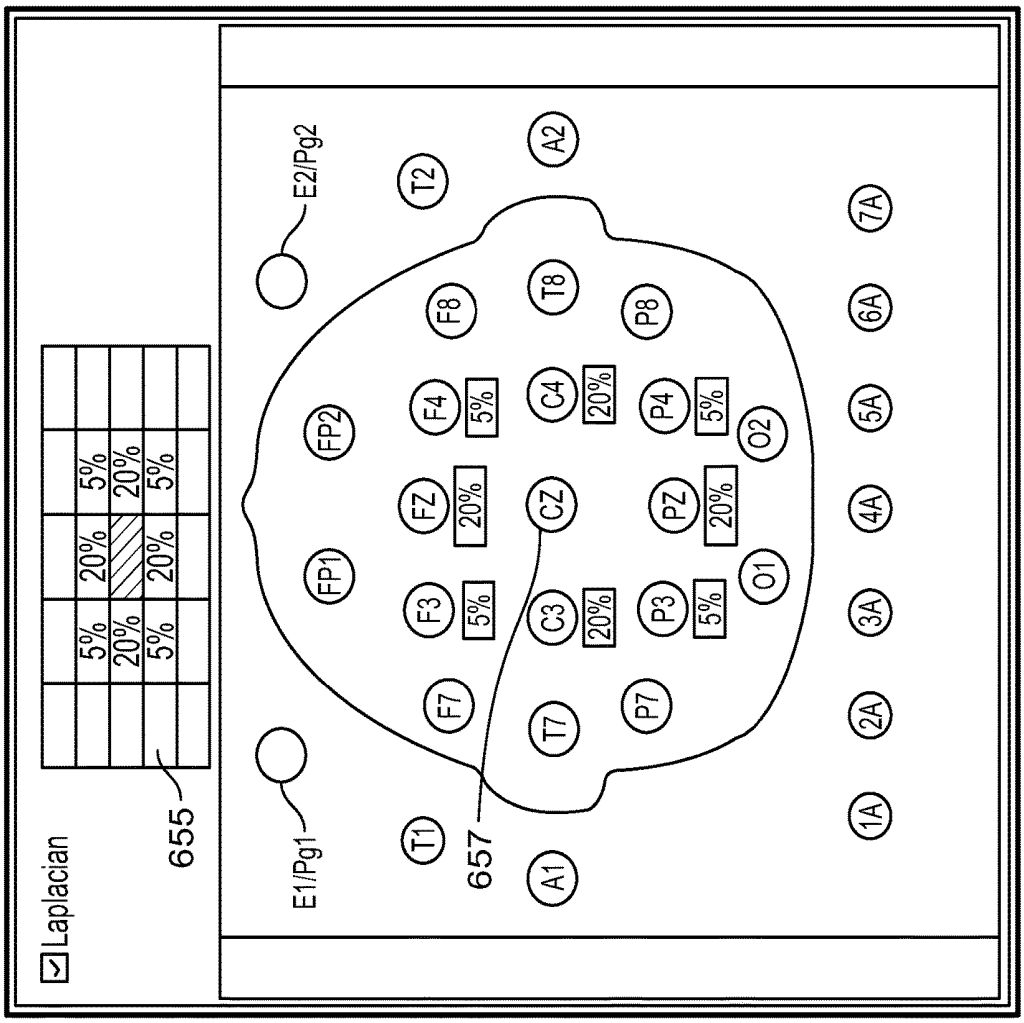

635f
Laplacian
655
5%
20%
5%
20%
5%
20%
5%
20%
5%
E1/Pg1
E2/Pg2
657
FP1
FP2
F7
F3
FZ
F4
F8
T1
T7
C3
CZ
C4
T8
A1
T2
A2
P7
P3
PZ
P4
P8
O1
O2
1A
2A
3A
4A
5A
6A
7A

FIG. 6I

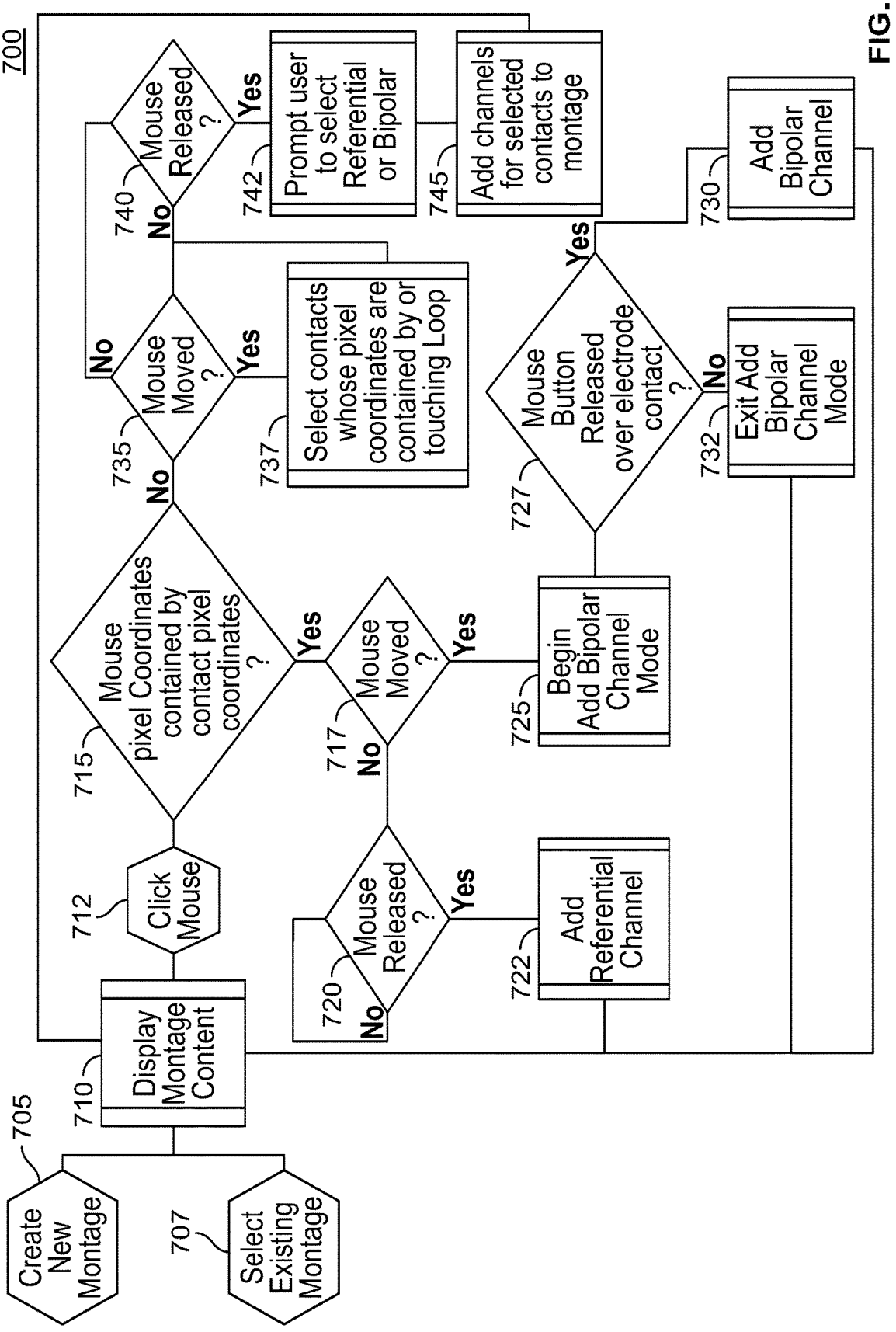

700
705
Create New Montage
707
Select Existing Montage
710
Display Montage Content
712
Click Mouse
715
Mouse pixel Coordinates contained by contact pixel coordinates ?
Yes
No
717
Mouse Moved ?
Yes
No
720
Mouse Released ?
Yes
No
722
Add Referential Channel
725
Begin Add Bipolar Channel Mode
727
Mouse Button Released over electrode contact ?
Yes
No
730
Add Bipolar Channel
732
Exit Add Bipolar Channel Mode
735
Mouse Moved ?
Yes
No
737
Select contacts whose pixel coordinates are contained by or touching Loop
740
Mouse Released ?
Yes
No
742
Prompt user to select Referential or Bipolar
745
Add channels for selected contacts to montage

FIG. 7

METHODS FOR AUTOMATIC GENERATION OF EEG MONTAGES

CROSS REFERENCE

[0001] The present application relies on U.S. Patent Provisional Application No. 62/771,897, entitled "Methods for Automatic Generation of EEG Montages" and filed on Nov. 27, 2018, for priority, which is herein incorporated by reference in its entirety.

FIELD

[0002] The present specification is related generally to the field of electroencephalography. More specifically the present specification is related to systems and methods for automatically generating one or more montages subsequent to a user's inputs, on at least one GUI, indicative of the user's selection of one or more EEG channels or electrodes.

BACKGROUND

[0003] An electroencephalograph (EEG) is a device which measures and records brain wave activity by sensing electrical potential of a patient's scalp, cortex or cerebrum at various sites. Each EEG channel corresponds to a particular electrode combination attached to the patient. The EEG may be recorded with reference to a common passive electrode, which is referred to as a monopolar (referential) recording, or the EEG may be recorded differentially between pairs of contiguous electrodes, which are referred to as bipolar recordings. In the case of bipolar recordings, there are various ways to select the electrode pairs according to montages designed to visualize the propagation of neural activity in different directions of the patient's brain.

[0004] Montages are visual, graphical representations of waveforms, also referred to as channels or derivations, which are generated as a function of the potential difference between two or more electrodes. When aggregated together from electrodes spanning a patient's scalp, these montages graphically represent the patient's EEG activity, allow a comparison of EEG activity on the two sides of the brain (lateralization), and can aid in a localization of recorded activity to a specific brain region. Different montages may be useful for visualizing the sources of different EEG patterns. However, with 21 electrode positions in the 10-20 system and 16 total channels, the number of possible montages is 21^{16}. The 10-10 system, with more than 70 electrode positions, and the ability to display up to 256 channels in modern digital EEG machines, provides the ability to create an even greater number of montages, such as 70^{256}. The "10" and "20" refer to the actual distances between adjacent electrodes, which are either 10% or 20% of the total front-back or right-left distance of the skull.

[0005] While 10-10 and 10-20 EEG monitoring systems using electrodes placed on the patient's scalp are useful in many neuromonitoring situations, there are indications (for example, neuromonitoring and mapping of epileptic brains to determine surgery candidates) where more precise neuromonitoring is required. Electrocorticography (ECoG) and stereoelectroencephalography (sEEG) are methods of intracranial EEG monitoring and cortical mapping that require high channel count recording and stimulating devices. These systems use amplifiers capable of receiving input electrodes typically in a range of 21 to 256 electrodes and sometimes more than 500 electrodes. In ECoG, electrodes are placed on the cerebral cortex via a craniotomy. In sEEG, depth electrodes may be placed via small holes (burr holes) drilled in the skull. ECoG and sEEG may be used when standard EEG monitoring results are inconclusive, particularly for epilepsy patients. Since ECoG and sEEG use strip or grid electrodes and depth electrodes on the surface of the brain and in the brain respectively, they provide a benefit of using electrodes that are closer to the area(s) producing seizures than electrodes placed on the scalp in standard EEG monitoring. In addition, electrodes placed directly on or in the brain have the advantage of recording signals without the interference of skin, fat tissue, muscle or bone. ECoG and sEEG may be used to monitor, assess and map the brains of epilepsy patients who have may benefit from surgery and have not responded to less invasive treatments including pharmaceuticals. Mapping will indicate to physicians areas of an epileptic brain for resection and functional areas of the brain to be safeguarded during surgery. Functional mapping involves using the electrodes (grid or strip) to stimulate the brain and record signals to identify the underlying function of a brain region, such as language, sensation, or motor function, to precisely map an origin of seizures. ECoG and sEEG typically involve long term monitoring where electrodes are placed intracranially during a surgery, then the monitoring device remains connected to the patient for monitoring and recording to identify areas of pathological brain activity. Later, the electrodes are removed and the device may be used during surgery to monitor or stimulate nerves to direct the surgery. When a discrete epileptogenic region of the brain is identified and can be removed without the introduction of unacceptable additional neurological deficits, respective surgery is performed.

[0006] In high channel count systems it is a challenge to create montages and display acquired EEG data in ways that are visually useful and discernible. While the user can see general activity on specific traces, it may be visually arduous for a user to discern details of EEG activity when there are upwards of 128 traces on a screen. With high channel count systems (that include surgically implanted electrodes as well as scalp locations, for example) conventional predefined montages are not practical as there is not a standard set of electrode sites defined from which to create a montage subset. Electrodes are surgically implanted differently for each patient. Accordingly, the montages need to be customized based on a review of live data and a desire to look in more detail at a subset of the total set of electrode signals. Thus, it is desirable to create multiple custom montages during a neurological study using high channel count systems. However, legacy high channel count systems are too inflexible to allow for the kind of customized exploration often required. Additionally, in conventional high channel count systems, it can take an extended amount of time to manually select EEG signal inputs in order to build a montage.

[0007] Thus, there is a need for systems and methods to generate one or more interfaces, preferably a graphical user interface (GUI) integrated into a display device, that enable a user to select any combination of two or more EEG signal inputs from which a channel or derivation may be dynamically generated and, accordingly, from which a montage may be dynamically generated. There is also a need for one or more interfaces that facilitate isolation of EEG traces by a user, that provide desired flexibility and that allow for customized exploration enabling a user to see detailed

morphology of the EEG data where there is activity. There is also a need for systems and methods for automatically generating or creating multiple custom montages, during and/or after recordation of EEG signals, as a result of the user's inputs or selections on the one or more GUIs.

SUMMARY

[0008] The following embodiments and aspects thereof are described and illustrated in conjunction with systems, tools and methods, which are meant to be exemplary and illustrative, and not limiting in scope. The present application discloses numerous embodiments.

[0009] The present specification discloses a computer readable non-transitory medium comprising a plurality of executable programmatic instructions wherein, when the plurality of executable programmatic instructions are executed by a processor in a computing device, at least one user-defined montage from a plurality of EEG electrodes positioned in a patient's brain, on the patient's brain or on the patient's scalp is generated, the plurality of executable programmatic instructions comprising: programmatic instructions, stored in the computer readable non-transitory medium, for generating a first graphical interface to display at least one graphical view of the patient's brain and/or scalp overlaid with a plurality of identifications corresponding to the plurality of EEG electrodes, wherein each of the plurality of identifications uniquely references a position of each of the plurality of EEG electrodes relative to the patient's brain and/or scalp; programmatic instructions, stored in the computer readable non-transitory medium, for displaying a tool within the first graphical interface, wherein the tool is configured to be manipulated in order to select at least one identification of the plurality of identifications; programmatic instructions, stored in the computer readable non-transitory medium, for prompting the user to indicate at least one reference identification corresponding to the at least one identification; programmatic instructions, stored in the computer readable non-transitory medium, for acquiring EEG signals associated with EEG electrodes corresponding to the at least one identification and the at least one reference identification; and programmatic instructions, stored in the computer readable non-transitory medium, for generating a second graphical interface to display at least one EEG trace indicative of a comparison of EEG signals associated with EEG electrodes corresponding to the at least one identification and the at least one reference identification.

[0010] Optionally, the computer readable non-transitory medium further comprises programmatic instructions configured to enable a user to input a selection of the at least one identification comprising at least one of programmatic instructions for enabling a drawing a loop around the at least one identification, programmatic instructions for enabling a clicking from the at least one identification to multiple other identifications of the plurality of identifications to thereby visually connect the at least one identifications and multiple other identifications, programmatic instructions for enabling a clicking and/or dragging an icon over or looping around at least one of the plurality of EEG electrodes, programmatic instructions for enabling a clicking a body of at least one of the plurality of EEG electrodes or programmatic instructions for enabling a pressing a key on a keyboard and clicking upon more than one of the plurality of EEG electrodes.

[0011] The user may select first and second identifications, said first and second identification being adjacent to each other.

[0012] Optionally, the computer readable non-transitory medium further comprises programmatic instructions configured to prompt the user to indicate one of said first and second identifications as the at least one reference identification.

[0013] The plurality of EEG electrodes may comprise at least one of strip, grid or depth electrodes.

[0014] Optionally, the computer readable non-transitory medium further comprises programmatic instructions for acquiring the EEG signals in real time while said EEG signals are being recorded using the plurality of EEG electrodes.

[0015] Optionally, the computer readable non-transitory medium further comprises programmatic instructions configured to acquire the EEG signals from a database system, wherein the database system is configured to store the EEG signals for offline processing.

[0016] The at least one identification may be a single identification.

[0017] Optionally, the computer readable non-transitory medium further comprises programmatic instructions configured to prompt the user to indicate reference identification from said plurality of identifications, wherein said reference identification is same for all subsequently selected single identifications.

[0018] The present specification also discloses a computer-implemented method of enabling a generation of at least one user-defined montage from a plurality of EEG electrodes positioned in a patient's brain, on the patient's brain and/or on the patient's scalp, said method comprising: generating a first graphical interface to visually display at least one view of the patient's brain and/or scalp overlaid with a spatial distribution of the plurality of EEG electrodes, wherein each of said plurality of EEG electrodes in the at least one view is uniquely identified with reference to its position in the patient's brain, on the patient's brain and/or on the patient's scalp; displaying a tool within the first graphical interface; receiving an input from a user using the tool to select at least one electrode from the plurality of EEG electrodes displayed in the at least one view; prompting the user to indicate at least one reference electrode corresponding to the selected at least one electrode; accessing EEG signals corresponding to the at least one electrode and the at least one reference electrode; and generating a second graphical interface to display at least one EEG trace indicative of a comparison of EEG signals of the at least one electrode and the at least one reference electrode.

[0019] Selecting the at least one electrode from the plurality of EEG electrodes may be achieved by at least one of drawing a loop around the at least one electrode, clicking on multiple electrodes of the plurality of EEG electrodes to visually connect them, clicking and dragging an icon over or looping the at least one electrode, clicking a body of the at least one electrode, or by pressing a key on a keyboard and clicking upon at least one electrode and additional electrodes of the plurality of EEG electrodes.

[0020] Optionally, the computer-implemented method further comprises receiving a selection of the at least one electrode and a second electrode from the plurality of EEG electrodes in the at least one view, wherein the at least one electrode and the second electrode are adjacent to each other.

Optionally, the computer-implemented method further comprises prompting the user to indicate one of the at least one electrode and the second electrodes as the at least one reference electrode.

[0021] The plurality of EEG electrodes may comprise at least one of strip, grid or depth electrodes.

[0022] Optionally, the computer-implemented method further comprises acquiring the EEG signals in real time while the EEG signals are being recorded using said plurality of EEG electrodes.

[0023] Optionally, the computer-implemented method further comprises acquiring the EEG signals from a database system configured to store the EEG signals for offline processing.

[0024] Optionally, the computer-implemented method further comprises receiving a selection of only the at least one electrode in the at least one view. Optionally, the computer-implemented method further comprises prompting the user to indicate the at least one reference electrode from the plurality of electrodes, wherein the at least one reference electrode is designated to be a same reference electrode for all subsequently selected electrodes from the plurality of electrodes.

[0025] The present specification also discloses a computer-implemented method of enabling a real-time generation of at least one user-defined bipolar montage from a plurality of EEG electrodes positioned in a patient's brain, on the patient's brain and/or on the patient's scalp, said method comprising: generating a first graphical interface to display at least one view of said patient's brain and/or scalp overlaid with a plurality of identifications corresponding to the plurality of EEG electrodes, wherein each of said identifications uniquely references each of the plurality of EEG electrodes in the patient's brain, on the patient's brain and/or on the patient's scalp; displaying a tool within the first graphical interface, wherein the tool is configured to receive a user's input that selects a first identification and a second identification; prompting the user to indicate a reference identification from the selected first identification and the second identification; acquiring EEG signals associated with the plurality of EEG electrodes corresponding to the first identification, the second identification and the reference identification; and generating a second graphical interface to display an EEG trace associated with the first identification, the second identifications and the reference identification, wherein the plurality of EEG electrodes include at least one of strip, grid or depth electrodes.

[0026] Selecting the first identification and the second identification may be achieved by at least one of drawing a loop around the first identification and the second identification, clicking on the first identification and the second identification to visually connect them, clicking and dragging an icon over or looping the first identification and the second identification, clicking a body of the first identification and the second identification, or by pressing a key on a keyboard and clicking upon the first identification and the second identification.

[0027] Optionally, the computer-implemented method further comprises acquiring the EEG signals in real time while the EEG signals are being recorded using the plurality of EEG electrodes.

[0028] Optionally, the computer-implemented method further comprises acquiring the EEG signals from a database system configured to store the EEG signals for offline processing.

[0029] The present specification also discloses a computer readable non-transitory medium comprising a plurality of executable programmatic instructions wherein, when said plurality of executable programmatic instructions are executed by a processor in a computing device, a process is performed for generating at least one user-defined montage from a plurality of EEG electrodes positioned on a patient's scalp, said plurality of executable programmatic instructions comprising: programmatic instructions, stored in said computer readable non-transitory medium, for generating a first graphical interface to display at least one view of said patient's scalp overlaid with a plurality of identifications corresponding to said plurality of EEG electrodes, wherein each of said identifications is unique with reference to positions of said plurality of EEG electrodes on said patient's scalp; programmatic instructions, stored in said computer readable non-transitory medium, for displaying a drawing tool within said first graphical interface, wherein a user utilizes said drawing tool to select at least one identification; programmatic instructions, stored in said computer readable non-transitory medium, for prompting the user to indicate at least one reference identification corresponding to said at least one identification; programmatic instructions, stored in said computer readable non-transitory medium, for acquiring EEG signals associated with EEG electrodes corresponding to said at least one identification and said at least one reference identification; and programmatic instructions, stored in said computer readable non-transitory medium, for generating a second graphical interface to display at least one EEG trace indicative of a comparison of EEG signals associated with EEG electrodes corresponding to said at least one identification and said at least one reference identification.

[0030] Optionally, the user draws a loop around said at least one identification to indicate selection of said at least one identification. In various embodiments, the loop may have any one of a plurality shapes such as, but not limited to, circular/oval, rectangular with sharp corners, rectangular with rounded corners, square, spherical, cylindrical, and free form. In various embodiments, the user may click from identification to identification in a 'connect the dots' or 'dot to dot' manner to select identifications. In various embodiments, an entire strip, grid, or depth electrode may be selected by clicking and dragging a cursor over or 'looping' the electrode. In some embodiments, the user may click on a strip, grid or depth electrode body (instead of on a specific identifier electrode site) to select an entirety of the strip, grid or depth electrode. In some embodiments, the user may press the 'shift' key (on his keyboard) and click to select multiple electrode collections.

[0031] Optionally, the user selects first and second identifications, said first and second identification being adjacent to each other.

[0032] Optionally, the user is prompted to indicate one of said first and second identifications as a reference identification.

[0033] Optionally, said plurality of EEG electrodes are positioned on said patient's scalp in accordance with the International 10-20 system.

[0034] Optionally, said EEG signals are acquired in real time while said EEG signals are being recorded using said plurality of EEG electrodes.

[0035] Optionally, said EEG signals are acquired from a database system that stores said EEG signals for offline processing.

[0036] Optionally, the user selects a single identification. Optionally, the user is prompted to indicate reference identification from said plurality of identifications, and wherein said reference identification is same for all subsequently selected single identifications.

[0037] The present specification also discloses a computer-implemented method of enabling generation of at least one user-defined montage from a plurality of EEG electrodes positioned on a patient's scalp, said method comprising: generating a first graphical interface to display at least one view of said patient's scalp overlaid with a spatial distribution of said plurality of EEG electrodes, wherein each of said plurality of EEG electrodes on said at least one view is uniquely identified with reference to its position on said patient's scalp; displaying a drawing tool within said first graphical interface; enabling a user to use said drawing tool to select at least one electrode from said plurality of EEG electrodes displayed in said at least one view; prompting the user to indicate at least one reference electrode corresponding to said at least one electrode; accessing EEG signals corresponding to said at least one electrode and said at least one reference electrode; and generating a second graphical interface to display at least one EEG trace indicative of a comparison of EEG signals of said at least one electrode and said at least one reference electrode.

[0038] Optionally, the user draws a loop around said at least one EEG electrode to indicate selection of said at least one EEG electrode.

[0039] Optionally, the user selects first and second electrodes from said plurality of EEG electrodes in said at least one view, said first and second electrodes being adjacent to each other.

[0040] Optionally, the user is prompted to indicate one of said first and second electrodes as reference electrode.

[0041] Optionally, said plurality of EEG electrodes is positioned on said patient's scalp in accordance with the International 10-20 system.

[0042] Optionally, said EEG signals are acquired in real time while said EEG signals are being recorded using said plurality of EEG electrodes.

[0043] Optionally, said EEG signals are acquired from a database system that stores said EEG signals for offline processing.

[0044] Optionally, the user selects a single electrode from said plurality of EEG electrodes in said at least one view.

[0045] Optionally, the user is prompted to indicate reference electrode from said plurality of electrodes in said at least one view, and wherein said reference electrode is same for all subsequently selected single electrodes.

[0046] The present specification also discloses a computer-implemented method of enabling on-the-fly generation of at least one user-defined bipolar montage from a plurality of EEG electrodes positioned on a patient's scalp, said method comprising: generating a first graphical interface to display at least one view of said patient's scalp overlaid with a plurality of identifications corresponding to said plurality of EEG electrodes, wherein each of said identifications is unique with reference to positions of said plurality of EEG electrodes on said patient's scalp; displaying a drawing tool within said first graphical interface, wherein a user utilizes said drawing tool to select first and second identifications; prompting the user to indicate reference identification from the selected first and second identifications; acquiring EEG signals associated with EEG electrodes corresponding to said first and second identifications and said reference identification; and generating a second graphical interface to display an EEG trace associated with said first and second identifications and said reference identification.

[0047] Optionally, the user draws a loop around said first and second identification to indicate selection.

[0048] The aforementioned and other embodiments of the present shall be described in greater depth in the drawings and detailed description provided below.

BRIEF DESCRIPTION OF THE DRAWINGS

[0049] These and other features and advantages of the present specification will be further appreciated, as they become better understood by reference to the following detailed description when considered in connection with the accompanying drawings:

[0050] FIG. **1** illustrates an EEG system for detecting, diagnosing, and/or predicting neurological events from EEG signals, in accordance with some embodiments of the present specification;

[0051] FIG. **2** illustrates the International 10-20 system of electrode placement on a patient's scalp, in accordance with some embodiments of the present specification;

[0052] FIG. **3**A is a perspective view of a multi-channel amplifier, in accordance with an embodiment of the present specification;

[0053] FIG. **3**B is a perspective view of a multi-channel amplifier, in accordance with another embodiment of the present specification;

[0054] FIG. **3**C is a side view of the multi-channel amplifier of FIG. **3**B;

[0055] FIG. **4**A is a depiction of an exemplary GUI screen illustrating a plurality of topographical maps of a patient's scalp and spatial positioning of a plurality of electrodes on the scalp, in accordance with some embodiments of the present specification;

[0056] FIG. **4**B is a depiction of various exemplary GUIs that demonstrate the use of drawing loops to select a plurality of exemplary bipolar montages, in accordance with some embodiments of the present specification;

[0057] FIG. **4**C is an EEG report comprising EEG tracings corresponding to a plurality of bipolar montages, in accordance with some embodiments of the present specification;

[0058] FIG. **5**A is a depiction of various exemplary GUIs demonstrating use of drawing loops to select a plurality of exemplary referential montages, in accordance with some embodiments of the present specification;

[0059] FIG. **5**B is an EEG report comprising EEG tracings corresponding to a plurality of referential montages, in accordance with some embodiments of the present specification;

[0060] FIG. **6**A is an illustration of an exemplary GUI showing a plurality of montages and a patient brain showing the locations of sections of the brain associated with the montages, in accordance with some embodiments of the present specification;

[0061] FIG. **6**B is a depiction of a multi-window GUI display in accordance with some embodiments of the present specification;

[0062] FIG. **6**C shows a first GUI depicting a patient brain along with a dialog box to generate a new montage, in accordance with some embodiments of the present specification;

[0063] FIG. **6**D shows a second GUI depicting selection of all channels of a grid electrode using a drawn area or loop encompassing the grid electrode, in accordance with some embodiments of the present specification;

[0064] FIG. **6**E shows a third GUI illustrating a plurality of referential montages created as a result of selection of all channels of the grid electrode on FIG. **6**D, in accordance with some embodiments of the present specification;

[0065] FIG. **6**F shows a GUI to enable a user to select one or more of a plurality of auto-generated montage settings, in accordance with some embodiments of the present specification;

[0066] FIG. **6**G shows another GUI to enable the user to configure and add electrodes, in accordance with some embodiments of the present specification;

[0067] FIG. **6**H shows yet another GUI to enable the user to auto-generate referential montages, in accordance with some embodiments of the present specification;

[0068] FIG. **6**I shows a GUI illustrating generation of a weighted/Laplacian montage, in accordance with some embodiments of the present specification; and

[0069] FIG. **7** is a workflow illustrating processes of user-selection and auto-generation of montages using at least one GUI, in accordance with some embodiments of the present specification.

DETAILED DESCRIPTION

[0070] The term 'user' is used interchangeably to refer to a surgeon, neuro-physician, neuro-surgeon, neuro-physiologist, technician or operator of the EEG system and/or other patient-care personnel or staff.

[0071] A "computing device" refers to at least one of a cellular phone, PDA, smart phone, tablet computing device, patient monitor, custom kiosk, or other computing device capable of executing programmatic instructions. It should further be appreciated that each device and monitoring system may have wireless and wired receivers and transmitters capable of sending and transmitting data. Each "computing device" may be coupled to at least one display, which displays information about the patient parameters and the functioning of the system, by means of a GUI. The GUI also presents various menus that allow users to configure settings according to their requirements. The system further comprises at least one processor to control the operation of the entire system and its components. It should further be appreciated that the at least one processor is capable of processing programmatic instructions, has a memory capable of storing programmatic instructions, and employs software comprised of a plurality of programmatic instructions for performing the processes described herein. In one embodiment, the at least one processor is a computing device capable of receiving, executing, and transmitting a plurality of programmatic instructions stored on a volatile or non-volatile computer readable medium. In addition, the software comprised of a plurality of programmatic instructions for performing the processes described herein may be implemented by a computer processor capable of processing programmatic instructions and a memory capable of storing programmatic instructions.

[0072] "Electrode" refers to a conductor used to establish electrical contact with a nonmetallic part of a circuit. EEG electrodes are small metal discs usually made of stainless steel, tin, gold or silver covered with a silver chloride coating. They are typically placed on the scalp on predetermined locations.

[0073] A "subdural electrode grid" refers to a thin sheet of material with multiple small (roughly a couple mm in size) recording electrodes implanted within it. These are placed directly on the surface of the brain and have the advantage of recording the EEG without the interference of the skin, fat tissue, muscle, and bone that may limit scalp EEG. Shapes and sizes of these sheets are chosen to best conform to the surface of the brain and the area of interest.

[0074] A "depth electrode" refers to small wires that are implanted within the brain itself. Each wire has electrodes which surround it. These electrodes are able to record brain activity along the entire length of the implanted wire. They have the advantage of recording activity from structures deeper in the brain. They can be implanted through small skin pokes.

[0075] "Montage" refers to one or more data sets, each typically represented in the form of a waveform, that are generated by a processor applying a function, such as a comparison function, to data inputs received from two or more electrodes. For example, a bipolar montage is a collection of waveforms, or channels, generated as a function of data from two electrodes, typically adjacent each other. A referential montage uses a common reference electrode, in combination with other electrodes, to generate the channels.

[0076] The present specification is directed towards multiple embodiments. The following disclosure is provided in order to enable a person having ordinary skill in the art to practice the invention. Language used in this specification should not be interpreted as a general disavowal of any one specific embodiment or used to limit the claims beyond the meaning of the terms used therein. The general principles defined herein may be applied to other embodiments and applications without departing from the spirit and scope of the invention. Also, the terminology and phraseology used is for the purpose of describing exemplary embodiments and should not be considered limiting. Thus, the present invention is to be accorded the widest scope encompassing numerous alternatives, modifications and equivalents consistent with the principles and features disclosed. For purpose of clarity, details relating to technical material that is known in the technical fields related to the invention have not been described in detail so as not to unnecessarily obscure the present invention.

[0077] In the description and claims of the application, each of the words "comprise" "include" and "have", and forms thereof, are not necessarily limited to members in a list with which the words may be associated. It should be noted herein that any feature or component described in association with a specific embodiment may be used and implemented with any other embodiment unless clearly indicated otherwise.

[0078] As used herein, the indefinite articles "a" and "an" mean "at least one" or "one or more" unless the context clearly dictates otherwise.

Electroencephalography System

[0079] FIG. **1** illustrates an electroencephalography (EEG) system **100** for detecting, diagnosing, or predicting neurological events from EEG signals, in accordance with some embodiments of the present specification. The figure shows a plurality of EEG sensors or electrodes **105** spatially positioned in and/or on a layer of tissue such as in the brain, on the brain and/or on the scalp of a patient **115**. The plurality of electrodes **105** are in data communication with a multi-channel amplifier **120** that is in data communication with a computing device **140**. The computing device **140** is in data communication with a display unit **130** and at least one database **135**.

[0080] In various embodiments, the plurality of electrodes **105** are small metal discs typically made of stainless steel, tin, gold or silver covered with a silver chloride coating. In various embodiments, the plurality of electrodes **105** comprises subdural (strip and grid electrodes) and depth electrodes placed directly on or in the patient's brain. The plurality of electrodes **105** record electrical signals (EEG signals) from the patient's brain and communicate the analog signals over a first communication link to the multi-channel amplifier **120** that amplifies the signals, converts the signals from an analog EEG data set to a digital EEG data set, and communicates the resultant digital EEG signal to the computing device **140** over a second communication link. In embodiments, the first and second communication links may be wired or wireless links.

[0081] The computing device **140** includes an input/output controller, at least one communications interface and system memory. The system memory includes at least one random access memory (RAM) and at least one read-only memory (ROM). These elements are in communication with a central processing unit (CPU) to enable operation of the computing device **140**. In various embodiments, the computing device **140** may be a conventional standalone computer or alternatively, the functions of the computing device **140** may be distributed across multiple computer systems and architectures. For example, in a distributed architecture, the at least one database **135** and processing circuitry are housed in separate units or locations. Some units perform primary processing functions and contain at a minimum a general controller or a processing circuitry and a system memory.

[0082] The computing device **140** executes EEG software **145** to process, store, retrieve and display, on the display unit **130**, the patient's EEG data. In embodiments, the EEG software **145** processes the received signals, extracts parameters that characterize the EEG data, and generates a display of the data for a user. The processed EEG data is either displayed on the display unit **130** in real-time or stored in the at least one database **135** for later analyses. It should be appreciated that the term real-time means a process is occurring substantially concurrent to another process, such as concurrent to a measurement or EEG signal acquisition process.

[0083] In accordance with an aspect of the present specification, the EEG software **145** comprises an automated montage creation module **125** that implements a plurality of programmatic instructions or code to generate one or more GUIs (Graphical User Interfaces), including views of the spatial distribution or positioning of the electrodes **105** in the brain, on the brain and/or on the patient's scalp, and enable the user to provide inputs indicative of selection of one or more electrode combinations or montages. Consequent to the user's inputs, selections and/or responses on the one or more GUIs, the module **125** creates or generates the one or more montages in real-time (that is, on-the-fly while the EEG signals are being recorded by the plurality of electrodes **105**) or offline (that is, by accessing EEG data stored in the at least one database **135**).

[0084] In some embodiments, execution of sequences of programmatic instructions enables or causes the CPU to perform various functions and processes. In alternate embodiments, hard-wired circuitry may be used in place of, or in combination with, software instructions for implementation of the processes of systems and methods described in this application. Thus, the systems and methods described are not limited to any specific combination of hardware and software.

[0085] It should be appreciated that the systems and methods of the present specification are particularly advantageous in high channel counts of electrodes requiring automated and customized montage creation. However, for the purposes of illustration the montage creation methods of the present specification are also described with reference to low channel counts of electrodes. For example, as shown in FIG. **2**, the plurality of electrodes **105** may be spatially positioned on the patient's scalp **210** in accordance with the International 10-20 system **200**. As known to persons of ordinary skill in the art, the system **200** uses the distance from the bridge of the nose (nasion) to the lowest point of the skull from the back of the head (normally indicated by a prominent bump—the inion) as a reference distance for a given person's head size. The electrodes **105** are then separated from each other either by 10% or 20% of this reference distance. Each electrode placement site has a letter to identify the lobe, or area of the brain it is reading from: Pre-frontal (N), Frontal (F), Temporal (T), Parietal (P), Occipital (**0**), and Central (C) and a numerical subscript representing position. The midline electrodes are marked with a subscript z, which stands for zero. The odd numbers are used as subscript for points over the left hemisphere and even numbers over the right.

[0086] In other embodiments, when greater resolution or granularity is required, the 10-20 system is extended where now the electrodes are separated by 10% of the reference distance (10-10). Further resolution of 5% separation (10-5) distances adds even more electrodes to the scalp. One of ordinary skill in the art would understand that the embodiments disclosed herein, wherein the electrodes are positioned on the patient's scalp, apply equally to data sets generated from a 10-20 system, a 10-10 system, a 10-5 system, or any other relative electrode distance that may be used.

[0087] FIG. **3**A shows a perspective view of an exemplary multi-channel amplifier **320***a*, in accordance with some embodiments of the present specification. The amplifier **320***a* has a plurality of electrode input channels or ports **305**. In accordance with an embodiment, the plurality of input channels or ports **305** are arranged to replicate and correspond to the 10-20 system (system **200** of FIG. **2**) of electrode placement on the patient's scalp, for example. The multi-channel amplifier **120** of FIG. **3**A is used for neuro-monitoring of patients using a plurality of electrodes positioned on their scalps.

[0088] FIGS. **3**B and **3**C show perspective and side views, respectively, of another exemplary multi-channel amplifier **320***b*, in accordance with other embodiments of the present

specification. The amplifier **320***b* has a plurality of electrode input channels or ports **325**. In some embodiments, the amplifier **320***b* is configured to record up to 576 channels at an 8 kHz sampling rate. In some embodiments, the amplifier **320***b* includes an onboard battery and data storage to allow for patient mobility. In embodiments, the amplifier **320***b* is configured so that a user may select any input as ground on any input channel or port **325** and select any other input as the recording reference. Further, as discussed below, a user may create montages up to, and including, all electrodes with a single click on an associated GUI. In some embodiments, the amplifier **320** is configured to streamline electrode layout with automated input mapping.

[0089] The multi-channel amplifier **320***b* of FIGS. **3**B and **3**C may be used for high channel counts of electrodes positioned on a patient's scalp but is specialized for neuromonitoring of patients using a plurality of electrodes positioned intracranially. The electrodes may comprise grid, strip electrodes and/or depth electrodes and may be implanted via craniotomy or through small burr holes in the skull. The multi-channel amplifier **320***b* of FIGS. **3**B and **3**C may be used for ECoG and sEEG monitoring. In some embodiments, the multi-channel amplifier **320***b* of FIGS. **3**B and **3**C may be used for long term monitoring, for example, of epilepsy patients to monitor and map an epileptic brain to determine candidates for surgery. In some embodiments, referring back to FIG. **1**, the automated montage creation module **125** of the EEG software **145** is configured to control integrated switch matrix stimulation. Additionally, in some embodiments, the software **145** allows a user to monitor multiple patients from one computer, control IP camera switching and functions, and simplify data review with trends and detection software. In some embodiments, all case settings, including montages, follow the patient record. In some embodiments, the software **145** includes a feature to automatically synchronize stimulus to response annotations.

[0090] Referring to FIGS. **1**, **2**, **3**A, **3**B and **3**C in an embodiment, each of the plurality of electrodes **105** (FIG. **1**) is in wired data communication with the corresponding input channel or port **305** (or **325**) identifiable with the respective electrode. For example, an output wire or lead of the electrode Fp**1** (referred to as element **215** in FIG. **2**) is connected to the corresponding input channel **305** (FIG. **3**A) on the amplifier **320***a* (or to the corresponding input channel **325** on the amplifier **320***b*), and so on. Thus, each recording electrode is uniquely identified and connected to the corresponding uniquely identified input channel or port **305**. Consequently, each of the EEG signals acquired by the amplifier **120** is uniquely identified with the associated electrode **105**.

Automated Montage Creation Module **125**

[0091] Referring back to FIG. **1**, the automated montage creation module **125** implements a plurality of programmatic instructions to enable a plurality of functions and features, as described in the paragraphs that follow. In some embodiments, the automated montage creation module **125** generates a GUI (Graphical User Interface) to display one or more two and/or three-dimensional topographical maps or views of the patient's head such that the plurality of electrodes and their relative positioning in the brain, on the brain and/or on the scalp are correspondingly identified and marked or displayed on the maps.

[0092] FIG. **4**A shows an exemplary GUI screen **400** illustrating a plurality of topographical maps of a patient's scalp and spatial positioning of a plurality of electrodes on the scalp, in accordance with some embodiments of the present specification. The screen **400** shows sagittal, coronal and top orthographic views **410**, **415**, **420** of the patient's scalp. It should be appreciated that the views **410**, **415**, **420** are exemplary and in no way limiting or binding. In embodiments where a large number of electrodes are used for monitoring and there is a high channel count (implanted electrodes plus possible scalp electrodes), there is a need for identifying which amplifier input corresponds to which electrode since the amplifier inputs may not be predefined or fixed. Further, naming electrodes may not be standardized as some electrodes (such as grid or strip electrodes or depth electrodes implanted via craniotomy or through small burr holes in the skull) may not correspond to a single anatomically standardized brain location. In such embodiments, for identifying graphical representations of electrodes against corresponding amplifier inputs, a special connector may be employed, such as the connector described in U.S. patent application Ser. No. 15/376,655, entitled "System and Method for High Density Electrode Management" and filed on Dec. 12, 2016, and in PCT Application No. PCT/US17/62559, entitled "System and Method for High Density Electrode Management" and filed on Nov. 20, 2017, both applications by the applicant of the present specification and both of which are herein incorporated by reference in their entirety.

[0093] The special connector described in said applications comprises a plurality of signal output pins which corresponds to a plurality of electrodes deployed on the body of the patient with the help of the connector. The plurality of electrodes are not directly connected with the input channels in the amplifier, rather the amplifier is coupled to the plurality of electrodes with the help of the special connectors which enable automatic detection of the electrodes, including their type and deployment location. The connectors are coupled to groups of a plurality of electrodes through one or more electrical leads. In some embodiments, the connectors are coupled to the groups of the plurality of electrodes through a wireless communication link. Each connector has a unique identity and is coupled to a plurality of electrodes which are included in the same group. When the electrodes are classified in the same group, it means their input signals are of the same type and their relative positions are fully defined. These electrodes are connected to the input terminals of the connector in a specific pre-defined order. A connector having 'n' channels can accommodate an electrode group with maximum number of n electrodes wherein n is any natural number. In commercial applications, the value of n is usually 4, 6, 8, 10, 12 and 16, such that the corresponding number of electrodes can be coupled to a single connector.

[0094] Each connector comprises a specific identification (ID) output pin which is used to establish the unique identity (ID) of the connector. A receiving socket corresponding to the connector comprises a bank of signal input points or sockets which are configured to receive the signal output pins of the connector. Usually, a receiving socket comprises enough input points to receive multiple connectors. In practical applications involving high density electrodes, the number of input points is over 200. The receiving socket is coupled to a control unit/amplifier which is used to control

the entire system. The receiving socket may comprise a separate ID input socket which is configured to receive the ID output pin of the connector. The connector is inserted in the receiving socket such that the ID output pin is received in the ID input socket and the signal output pins are received in a subset of signal input sockets.

[0095] Once the identity of the connector is established, the type and location of all the electrodes coupled to the connector irrespective of the set of input sockets in which the connector is inserted may be identified. Once the electrodes are identified, the control unit coupled to the receiving socket reconfigures the detection system to automatically correlate, associate, assign or map each electrode with its corresponding input channel.

[0096] Each of the connectors has a unique ID (identity). This identification information is stored in the connector and is accessible to the system from its identification (ID) output pin. The ID information specifies the type and relative location of each electrode in the connector. In embodiments, the ID field comprises a GUID (Globally Unique Identifier) which is a standard format comprising 128-bit data and is used as an identifier in the computer software. It may also contain other device specific information about the attached device. Once a GUID is assigned, each input can be uniquely identified thereafter. In embodiments, the GUID data is stored in an inbuilt memory device in the connector and, optionally, the memory device is an EPROM storage device.

[0097] In some embodiments, a user may set up the graphical representation, such as shown in FIG. **4**A by using the special connector described above. Typically, each subcontact in a multi-contact electrode is numbered and the electrodes have a color coded tail with multiple contact points, each with a known correlation to numbered sites on the implanted multi-contact electrode. In order to set up the graphical representation and enable detection, each of the electrode tails is connected to amplifier inputs via the special connector described above. A control unit coupled with the connector and the amplifier may also provide a graphical representation of the connector and its position on the amplifier and, in cases where the electrodes have been manually connected to the connector and the amplifier, the user is required to associate the graphical representation of the multi-contact electrode to the graphical representation of the amplifier input. For example, in some embodiments, a user uses an input device, such as a mouse, to click and drag a cursor on a GUI to or over specific a specific electrode or electrodes to select the electrode or electrodes for a montage. In another example, in other embodiments, a user touches an area on a touchscreen of a GUI to click and drag a selection area to or over specific a specific electrode or electrodes to select the electrode or electrodes for a montage.

[0098] In some embodiments, each of the electrodes **105** (FIG. **1**, **2**) is correspondingly identified and marked/displayed as an electrode channel **405** on each of the views **410**, **415**, **420** by using the connector and corresponding control unit as described above. For example, the actual electrode position Fp**1** (referenced as **215**) on the scalp in FIG. **2** is correspondingly identified and marked as Fp**1** (referenced as **401**) on the views **410**, **415**, **420** on the screen **400**. Similarly, in high channel counts of electrodes (such as those used with amplifier **320***b* of FIGS. **3**B and **3**C), each of the electrode **105** is uniquely identified and marked/displayed as an electrode channel **405** on each of the views **410**, **415**, **420** by using the connector.

[0099] In some embodiments, when executed by the processor of the computing device **140**, the automated montage creation module **125** generates and transmits data to the display **130** that is indicative of a montage selection toolbar. The montage selection toolbar enables a user to use a drawing loop to indicate selection of one or more electrode combinations or montages. Additionally or alternatively, the user may point and click his mouse at an electrode channel or the user may point, click and drag the mouse between two electrode channels/contacts to indicate selection of one or more electrodes combinations or montages. Montages (or combinations of electrodes) provide a picture of the spatial distribution of the EEG across the patient's cortex. Accordingly, a montage is an electrical map obtained from a spatial array of recording electrodes and refers to a particular combination of electrodes examined at a particular point in time.

[0100] Referring back to FIG. **4**A, a montage selection toolbar **425** enables the user to pick a selection drawing tool or loop from a plurality of exemplary drawing tool or loop shapes such as, but not limited to, circular/oval **426**, rectangular with sharp corners **427**, rectangular with rounded corners **428** and free form **429**. In various embodiments, the loop shapes may be square, spherical, or cylindrical. In various embodiments, the user may click from identification to identification in a 'connect the dots' or 'dot to dot' manner to select identifications. In various embodiments, an entire strip, grid, or depth electrode may be selected by clicking and dragging a cursor over or 'looping' the electrode. In some embodiments, the user may click on a strip, grid or depth electrode body (instead of on a specific identifier electrode site) to select an entirety of the strip, grid or depth electrode. In some embodiments, the user may press the 'shift' key (on his keyboard) and click to select multiple electrode collections. An optional color palette **435** allows the user to select different colors for the selection loop.

[0101] FIG. **4**B shows GUIs demonstrating use of drawing loops to select a plurality of exemplary bipolar montages, in accordance with some embodiments of the present specification. Bipolar montages are based on the principle of comparing a single EEG electrode tracing to its adjacent neighboring electrode. In an embodiment, the user may use a selection drawing loop such as, for example, the circular/oval loop (loop **426** of FIG. **4**A) to select a plurality of anterior-posterior bipolar montages. In embodiments, when the user draws a loop around two adjacent electrode channels, the module **125** (FIG. **1**) senses selection of two electrode channels and concludes that the user would like to create bipolar montages. In some embodiments, the module **125** senses the electrode channels as being selected if the pixel coordinates of the electrode channels lie within and/or touch the pixel coordinates of the drawn loop.

[0102] Thus, the user may draw a first loop **440** to enclose Fp**2** and F**8** electrodes to indicate formation of a first bipolar montage **442**, a second loop **444** to enclose F**8** and T**8** electrodes to indicate formation of a second bipolar montage **446** and a third loop **448** to enclose T**8** and P**8** electrodes to indicate formation of a third bipolar montage **450** and so on. In embodiments, for each indicated montage the module **125** may prompt the user to specify active and reference electrode channels—that is, a "direction" of the montage. As an illustration, the module **125** displays a dialog box **470** when the user draws the first loop **440**. The dialog box **470** asks the user to select the active electrode from the two enclosed

electrodes Fp2 and F8. When the user selects, for example, Fp2 as the active electrode the other electrode F8 is automatically designated as a reference electrode. Similar dialog boxes may be presented to the user for each of the second and third loops **444**, **448**.

[0103] The automated montage creation module **125** acquires or accesses EEG signals corresponding to the electrodes associated with the one or more montages, selected by the user using the montage selection toolbar **425**. Referring back to FIG. **1**, in some embodiments, the automated montage creation module **125** accesses EEG signals acquired using the plurality of electrodes and stored in the database **135** of the EEG system **100**. In other words, the module **125** accesses offline or pre-stored EEG signals in order to create montages. In some embodiments, the automated montage creation module **125** acquires EEG signals in real time while the EEG signals are being recorded using the plurality of electrodes **105**. As discussed with reference to FIGS. **1**, **2**, **3**A, and **3**B each recording electrode **105** is uniquely identified and connected to the corresponding uniquely identified input channel or port **305** of the amplifier **120**. Consequently, each of the EEG signals acquired by the amplifier **120** is uniquely identified with the associated electrode.

[0104] In some embodiments, the automated montage creation module **125** creates or generates the one or more montages as selected by the user on the GUI. In some embodiments, the module **125** uses pre-stored EEG signals to create or generate the one or montages as a consequence of the user's selection. In some embodiments, the module **125** uses real time EEG signals to create or generate the one or more montages, on the fly, as a consequence of the user's selection. It should be appreciated that for montage creation, EEG channel names are automatically derived from the letter (that represents the underlying area or lobe of the brain) and numerical subscript (representing position on the underlying area of lobe of the brain) of the electrodes.

[0105] In some embodiments, the automated montage creation module **125** displays at least one EEG report that shows EEG traces corresponding to the one or more montages created or generated as a result of the user's selection. Referring back to FIG. **4**B, as a result of the user's selection to form first, second and third bipolar montages **442**, **446**, **450**, corresponding first, second and third EEG tracings **452**, **454**, **456** are displayed. FIG. **4**C shows an exemplary EEG report **460** comprising a plurality of EEG tracings **462** corresponding to a plurality of bipolar montages **465** selected by the user using the drawing loop and, consequently, automatically generated by the module **125**.

[0106] In some embodiments, the user may use his mouse to point and click on a first electrode contact and then drag the mouse pointer to release at a second electrode contact. As a result of the user pointing, clicking, dragging and releasing the mouse pointer between two electrodes, the module **125** (FIG. **1**) senses selection of two electrode channels and concludes that the user would like to configure the first and second electrodes as a bipolar montage. In some embodiments, clicking and dragging the mouse between the first and second electrodes may also result in drawing an arrow between the first electrode used as the active input and the second electrode used as the reference input. In some embodiments, a head of the arrow is at the reference input contact/electrode and is indicative of the "direction" of the bipolar montage.

[0107] In some embodiments, a plurality of referential montages (or common-reference montages) may be indicated by the user via selection of singular electrodes using the drawing loop. These referential montages are then generated or created automatically by the module **125**. For referential montages, signals at each of the plurality of electrodes are compared to a single common reference. FIG. **5**A shows GUIs demonstrating use of drawing loops to select a plurality of exemplary referential montages, in accordance with some embodiments of the present specification. In an embodiment, the user uses a first selection loop **526** such as, for example, a circular/oval loop to select a first electrode such as, for example, F**8**. The module **125** senses that the user has selected a single electrode (that is, F**8** in this example) and therefore concludes that the user would like to form a referential montage. Consequently, the module **125** displays a dialog box **510** to the user asking the user to select a reference for the selected first electrode F**8**. In an embodiment, the user selects Cz (for example) as a reference for the first electrode F**8** from a drop down list **515** of references. In some embodiments, the dialog box **510** provides the user with an option **520** to set the selected reference, that is Cz in this case, as a default reference for all subsequent singular electrode selections for montage formation. On clicking the ok button **522**, the module **125** generates or creates a first referential montage **525** and displays a first EEG tracing **528** corresponding to the first referential montage **525**. Also, when the user draws a second selection loop **530** around a second electrode C**4**, for example, the module **125** generates a second referential montage C**4**-Cz (FIG. **5**B) and displays a second EEG tracing (FIG. **5**B) corresponding to the second referential montage.

[0108] In some embodiments, the user may use his mouse to point, click and release on an electrode—as a result of which, the module **125** (FIG. **1**) senses selection of a single electrode channel and concludes that the user would like to configure the electrode as part of a referential montage. In some embodiments, an electrode contact that has a referential channel in the montage is highlighted either in a unique color or any other indication such as, but not limited to, a circle around it.

[0109] FIG. **5**B shows an EEG report **560** comprising a plurality of EEG tracings **562** corresponding to a plurality of referential montages **565** selected by the user using the drawing loop and automatically generated by the module **125**.

[0110] In some embodiments, the user clicks the mouse in a region of the GUI that does not display an electrode and thereafter drags the mouse pointer to begin drawing a selection loop. When the mouse is released, all electrode contacts contained in or touched by the loop are automatically added to the montage—by the module **125** (FIG. **1**). At this point the user is prompted to select referential or bipolar for the type of channels to be added. This looping mode of selection is efficient since the user may simply draw a loop around, for example, 64 input channels of an 8×8 grid electrode (for example) and thereafter choose whether the selected channels should be referential or bipolar. Comparatively, in the mouse clicking mode of selection the user would have to click 64 times in order to add all channels for a montage.

[0111] For bipolar traces, the user selects a 'direction' to define which channels will be active and which channel(s) will be reference. In some embodiments, a system setting of

'ascending' will automatically assign a lower numbered channel as the active and the next highest numbered channel as the reference. Alternatively, a system setting of 'descending' will assign the higher numbered channel as the active and the next lower numbered channel as the reference. Further, a system setting of 'ascending across' will assign the lower numbered channel as the active and the next highest channel that is in the same column as the active channel as the reference. For example, in an 8×8 grid, channel **1** is the active and channel **9** is the reference. Still further, a system setting of 'descending across' is the reverse of 'ascending across' so that channel **9** is the active and channel **1** is the reference (from previous example). In some embodiments, the system settings indicative of the 'direction' are available by default, which may be modified by the user.

[0112] In some embodiments, where multi-contact electrodes are used, a user may set up a graphical representation of a montage, such as shown in FIG. **6**A. FIG. **6**A is an illustration of an exemplary GUI **600** depicting a plurality of montages **605** and a patient brain **610** depicting the locations of sections **611**, **612**, **613** of the brain **610** associated with the montages, in accordance with some embodiments of the present specification. In some embodiments, the montages are color coded for reference. For example, in one embodiment, montage LF**1** **605***a* is coded blue and refers to section **611** of the brain **610** and associated grid electrodes **621**, montage LF**2** **605***b* is coded red and refers to section **612** of the brain **610** and associated strip electrodes **622** while montage D**1** **605***c* is coded green and refers to section **613** of the brain **610** and associated depth electrodes **623**.

[0113] FIG. **6**B is a depiction of a multi-window GUI display **630** in accordance with some embodiments of the present specification. The multi-window GUI display **630** may be used with the EEG systems of the present specification and provides several sub-windows to enhance monitoring during acquisition. In some embodiments, the multi-window GUI display **630** includes a main window **631** and at least a first sub-window **632** and a second sub-window **633**. In some embodiments, the first sub-window **632** is configured to display a specific subset of channels, with less density, of the group of channels displayed in the main window **631**. In some embodiments, the second sub-window **633** is configured to allow for quick montaging with electrode group bars.

[0114] FIG. **6**C shows a first GUI **635***c* depicting a patient brain **610** along with a dialog box **637** to generate a new montage, in accordance with some embodiments of the present specification. The GUI **635***c* shows positioning of first and second strip electrodes **640**, **642** (identified as LF**1** and LF**2**, respectively) along with an 8×8 grid electrode **644** (identified as LFO). In an embodiment, the user may input "LFO-Ref" in the dialog box **637** indicating that he would like to create referential montages for the grid electrode **644** (LFO). Thereafter, as shown in a second GUI **635***d* of FIG. **6**D, in embodiments, the user may click and drag his mouse to draw an area or a loop **646** (that in one embodiment is a free form drawing) to encompass the grid electrode **644**, thereby simultaneously selecting all 64 channels of the grid electrode **644** for the new montage. It should be appreciated that each of the 64 channels is uniquely identified with alpha-numeric notation ranging from LFO **1** to LFO **64**. Consequently, 64 channels are automatically and simultaneously grouped into a new montage. The third GUI **635***e* of FIG. **6**E shows the 64 montage channels **648** listed in a window **650**. In embodiments, the montage channels **648** are associated by color codes **652**.

[0115] In some embodiments, the module **125** (FIG. **1**) provides the user a feature to automatically create montages that include, for example, "all depth electrodes", "all subdural (strip, grid) electrodes", "all electrodes" (that is, all depth and subdural electrodes) or other customized groups of electrodes based on particular characteristics of placement location or electrode type. FIG. **6**F is a GUI **660***f* to enable a user to select one or more of a plurality of auto-generated montage settings **665**, in accordance with some embodiments of the present specification. The user can interact with the GUI **660***f* to have montages automatically created as electrodes are added or removed. While implant cases rarely (if ever) have the same electrode configuration from patient to patient, the montages used often contain the same types of channels and patterns. Using the settings **665**, the user can simply add electrodes and have the needed general montages created automatically saving a significant amount of time and effort.

[0116] As an illustration, the plurality of auto-generated montage settings **665** of GUI **660***f* have been shown for implant electrodes (grid, strip and depth) only since those types of cases rarely have the same electrode configuration as opposed to scalp recordings which often have the same electrode configuration. Accordingly, with reference to the implant electrodes, the plurality of auto-generated montage settings **665** includes:

[0117] All Referential **665***a*—Selection of this setting automatically creates a montage containing referential channels for every electrode contact.

[0118] All Bipolar **665***b*—Selection of this setting automatically creates a montage containing bipolar channels (ascending) for every electrode contact.

[0119] Subdural Referential **665***c*—This montage is generated only if strip and/or grid electrodes are present. Selection of this setting automatically creates a montage containing referential channels for all contacts of every strip and grid electrode.

[0120] Subdural Bipolar **665***d*—This montage is generated only if strip and/or grid electrodes are present. Selection of this setting automatically creates a montage containing bipolar channels (ascending) for all contacts of every strip and grid electrode.

[0121] Depth Referential **665***e*—This montage is generated only if depth electrodes are present. Selection of this setting automatically creates a montage containing referential channels for all contacts of every depth electrode.

[0122] Depth Bipolar **665***f*—This montage is generated only if depth electrodes are present. Selection of this setting automatically creates a montage containing bipolar channels (ascending) for all contacts of every depth electrode.

[0123] Mixed **665***g*—This montage is generated only if depth and strip and/or grid electrodes are present. Selection of this setting automatically creates a montage containing referential channels for all contacts of every strip and grid electrode and bipolar channels (ascending) for all contacts of every depth electrode.

[0124] Sparse Referential **665***h*—This montage is generated only if the total electrode contact count exceeds 100. Selection of this setting automatically creates a

montage containing between 50 and 100 referential channels from each electrode.

[0125] Add Spaces between Electrodes **665***i*—Selection of this setting automatically adds a blank space between the channels of each electrode. For example, if electrode A has 8 channels and electrode B has 10 channels, a space will be added between A**8** and B**1** as a result of selection of this setting.

[0126] FIG. **6**G shows a GUI **660***g* to enable the user to configure and add electrodes, in accordance with some embodiments of the present specification. Upon selecting an electrode layout tab **689**, the user navigates to a first window **685***a* displaying a plurality of recently used electrodes (with associated spacing between the electrode channels), of which a 10 contact 5 mm spacing electrode **686** is shown as selected by the user. Also displayed in the first window **685***a* is a catalog **687** of a plurality of strip and grid electrodes (with associated spacing between the electrode channels). A second window **685***b* displays a view of a patient's brain **674** with positioning of an 8×8 contacts grid electrode **675**, an 8 contacts strip electrode **676** and a 10 contacts depth electrode **677**.

[0127] Once the user has configured and added electrodes using the electrode layout tab **689**, the user can auto-generate montages. Referring to a GUI **660***h* of FIG. **6**H, upon selecting a montage editor tab **690**, the user navigates to a first window **670***a* displaying a plurality of montage settings **672** available for auto-generation and a second window **670***b* displaying a view of the patient's brain **674** with positioning of the 8×8 contacts grid electrode **675**, the 8 contacts strip electrode **676** and the 10 contacts depth electrode **677**. In accordance with an embodiment, when a user selects the 'all referential' setting **673** in the first window **670***a* (and clicks the 'ok' button **681**), the module **125** (FIG. **1**) automatically creates referential montages **679** for every electrode contact in each of the grid, strip and depth electrodes **675**, **676**, **677**. These auto-generated referential montages **679** are displayed in a third window **670***c* along with their associated color codes **680**.

[0128] In some embodiments, the module **125** (FIG. **1**) allows the user to indicate that the user would like to set up default referential montages for all electrodes or the single electrodes that the user subsequently draws loops around. While setting the default referential montages, the module **125** may allow the user to set a common reference by selecting a reference from a drop down list of references. As a result, either all electrodes are configured automatically as referential montages with respect to the common reference or such referential montages are created only for the electrodes around which the user draws the selection loop.

[0129] In some embodiments, the module **125** allows the user to indicate that the user would like to set up default bipolar montages for all electrodes or the pairs of electrodes that the user subsequently draws loops around. As a result, either all electrodes are configured automatically as bipolar montages or such bipolar montages are created only for the pairs of electrodes around which the user draws the selection loop.

[0130] In some embodiments, the module **125** allows the user to select one of a plurality of pre-configured bipolar montages that are available to the user from, for example, a drop down list. Such pre-configured bipolar montages may include spatial configurations such as, but not limited to, anterior-posterior bipolar montages, transverse bipolar montages. For subdural grid, strip and depth electrodes additional pre-configured bipolar montages are referred by the terms: Ascending, Descending, Ascending Across, and Descending Across. These terms are applied to the contact numbers or identifications on the electrodes.

[0131] In other embodiments, average reference montages are defined by clicking individual electrode contacts or encircling contacts with loops. In some embodiments, when individual electrode contacts are clicked (by the mouse) or encircled (using drawing loops), the module **125** senses such individual electrode contact selections and concludes that the user would either like to create common-reference montages or average reference montages. Accordingly, the module **125** may generate a GUI with options to either create common-reference montages or average reference montages. If the user selects the option of creating common-reference montages, then the dialog box **510** of FIG. **5**A is displayed to the user (or the user may follow the method illustrated in FIGS. **6**C, **6**D and **6**E to create common-reference montages). On the other hand, if the user selects the option of creating average reference montages, then recordings from each channel electrode selected by the user are summed up and averaged. In still other embodiments, weighted/Laplacian montages are defined through a weighted pattern applied to electrode contacts proximal to an already selected contact. In some embodiments, selection of the contact, to apply the weighted pattern to, is accomplished by clicking using the mouse. As an illustration, FIG. **6**I shows a GUI **635***f* illustrating a weighted pattern **655** being applied to a plurality of electrode contacts proximal to a selected contact **657** in order to generate a weighted/Laplacian montage.

[0132] FIG. **7** is a workflow **700** illustrating processes of user-selection and auto-generation of montages using at least one GUI, in accordance with some embodiments of the present specification. The workflow **700** illustrates a plurality of exemplary steps of a first process wherein a user uses a mouse to click on an electrode to add it as a reference montage, a second process wherein the user clicks and drags the mouse pointer between two electrode contacts to create a bipolar montage and a third process wherein the user clicks the mouse in a region that does not display an electrode contact and thereafter drags or moves the mouse pointer to begin drawing a selection loop such that when the mouse is released, all electrode contacts contained in or touched by the drawn loop are automatically added to a montage.

[0133] Referring now to FIGS. **1** and **7**, to enable the user to create new montage at step **705** and/or to select existing montage at step **707**, the automated montage creation module **125** displays 'montage content', at step **710**, to the user on at least one GUI. In various embodiments, 'montage content' refers to graphical representation or display of a plurality of electrode contacts associated with a plurality of input channels of at least one amplifier or recording device.

[0134] At step **712**, the user clicks the mouse pointer or cursor on the GUI. At step **715**, the montage creation module **125** determines if the pixel coordinates at the location where the mouse was clicked lies within or is contained by the pixel coordinates associated with a first electrode contact. In other words, it is determined whether the user has clicked on the first electrode contact. If it is determined that the user has clicked the first electrode contact, then at step **717** the module **125** determines if the user has further dragged or moved the mouse pointer. If the mouse was not dragged it

is determined if the mouse is released, at step **720**. The module **125** awaits the user to release the mouse at step **720**. When the mouse is released, signifying that the user has clicked and released the mouse at the first electrode contact, the first electrode contact is added as a referential channel or montage at step **722**.

[0135] On the other hand, if at step **717**, the module **125** determines that the mouse has been moved or dragged (after clicking on the first electrode contact) then, at step **725**, the module **125** enters into a bipolar montage addition mode. At step **727**, the module **125** determines if the mouse is released on a second electrode contact. If yes, then, at step **730**, the first and second electrode contacts are added or used to generate a bipolar montage. If no, that is if the mouse is not released on a second electrode then, at step **732** the module ends or exits from the bipolar montage addition mode.

[0136] Referring back to step **715**, if it is determined that the user has not clicked on the first electrode contact or any electrode contact at all then, at step **735**, the module **125** determines if the mouse has been subsequently dragged or moved. If the mouse has not been dragged or moved then the process flow moves to step **740**. However, if the mouse has been dragged or moved this signifies that the user is using a drawing loop to encircle one or more electrode contacts. Consequently, at step **737**, the module **125** selects all electrode contacts whose pixel coordinates are contained within or touched by the coordinates of the drawing loop. Next, at step **740**, the module **125** awaits for the user to release the mouse. If the mouse is not released, the process flow moves back to step **735**. However, on release of the mouse, the user is prompted, at step **742**, to select whether the encircled one or more electrode contacts should be used to generate bipolar or referential montage. At step **745**, the channels corresponding to the encircled one or more electrode contacts are added to bipolar or referential montage based on user choice at step **742**.

[0137] In various embodiments, the systems and methods of the present specification enable a user to create and select montages in manners which simplify operational workflow, reduce the risk of errors, and reduce setup and surgical time compared to current systems. In addition, the systems and methods of the present specification enhance data accuracy and analyses to improve patient outcomes.

[0138] The above examples are merely illustrative of the many applications of the system and method of present specification. Although only a few embodiments of the present specification have been described herein, it should be understood that the present specification might be embodied in many other specific forms without departing from the spirit or scope of the specification. Therefore, the present examples and embodiments are to be considered as illustrative and not restrictive, and the specification may be modified within the scope of the appended claims.

We claim:

1. A computer readable non-transitory medium comprising a plurality of executable programmatic instructions wherein, when the plurality of executable programmatic instructions are executed by a processor in a computing device, at least one user-defined montage from a plurality of EEG electrodes positioned in a patient's brain, on the patient's brain or on the patient's scalp is generated, the plurality of executable programmatic instructions comprising:

programmatic instructions, stored in the computer readable non-transitory medium, for generating a first graphical interface to display at least one graphical view of the patient's brain and/or scalp overlaid with a plurality of identifications corresponding to the plurality of EEG electrodes, wherein each of the plurality of identifications uniquely references a position of each of the plurality of EEG electrodes relative to the patient's brain and/or scalp;

programmatic instructions, stored in the computer readable non-transitory medium, for displaying a tool within the first graphical interface, wherein the tool is configured to be manipulated in order to select at least one identification of the plurality of identifications;

programmatic instructions, stored in the computer readable non-transitory medium, for prompting the user to indicate at least one reference identification corresponding to the at least one identification;

programmatic instructions, stored in the computer readable non-transitory medium, for acquiring EEG signals associated with EEG electrodes corresponding to the at least one identification and the at least one reference identification; and

programmatic instructions, stored in the computer readable non-transitory medium, for generating a second graphical interface to display at least one EEG trace indicative of a comparison of EEG signals associated with EEG electrodes corresponding to the at least one identification and the at least one reference identification.

2. The computer readable non-transitory medium of claim **1**, further comprising programmatic instructions configured to enable a user to input a selection of the at least one identification comprising at least one of programmatic instructions for enabling a drawing a loop around the at least one identification, programmatic instructions for enabling a clicking from the at least one identification to multiple other identifications of the plurality of identifications to thereby visually connect the at least one identifications and multiple other identifications, programmatic instructions for enabling a clicking and/or dragging an icon over or looping around at least one of the plurality of EEG electrodes, programmatic instructions for enabling a clicking a body of at least one of the plurality of EEG electrodes or programmatic instructions for enabling a pressing a key on a keyboard and clicking upon more than one of the plurality of EEG electrodes.

3. The computer readable non-transitory medium of claim **1**, wherein the user selects first and second identifications, said first and second identification being adjacent to each other.

4. The computer readable non-transitory medium of claim **3**, further comprising programmatic instructions configured to prompt the user to indicate one of said first and second identifications as the at least one reference identification.

5. The computer readable non-transitory medium of claim **1**, wherein said plurality of EEG electrodes comprises at least one of strip, grid or depth electrodes.

6. The computer readable non-transitory medium of claim **1**, further comprising programmatic instructions for acquiring the EEG signals in real time while said EEG signals are being recorded using the plurality of EEG electrodes.

7. The computer readable non-transitory medium of claim **1**, further comprising programmatic instructions configured

to acquire the EEG signals from a database system, wherein the database system is configured to store the EEG signals for offline processing.

8. The computer readable non-transitory medium of claim **1**, wherein the at least one identification is a single identification.

9. The computer readable non-transitory medium of claim **8**, further comprising programmatic instructions configured to prompt the user to indicate reference identification from said plurality of identifications, and wherein said reference identification is same for all subsequently selected single identifications.

10. A computer-implemented method of enabling a generation of at least one user-defined montage from a plurality of EEG electrodes positioned in a patient's brain, on the patient's brain and/or on the patient's scalp, said method comprising:

generating a first graphical interface to visually display at least one view of the patient's brain and/or scalp overlaid with a spatial distribution of the plurality of EEG electrodes, wherein each of said plurality of EEG electrodes in the at least one view is uniquely identified with reference to its position in the patient's brain, on the patient's brain and/or on the patient's scalp;

displaying a tool within the first graphical interface;

receiving an input from a user using the tool to select at least one electrode from the plurality of EEG electrodes displayed in the at least one view;

prompting the user to indicate at least one reference electrode corresponding to the selected at least one electrode;

accessing EEG signals corresponding to the at least one electrode and the at least one reference electrode; and

generating a second graphical interface to display at least one EEG trace indicative of a comparison of EEG signals of the at least one electrode and the at least one reference electrode.

11. The computer-implemented method of claim **10**, wherein selecting the at least one electrode from the plurality of EEG electrodes is achieved by at least one of drawing a loop around the at least one electrode, clicking on multiple electrodes of the plurality of EEG electrodes to visually connect them, clicking and dragging an icon over or looping the at least one electrode, clicking a body of the at least one electrode, or by pressing a key on a keyboard and clicking upon at least one electrode and additional electrodes of the plurality of EEG electrodes.

12. The computer-implemented method of claim **10**, further comprising receiving a selection of the at least one electrode and a second electrode from the plurality of EEG electrodes in the at least one view, wherein the at least one electrode and the second electrode are adjacent to each other.

13. The computer-implemented method of claim **12**, further comprising prompting the user to indicate one of the at least one electrode and the second electrodes as the at least one reference electrode.

14. The computer-implemented method of claim **10**, wherein said plurality of EEG electrodes comprises at least one of strip, grid or depth electrodes.

15. The computer-implemented method of claim **10**, further comprising acquiring the EEG signals in real time while the EEG signals are being recorded using said plurality of EEG electrodes.

16. The computer-implemented method of claim **10**, further comprising acquiring the EEG signals from a database system configured to store the EEG signals for offline processing.

17. The computer-implemented method of claim **10**, further comprising receiving a selection of only the at least one electrode in the at least one view.

18. The computer-implemented method of claim **17**, further comprising prompting the user to indicate the at least one reference electrode from the plurality of electrodes, wherein the at least one reference electrode is designated to be a same reference electrode for all subsequently selected electrodes from the plurality of electrodes.

19. A computer-implemented method of enabling a real-time generation of at least one user-defined bipolar montage from a plurality of EEG electrodes positioned in a patient's brain, on the patient's brain and/or on the patient's scalp, said method comprising:

generating a first graphical interface to display at least one view of said patient's brain and/or scalp overlaid with a plurality of identifications corresponding to the plurality of EEG electrodes, wherein each of said identifications uniquely references each of the plurality of EEG electrodes in the patient's brain, on the patient's brain and/or on the patient's scalp;

displaying a tool within the first graphical interface, wherein the tool is configured to receive a user's input that selects a first identification and a second identification;

prompting the user to indicate a reference identification from the selected first identification and the second identification;

acquiring EEG signals associated with the plurality of EEG electrodes corresponding to the first identification, the second identification and the reference identification; and

generating a second graphical interface to display an EEG trace associated with the first identification, the second identifications and the reference identification, wherein the plurality of EEG electrodes include at least one of strip, grid or depth electrodes.

20. The computer-implemented method of claim **19**, wherein selecting the first identification and the second identification is achieved by at least one of drawing a loop around the first identification and the second identification, clicking on the first identification and the second identification to visually connect them, clicking and dragging an icon over or looping the first identification and the second identification, clicking a body of the first identification and the second identification, or by pressing a key on a keyboard and clicking upon the first identification and the second identification.

21. The computer-implemented method of claim **19**, further comprising acquiring the EEG signals in real time while the EEG signals are being recorded using the plurality of EEG electrodes.

22. The computer-implemented method of claim **19**, further comprising acquiring the EEG signals from a database system configured to store the EEG signals for offline processing.

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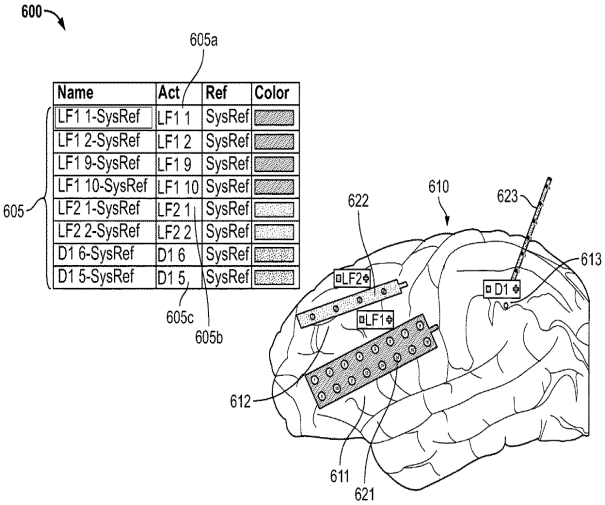
计算机实现的方法，能够从位于患者大脑，患者大脑和/或患者头皮上的EEG电极即时生成至少一个用户定义的剪辑画面。 该方法包括生成图形界面以显示患者脑部和/或覆盖有EEG电极的头皮的视图，每个电极均参考其在患者脑部，患者大脑和/或皮肤上的位置进行唯一标识。 患者的头皮，在图形界面内显示一种工具，用于从显示的EEG电极中选择至少一个电极，指示与所选电极相对应的参考电极，访问与该电极和参考电极相对应的EEG信号，并生成另一图形界面以 显示指示电极与参考电极的EEG信号比较的EEG迹线。