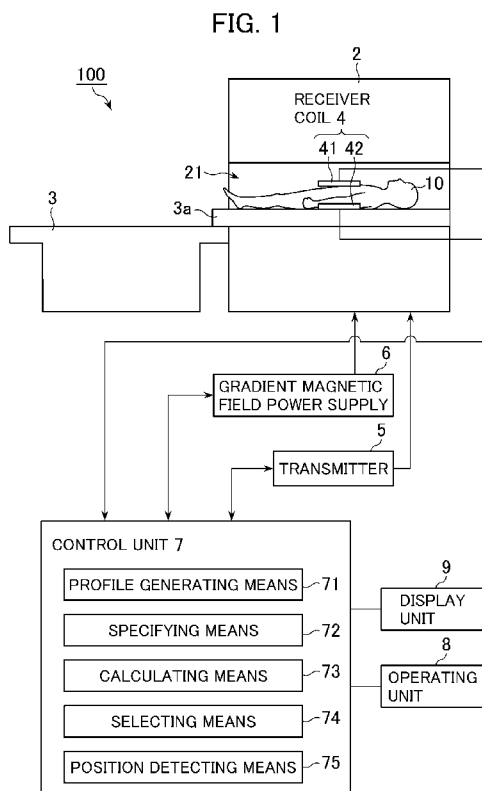




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- (71) Applicant: GE MEDICAL SYSTEMS GLOBAL TECHNOLOGY COMPANY, LLC [US/US]; 3000 North Grandview Boulevard, Waukesha, WI 53188-1696 (US).
- (72) Inventors: TOMODA, Yoshihiro; 4-7-127 Asahigaoka, Hino (JP). IWADATE, Yuji; 4-7-127 Asahigaoka, Hino (JP). MIYOSHI, Kunihiro; 4-7-127 Asahigaoka, Hino (JP).
- (74) Agents: CONKLIN, Mark, A. et al.; General Electric Company, Global Patent Operation, 2 Corporate Drive, Suite 648, Shelton, CT 06484 (US).
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(54) Title: MRI WITH A MULTI-CHANNEL COIL USING CHANNEL SELECTION FOR NAVIGATOR



(57) Abstract: To select a channel adapted to detection of the position of a liver. The position "m" of the border between the liver and the lung is obtained from a profile. A sum S_{liver} of signal intensities in a liver region R_1 and a sum S_{lung} of signal intensities in a lung region R_2 are calculated. After obtaining the sums S_{liver} and S_{lung} of the signal intensities, S_{liver} and S_{lung} are compared to determine whether S_{liver} is equal to or less than S_{lung} . In the case where S_{liver} is equal to or less than S_{lung} ($S_{liver} \leq S_{lung}$), a channel is not selected as a channel used at the time of detecting the position of the edge of the liver. On the other hand, in the case where S_{liver} is larger than S_{lung} ($S_{liver} > S_{lung}$), a channel is selected as a channel used at the time of detecting the position of the edge of the liver.



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MRI WITH A MULTI-CHANNEL COIL USING CHANNEL SELECTION FOR NAVIGATOR

TECHNICAL FIELD

[0001] The present invention relates to a magnetic resonance apparatus obtaining a navigator signal generated from a navigator region including a body site which moves by using a coil having a plurality of channels and to a program applied to the magnetic resonance apparatus.

BACKGROUND ART

[0002] Respiration synchronization imaging using a navigator signal is known, refer to Japanese Patent Application No. 2011-193884.

SUMMARY OF THE INVENTION

Problem to be Solved by the Invention

[0003] In recent years, a multi-channel coil having a plurality of channels is spread, and aspiration synchronization imaging using the multi-channel coil is performed. In the imaging, generally, a navigator region is set in a border position of the liver and the lung and a navigator signal is acquired from the navigator region by the multi-channel coil. On the basis of the navigator signals acquired by the channels in the multi-channel, the position of the edge of the liver is detected. There is, however, a case that depending on the channels, the signal of the lung region is strong. In the case where the signal of the lung region is strong, there is a problem such that the detection precision of the position of the liver is low. Therefore, a technique capable of selecting a channel suitable to detect the position of the liver from the plurality of channels in the case where a channel acquiring the strong signal of the lung region is included in the plurality of channels is demanded.

Means for Solving the Problem

[0004] A first aspect of the present invention relates to a magnetic resonance apparatus obtaining a navigator signal generated from a navigator region including a first body site which moves and a second body site which moves by using a coil having a plurality of channels, including:

scan means executing a first navigator sequence for obtaining a first navigator signal generated from the navigator region;

profile generating means generating a first profile expressing relation between each position in the navigator region and signal intensity for each of the channels on the basis of the first navigator signal received by each of the plurality of channels;

means obtaining a first region corresponding to the first body site in the first profile and a second region corresponding to the second body site in the first profile; and

selecting means selecting a channel used to obtain the position of the first body site from the plurality of channels on the basis of a feature amount of the signal intensity in the first region and a feature amount of the signal intensity in the second region.

[0005] A second aspect of the present invention relates to a program applied to a magnetic resonance apparatus executing a first navigator sequence for obtaining a first navigator signal generated from a navigator region including a first body site which moves and a second body site which moves by using a coil having a plurality of channels, the program for making a computer execute:

a profile generating process generating a first profile expressing relation between each position in the navigator region and signal intensity for each of the channels on the basis of the first navigator signal received by each of the plurality of channels;

a process obtaining a first region corresponding to the first body site in the first profile and a second region corresponding to the second body site in the first profile; and

a selecting process selecting a channel used to obtain the position of the first body site from the plurality of channels on the basis of a feature amount of the signal intensity in the first region and a feature amount of the signal intensity in the second region.

Advantage of the Invention

[0006] A channel is selected on the basis of the feature amount of the signal intensity in the first region and the feature amount of the signal intensity in the second region. Therefore, a channel adapted to obtain the position of the first body site can be selected.

BRIEF DESCRIPTION OF DRAWINGS

[0007] FIG. 1 is a schematic diagram illustrating a magnetic resonance apparatus as an embodiment of the present invention.

- [0008] FIG. 2 is an explanatory diagram of a reception coil 4.
- [0009] FIG. 3 is a diagram illustrating scans executed in a first mode.
- [0010] FIG. 4 is a diagram schematically illustrating an imaging region.
- [0011] FIG. 5 is an explanatory diagram of a sequence executed by a pre-scan A.
- [0012] FIG. 6 is a diagram illustrating the flow at the time of executing a navigator sequence NAV at time t_1 and detecting the position of the edge of the liver at time t_1 .
- [0013] FIG. 7 is a diagram schematically illustrating profiles F_1 to F_{m+n} obtained by channels CH_1 to CH_{m+n} of the reception coil 4.
- [0014] FIG. 8 is an explanatory diagram at the time of determining whether the channel CH_1 is selected or not.
- [0015] FIG. 9 is a diagram illustrating a result of comparison between S_{liver} and S_{lung} .
- [0016] FIG. 10 is a diagram illustrating channels CH_2 to CH_m and CH_{m+2} to CH_{m+n} .
- [0017] FIG. 11 is an explanatory diagram at the time of acquiring the position of the edge of the liver.
- [0018] FIG. 12 is a diagram illustrating the flow at the time of executing the navigator sequence NAV at time t_2 and detecting the position of the edge of the liver at time t_2 .
- [0019] FIG. 13 is a diagram schematically illustrating profiles F_2 to F_m and F_{m+2} to F_{m+n} generated.
- [0020] FIG. 14 is a diagram schematically illustrating a composite profile F_c .
- [0021] FIG. 15 is a diagram illustrating an example of a trigger level TL.
- [0022] FIG. 16 is an explanatory diagram of a main scan B.
- [0023] FIG. 17 is an explanatory diagram of an example of a method of selecting a channel by using a template TI.
- [0024] FIG. 18 is a diagram schematically illustrating a composite profile X obtained by using a method of using the template TI.

MODES FOR CARRYING OUT THE INVENTION

[0025] Hereinafter, modes for carrying out the invention will be described. The present invention, however, is not limited to the following modes.

[0026] FIG. 1 is a schematic diagram illustrating a magnetic resonance apparatus as an embodiment of the present invention. A magnetic resonance apparatus (hereinbelow, called an “MR apparatus”) 100 has a magnet 2, a table 3, a reception coil 4, and the like.

[0027] The magnet 2 has a bore 21 in which a subject 10 is put. The magnet 2 has therein a superconductive coil, a gradient coil, an RF coil, and the like.

[0028] The table 3 has a cradle 3a supporting the subject 10. The cradle 3a is configured to be movable in the bore 21. By the cradle 3a, the subject 10 is carried into the bore 21. The reception coil 4 receives a magnetic resonance signal from the subject 10.

[0029] FIG. 2 is an explanatory diagram of the reception coil 4. The reception coil 4 has a first coil unit 41 and a second coil unit 42. The first coil unit 41 has m pieces of channels CH_1 to CH_m for receiving a magnetic resonance signal from the subject, and the second coil unit 42 has n pieces of channels CH_{m+1} to CH_{m+n} for receiving a magnetic resonance signal from the subject. Therefore, in the embodiment, the reception coil 4 is constructed as an $(m+n)$ -channel coil. The first coil unit 41 is disposed on the abdomen side of the subject, and the second coil unit 42 is disposed on the back side of the subject. Referring again to FIG. 1, the description will be continued.

[0030] The MR apparatus 100 further has a transmitter 5, a gradient magnetic field power supply 6, a controller 7, an operator 8, a display unit 9, and the like. The transmitter 5 supplies current to the RF coil, and the gradient magnetic field power supply 6 supplies current to the gradient coil. A combination of the magnet 2, the reception coil 4, the transmitter 5, and the gradient magnetic field power supply 6 corresponds to scan means.

[0031] The controller 7 controls the operations of the components of the MR apparatus 100 so as to realize various operations of the MR apparatus 100 such as transmission of necessary information to the display unit 9 and reconfiguration of an image on the basis of signals received from the reception coil 4. The controller 7 includes profile generating means 71 to position detecting means 75.

[0032] The profile generating means 71 generates a profile expressing the relation between each of positions in the navigator region and signal intensity. Specifying means 72 specifies a region corresponding liver and a region corresponding lung in each profile. Calculating means 73 calculates a sum of signal intensities in the liver region and a sum of signal intensities in the lung region. Selecting means 74 selects a channel adapted to detect the position of the edge of the liver from the channels CH_1 to CH_{m+n} of the reception coil 4 on the basis of the sum of the signal intensities in the liver region and the sum of signal intensities in the lung region. The position detecting means 75 detects the position of the edge of the liver.

[0033] The controller 7 is an example of constructing the profile generating means 71 to the position detecting means 75 and functions as those means by executing a predetermined program.

[0034] The operator 8 is operated by the operator and enters various information to the controller 7. The display unit 9 displays various information. The MR apparatus 100 is constructed as described above.

[0035] FIG. 3 is a diagram illustrating scans executed in a first mode, and FIG. 4 is a diagram schematically illustrating an imaging region. In the first embodiment, a pre-scan A and a main scan B are executed.

[0036] The pre-scan A is a scan executed to determine a trigger level TL (refer to FIG. 16) which will be described later. The trigger level TL will be described later. The main scan B is a scan for imaging the liver. Hereinbelow, the pre-scan A and the main scan B will be described in order.

[0037] FIG. 5 is an explanatory diagram of a sequence executed by the pre-scan A. In the pre-scan A, a navigator sequence NAV is repeatedly executed. The navigator sequence NAV is a sequence for collecting a navigator signal from a navigator region R_{nav} .

[0038] In the pre-scan A, first, the navigator sequence NAV is executed at time t_1 to detect the position of the edge of the liver at time t_1 (refer to FIG. 6).

[0039] FIG. 6 is a diagram illustrating the flow at the time of executing the navigator sequence NAV at time t_1 and detecting the position of the edge of the liver at time t_1 .

[0040] In step ST1, the navigator sequence NAV is executed at time t_1 . By executing the

navigator sequence NAV, the navigator signal is obtained from the navigator region R_{nav} . The navigator signal is received by each of the channels CH_1 to CH_{m+n} of the reception coil 4. The profile generating means 71 (refer to FIG. 1) converts the navigator signal obtained by each of the channels CH_1 to CH_{m+n} of the reception coil 4 to a profile expressing the relation between each position in the SI direction of the navigator region R_{nav} and signal intensity. By the operation, a profile is generated for each of the channels of the reception coil 4. FIG. 7 schematically illustrates profiles F_1 to F_{m+n} obtained by the channels CH_1 to CH_{m+n} of the reception coil 4, respectively. The navigator sequence NAV is designed so that a high signal corresponds to the liver and the low signal corresponds to the lung. Therefore, by detecting the position where the signal values of the profiles F_1 to F_{m+1} change drastically, the position of the edge of the liver at time t_1 can be detected. For example, referring to the profile F_2 , the signal intensity changes drastically in position x , so that the position x can be therefore considered as the position of the edge of the liver.

[0041] There is, however, the case that, depending on the channels of the coil, the signal intensity in the region of the lung in the profile is high. For example, in the profile F_1 , the signal intensity in the region of the lung is high. When the signal intensity in the region of the lung is high as described above, the position where the signal intensity changes drastically appears not only in the vicinity of the edge of the liver but also in the region of the lung. It causes erroneous detection of the position of the edge of the liver. Therefore, although $(m+n)$ pieces of the profiles F_1 to F_{m+n} are obtained by the channels CH_1 to CH_{m+n} , it does not mean that a profile suitable to detect the position of the edge of the liver is obtained from all of the channels.

[0042] It is consequently necessary to select a channel from which a profile suitable to detect the position of the edge of the liver from the channels CH_1 to CH_{m+n} . To select a channel, the program advances to step ST2.

[0043] In step ST2, on the basis of the profiles of the channels, a channel used at the time of detecting the position of the edge of the liver is selected from the channels CH_1 to CH_{m+n} . Hereinafter, a method of selecting a channel in the embodiment will be described.

[0044] In the case of selecting a channel, whether or not the channel CH_1 is selected as a channel used at the time of detecting the position of the edge of the liver from the channels CH_1 to CH_{m+1} is determined. The determination is performed as follows.

[0045] FIG. 8 is an explanatory diagram at the time of determining whether the channel CH₁ is selected or not.

[0046] First, the specifying means 72 (refer to FIG. 1) obtains position “b” of the border between the liver and the lung on the basis of the profile F₁ of the channel CH₁. As a method of obtaining the position “b” of the border, various methods are considered. For example, by combining all of the profiles F₁ to F_{m+n}, a composite profile is obtained. The position where the signal intensity changes drastically is detected from the composite profile, and the detected position can be considered as the position “b” of the border in the profile F₁.

[0047] It is sufficient that the position “b” of the border expresses a rough position of the border between the liver and the lung, and it is unnecessary to accurately obtain the position of the border. Therefore, an intermediate position in the SI direction of the navigator region may be set as the position “b” of the border.

[0048] The specifying means 72 specifies two regions in the profile F₁ using the position “b” of the border as a reference, that is, a region R₁ corresponding to the liver (hereinbelow, called “liver region”) and a region R₂ corresponding to the lung (hereinbelow, called “lung region”).

[0049] Next, the calculating means 73 (refer to FIG. 1) calculates a sum S_{liver} of signal intensities in the liver region R₁ and a sum S_{lung} of signal intensities in the lung region R₂. The sums S_{liver} and S_{lung} of the signal intensities can be obtained by the following equations.

$$S_{liver} = \sum_{i=0}^{b-1} S_i \dots (1)$$

$$S_{lung} = \sum_{i=b}^Z S_i \dots (2)$$

where i: position in the SI direction, and S_i: signal intensity in the position “i”.

[0050] After obtaining the sums S_{liver} and S_{lung} of the signal intensities, the selecting means 74 (refer to FIG. 1) compares S_{liver} and S_{lung} and determines whether S_{liver} is equal to or less than S_{lung}. In the case where S_{liver} is equal to or less than S_{lung} (S_{liver} ≤ S_{lung}), it is considered that the signal intensity in the region of the lung is high, so that the selecting means 74 determines not to select the channel CH₁ as a channel used at the time of detecting the position of the edge of the liver. On the other hand, in the case where S_{liver} is larger than S_{lung} (S_{liver} > S_{lung}), it is considered that the signal intensity in the region of the lung is low, so that the selecting means 74 selects the channel CH₁ as a channel used at the time of detecting the position of the edge of the liver.

[0051] It is assumed here that $S_{\text{liver}} \leq S_{\text{lung}}$. Therefore, the selecting means 74 determines not to select the channel CH_1 as a channel used at the time of detecting the position of the edge of the liver.

[0052] Similarly, the position “b” of the border is set also for the profile F_2 of the channel CH_2 to the profile F_{m+n} of the channel CH_{m+n} , and the sums S_{liver} and S_{lung} of the signal intensities are calculated by the equations (1) and (2). S_{liver} and S_{lung} are compared. In the case where $S_{\text{liver}} \leq S_{\text{lung}}$, the selecting means 74 determines not to select the channel as a channel used at the time of detecting the position of the edge of the liver. On the other hand, in the case of $S_{\text{liver}} > S_{\text{lung}}$, the selecting means 74 selects the channel as a channel used at the time of detecting the position of the edge of the liver. FIG. 9 illustrates a result of comparison between S_{liver} and S_{lung} in each of the profiles F_1 to F_{m+n} of the channels CH_1 to CH_{m+n} . It is assumed that $S_{\text{liver}} \leq S_{\text{lung}}$ is satisfied in the profile F_1 of the channel CH_1 and the profile F_{m+1} of the channel CH_{m+1} , and $S_{\text{liver}} > S_{\text{lung}}$ is satisfied in the profiles of the other channel CH_2 to CH_m and CH_{m+2} to CH_{m+n} . Therefore, the selecting means 74 determines not to select the channels CH_1 and CH_{m+1} as channels used at the time of detecting the position of the edge of the liver, and to select the other channels CH_2 to CH_m and the channels CH_{m+2} to CH_{m+n} as channels used at the time of detecting the position of the edge of the liver. In FIG. 10, the channels CH_2 to CH_m and CH_{m+2} to CH_{m+n} are indicated by thick broken lines. After selecting the channels, the program advances to step ST3.

[0053] In step ST3, based on the profiles F_2 to F_m and F_{m+2} to F_{m+n} obtained by the channels CH_2 to CH_m and CH_{m+2} to CH_{m+n} , the position of the edge of the liver at time t_1 is obtained (refer to FIG. 11).

[0054] FIG. 11 is an explanatory diagram at the time of acquiring the position of the edge of the liver. The position detecting means 75 (refer to FIG. 1), first, combines the profiles F_2 to F_m and F_{m+2} to F_{m+n} to obtain a composite profile F_c . In this case, the position detecting means 75 obtains the composite profile F_c by calculating the root mean of the signal intensities of the profiles F_2 to F_m and F_{m+2} to F_{m+n} .

[0055] The position detecting means 75 detects the position $i = i_1$ where the signal intensity changes drastically from the composite profile F_c . Consequently, the position i_1 (refer to FIG. 5) of the edge of the liver at time t_1 can be detected. By combining the profiles F_2 to F_m and F_{m+2} to

F_{m+n} , the SN ratio can be increased, so that the detection precision of the position of the edge of the liver can be improved. After obtaining the position i_1 of the edge, the flow of FIG. 6 is finished.

[0056] After detecting the position p_1 of the edge of the liver at time t_1 , the navigator sequence is executed at the following time t_2 .

[0057] FIG. 12 is a diagram illustrating the flow at the time of executing the navigator sequence NAV at time t_2 and detecting the position of the edge of the liver at time t_2 .

[0058] In step ST1, the navigator sequence NAV is executed at time t_2 . By executing the navigator sequence NAV, the navigator signal is obtained from the navigator region R_{nav} . The profile generating means 71 converts the navigator signals received by the channels CH_2 to CH_m and CH_{m+2} to CH_{m+n} (refer to FIG. 10) to profiles each expressing the relation between each position in the SI direction of the navigator region R_{nav} and signal intensity. By the conversion, profiles are generated for the channels CH_2 to CH_m and CH_{m+2} to CH_{m+n} . FIG. 13 schematically illustrates the profiles F_2 to F_m and F_{m+2} to F_{m+n} generated. After obtaining the profiles F_2 to F_m and F_{m+2} to F_{m+n} , the position detecting means 75 calculates the root mean of the signal intensities of the profiles F_2 to F_m and F_{m+2} to F_{m+n} to obtain the composite profile F_c . FIG. 14 schematically illustrates the composite profile F_c .

[0059] The position detecting means 75 detects the position i_2 where the signal intensity changes drastically from the composite profile F_c . In such a manner, the position i_2 (refer to FIG. 5) of the edge of the liver at time t_2 can be detected.

[0060] Similarly, also at time t_3 to t_z (refer to FIG. 5), according to the flow shown in FIG. 12, the navigator sequence NAV is executed, and profiles are generated by using the navigator signals received in the selected channels CH_2 to CH_m and CH_{m+2} to CH_{m+n} . The profiles are combined and the position of the edge of the liver is detected from the composite profile.

[0061] Therefore, as illustrated in FIG. 5, data of the positions i_1 to i_z of the edge of the liver at time t_1 to t_z can be obtained. After obtaining the data, on the basis of the data of the positions i_1 to i_z of the edge of the liver, the trigger level TL is determined. FIG. 15 is a diagram illustrating an example of the trigger level TL. The trigger level TL expresses the reference position of the edge of the liver at the time of executing a data acquisition sequence DAQ (refer

to FIG. 16) in the main scan B which will be described later. The trigger level TL can be set, for example, in an intermediate value between the maximum value and the minimum value of the position of the edge of the liver. How the trigger level TL is used at the time of executing the main scan B will be described later. After executing the pre-scan A, the main scan B is executed.

[0062] FIG. 16 is an explanatory diagram of the main scan B. In the main scan B, the navigator sequence NAV and the data acquisition sequence DAQ for acquiring data of the liver are executed.

[0063] Also in the main scan B, the navigator system NAV is executed according to the flow illustrated in FIG. 12 to detect the position of the edge of the liver.

[0064] In such a manner, changes with time of the position of the edge of the liver are monitored. When the position of the edge of the liver moves from the upper side of the trigger level TL to the lower side, the data acquisition sequence DAQ is executed.

[0065] Similarly, the navigator sequence NAV and the data acquisition sequence DAQ are repeatedly executed, and the main scan B is finished. On the basis of the data acquired by the main scan B, an image of the liver is reconstructed, and the imaging of the subject is finished.

[0066] In the embodiment, the sum S_{liver} of signal intensities in the liver region and the sum S_{lung} of signal intensities in the lung region are compared, and a channel where $S_{\text{liver}} > S_{\text{lung}}$ is satisfied is selected as a channel used to detect the position of the edge of the liver. Therefore, a channel where $S_{\text{liver}} \leq S_{\text{lung}}$ is satisfied is not selected as a channel used to detect the position of the edge of the liver, so that the precision of detection of the position of the edge of the liver can be increased.

[0067] In the embodiment, the sum S_{liver} of signal intensities in the liver region and the sum S_{lung} of signal intensities in the lung region are calculated. However, if a feature amount of the signal intensities in the liver region and a feature amount of the signal intensities in the lung region can be obtained, values different from the sums S_{liver} and S_{lung} of the signal intensities may be calculated. For example, an average value S_1 of the signal intensities in the liver region may be calculated in place of the sum S_{liver} of signal intensities in the liver region, and an average S_2 of the signal intensities in the lung region may be calculated in place of the sum S_{lung} of the signal intensities of the lung region. In the case of calculating the average values S_1 and S_2 of the

signal intensities, it is sufficient to select a channel where $S_1 > S_2$ is satisfied as a channel used to detect the position of the edge of the liver. In this case, a channel where $S_1 \leq S_2$ is satisfied is not selected as a channel used to detect the position of the edge of the liver, so that the precision of detection of the position of the edge of the liver can be increased.

[0068] In the embodiment, by comparing the sum S_{liver} of signal intensities in the liver region and the sum S_{lung} of signal intensities in the lung region, a channel is selected. On the other hand, it is also considered to prepare a template expressing an ideal signal intensity of each position in the navigator region, obtain a correlation coefficient between the template and each profile, and select a channel where the correlation coefficient is large (refer to FIG. 17).

[0069] FIG. 17 is an explanatory diagram of an example of a method of selecting a channel by using a template TI.

[0070] In FIG. 17, the template TI is illustrated. The template TI is data expressing ideal signal intensity in each position in the navigator region. In the method using the template TI, correlation coefficients C_1 to C_{m+n} between the template TI and the profiles F_1 to F_{m+n} are obtained, and a channel in which the correlation coefficient is large is selected from the channels CH_1 to CH_{m+n} . Therefore, a channel in which the correlation coefficient is small is not selected, so that the precision of detecting the position of the edge of the liver can be increased. In this method, however, it is considered to select only a channel in which the correlation coefficient is as high as possible. The number of channels selected is small and, generally, it is set to select only the channel in which the correlation coefficient is the largest and the channel in which the correlation coefficient is the second largest (that is, two channels). For example, when it is assumed that, in FIG. 17, the correlation coefficient C_2 of the channel CH_2 is the largest and the correlation coefficient C_{m+2} of the channel CH_{m+2} is the second largest in the correlation coefficients C_1 to C_{m+n} , only the two channels CH_2 and CH_{m+2} are selected. Therefore, in the method using the template TI, a profile F_2 of the channel CH_2 and a profile F_{m+2} of the channel CH_{m+2} are combined (refer to FIG. 18).

[0071] FIG. 18 is a diagram schematically illustrating a composite profile X obtained by using the method of using the template TI. In FIG. 18, the composite profile Fc obtained by the method of the embodiment is also illustrated.

[0072] There is a case that signal unevenness appears in the liver region of the profile

depending on imaging parameters or the like. FIG. 18 illustrates an example where signal unevenness appears in the liver region in the profile F_2 . Generally, the signal unevenness in the liver region tends to appear as the number of channels of the coil becomes larger. In the case where such signal unevenness appears in the profile F_2 , only by combining the profiles F_2 and F_{m+2} , signal unevenness in the profile F_2 cannot be sufficiently reduced, and signal unevenness appears also in the region of the liver in the composite profile X. When signal unevenness appears in the composite profile X, it causes deterioration in the precision of detecting the position of the edge of the liver.

[0073] On the other hand, in the embodiment, the template TI is not used. The sum S_{liver} of signal intensities in the liver region and the sum S_{lung} of signal intensities in the lung region are compared, and a channel where $S_{\text{liver}} > S_{\text{lung}}$ is satisfied is selected as a channel used to detect the position of the edge of the liver. Therefore, the channel where $S_{\text{liver}} > S_{\text{lung}}$ is satisfied is selected as a channel used to detect the position of the edge of the liver regardless of the correlation coefficient. Consequently, in the method of the embodiment, as compared with the method using the template, larger number of channels can be selected as channels used at the time of detecting the position of the edge of the liver. Referring to FIG. 18, it is understood that, in the method using the template, only the channels CH_2 and CH_{m+2} (that is, two channels) are selected and, in the method of the embodiment, the channels CH_2 to CH_m and CH_{m+2} to CH_{m+n} are selected. Therefore, in the method of the embodiment, larger number of profiles are combined than that in the method using the template, so that the composite profile Fc in which the influence of the signal unevenness of the channel CH_2 is sufficiently reduced can be obtained, and the precision of detecting the position of the edge of the liver can be improved.

[0074] In the embodiment, the navigator region R_{nav} is set so as to include the liver and the lung. As long as a body site which is moves is included, the navigator region R_{nav} may include parts different from the liver or lung. For example, the navigator region R_{nav} may be set so as to include the liver and the heart.

[0075] In the embodiment, on the basis of a navigator signal obtained by the navigator sequence NAV at the time t_1 of the pre-scan A, a channel used to detect the position of the edge of the liver is selected from the channels CH_1 to CH_{m+n} . It is also possible to execute the navigator sequence NAV for selecting a channel twice or more and select a channel on the basis

of navigator signals obtained by the navigator sequences NAV.

[0076] In the embodiment, the position of the edge of the liver is detected according to the flow of FIG. 6 at time t_1 and the position of the edge of the liver is detected according to the flow of FIG. 12 at time t_2 and after that. However, also at time t_2 and after that, the position of the edge of the liver may be detected according to the flow of FIG. 6.

[0077] In the embodiment, the example of acquiring data by triggering has been described. The present invention, however, is not limited to triggering but can be applied to any imaging as long as a navigator signal has to be received by a coil having a plurality of channels.

DESCRIPTION OF REFERENCE NUMERALS

2	magnet
3	table
3a	cradle
4	reception coil
41	first coil unit
42	second coil unit
5	transmitter
6	gradient magnetic field power supply
7	controller
8	operator
9	display unit
10	subject
21	bore
71	profile generating means
72	specifying means
73	calculating means

- 74 selecting means
- 75 position detecting means
- 100 MR apparatus

CLAIMS

What Is Claimed Is:

1. A magnetic resonance apparatus for obtaining a navigator signal generated from a navigator region including a first body site which moves and a second body site which moves by using a coil having a plurality of channels, comprising:

scan means for executing a first navigator sequence for obtaining a first navigator signal generated from the navigator region;

profile generating means for generating a first profile expressing relation between each position in the navigator region and signal intensity, for each of the channels, on the basis of the first navigator signal received by each of the plurality of channels;

means for obtaining a first region corresponding to the first body site in the first profile and a second region corresponding to the second body site in the first profile; and

selecting means for selecting a channel used to obtain the position of the first body site from the plurality of channels on the basis of a feature amount of the signal intensity in the first region and a feature amount of the signal intensity in the second region.

2. The magnetic resonance apparatus according to claim 1, wherein the feature amount of the signal intensity in the first region is a sum of the signal intensities in the first region or an average value of the signal intensities in the first region, and

the feature amount of the signal intensity in the second region is a sum of the signal intensities in the second region or an average value of the signal intensities in the second region.

3. The magnetic resonance apparatus according to claim 1 or 2, wherein the means for obtaining the first region and the second region obtains position of a border between the first body site and the second body site and, using the position of the border as a reference, obtains the first region and the second region.

4. The magnetic resonance apparatus according to claim 3, wherein the means for obtaining the first region and the second region obtains the position of the border on the basis of the signal intensity of the first profile.

5. The magnetic resonance apparatus according to claim 3, wherein the means for obtaining the first region and the second region obtains, as the position of the border, an intermediate position of the navigator region.

6. The magnetic resonance apparatus according to any one of claims 1 to 5, wherein:
the scan means executes a second navigator sequence for obtaining a second navigator signal generated from the navigator region, and
the profile generating means generates a second profile expressing the relation between each of positions in the navigator region and the signal intensity on the basis of the second navigator signal received by the channel selected by the selecting means.

7. The magnetic resonance apparatus according to claim 6, further comprising means obtaining the position of the first body site on the basis of the second profile.

8. The magnetic resonance apparatus according to claim 7, wherein:
the selecting means selects two or more channels from the plurality of channels,
the profile generating means generates the second profile for each selected channel on the basis of the second navigator signal received by the two or more channels selected by the selecting means, and
the means obtaining the position of the first body site combines the second profiles obtained for the selected channels and obtains the position of the first body site on the basis of a profile obtained by the combining.

9. The magnetic resonance apparatus according to claim 7 or 8, wherein the means obtaining the position of the first body site combines the first profiles obtained for the selected channels and obtains the position of the first body site on the basis of a profile obtained by the combining.

10. The magnetic resonance apparatus according to any one of claims 1 to 9, wherein:
the first body site includes an edge of a liver, the second body site includes a part of a lung, and
the position of the first body site is the position of the edge of the liver.

11. A program applied to a magnetic resonance apparatus executing a first navigator sequence for obtaining a first navigator signal generated from a navigator region including a first body site which moves and a second body site which moves by using a coil having a plurality of channels, the program for making a computer execute:

a profile generating process generating a first profile expressing relation between each position in the navigator region and signal intensity for each of the channels on the basis of the first navigator signal received by each of the plurality of channels;

a process obtaining a first region corresponding to the first body site in the first profile and a second region corresponding to the second body site in the first profile; and

a selecting process selecting a channel used to obtain the position of the first body site from the plurality of channels on the basis of a feature amount of the signal intensity in the first region and a feature amount of the signal intensity in the second region.

FIG. 1

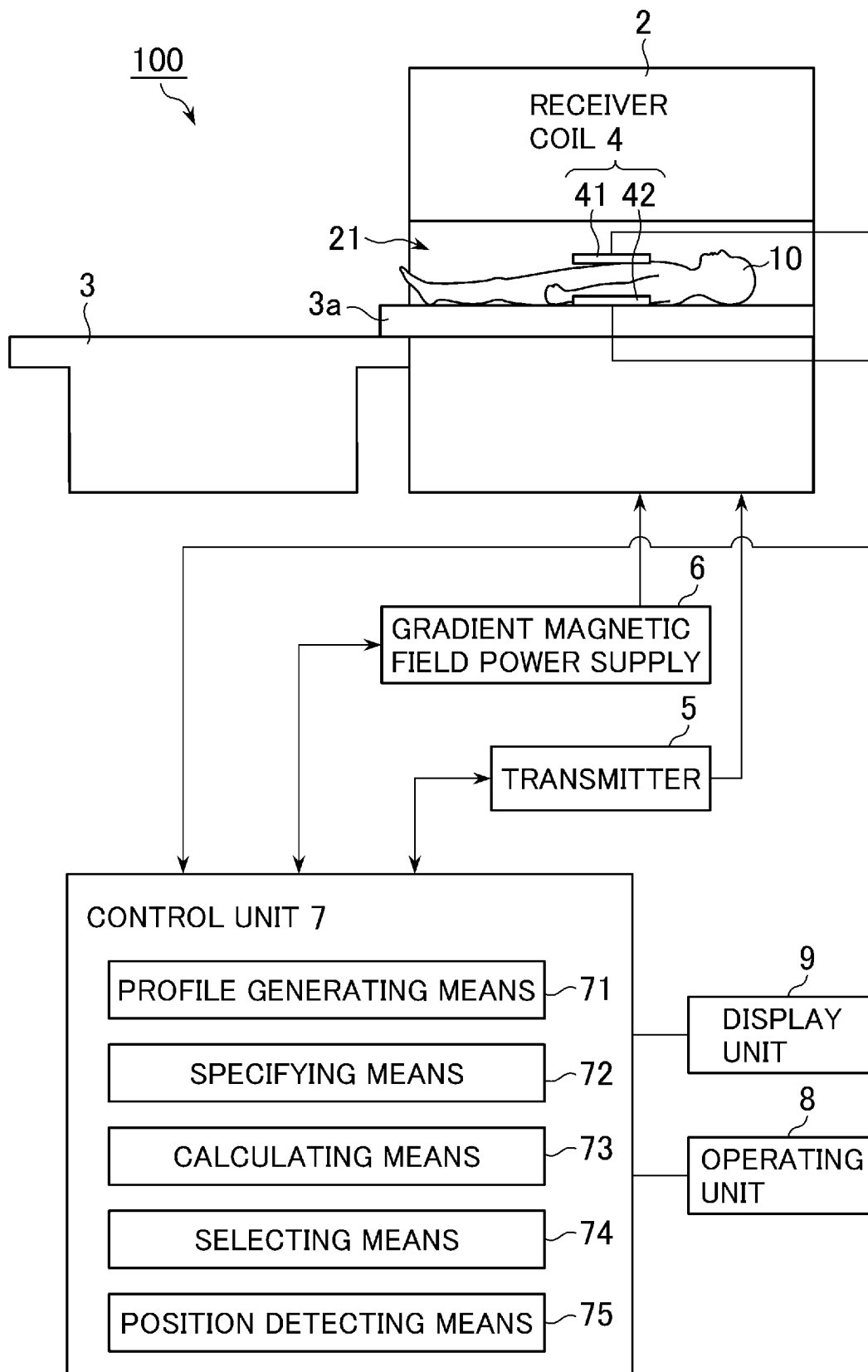


FIG. 2

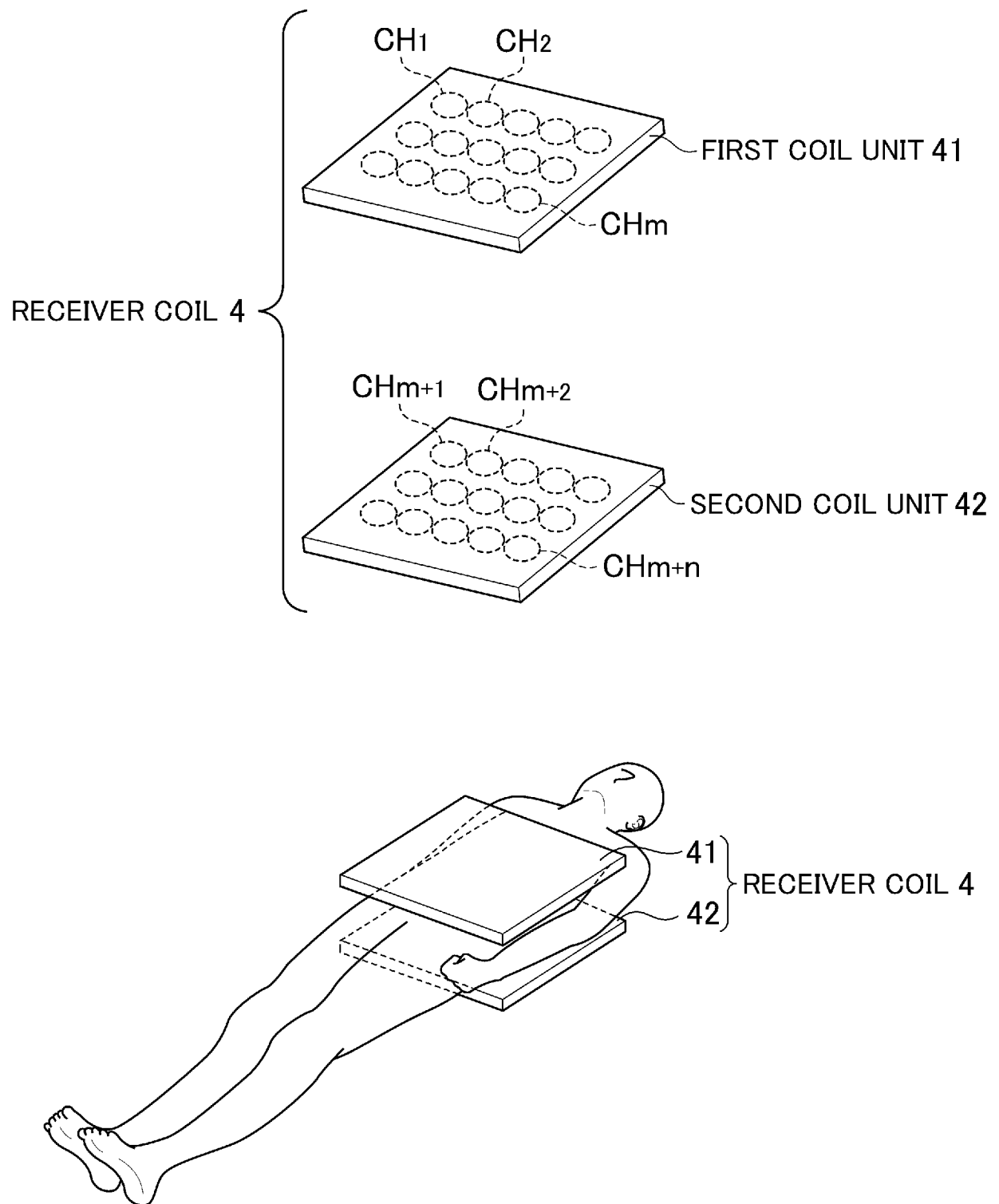


FIG. 3



FIG. 4

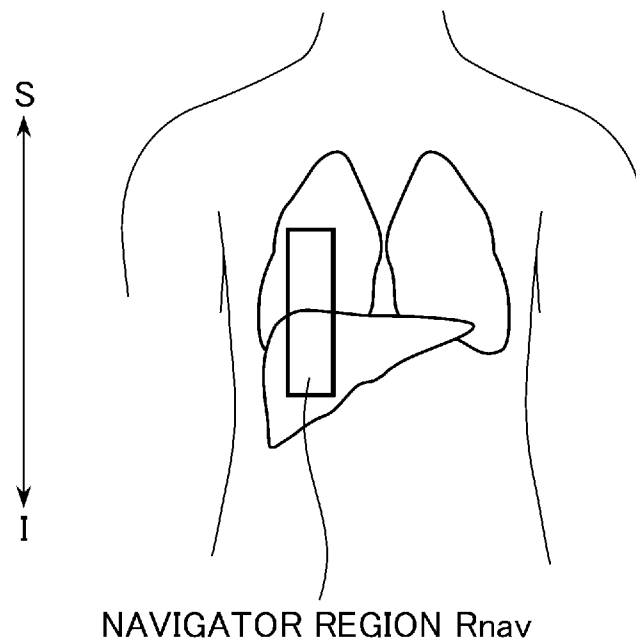


FIG. 5

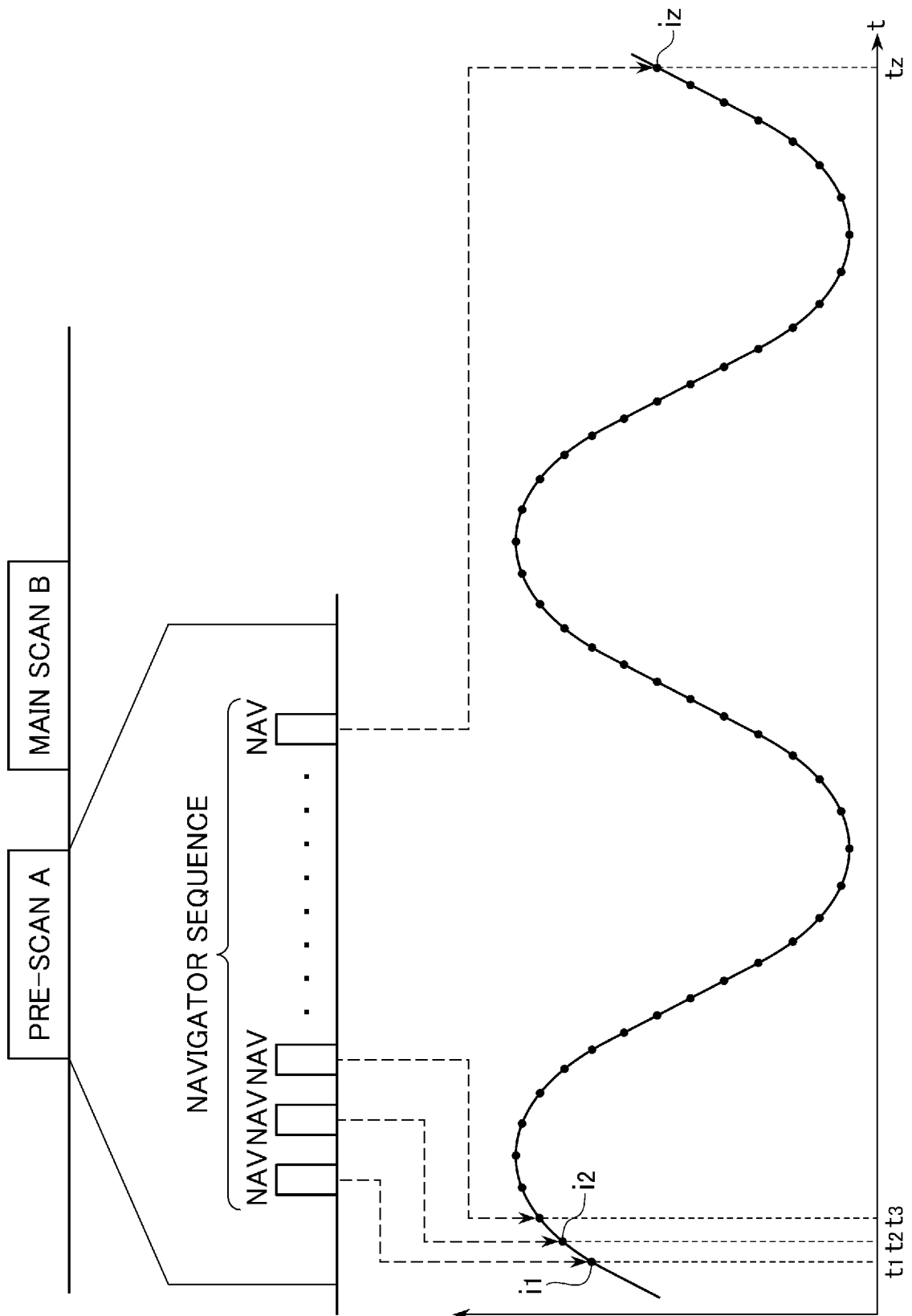


FIG. 6

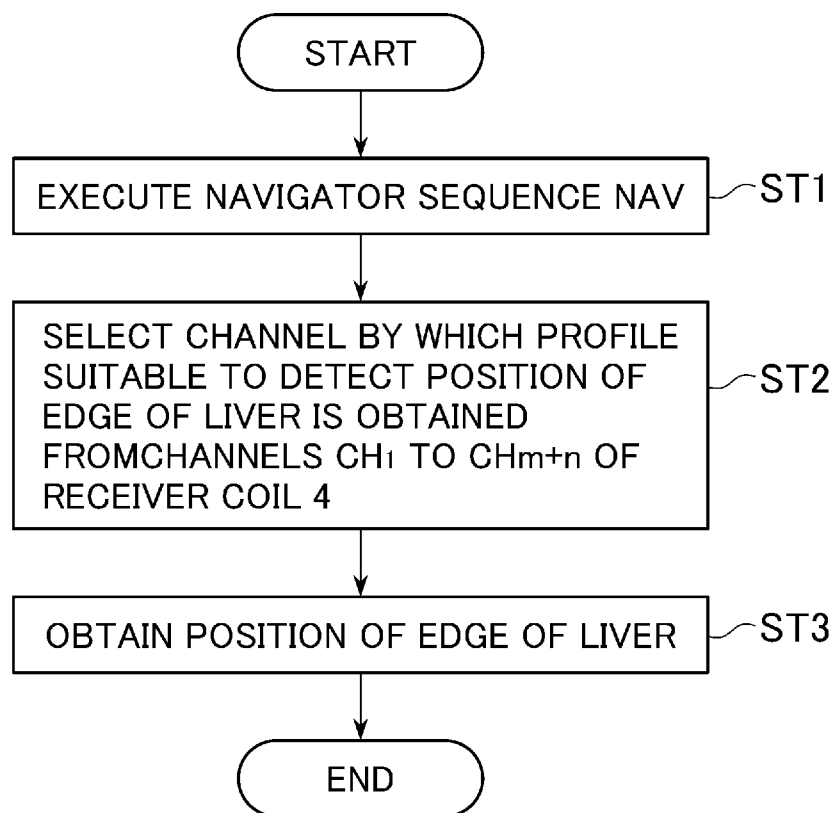


FIG. 7

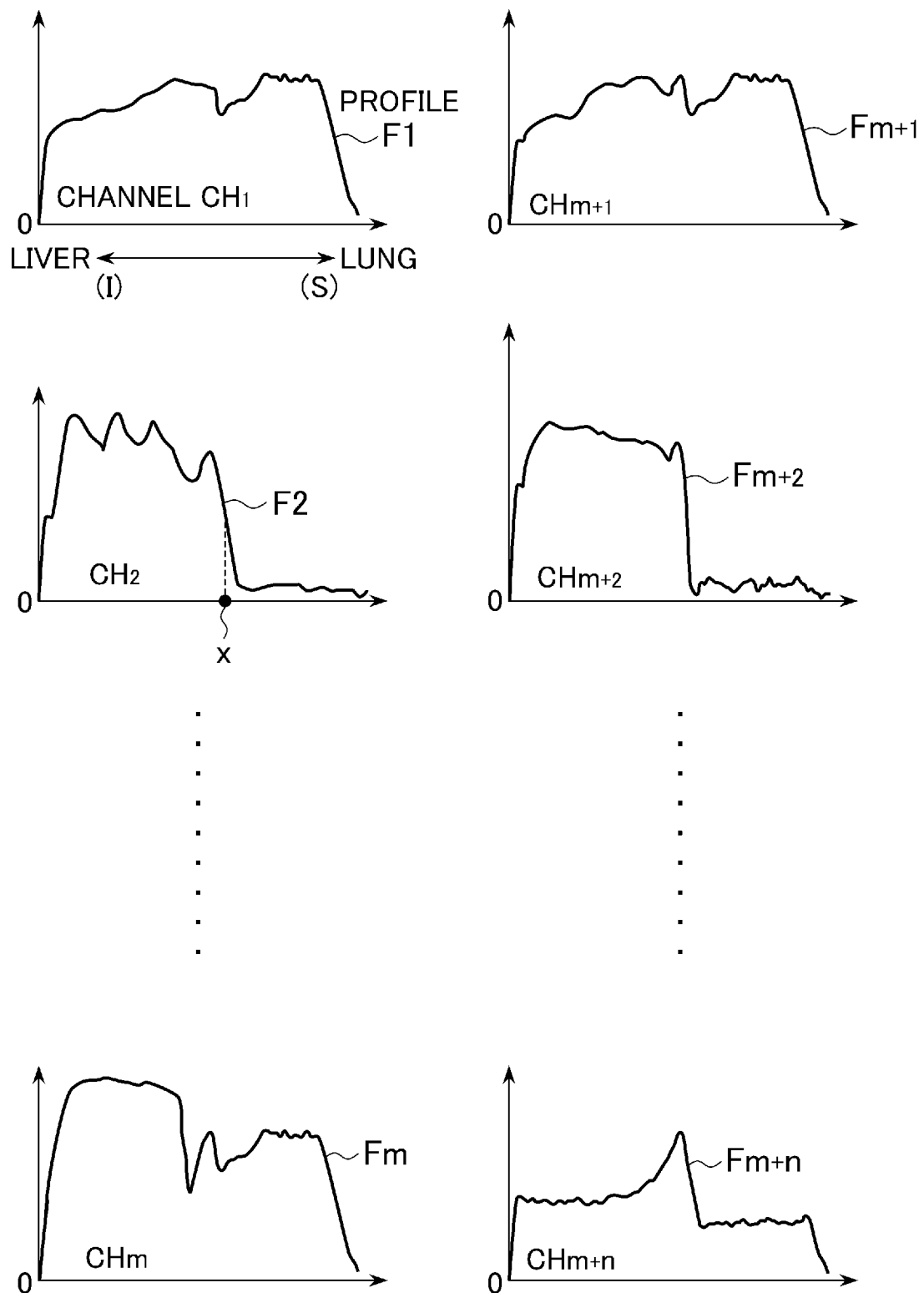


FIG. 8

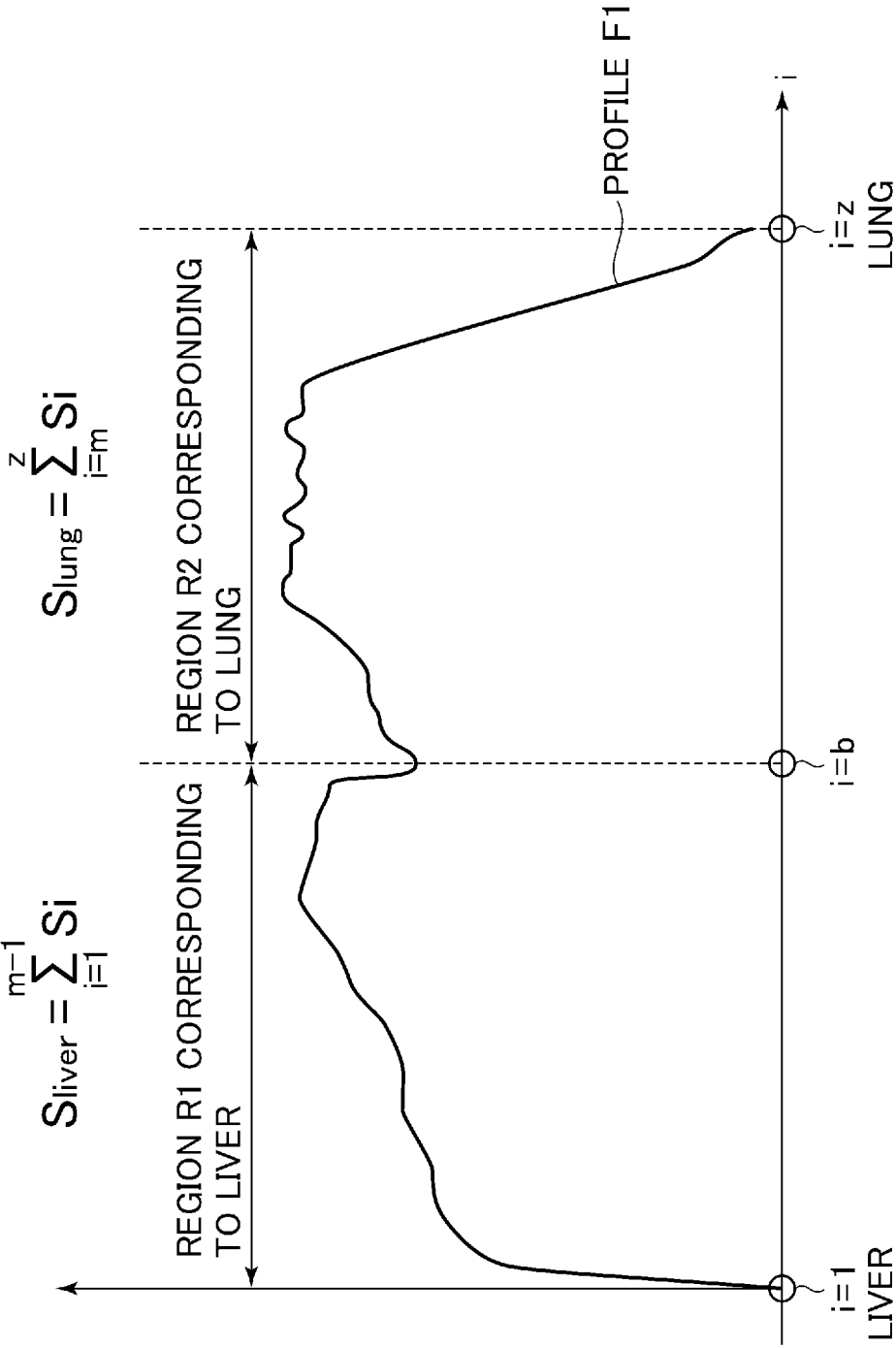


FIG. 9

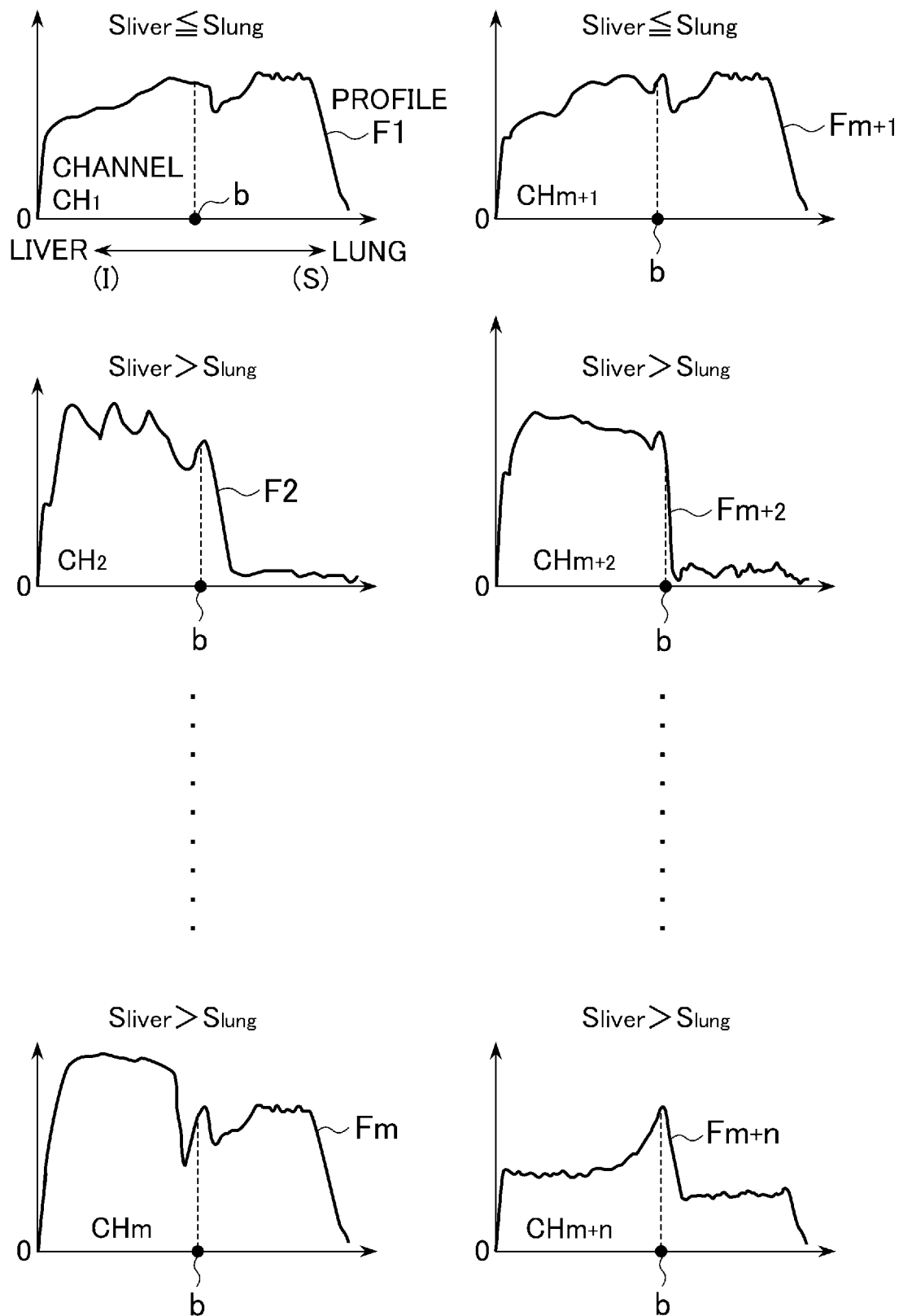


FIG. 10

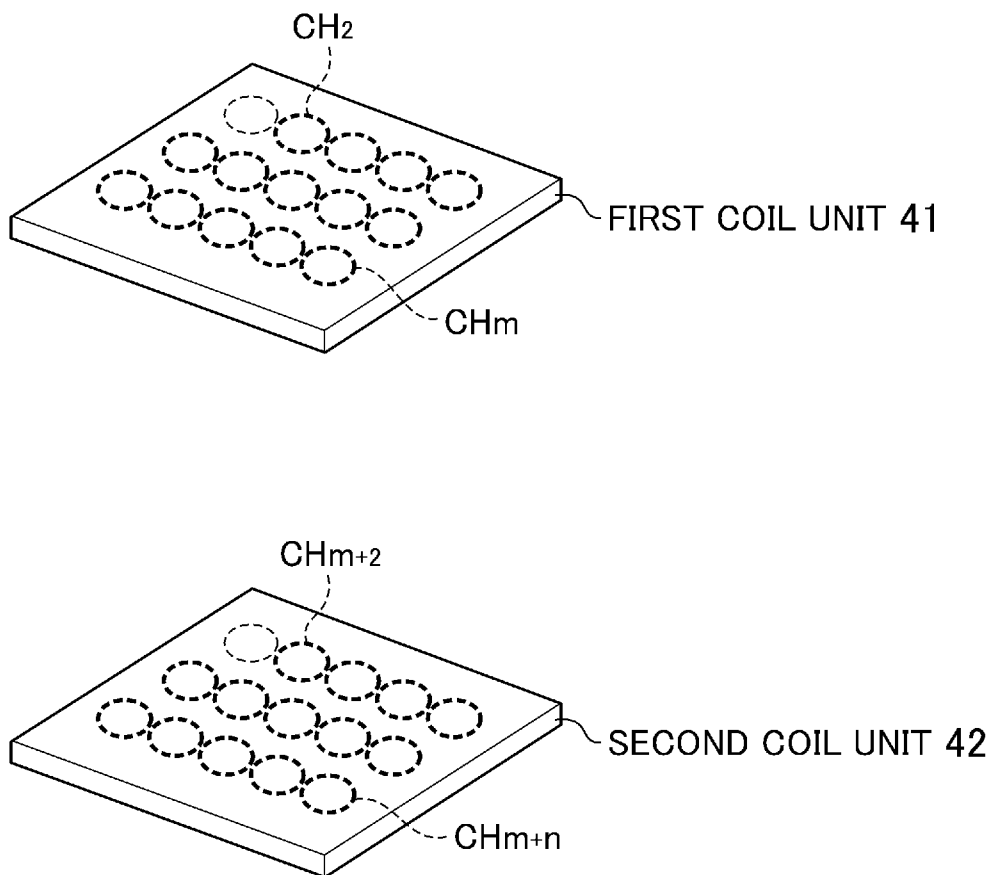


FIG. 11

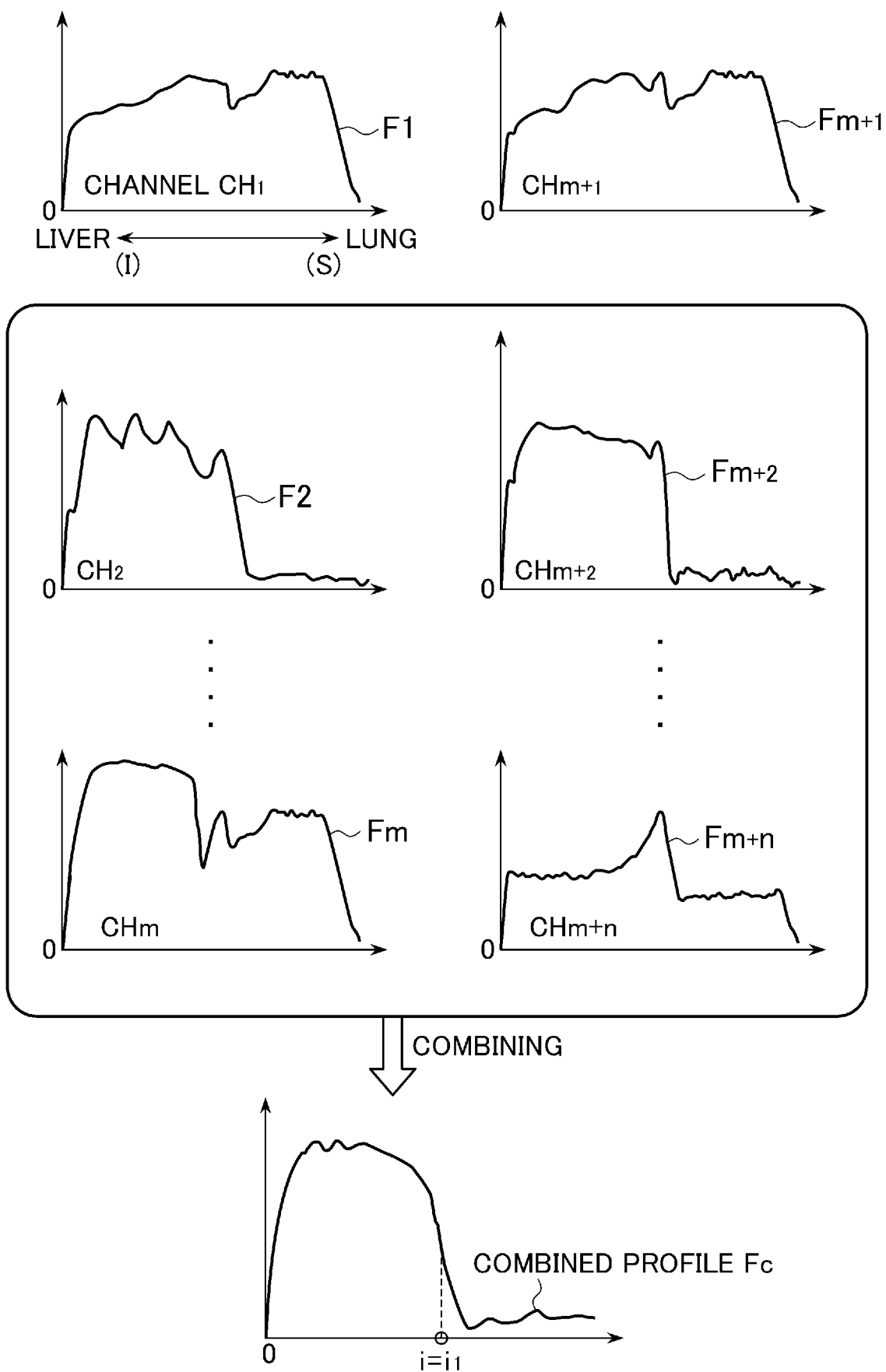


FIG. 12

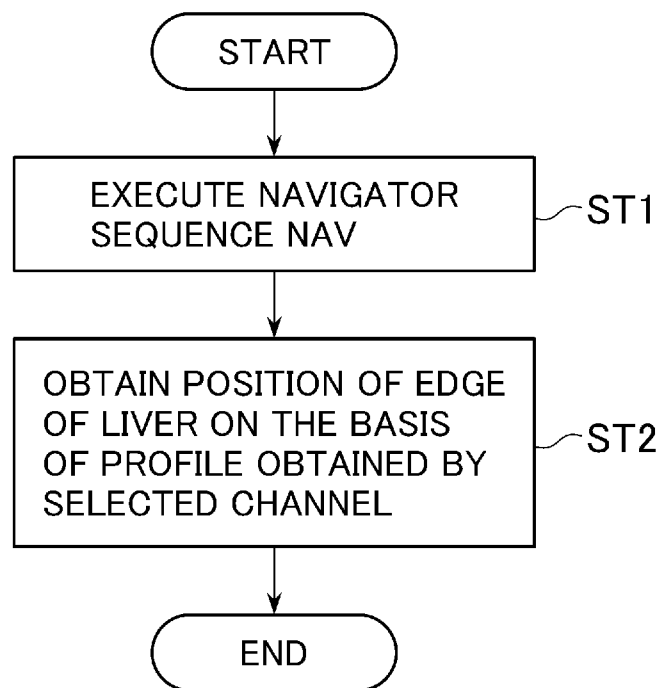


FIG. 13

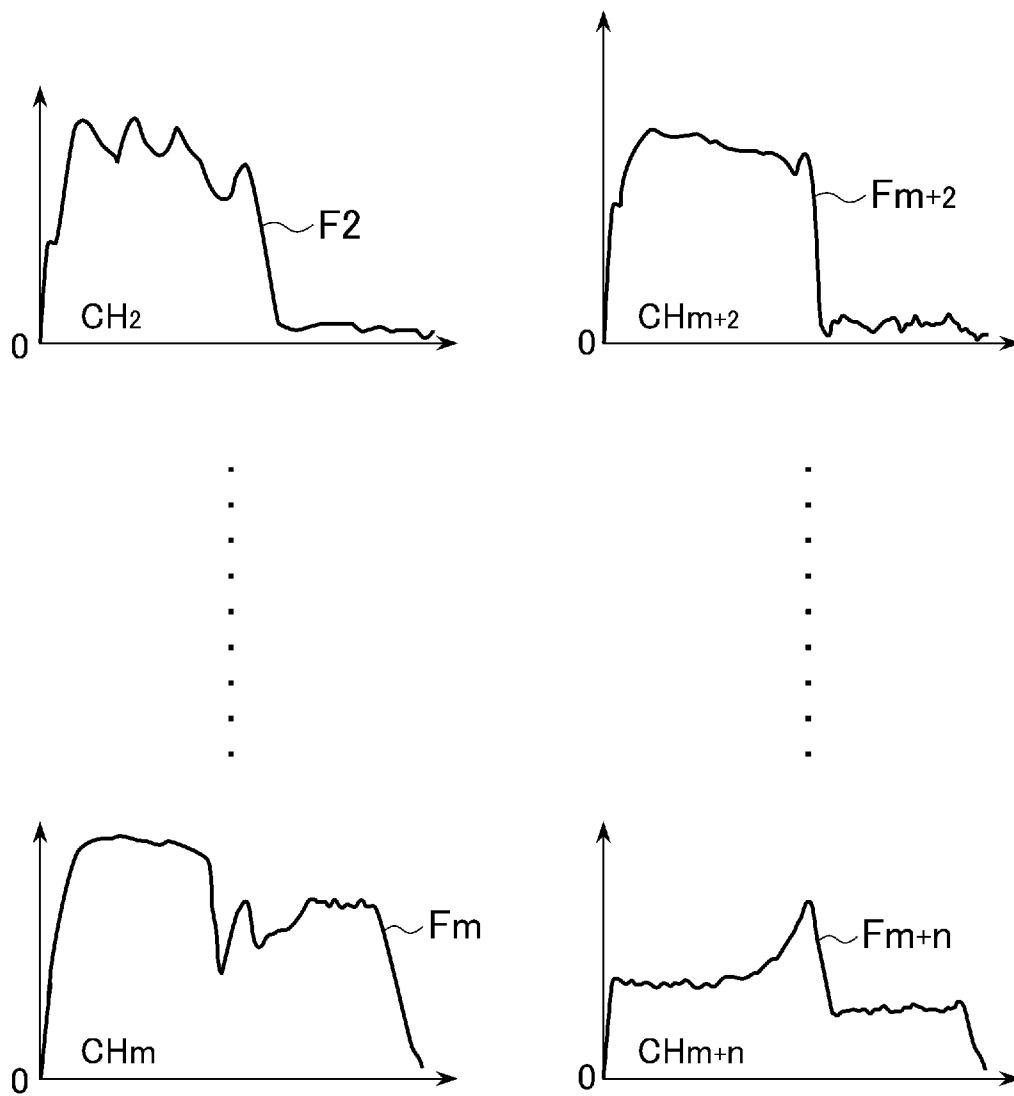


FIG. 14

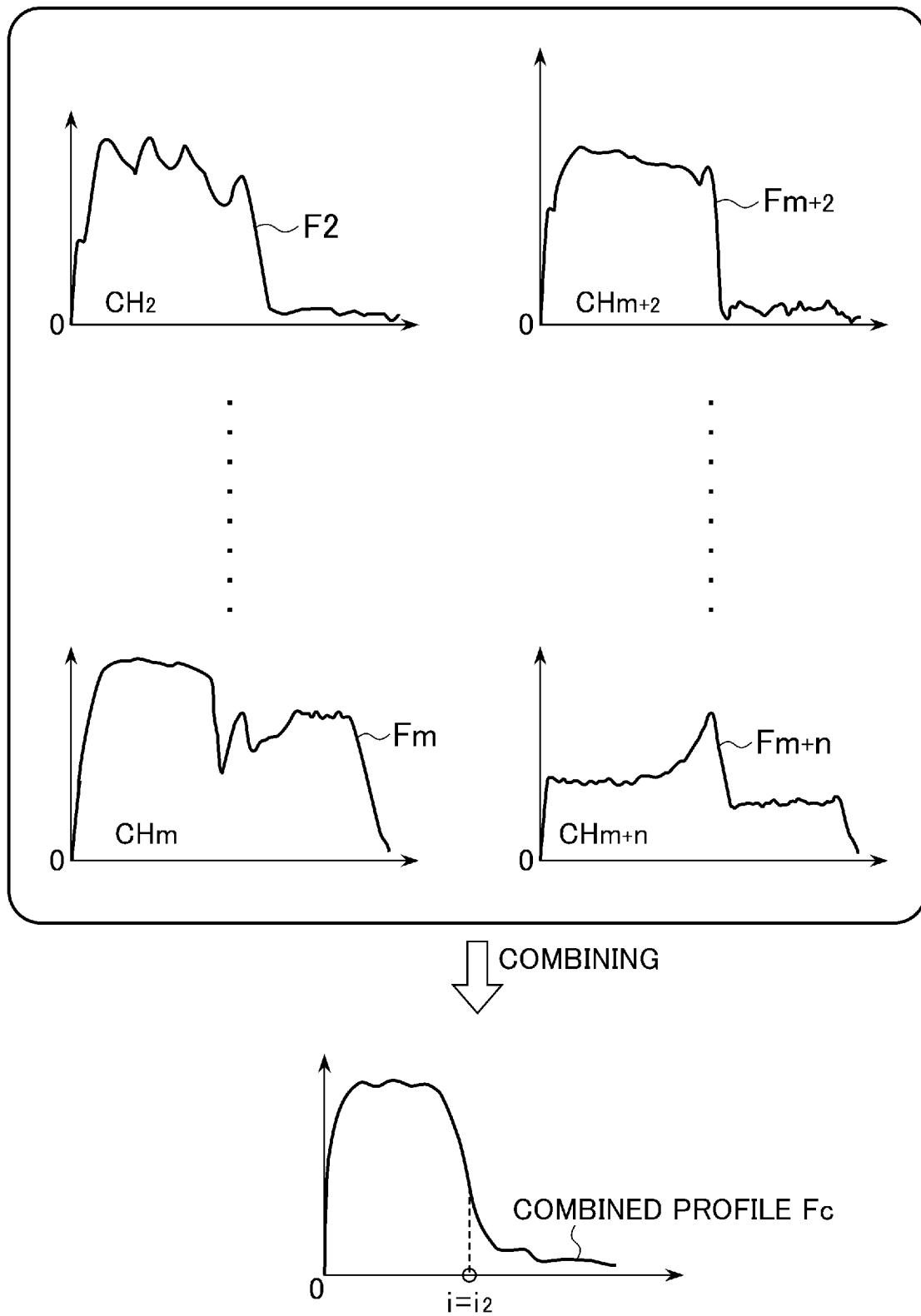


FIG. 15

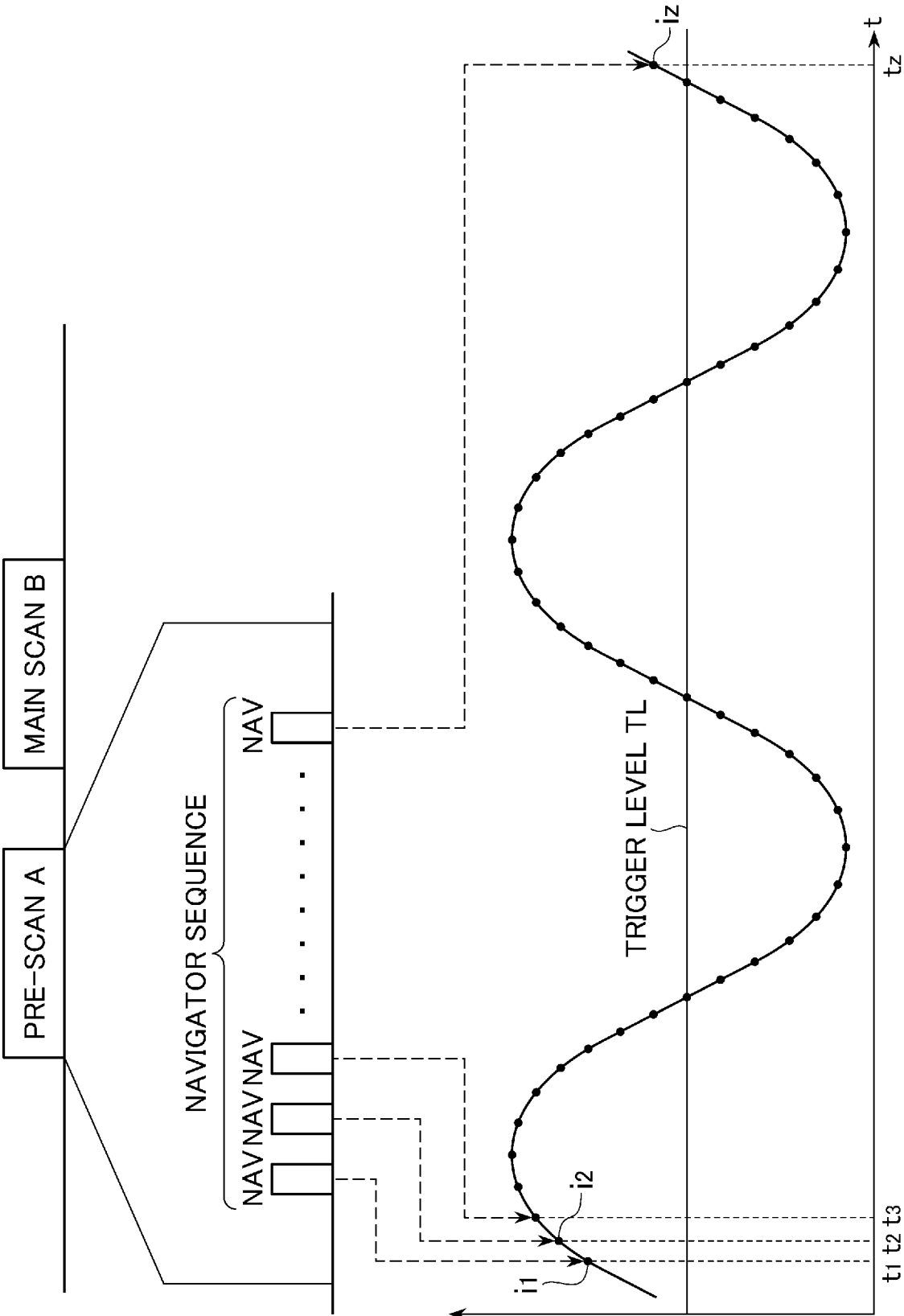


FIG. 16

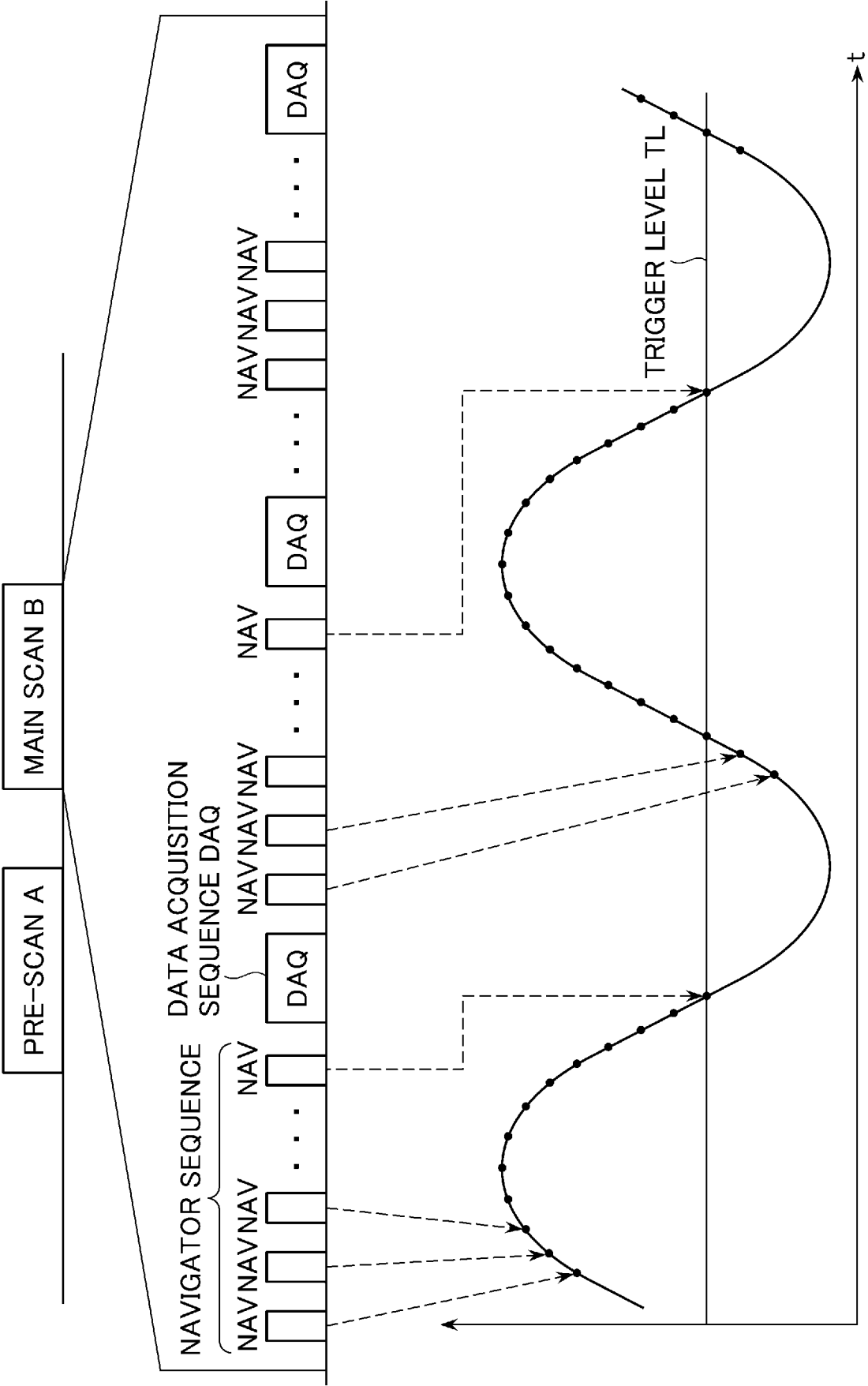


FIG. 17

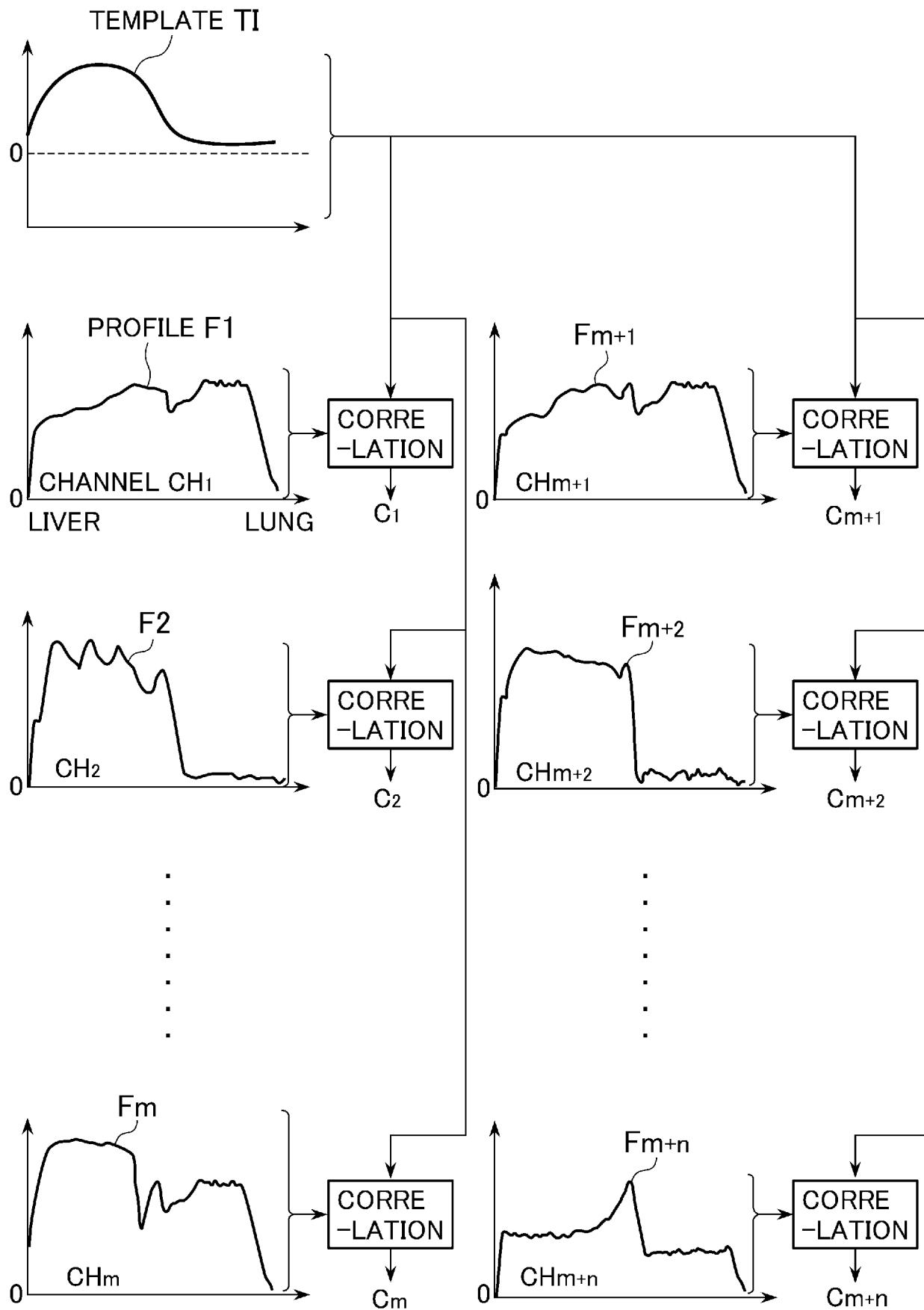
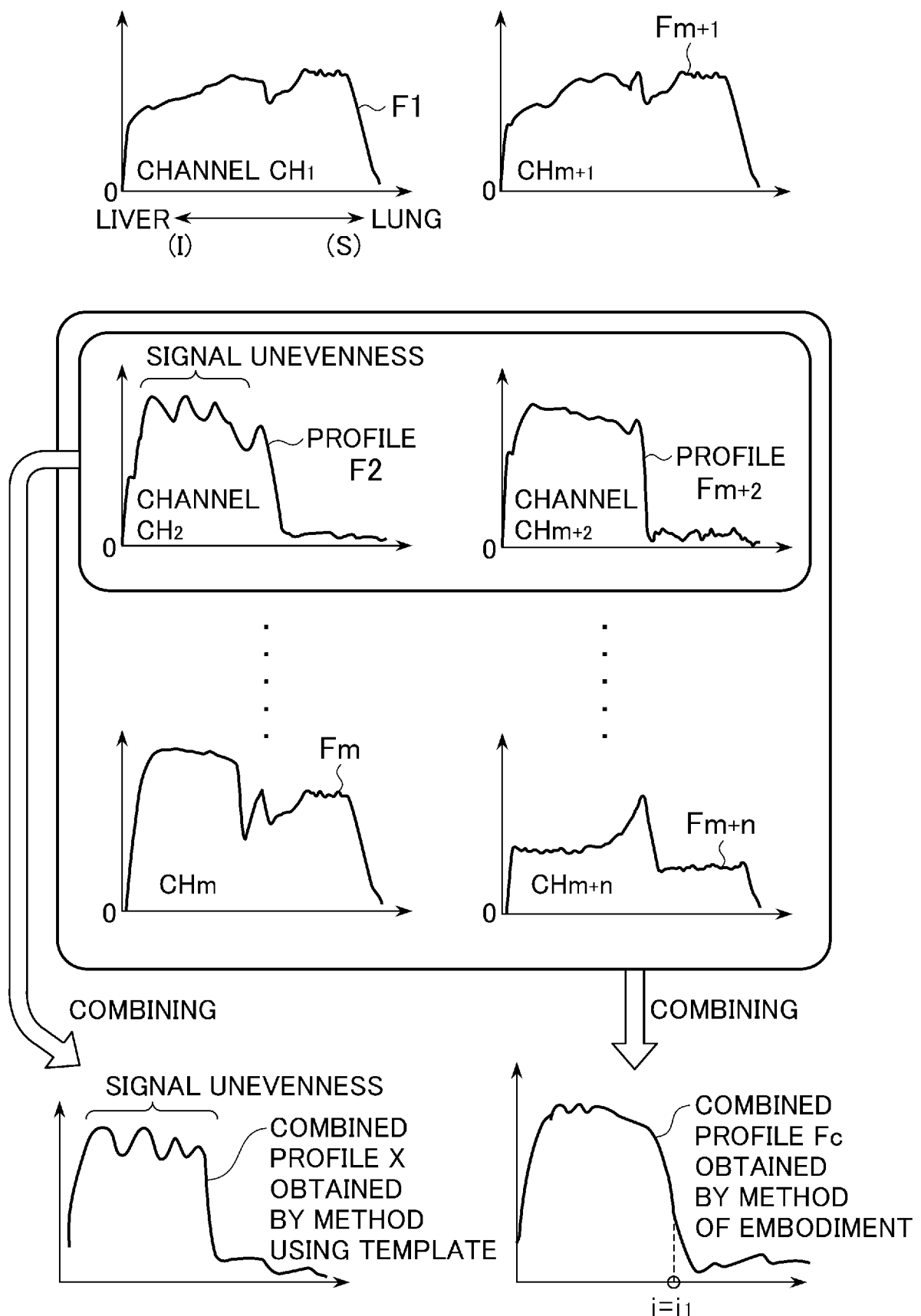


FIG. 18



INTERNATIONAL SEARCH REPORT

International application No
PCT/US2014/042519

A. CLASSIFICATION OF SUBJECT MATTER
INV. G01R33/561 G01R33/565 G01R33/567
ADD.

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
G01R

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	BRAU ANJA, IWADATE YUJI: "Evaluation of Coil Selection Algorithms for Body Navigators", PROCEEDINGS OF THE INTERNATIONAL SOCIETY FOR MAGNETIC RESONANCE IN MEDICINE, 20TH ANNUAL MEETING AND EXHIBITION, MELBOURNE, AUSTRALIA, 5-11 MAY 2012, vol. 20, 21 April 2012 (2012-04-21), XP040625829, paragraph [0001] - paragraph [0002]; figures 1-4	1-11
X	US 2010/171497 A1 (IWADATE YUJI [JP] ET AL) 8 July 2010 (2010-07-08) paragraph [0007] - paragraph [0026]; figures 1, 3-5, 8 ----- -/--	1-11



Further documents are listed in the continuation of Box C.



See patent family annex.

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

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

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

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

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

"&" document member of the same patent family

Date of the actual completion of the international search

30 October 2014

Date of mailing of the international search report

10/11/2014

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040,
Fax: (+31-70) 340-3016

Authorized officer

Raguin, Guy

INTERNATIONAL SEARCH REPORT

International application No

PCT/US2014/042519

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 6 275 720 B1 (DU YIPING [US] ET AL) 14 August 2001 (2001-08-14) the whole document -----	1-11

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2014/042519

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			JP 5305925 B2	02-10-2013
			JP 2010155021 A	15-07-2010
			US 2010171497 A1	08-07-2010

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