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(54) **NOTIFICATION SIGNAL CONTROL APPARATUS AND METHOD**

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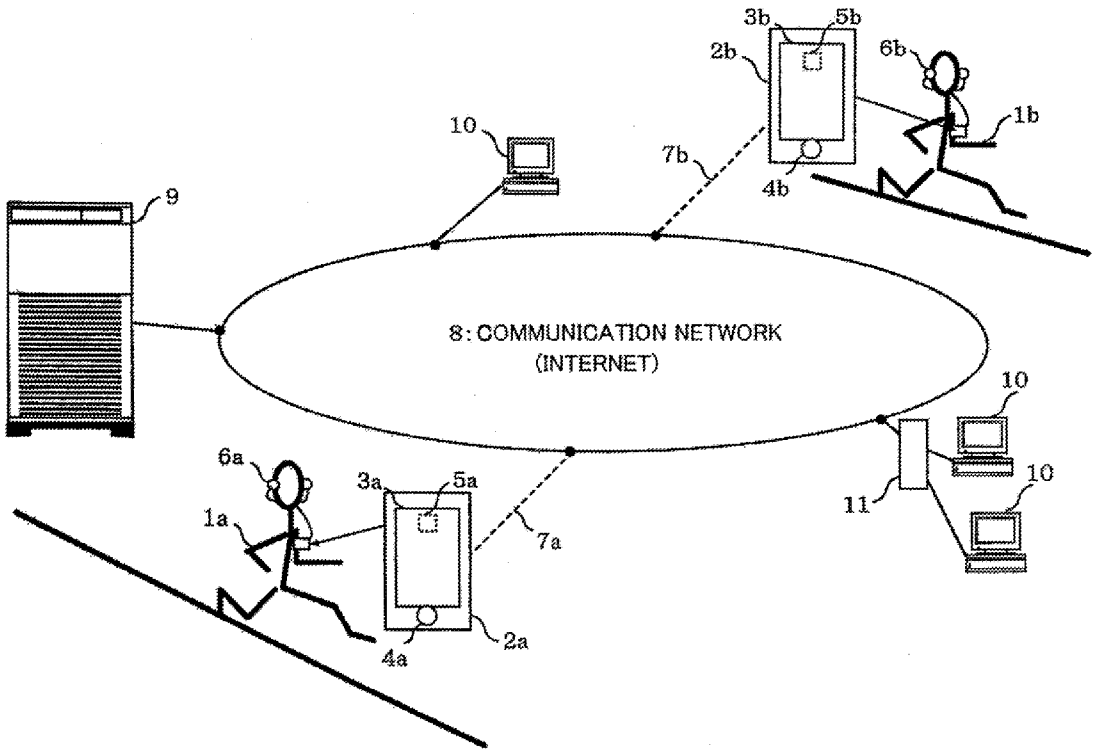
(57) **ABSTRACT**

A first notification signal generation apparatus (first music playback apparatus) is attached to an upper arm of a first exercising person. The first notification signal generation apparatus includes a display, an operation button **4***a*, and a sensor that detects an exercise condition of the first exercising person **1***a*, such as repetition tempo. The sensor is either built in, or connected external to, the first notification signal generation apparatus. A second notification signal generation apparatus (second music playback apparatus) also includes the same elements as the first notification signal generation apparatus. A second exercising person performs repetitive exercise in synchronization with a repetition notification tempo (music tempo) of a notification signal (music), and therefore shares a value of certain exercise information, obtained during his or her repetitive exercise, with the first exercising person. Thus, the first and second exercising person can share a value of certain exercise information.



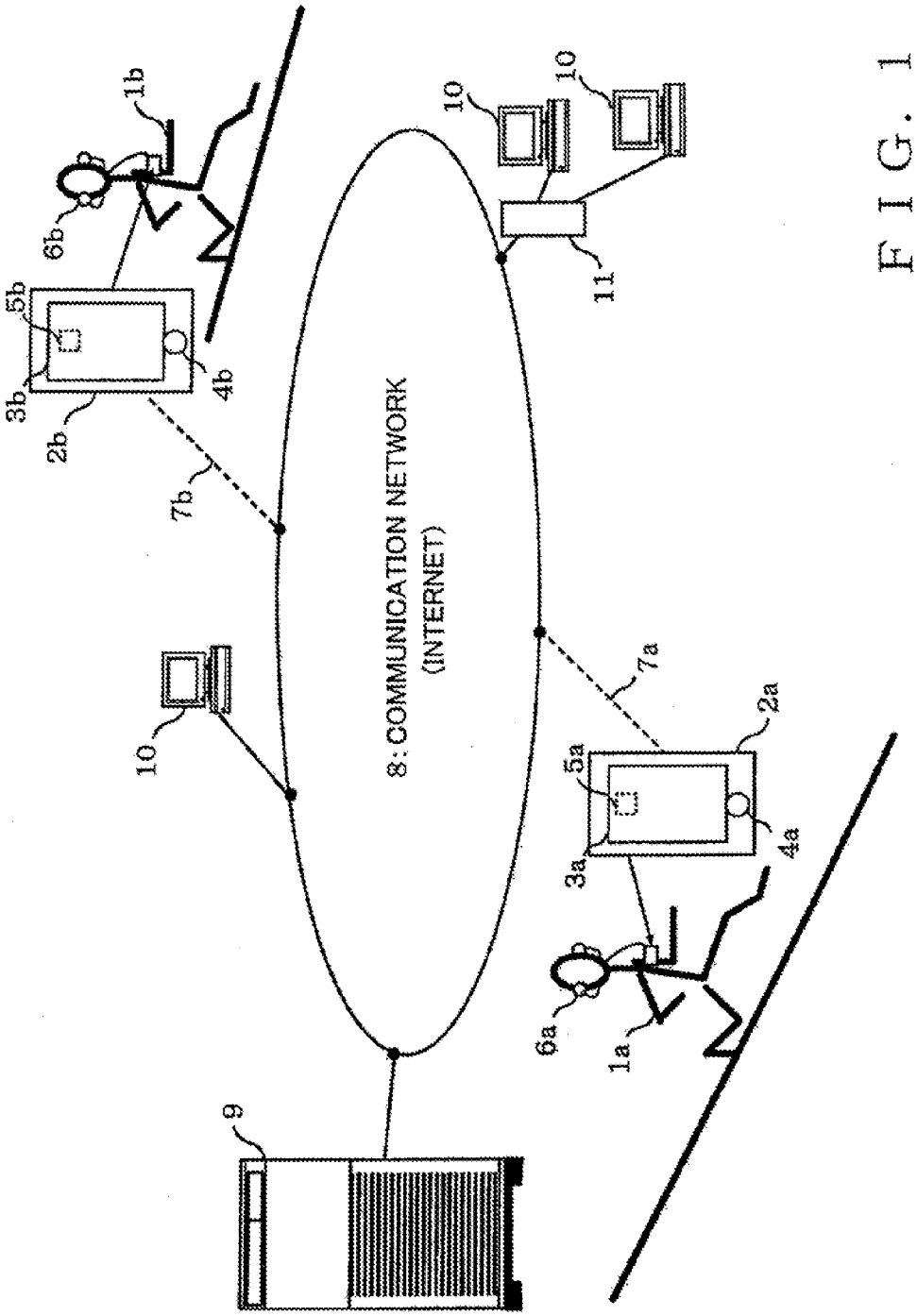

8: COMMUNICATION NETWORK
(INTERNET)
1a
1b
2a
2b
3a
3b
4a
4b
5a
5b
6a
6b
7a
7b
9
10
11

FIG. 1

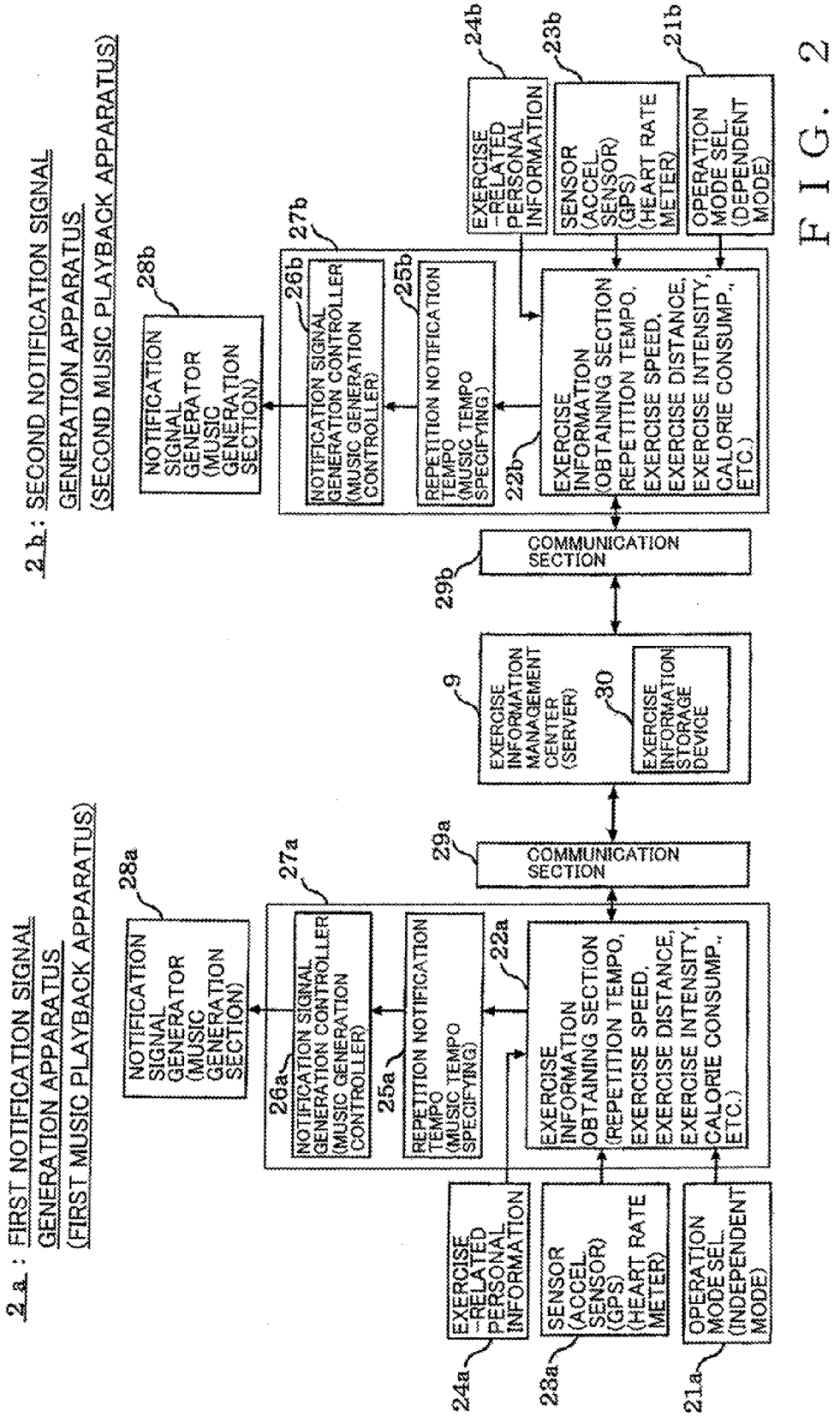

2a : FIRST NOTIFICATION SIGNAL GENERATION APPARATUS (FIRST MUSIC PLAYBACK APPARATUS)
2b : SECOND NOTIFICATION SIGNAL GENERATION APPARATUS (SECOND MUSIC PLAYBACK APPARATUS)
NOTIFICATION SIGNAL GENERATOR (MUSIC GENERATION SECTION)
28a
NOTIFICATION SIGNAL GENERATION CONTROLLER (MUSIC GENERATION CONTROLLER)
26a
27a
REPETITION NOTIFICATION TEMPO (MUSIC TEMPO SPECIFYING)
25a
EXERCISE INFORMATION OBTAINING SECTION (REPETITION TEMPO, EXERCISE SPEED, EXERCISE DISTANCE, EXERCISE INTENSITY, CALORIE CONSUMP., ETC.)
22a
COMMUNICATION SECTION
29a
EXERCISE INFORMATION MANAGEMENT CENTER (SERVER)
9
EXERCISE INFORMATION STORAGE DEVICE
30
COMMUNICATION SECTION
29b
EXERCISE INFORMATION OBTAINING SECTION (REPETITION TEMPO, EXERCISE SPEED, EXERCISE DISTANCE, EXERCISE INTENSITY, CALORIE CONSUMP., ETC.)
22b
REPETITION NOTIFICATION TEMPO (MUSIC TEMPO SPECIFYING)
25b
NOTIFICATION SIGNAL GENERATION CONTROLLER (MUSIC GENERATION CONTROLLER)
26b
27b
NOTIFICATION SIGNAL GENERATOR (MUSIC GENERATION SECTION)
28b
EXERCISE -RELATED PERSONAL INFORMATION
24a
SENSOR (ACCEL SENSOR) (GPS) (HEART RATE METER)
23a
OPERATION MODE SEL. (INDEPENDENT MODE)
21a
EXERCISE -RELATED PERSONAL INFORMATION
24b
SENSOR (ACCEL SENSOR) (GPS) (HEART RATE METER)
23b
OPERATION MODE SEL. (DEPENDENT MODE)
21b

FIG. 2

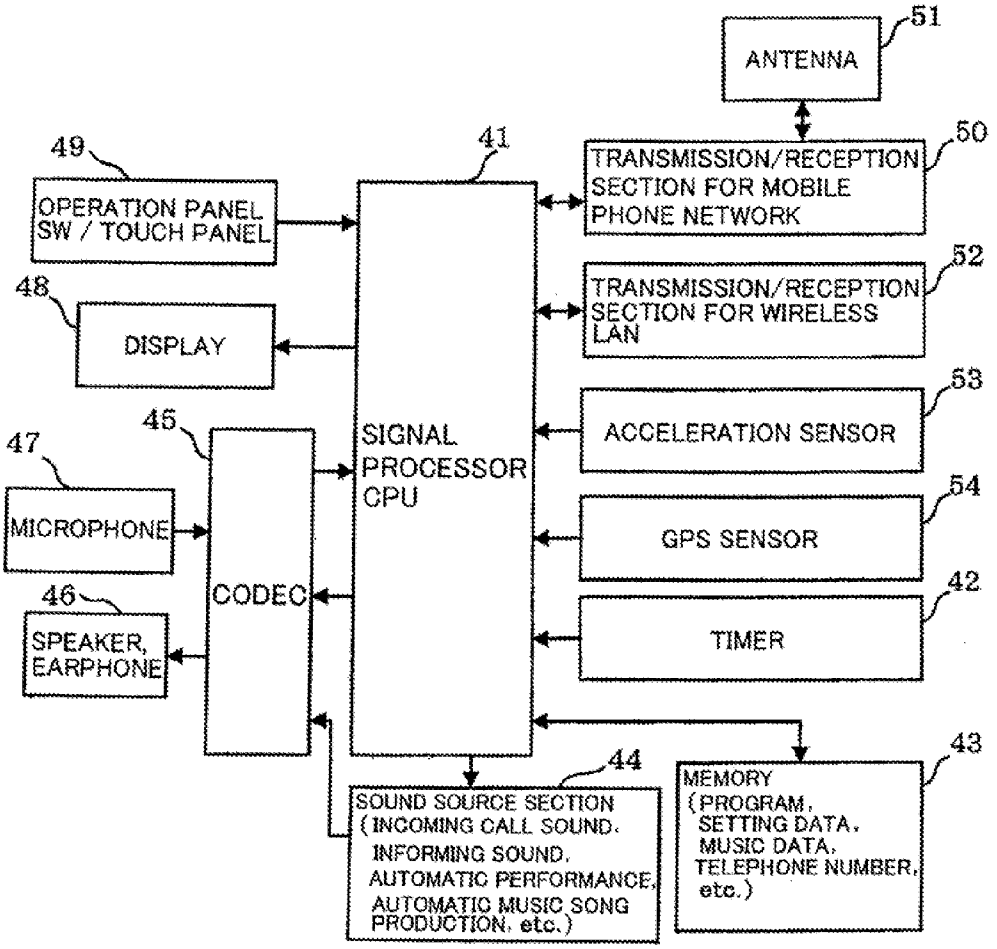

ANTENNA
51
49
41
50
OPERATION PANEL SW / TOUCH PANEL
TRANSMISSION/RECEPTION SECTION FOR MOBILE PHONE NETWORK
48
52
DISPLAY
TRANSMISSION/RECEPTION SECTION FOR WIRELESS LAN
53
45
47
SIGNAL PROCESSOR CPU
ACCELERATION SENSOR
MICROPHONE
54
GPS SENSOR
CODEC
46
42
SPEAKER, EARPHONE
TIMER
43
44
SOUND SOURCE SECTION (INCOMING CALL SOUND, INFORMING SOUND, AUTOMATIC PERFORMANCE, AUTOMATIC MUSIC SONG PRODUCTION, etc.)
MEMORY (PROGRAM, SETTING DATA, MUSIC DATA, TELEPHONE NUMBER, etc.)

FIG. 3

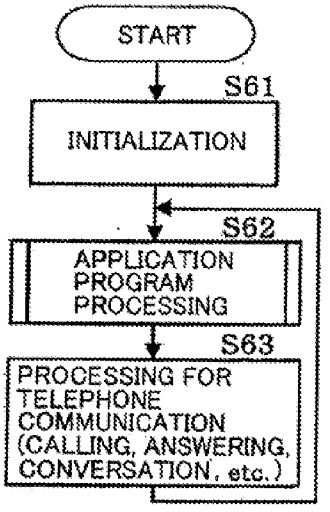

START
S61
INITIALIZATION
S62
APPLICATION PROGRAM PROCESSING
S63
PROCESSING FOR TELEPHONE COMMUNICATION (CALLING, ANSWERING, CONVERSATION, etc.)

FIG. 4

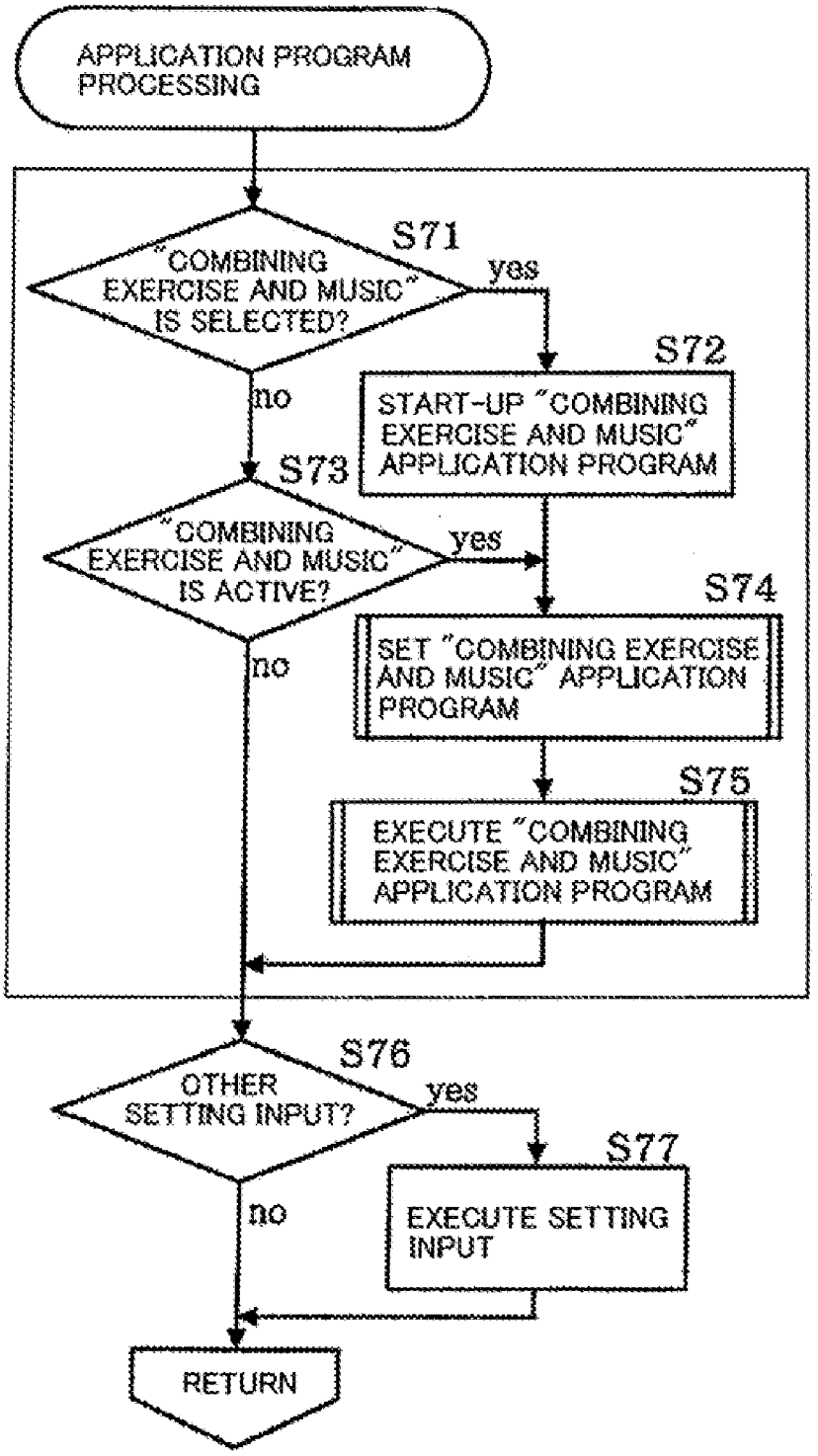

APPLICATION PROGRAM PROCESSING
S71
"COMBINING EXERCISE AND MUSIC" IS SELECTED?
yes
no
S72
START-UP "COMBINING EXERCISE AND MUSIC" APPLICATION PROGRAM
S73
"COMBINING EXERCISE AND MUSIC" IS ACTIVE?
yes
no
S74
SET "COMBINING EXERCISE AND MUSIC" APPLICATION PROGRAM
S75
EXECUTE "COMBINING EXERCISE AND MUSIC" APPLICATION PROGRAM
S76
OTHER SETTING INPUT?
yes
no
S77
EXECUTE SETTING INPUT
RETURN

FIG. 5A

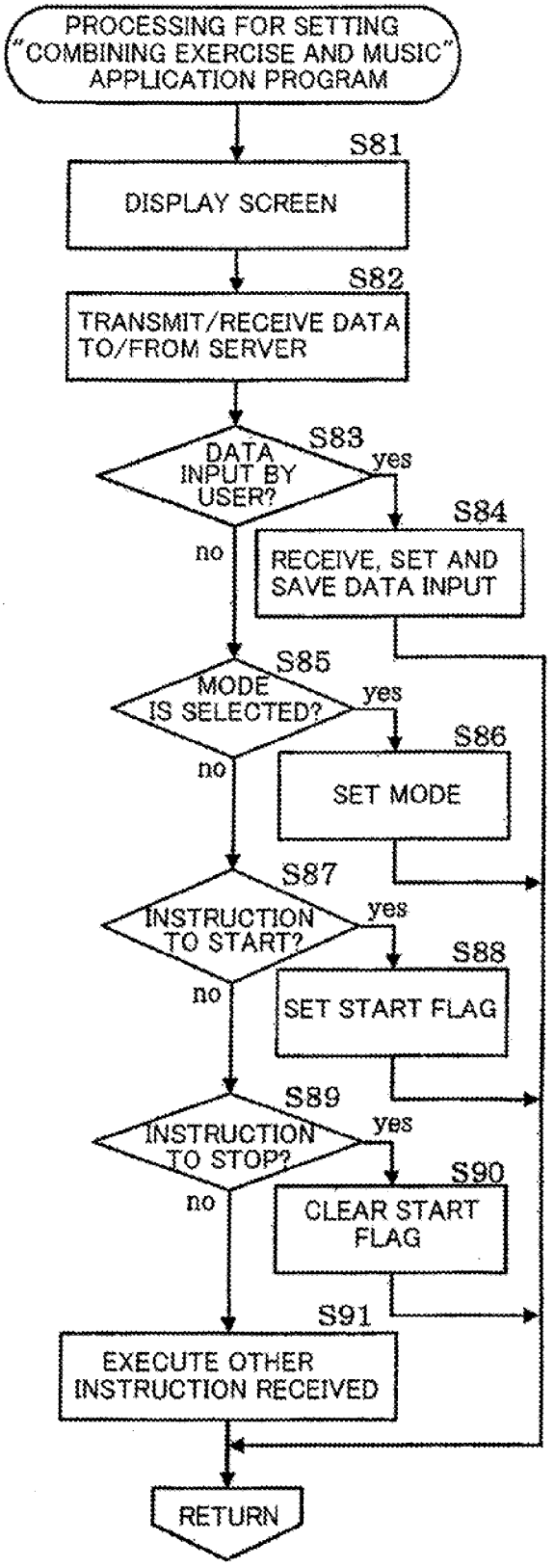

PROCESSING FOR SETTING "COMBINING EXERCISE AND MUSIC" APPLICATION PROGRAM
S81
DISPLAY SCREEN
S82
TRANSMIT/RECEIVE DATA TO/FROM SERVER
S83
DATA INPUT BY USER?
yes
no
S84
RECEIVE, SET AND SAVE DATA INPUT
S85
MODE IS SELECTED?
yes
no
S86
SET MODE
S87
INSTRUCTION TO START?
yes
no
S88
SET START FLAG
S89
INSTRUCTION TO STOP?
yes
no
S90
CLEAR START FLAG
S91
EXECUTE OTHER INSTRUCTION RECEIVED
RETURN

FIG. 5B

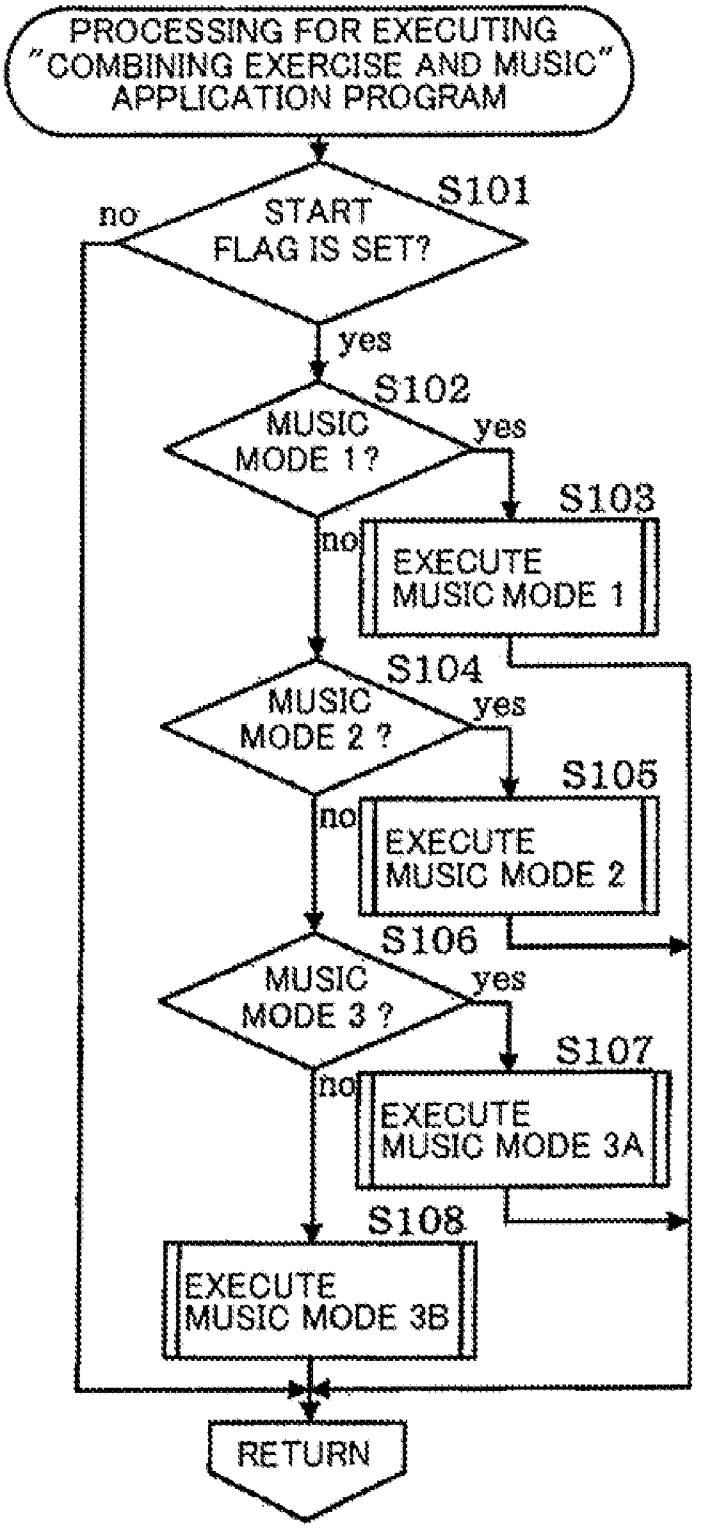

PROCESSING FOR EXECUTING "COMBINING EXERCISE AND MUSIC" APPLICATION PROGRAM
S101
START FLAG IS SET?
no
yes
S102
MUSIC MODE 1?
yes
S103
EXECUTE MUSIC MODE 1
no
S104
MUSIC MODE 2?
yes
S105
EXECUTE MUSIC MODE 2
no
S106
MUSIC MODE 3?
yes
S107
EXECUTE MUSIC MODE 3A
no
S108
EXECUTE MUSIC MODE 3B
RETURN

FIG. 6A

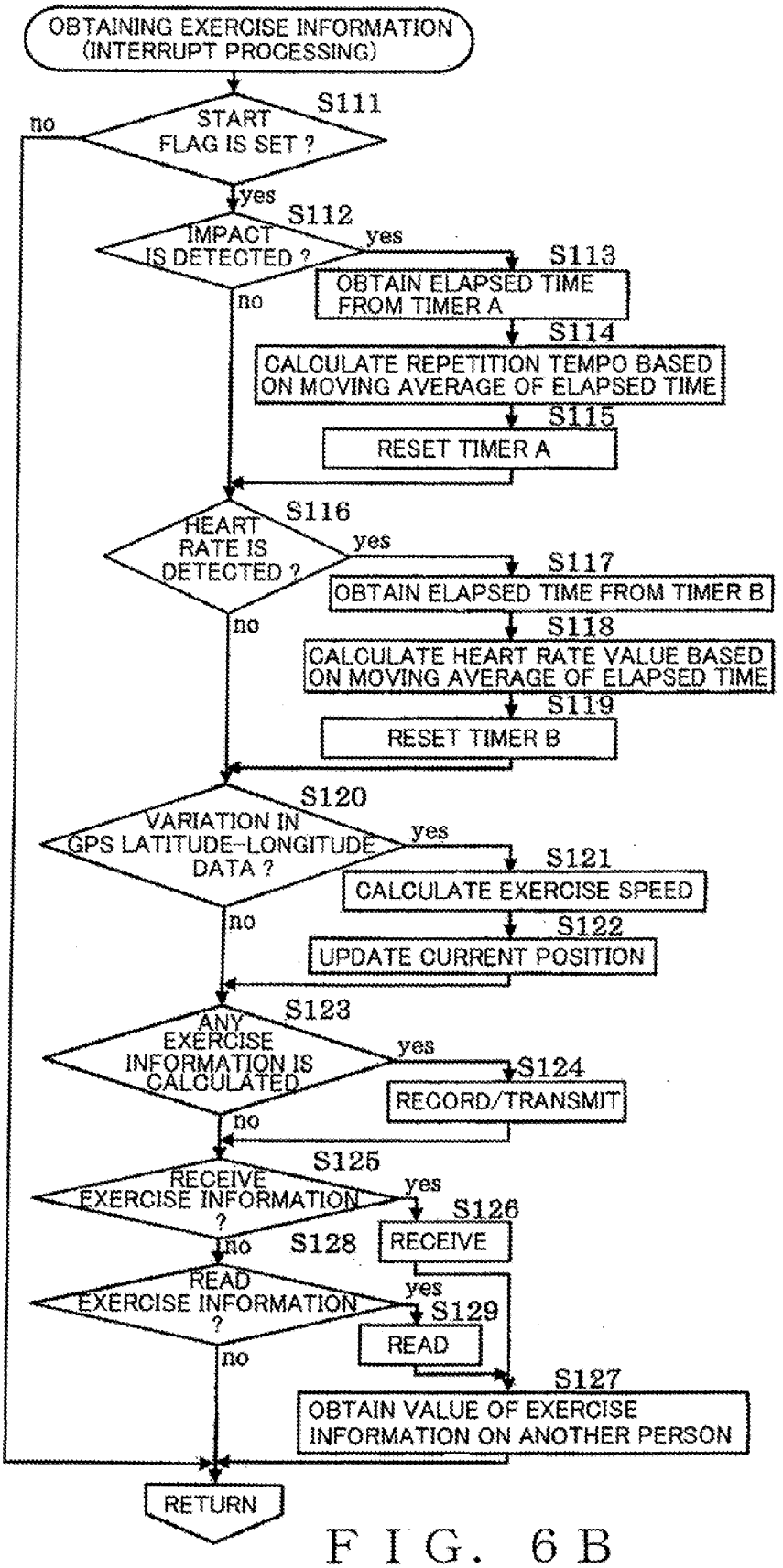

OBTAINING EXERCISE INFORMATION (INTERRUPT PROCESSING)
S111
START FLAG IS SET ?
no
yes
S112
IMPACT IS DETECTED ?
yes
S113
OBTAIN ELAPSED TIME FROM TIMER A
no
S114
CALCULATE REPETITION TEMPO BASED ON MOVING AVERAGE OF ELAPSED TIME
S115
RESET TIMER A
S116
HEART RATE IS DETECTED ?
yes
S117
OBTAIN ELAPSED TIME FROM TIMER B
no
S118
CALCULATE HEART RATE VALUE BASED ON MOVING AVERAGE OF ELAPSED TIME
S119
RESET TIMER B
S120
VARIATION IN GPS LATITUDE-LONGITUDE DATA ?
yes
S121
CALCULATE EXERCISE SPEED
no
S122
UPDATE CURRENT POSITION
S123
ANY EXERCISE INFORMATION IS CALCULATED
yes
S124
RECORD/TRANSMIT
no
S125
RECEIVE EXERCISE INFORMATION ?
yes
S126
RECEIVE
no
S128
READ EXERCISE INFORMATION ?
yes
S129
READ
no
S127
OBTAIN VALUE OF EXERCISE INFORMATION ON ANOTHER PERSON
RETURN

FIG. 6B

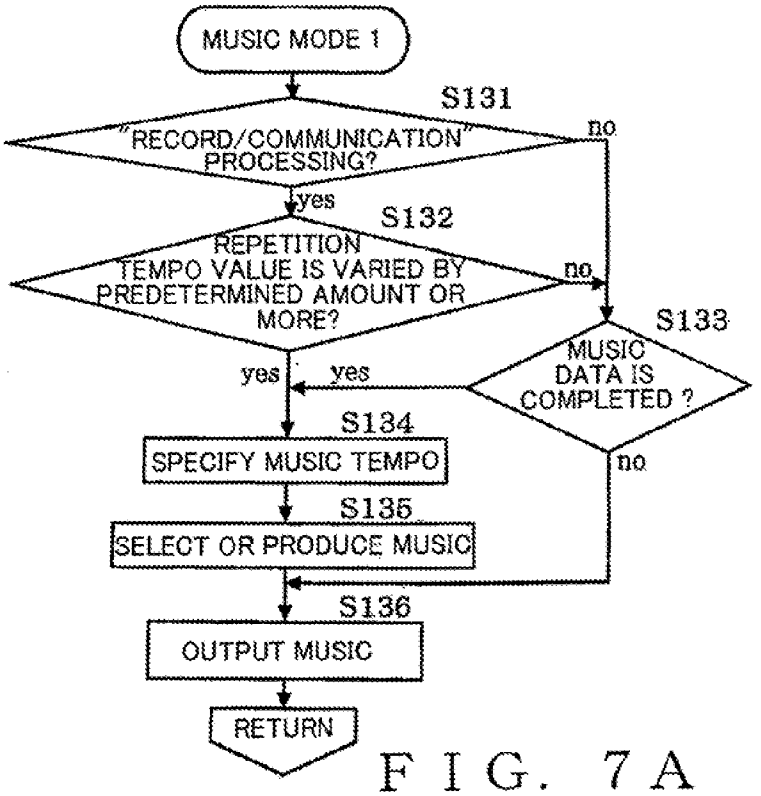

MUSIC MODE 1
S131
"RECORD/COMMUNICATION" PROCESSING?
no
yes
S132
REPETITION TEMPO VALUE IS VARIED BY PREDETERMINED AMOUNT OR MORE?
no
S133
MUSIC DATA IS COMPLETED ?
yes
yes
S134
SPECIFY MUSIC TEMPO
S135
SELECT OR PRODUCE MUSIC
no
S136
OUTPUT MUSIC
RETURN

FIG. 7A

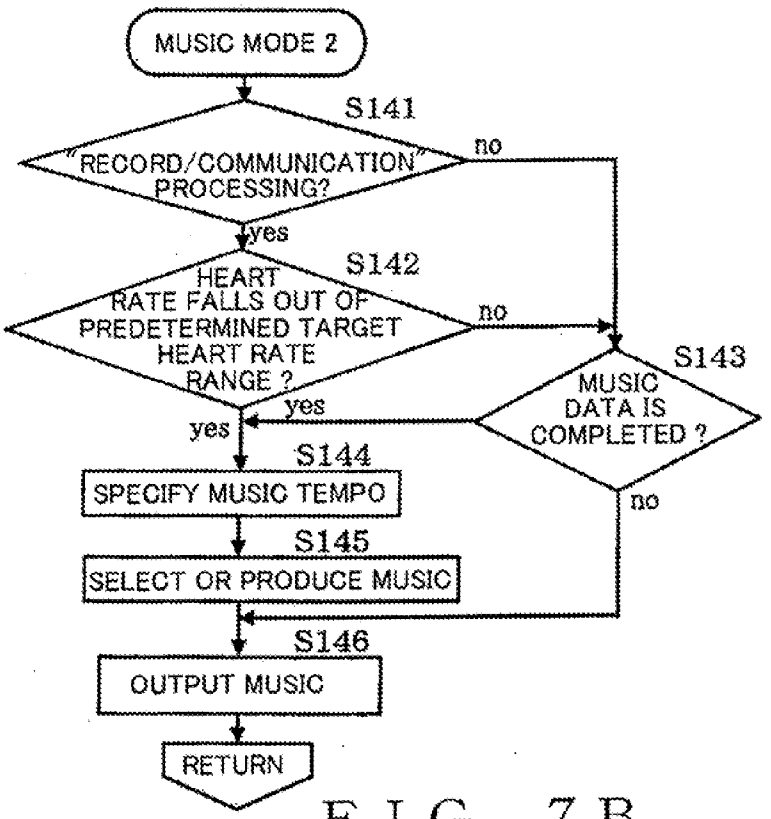

MUSIC MODE 2
S141
"RECORD/COMMUNICATION" PROCESSING?
no
yes
S142
HEART RATE FALLS OUT OF PREDETERMINED TARGET HEART RATE RANGE ?
no
S143
MUSIC DATA IS COMPLETED ?
yes
yes
S144
SPECIFY MUSIC TEMPO
S145
SELECT OR PRODUCE MUSIC
no
S146
OUTPUT MUSIC
RETURN

FIG. 7B

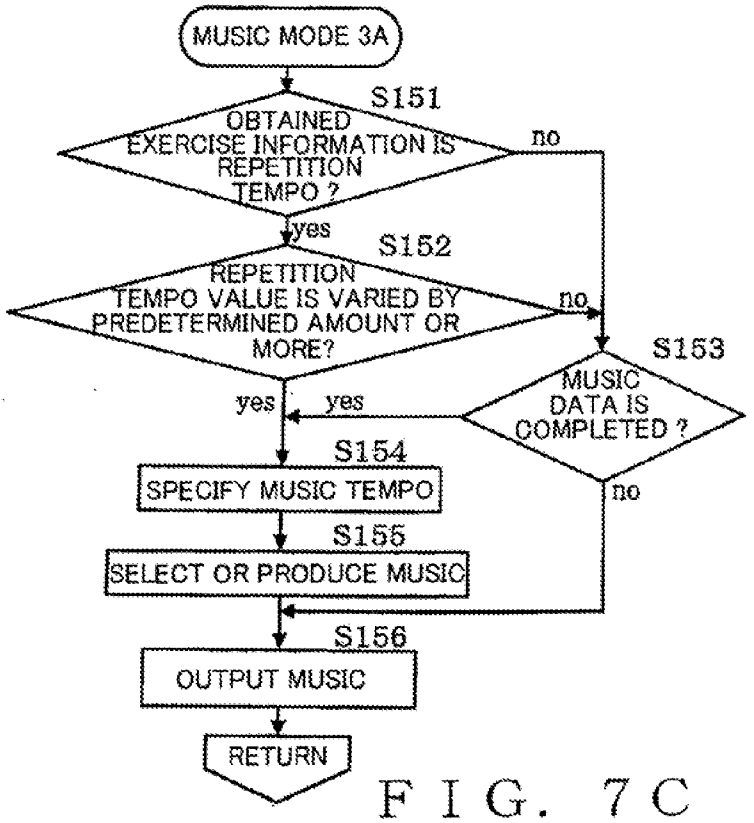

MUSIC MODE 3A
S151
OBTAINED EXERCISE INFORMATION IS REPETITION TEMPO ?
no
yes
S152
REPETITION TEMPO VALUE IS VARIED BY PREDETERMINED AMOUNT OR MORE?
no
S153
MUSIC DATA IS COMPLETED ?
yes
yes
no
S154
SPECIFY MUSIC TEMPO
S155
SELECT OR PRODUCE MUSIC
S156
OUTPUT MUSIC
RETURN

FIG. 7C

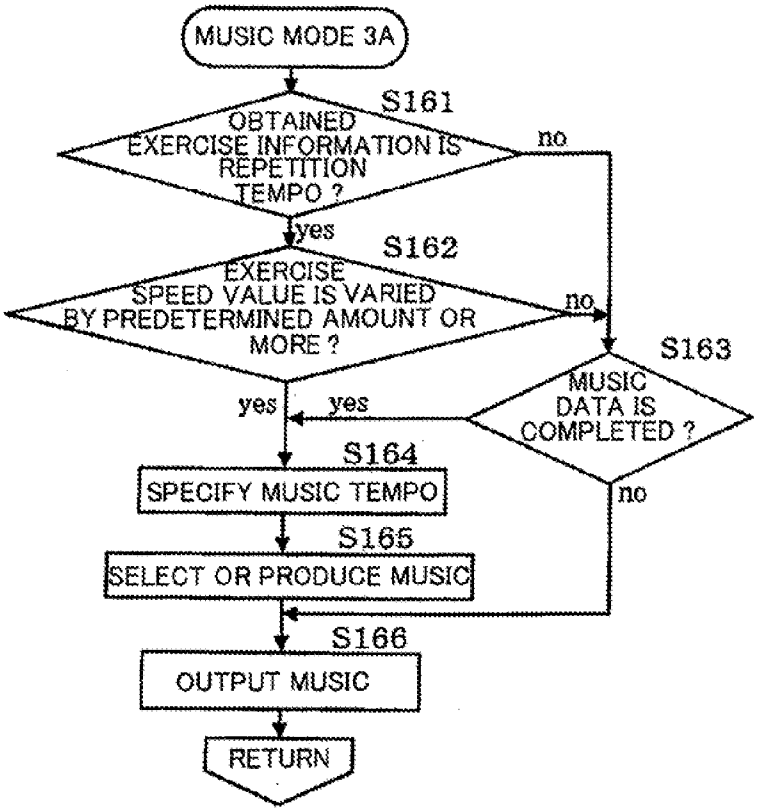

MUSIC MODE 3A
S161
OBTAINED EXERCISE INFORMATION IS REPETITION TEMPO ?
no
yes
S162
EXERCISE SPEED VALUE IS VARIED BY PREDETERMINED AMOUNT OR MORE ?
no
S163
MUSIC DATA IS COMPLETED ?
yes
yes
no
S164
SPECIFY MUSIC TEMPO
S165
SELECT OR PRODUCE MUSIC
S166
OUTPUT MUSIC
RETURN

FIG. 7D

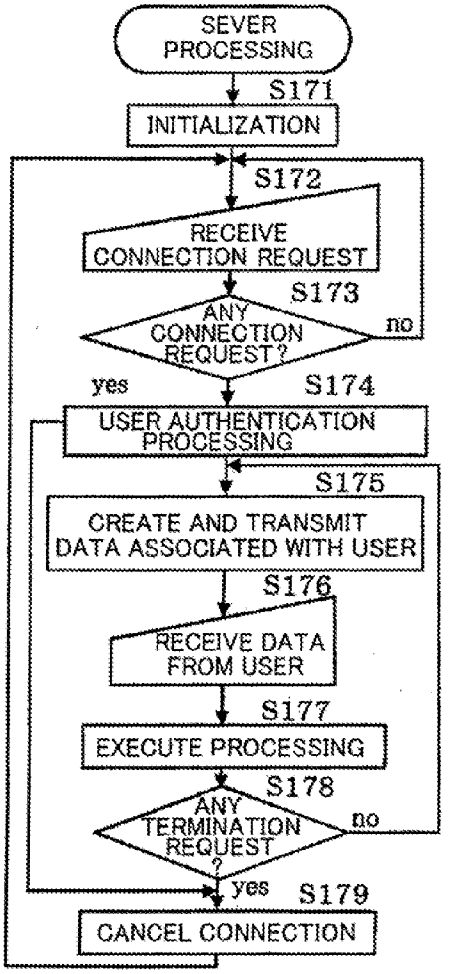


FIG. 8

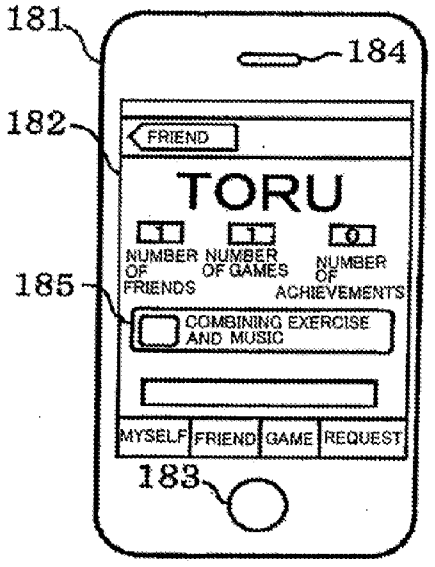


FIG. 9A

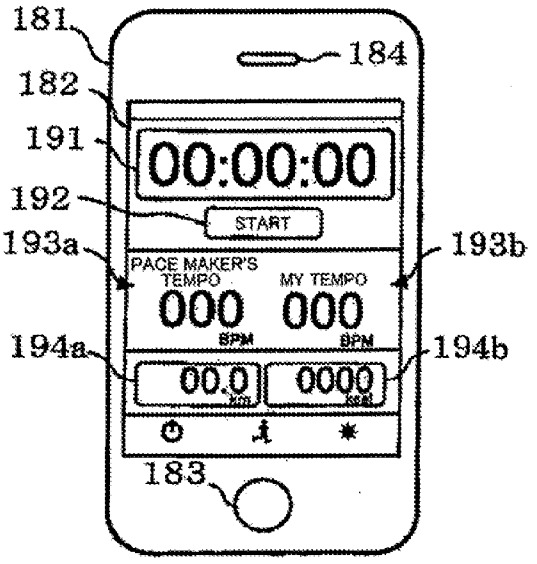


FIG. 9B

NOTIFICATION SIGNAL CONTROL APPARATUS AND METHOD

BACKGROUND

[0001] The present invention relates to a notification signal control apparatus suitable for sharing exercise information, such as repetition tempo, between plural exercising persons while the exercising persons perform repetitive exercise.

[0002] Conventionally, while an exercising person performs repetitive exercise, such as walking, jogging, and dancing, the exercising person plays and listens to the music suitable for the exercise with a portable music player.

[0003] For example, there is a known technique that an exercise tempo (repetition tempo) of an exercising person is detected to reproduce music data with a music tempo corresponding to the detected exercise tempo (see US 2007/0169614A1 which corresponds to JP 2007-193907A). As for running or the like, a value of the repetition tempo indicates how many steps, including both right-foot steps and left-foot steps, the exercising person has taken per unit time (e.g. one minute).

[0004] There is another known technique that a heart rate of an exercising person is detected to specify a music tempo value such that a difference between the detected heart rate and a target heart rate is reduced, and to reproduce music data with a music tempo value corresponding to the specified music tempo value, thereby to control the heart rate (see US 200710169614A1 which corresponds to JP 2007-193908A).

[0005] An apparatus provided with the aforementioned techniques called "free workout mode" and "fitness mode" as well as with a "training mode" has been commercially available. In the "training mode," target values (pace [minute: second/km], exercise tempo [bpm], heart rate [bpm], and exercise intensity [%]) are preset for each of plural intervals (time or distance) to create an exercise program and perform repetitive exercise according to the program (see "BF-11 Manual," [online], Yamaha Corporation, the Internet<URL: http://www2.yamaha.co.jp/manual/pdf/emi/japan/others/bf11_ja_om_v10b.pdf).

[0006] There is a still another known technique that each time an exercising person walks a certain distance, the elapsed time, exercise intensity, heart rate, and walking tempo are transmitted from the portable terminal to the distribution site on the Internet. Song data having a music tempo that approximately matches the walking tempo to provide the optimum load to the exercising person is searched on the distribution site, and is then distributed to the portable terminal to reproduce the song data (see JP 2003-108154A).

[0007] However, the aforementioned techniques are all designed to play music that fits the exercise information on the exercising person him or herself, such as repetition tempo and exercise intensity. Thus, even when the exercising person exercises with another exercising person, the exercising person cannot feel togetherness with the other exercising person during the exercise.

[0008] In contrast, there is a known technique that plural exercising persons can share values of their exercise information on the network (see paragraphs 0110, 0117, and 0120 in US 2008/0200312A1 which corresponds to paragraphs 0082, 0089, and 0092 in JP 2010-517725A).

[0009] In this technique, exercise information on plural exercising persons is collected through a music player (portable terminal) for each of the exercising persons based on an output from an acceleration sensor located on his or her shoe. The collected exercise information is transferred to an exercise information display configuration device (center) on the network and is then stored in a storage device.

[0010] The exercise information on each exercising person is displayed with the bar graph on the display screen to show his or her progress toward the challenging goal. Also, in the exercise history of the other exercising persons, the exercise information on the other exercising persons and the exercise information on the exercising person him or herself are displayed by ranking.

[0011] However, the exercising person cannot know the exercise information on the other exercising persons in real time during the exercise. This prevents the exercising person from feeling togetherness or feeling as if he or she is running with someone during the exercise.

SUMMARY OF THE INVENTION

[0012] The present invention has been achieved to solve the above problems and an object of the present invention is to provide a notification signal control apparatus that outputs a notification signal to allow a first exercising person and a second exercising person to share a value of certain exercise information and perform repetitive exercise.

[0013] In view of the foregoing, it is an object of the present invention to provide a notification signal control apparatus (**27***b*) for providing a notification synchronized with repetitive exercise performed by a first exercising person (**1***a*) to a second exercising person (**1***b*), which comprises: an exercise information obtaining section (**22***b*) that obtains exercise information related to exercise performed by the first exercising person (**1***a*) in order for the second exercising person (**1***b*) to utilize the exercise information; a repetition-notification-tempo specifying section (**25***b*) that specifies, based on the obtained exercise information, a repetition notification tempo synchronized with repetitive exercise performed by the first exercising person in order for the second exercising person to perform repetitive exercise; and a notification signal generation controller (**26***b*) that controls a notification signal generator (**28***b*) to generate a notification signal with a tempo corresponding to the repetition notification tempo specified by the repetition-notification-tempo specifying section.

[0014] According to the invention, the second exercising person senses the repetition notification tempo of the notification signal, and performs repetitive exercise in synchronization with the repetition notification tempo. This allows the second exercising person to share a value of certain exercise information with the first exercising person and perform the repetitive exercise.

[0015] Specific examples of the exercise information are a repetition tempo (i.e. a tempo of repetitive exercise), an exercise speed (exercise pace), an exercise distance, exercise intensity, and a calorie consumption. The exercise information may include at least either one of these examples. It should be understood that the notification signal generation controller may not necessarily output a notification signal with a tempo value equal to the specified repetition notification tempo value. More specifically, to output a notification signal with a tempo corresponding to the specified repetition notification tempo indicates to output a notification signal with a tempo that may be approximately equal to or similar to or in harmony with the specified repetition notification tempo. This is because when the notification signal is music, it is not always possible to output music with a tempo value equal to the specified tempo value. Alternatively, the notifi-

cation signal with a tempo value approximately equal to an integral submultiple or an integral multiple of (i.e. in harmony with) the specified repetition notification tempo value may be output. As described above, when there is a multiple relation between the tempo value and the repetition notification tempo value, the second exercising person can also perform the repetitive exercise in synchronization with the repetition notification tempo easily. Particularly, a half of the specified repetition notification tempo value is referred to as "half tempo."

[0016] There is a case when the notification signal is music, and there is not any music available with a music tempo value that coincides with, or is approximately equal to, the specified value among a limited number of pieces of music stored in the storage device. In this case, music with a music tempo value that is an integral submultiple or an integral multiple of the specified tempo value, particularly music with the "half tempo" may be selected exceptionally. Whether or not a notification signal (music) with an exceptional music tempo, such as "half tempo," is permitted to be output may be preset through the exercising person's operation.

[0017] According to an embodiment of the invention, the exercise information indicates a repetition tempo of the repetitive exercise performed by the first exercising person. Also, the repetition-notification-tempo specifying section (**25***b*) specifies a repetition notification tempo corresponding to the repetition tempo of the first exercising person (**1***a*), the repetition tempo being indicated by the exercise information.

[0018] The second exercising person senses a repetition notification tempo of a notification signal, and then performs repetitive exercise in synchronization with the repetition notification tempo. This allows the second exercising person to perform the repetitive exercise with the repetition tempo of the first exercising person. The repetition-notification-tempo specifying section can be easily achieved.

[0019] According to an embodiment of the invention, the repetition-notification-tempo specifying section (**25***b*) calculates a repetition tempo for the second exercising person (**1***b*) based on the obtained exercise information, and specifies a repetition notification tempo corresponding to the calculated repetition tempo. The repetition-notification-tempo specifying section can thus be easily achieved.

[0020] Particularly, in the case when the exercise information is an exercise speed for running (including walking and jogging), the repetition-notification-tempo specifying section can convert the exercise speed value into a repetition tempo value of the second exercising person by dividing the exercise speed value of the first exercising person by a stride of the second exercising person. The second exercising person senses a repetition notification tempo of a notification signal, and then performs repetitive exercise in synchronization with the repetition notification tempo. This allows the second exercising person to perform the repetitive exercise at the exercise speed of the first exercising person. Generally, exercising persons have different stride lengths. Therefore, when the first exercising person and the second exercising person share an exercise speed value, they perform repetitive exercise with different repetition tempos.

[0021] According to an embodiment of the invention, the exercise information obtaining section (**22***b*) further obtains second exercise information related to repetitive exercise performed by the second exercising person in real time during the exercise performed by the second exercising person. Also, the repetition-notification-tempo specifying section (**25***b*) compares a value indicated by first exercise information and a value indicated by the second exercise information, and increases or decreases a current value of the repetition notification tempo to reduce a difference between the compared values. Thus, even when a value of certain exercise information on the second exercising person is significantly different from a value of the certain exercise information on the first exercising person, these values can coincide with each other as the time elapses.

[0022] According to an embodiment of the invention, the notification signal is music, while the repetition notification tempo is a music tempo. Also, the notification signal generation controller (**26***b*) controls the notification signal generator (**28***b*) to produce music with a music tempo corresponding to the music tempo specified by the repetition-notification-tempo specifying section (**25***b*). The notification signal is music, which means that the exercising person can sense the repetition notification tempo while listening to the lively music. This helps the exercising person continue repetitive exercise without getting bored of the exercise.

[0023] There is a case when plural pieces of music together with their respective music tempo values are stored in a storage device. In this case, the notification signal generation controller may select music with a music tempo corresponding to the repetition notification tempo from the plural pieces of music stored in the storage device, and may cause the notification signal generation section to output the selected music. The aforementioned music is generally existing music song data. However, the music may not necessarily be complete music song data, but may be an extracted part of the existing music song data. Preferably the music data may be stored in a wave format (such as WAV file and MP3 file) in the storage device. However, the music data may also be stored in a performance data format (mid file), such as MIDI sequence data, that records the song performance data containing information on the pitch and duration of the note. The aforementioned music may not be necessarily stored in advance in the storage device, but may be automatically produced by an automatic music production apparatus or a program section.

[0024] The aforementioned inventions may also be applied to the case when there are three or more exercising persons. Each of the exercising persons may designate the first exercising person (**1***a*), while the other exercising persons may act as the second exercising persons (**1***b*). Thus, in the notification signal control apparatus of the inventions, the exercise information obtaining section (**22***b*) for the second exercising person obtains exercise information on the second exercising person (**1***b*) in real time during the repetitive exercise performed by the second exercising person (**1***b*), and supplies the exercise information to other exercise information obtaining sections (**22***a* and so forth) for other exercising persons (**1***a* and so forth). Such notification signal control apparatus achieves not only the function of the notification signal control apparatus for the second exercising person, but also the function of the notification signal control apparatus for the first exercising person when the second exercising person is designated as a first exercising person by the other exercising person. It should be understood that even when there are only two exercising persons, they can designate their partner each other as a first exercising person so that they can set a value of their partner's exercise information as a target to perform repetitive exercise.

[0025] The first exercising person (**1***a*) and the second exercising person (**1***b*) are real human beings. However, the first

exercising person (**1***a*) may be a virtual exercising person who behaves like a real human being. In this case, the first exercising person (**1***a*) may not be allowed to perform repetitive exercise accurately in accordance with the preset sequence data of the exercise information (time-versus-exercise information data). For example, repetitive exercise with natural "fluctuations" may be simulated for the virtual first exercising person (**1***a*), so that his or her exercise information may be generated based on the simulated exercise.

[0026] It should be understood that reference numerals in parentheses, which are assigned to the aforementioned respective components, are used in the drawings to represent the corresponding elements to those respective components, which are described in an embodiment of the invention. The embodiment of the invention will be described later. The reference numerals in parentheses are provided for illustration purpose only, and not for the purpose of limiting the claimed inventions.

[0027] According to the invention, the second exercising person senses a repetition notification tempo of a notification signal, and performs repetitive exercise in synchronization with the repetition notification tempo. The invention thus provides the effect that the second exercising person can share a common value of certain exercise information with the first exercising person. To share certain exercise information is not merely to understand a value of the exercise information in the brain, but to share the information by sensing a repetition notification tempo of a notification signal, and further to experience a sense of sharing through performing repetitive exercise by the exercising person him or herself.

[0028] For example, even when plural exercising persons are distanced from each other while exercising, the exercising persons can experience motions of the repetitive exercise performed by one or both of the exercising persons through the medium of the notification signal. This allows the exercising person who is exercising even alone to have a feel of bonding together with the other exercising person. This motivates the exercising person to continue exercising. When the exercise information is an exercise speed, for example, the exercising person can feel as if he or she is running together with the other exercising person at the same speed.

[0029] When the first exercising person is a coach, while the second exercising person is an athlete, for example, the athlete can perform repetitive exercise in synchronization with the exercise information on the coach who is actually exercising, such as an ideal pace value. This allows the athlete to receive effective guidance from the coach, not through the words from the mouth, but through the athlete's own experience. In addition, the coach can adjust his or her own exercise conditions (e.g. speed up or slow down the repetition tempo), while directly visually checking the exercise conditions of the athlete or monitoring the image of the athlete, which is captured by the TV camera, or checking a value of the exercise information on the athlete. This helps the coach provide more effective guidance to the athlete.

[0030] The present invention may be constructed and implemented not only as the apparatus invention as discussed above but also as a method invention. Also, the present invention may be arranged and implemented as a software program for execution by a processor such as a computer or DSP, as well as a non-transitory storage medium storing such a software program. In this case, the program may be provided to a user in the storage medium and then installed into a computer of the user, or delivered from a server apparatus to a computer of a client via a communication network and then installed into the client's computer. Further, the processor used in the present invention may comprise a dedicated processor with dedicated logic built in hardware, not to mention a computer or other general-purpose type processor capable of running a desired software program.

BRIEF DESCRIPTION OF THE DRAWINGS

[0031] Certain preferred embodiments of the present invention will hereinafter be described in detail, by way of example only, with reference to the accompanying drawings, in which:

[0032] FIG. **1** is an overall configuration diagram of a notification signal generation system to illustrate one embodiment of the present invention;

[0033] FIG. **2** is a functional block diagram that illustrates the embodiment of the invention;

[0034] FIG. **3** is a hardware configuration diagram to achieve the embodiment of the invention;

[0035] FIG. **4** is a flowchart that illustrates part of the operation of a signal processor shown in FIG. **3**, which relates to the invention;

[0036] FIG. **5**A is a flowchart of a routine to execute the application program at the step S**62** in FIG. **4**;

[0037] FIG. **5**B is a flowchart to perform processing for setting the "combining exercise and music" program at the step S**74** in FIG. **5**A;

[0038] FIG. **6**A is a flowchart to perform processing for executing the "combining exercise and music" program at the step S**75** in FIG. **5**A;

[0039] FIG. **6**B is a flowchart of a routine to perform interrupt processing in parallel with the processing according to the main flowchart in FIG. **4**;

[0040] FIGS. **7**A to **7**D are flowcharts that illustrate processing in respective music modes in FIG. **6**A;

[0041] FIG. **8** is a flowchart of a processing in a server connected to a communication network; and

[0042] FIGS. **9**A and **9**B illustrate specific examples to which the embodiment of the invention is applied.

DETAILED DESCRIPTION

[0043] FIG. **1** is an overall configuration diagram of a notification signal generation system to illustrate one embodiment of the present invention. In FIG. **1**, reference numerals **1***a* and **1***b* respectively denote a first exercising person and a second exercising person. They are real individuals who perform repetitive exercise. The first exercising person **1***a* and the second exercising person **1***b* may reside in different areas away from each other.

[0044] A first notification signal generation apparatus **2***a* (first terminal) is attached to a part of the body (e.g., upper arm) of the first exercising person **1***a*. The first notification signal generation apparatus **2***a* includes a display **3***a*, an operation button **4***a*, and a sensor **5***a* that detects an exercise condition (or motion) of the first exercising person **1***a*. The sensor **5***a* is either built in, or connected externally to, the first notification signal generation apparatus **2***a*. A second notification signal generation apparatus **2***b* (second terminal) also includes the same elements as the first notification signal generation apparatus **2***a*.

[0045] The notification signal generation system allows the second exercising person **1***b* to perform repetitive exercise in synchronization with a repetition notification tempo of a notification signal, so that the second exercising person **1***b* can

share a value of certain exercise information with the first exercising person **1***a*, obtained during his or her repetitive exercise and perform the repetitive exercise. The repetitive exercise is typically athletics, such as running, jogging, and walking. However, the repetitive exercise may also be gymnastics such as push-ups or dance such as aerobics or swimming, or may also be exercises using training machines such as bicycle ergo meter, treadmill, and strength machine. The exercising person may also be referred to as athlete or player. Any kind of exercises that involve repetitive motions is defined as the repetitive exercise. The certain exercise information includes, for example, a repetition tempo, an exercise speed (exercise pace), an exercise distance, exercise intensity, and a calorie consumption. The "repetition tempo" indicates a tempo of the repetitive exercise. The second exercising person **1***b* can select any of the exercise information through operating the second notification signal generation apparatus **2***b*.

[0046] The notification signal is, for example, an audible sound, such as beep with variable repetition period (single-tone electronic beep generated intermittently), metronome sound with a timbre (rhythmic musical instrument sound), and music with scales. In the case when the notification signal is music, the first and the second notification signal generation apparatuses **2***a* and **2***b* may be each referred to as music playback apparatus, and more specifically, portable music player. The notification signal may also be a visual notification signal that has variable brightness, tint or the like depending on the repetition notification tempo. The visual notification signal may be output from a light-emitting indicator or be indicated on the display. The repetition notification tempo can be the reciprocal of the repetition period of the beep, a music tempo or a flashing tempo, depending on the cases.

[0047] In the illustrated example, the first and second notification signal generation apparatuses **2***a* and **2***b* output notification signals respectively to sensory organs (ear) of the first and second exercising persons **1***a* and **1***b* through their earphones **6***a* and **6***b*. The first and second notification signal generation apparatuses **2***a* and **2***b* can be connected to a communication network **8** respectively through arbitrary wireless transmission paths **7***a* and **7***b*. The communication network **8** is the Internet, for example. The wireless transmission paths **7***a* and **7***b* each are a mobile phone network provided by a mobile phone company, a Wireless Fidelity (Wi-Fi) standard wireless Local Area Network (LAN) or a Worldwide Interoperability for Microwave Access (WiMAX) standard wireless access channel, for example.

[0048] Exercise information on the first exercising person **1***a* is transmitted to the second exercising person **1***b* via the communication network **8** in real time. The second exercising person **1***b* senses the exercise information through the repetition notification tempo or variations in the repetition notification tempo. In the illustrated example, an exercise information management center (e.g., server) **9** is connected to the communication network **8**. The first notification signal generation apparatus **2***a* supplies the exercise information on the first exercising person **1***a* to the second notification signal generation apparatus **2***b* via the exercise information management center **9** that serves as a relay device. Alternatively, the first notification signal generation apparatus **2***a* may be a peer-to-peer notification signal generation system that supplies the exercise information on the first exercising person **1***a* to the second notification signal generation apparatus **2***b* without passing via the exercise information management center **9**.

[0049] The exercise information management center **9** not only has the aforementioned function of relaying the exercise information, but also has functions of storing exercise information and/or statistical information on the exercise results, which are transferred from the first and second notification signal generation apparatuses **2***a* and **2***b*, in a storage device separately for the first and second exercising persons **1***a* and **1***b*, comparing the exercise results between the first and second exercising persons **1***a* and **1***b*, and storing the comparison results.

[0050] A display screen is created based on the exercise information, the statistical information, and the comparison results, and is displayed on the respective displays **3***a* and **3***b* of the first and second notification signal generation apparatuses **2***a* and **2***b* through the communication network **8**. This allows the first and second exercising persons **1***a* and **1***b* to share a numerical value of the exercise information. In the illustrated example, a personal computer **10** is connected to the communication network **8** either directly or via a router **11**. The personal computer **10** can also access the exercise information management center **9** to view the aforementioned display screen.

[0051] FIG. **2** is a functional block diagram that illustrates the embodiment of the invention. In FIG. **2**, the same or like elements are denoted by the same reference numerals. Functions of the individual sections in the first notification signal generation apparatus **2***a* and the second notification signal generation apparatus **2***b*, when these apparatuses **2***a* and **2***b* serve respectively as the first music playback apparatus and the second music playback apparatus, will be described in brackets.

[0052] The first notification signal generation apparatus **2***a* and the second notification signal generation apparatus **2***b* have the same configuration. However, it is assumed in the following description that the first notification signal generation apparatus **2***a* is set in an "independent mode" in which a notification signal (music) is output only based on the exercise information on the first exercising person **1***a*, while the second notification signal generation apparatus **2***b* is set in a "dependent mode" in which a notification signal (music) is output based on a value of certain exercise information obtained from another exercising person or in the illustrated example, from the first notification signal generation apparatus **2***a*.

[0053] The second exercising person **1***b* senses a repetition notification tempo (music tempo) of a notification signal (music), and performs repetitive exercise in synchronization with the repetition notification tempo. This allows the second exercising person **1***b* to share a value of certain exercise information with the first exercising person **1***a* and perform the repetitive exercise.

[0054] As discussed in the description of BACKGROUND of the present disclosure, specific examples of the "independent mode" are "free workout mode" (music mode **1** that will be described later with reference to FIG. **7**A), "fitness mode" (music mode **2** that will be described later with reference to FIG. **7**B), and "training mode." On the other hand, examples of the "dependent mode" are music modes **3**A and **3**B that will be described later with reference to FIGS. **7**C and **7**D.

[0055] In the first notification signal generation apparatus **2***a*, an operation mode selection section **21***a* sets the "inde-

pendent mode" for a first exercise information obtaining section **22***a*. A sensor (detector) **23***a* sequentially outputs a value that is detected in real time during the repetitive exercise performed by the first exercising person **1***a* to the first exercise information obtaining section **22***a*. In the "independent mode," the first exercise information obtaining section **22***a* functions as an own exercise information generation section that generates one or more kinds of exercise information based on a value that is output from the sensor **23***a*. The sensor (detector) **23***a* may be adapted to detect at least one of motion performed by the exercising person and a physical reaction of the exercising person.

[0056] In the case when the sensor **23***a* is provided with an acceleration sensor, the first exercise information obtaining section **22***a* obtains a repetition tempo value (e.g., the number of times of repetition per minute) based on a detected value of an interval between impacts, which is output from the acceleration sensor. If the repetitive exercise is running, jogging or walking, the "repetition tempo" may be referred to as "walking tempo."

[0057] In the case when the sensor **23***a* is provided with a global positioning system (GPS), the first exercise information obtaining section **22***a* obtains an exercise speed (e.g. exercise distance per minute) or an exercise pace (e.g. exercise time (minute) per km) based on a difference between values of position data from the GPS. This exercise speed is integrated with respect to time to obtain an exercise distance. Alternatively, the exercise speed may be obtained by multiplying a stride by a repetition tempo value.

[0058] In the case when the sensor **23***a* is provided with a heart rate sensor (heart rate meter or pulse rate meter), the first exercise information obtaining section **22***a* obtains a value of the heart rate from a beat timing signal. Additionally, the first exercise information obtaining section **22***a* can obtain exercise intensity of the first exercising person **1***a* based on the value of the heart rate.

[0059] The exercise intensity is calculated by the following formula:

> The exercise intensity n [%]=(heart rate−resting heart rate)/(maximum heart rate−resting heart rate)×100;

where the maximum heart rate can be estimated with the formula: [220−age in years]. The age in years and the resting heart rate are stored in advance in an exercise-related-personal-information storage section **24***a*. Other than the aforementioned exercise information, a calorie consumption can also be calculated based on the type of exercise (walking, jogging, etc.), exercise speed, weight, and exercise time (see the "BF-11 Manual").

[0060] The first exercise information obtaining section **22***a* obtains a value of the exercise information and supplies it to a repetition-notification-tempo specifying section (music-tempo specifying section) **25***a* in real time. When the first notification signal generation apparatus **2***a* operates in the "free workout mode" discussed in the description of BACKGROUND, the repetition-notification-tempo specifying section (music-tempo specifying section) **25***a* specifies a repetition notification tempo (music tempo) value that corresponds to a repetition tempo value of the first exercising person **1***a* to a notification signal generation controller (music production controller) **26***a*.

[0061] When the first notification signal generation apparatus **2***a* operates in the "fitness mode" discussed in the description of BACKGROUND, the repetition-notification-tempo specifying section **25***a* specifies a repetition notification tempo (music tempo) value to the notification signal generation controller (e.g., a music generation controller) **26***a* such that a heart rate value of the first exercising person **1***a* approximates a target heart rate value stored in the exercise-related-personal-information storage section **24***a*, in other words, such that the difference in value between the target heart rate and the heart rate of the first exercising person **1***a* is reduced. The notification signal generation controller **26***a* causes a notification signal generator (e.g., a music generation section) **28***a* to output a notification signal (music signal) with a repetition notification tempo (music tempo) value corresponding to the specified repetition notification tempo (music tempo) value to an electric acoustic converter, such as the earphone **6***a* shown in FIG. **1**.

[0062] An apparatus that has the functions of the first exercise information obtaining section **22***a*, the repetition-notification-tempo specifying section **25***a*, and the notification signal generation controller **26***a* is equivalent to a notification signal control apparatus **27***a*. Operation of the first notification signal generation apparatus **2***a*, when serving as the first music playback apparatus, will be described later with reference to FIGS. **7**A and **7**B. It should be understood that when the second notification signal generation apparatus **2***b* operates in the dependent mode, the first exercising person **1***a* does not necessarily sense a notification signal. Thus, the functions of the repetition-notification-tempo specifying section **25***a*, the notification signal generation controller **26***a*, and the notification signal generator **28***a* may be disabled.

[0063] A value of the exercise information is obtained in the first exercise information obtaining section **22***a* and is then transferred in real time from a communication section **29***a* to the exercise information management center **9**. The value of the exercise information is once stored in an exercise information storage device **30** at an area assigned to the first exercising person **1***a*.

[0064] It is assumed that in the second notification signal generation apparatus (music playback apparatus) **2***b*, an operation mode selection section **21***b* sets the "dependent mode" for a second exercise information obtaining section **22***b*. In the "dependent mode," the second exercise information obtaining section **22***b* can also function as means for obtaining exercise information on another exercising person through a communication section **29***b*. More specifically, the second exercise information obtaining section **22***a* obtains a value of certain exercise information on the first exercising person **1***a*, which is acquired during the repetitive exercise performed by the first exercising person **1***a* and stored in the exercise information storage device **30** in the exercise information management center **9**, through the communication section **29***b* in real time during the repetitive exercise performed by the first exercising person **1***a*. It should be understood that the second exercise information obtaining section **22***b* can also function as the aforementioned "own exercise information obtaining section."

[0065] A repetition-notification-tempo specifying section (music-tempo specifying section) **25***b* specifies a repetition notification tempo value such that a value of certain exercise information on the second exercising person **1***b* approximates a value of the certain exercise information on the first exercising person **1***a*, which is obtained by the second exercise information obtaining section **22***b* for the second exercising person **1***b*, in other words, such that the difference in value of the certain exercise information between the first and second exercising persons **1***a* and **1***b* is reduced.

[0066] There are three specific approaches as described below.

[0067] (1) In the case when the exercise information is a repetition tempo, a repetition tempo value of the first exercising person **1***a* is specified directly as a repetition tempo value of the second exercising person **1***b*.

[0068] The repetition-notification-tempo specifying section (music-tempo specifying section) **25***b* specifies a repetition notification tempo (music tempo) value corresponding to the repetition tempo value of the first exercising person **1***a*. It is easy for the second exercising person **1***b* to perform repetitive exercise in synchronization with a repetition tempo that corresponds to the repetition notification tempo (music tempo) of the notification signal (music). The second exercising person **1***b* senses the notification signal with a repetition notification tempo value corresponding to the repetition tempo value of the first exercising person **1***a*. This allows the second exercising person **1***b* to follow the repetition tempo of the repetitive exercise performed by the first exercising person **1***a*, while performing repetitive exercise. It should be understood that even if the repetition notification tempo value does not coincide with the repetition tempo value of the first exercising person **1***a*, the music tempo can be sometimes easily synchronized with the repetition tempo in the case of setting a so-called "half tempo." More specific operation in the approach 1 will be described later with reference to the music mode **3**A in FIG. **7**C.

[0069] (2) A value of exercise information is converted into a repetition notification tempo value.

[0070] The repetition-notification-tempo specifying section (music-tempo specifying section) **25***b* defines a value that coincides with the value of the certain exercise information on the first exercising person **1***a* as a value of the second exercising person **1***b*, and converts the value of the second exercising person **1***b* into a repetition tempo value of the second exercising person **1***b* to specify a repetition notification tempo (music tempo) value corresponding to the converted repetition tempo value.

[0071] (a) In the case when the exercise information is an exercise speed, the exercise speed of the first exercising person **1***a* is divided by the stride of the second exercising person **1***b* to be converted into a repetition tempo of the second exercising person **1***b*.

[0072] (b) In the case when the exercise information is an exercise distance, the following approach is taken as appropriate, but not always the case. The exercise distance of the first exercising person **1***a* is divided by an elapsed exercise time of the first exercising person **1***a* to obtain an average exercise speed of the first exercising person **1***a*. This average exercise speed is divided by the stride of the second exercising person **1***b* to be converted into a repetition tempo of the second exercising person **1***b*. In this case, the exercise information is substantially the average exercise speed.

[0073] (C) In the case when the exercise information is exercise intensity of an exercising person, the repetition-notification-tempo specifying section **25***b* defines a value that coincides with an exercise intensity value of the first exercising person **1***a* as an exercise intensity value of the second exercising person **1***b*, and estimates a repetition tempo value to result in the exercise intensity value of the second exercising person **1***b* based on his or her exercise-related personal information and past exercise results so that the exercise intensity is converted into a repetition tempo of the second exercising person **1***b*. The correlation of the repetition tempo value relative to the exercise intensity value may be predetermined in a form of a table.

[0074] More specific operation in the case (a) when the exercise information is an exercise speed will be described later with reference to the music mode **3**B in FIG. **7**D.

[0075] (3) Values of certain exercise information are compared between the first and second exercising persons **1***a* and **1***b*.

[0076] The second exercise information obtaining section **22***b* for the second exercising person **1***b* obtains a value of the certain exercise information on the first exercising person **1***a* in real time during the repetitive exercise performed by the first exercising person **1***a*, and concurrently obtains a value of the certain exercise information on the second exercising person **1***b* in real time during the repetitive exercise performed by the second exercising person **1***b*. The repetition-notification-tempo specifying section **25***b* compares the values on the certain exercise information between the first and second exercising persons **1***a* and **1***b*, and specifies a repetition notification tempo (music tempo) value such that the difference in value between the first and second exercising persons **1***a* and **1***b* is reduced.

[0077] A more specific case when a value of certain exercise information on an exercising person increases as his or her exercise intensity increases, and vice versa, is described below (although the description of the vice-versa case is omitted for redundancy).

[0078] (a) (value of exercise information on second exercising person **1***b*)<(value of exercise information on first exercising person **1***a*)

[0079] The repetition-notification-tempo specifying section (music-tempo specifying section) **25***b* specifies a repetition notification tempo value larger than the current repetition notification tempo value of the notification signal (generally equal to the currently-specified repetition notification tempo value). For example, the repetition notification tempo value is increased by 5%, compared to the current repetition notification tempo value of the notification signal.

[0080] (b) (value of exercise information on second exercising person **1***b*)>(value of exercise information on first exercising person **1***a*)

[0081] The repetition-notification-tempo specifying section **25***b* specifies a repetition notification tempo value smaller than the current repetition notification tempo value of the notification signal. For example, the repetition notification tempo value is decreased by 5%, compared to the current repetition notification tempo value of the notification signal.

[0082] In the aforementioned specific examples, the repetition notification tempo value is increased or decreased by a predetermined rate from the current repetition notification tempo value of the notification signal. However, the repetition notification tempo value may be increased or decreased by adding or subtracting a predetermined value to or from the current repetition notification tempo value.

[0083] According to the approach (3), the second exercising person **1***b* senses if the repetition notification tempo (music tempo) is faster or slower than the current tempo value. This helps the second exercising person **1***b* intuitively understand if the current value of the exercise information exceeds or falls below the value of the exercise information on the first exercising person **1***a*. Eventually, the repetition notification tempo value is kept approximately constant or kept in a stable state in which the value of the exercise information on the

second exercising person **1***b* coincides with the value of the exercise information on the first exercising person **1***a*. This approach may also be applied to the case when the exercise information is a repetition tempo, in addition to the case when the exercise information is an exercise speed, an exercise distance, exercise intensity, or a calorie consumption.

[0084] In the case of sharing a repetition tempo between exercising persons according to the approach (1), the second exercising person **1***b* is not always performing repetitive exercise with a repetition tempo value close to the repetition tempo value of the first exercising person **1***a* at the current point in time. It is conceivable under this condition that even if the second exercising person **1***b* hears a notification signal with a repetition notification tempo value that coincides with the repetition tempo value of the first exercising person **1***a*, the difference between the repetition notification tempo value and the repetition tempo value of the second exercising person **1***b* is so large that the second exercising person **1***b* has difficulty in continuing the repetitive exercise. In contrast, according to the approach (3), even in the case when the exercise information is a repetition tempo, the first and second exercising persons **1***a* and **1***b* can share the repetition tempo through feedback including the information on the conditions of the repetitive exercise performed by the exercising persons.

[0085] In the case of sharing an exercise speed (exercise pace) between exercising persons according to the approach (2), the second exercising person **1***b* is not always performing repetitive exercise at an exercise speed close to the exercise speed of the first exercising person **1***a* at the current point in time. Otherwise the stride of the second exercising person **1***b* cannot be kept constant. It is conceivable under this condition that even if the second exercising person **1***b* hears a notification signal with a repetition notification tempo value that coincides with the repetition tempo value of the first exercising person **1***a* corresponding to his or her exercise speed value, the difference between the repetition notification tempo value and the repetition tempo value of the second exercising person **1***b* is so large that the second exercising person **1***b* has difficulty in continuing the repetitive exercise. In contrast, according to the approach (3), the first and second exercising persons **1***a* and **1***b* can share the exercise speed through feedback including the information on the conditions of the repetitive exercise performed by the exercising persons.

[0086] It should be understood that in the case when the exercise information to be shared between the exercising persons is other than the repetition tempo, a repetition notification tempo value does not always coincide with a repetition tempo value of the actual repetitive exercise even in the aforementioned stable state. For such a case, the second notification signal generation apparatus **2***b* may be provided with a "tempo-up switch" and a "tempo-down switch." The second exercising person **1***b* operates this switch to control the repetition notification tempo value to coincide with or approximately coincide with the repetition tempo value of the second exercising person **1***b* in the stable state. This helps the second exercising person **1***b* easily continue the repetitive exercise.

[0087] A notification signal generation controller (e.g., a music generation controller) **26***b* and a notification signal generator (e.g., a music generation section) **28***b* are respectively identical to the notification signal generation controller (music generation controller) **26***a* and the notification signal generation section (music generation section) **28***a* that are described above. The notification signal generator (music generation section) **28***b* outputs a notification signal (music signal) with a repetition notification tempo (music tempo) value corresponding to the specified repetition notification tempo (music tempo) value to the earphone **6***b* shown in FIG. **1**.

[0088] In the comparison approach (3), the repetition-notification-tempo specifying section **25***b* compares values of certain exercise information between the first and second exercising persons **1***a* and **1***b*. If the value of the second exercising person **1***b* deviates from the value of the first exercising person **1***a* by a predetermined amount (predetermined value or predetermined rate relative to the value of the first exercising person **1***a*) or more, the second exercising person **1***b* may be notified of the deviation with a special notification signal (warning signal). In this case, it is desirable that the warning signal allows the second exercising person **1***b* to sense whether the "deviation" results from the slower repetition tempo or the faster repetition tempo of the repetitive exercise. Such a notification signal may be a notification sound or synthetic voice distinguishable from the original notification sound designed to match the repetition tempo or may be a notification light or character display distinguishable from the original notification light designed to match the repetition tempo.

[0089] The warning notification may also be provided in the approaches (1) and (2), if the value of the second exercising person **1***b* deviates from the value of the first exercising person **1***a* by a predetermined amount (predetermined value or predetermined rate relative to the value of the first exercising person **1***a*) or more. The warning notification may include whether the deviation results from the faster or slower repetition tempo of the repetitive exercise.

[0090] In any of the approaches (1), (2), and (3), if a repetition tempo value of the actual repetitive exercise deviates from the current repetition notification tempo value by a predetermined amount (predetermined value or predetermined rate relative to the current repetition notification tempo value) or more, a warning notification of the deviation, including whether the deviation results from the faster or slower repetition tempo of the repetitive exercise, may be provided in a display mode either the same as or different from the display mode of the aforementioned warning notification.

[0091] It should be understood that there may be a plural number of the second exercising persons **1***b* (plural persons). The exercise information management center **9** may supply a value of exercise information on the first exercising person **1***a* to the plural second exercising persons **1***b* (not shown).

[0092] In the above description, a value of exercise information on the first exercising person **1***a* is supplied to the second exercising person **1***b*. However, a value of the exercise information on the second exercising person **1***b* may also be supplied to the first exercising person **1***a* simultaneously. In this case, the first notification signal generation apparatus **2***a* outputs a notification signal to the first exercising person **1***a* such that he or she performs repetitive exercise to have the value of his or her exercise information to coincide with the value of the exercise information on the second exercising person **1***b*. This allows the first and second exercising persons **1***a* and **1***b* to share the values of their partner's exercise information with each other as a target value to perform the repetitive exercise.

[0093] Therefore, among two or more exercising persons, the second exercising person **1***b* can select any of the other exercising persons as a target first exercising person **1***a*. Further, the second exercising person **1***b* can select any of plural kinds of exercise information, obtain a value of the selected kind of the exercise information, and set the obtained value as a target value. This allows the exercising person to specify a target exercising person that fits his or her program and do training based on his or her preferred exercise information.

[0094] FIG. **3** is a hardware configuration diagram to achieve the embodiment of the invention. This hardware apparatus has a function of connecting to the communication network through the wireless channel, a function of producing music, and individual sensors. In FIG. **3**, a reference numeral **41** denotes a signal processor (central processing unit (CPU)). Peripheral functional blocks are connected to the CPU **41**. A timer **42** is used as the timing reference for the main processing and interrupt processing in the CPU **41**, or used as the time reference for a calendar function (year: month: day: hour: minute: second).

[0095] A memory **43** includes a Random Access Memory (RAM) and a flash Read Only Memory (ROM). The memory **43** stores an operating system program, various application programs, setting data, music data (Musical Instrument Digital Interface (MIDI) format and/or MPEG-1 Audio Layer-III (MP3) format or other wave formats), a music information database (reference number, music tempo, etc.), performance pattern part data and template data, and a telephone number list, for example.

[0096] A sound source section **44** has functions of producing an incoming-call sound of a mobile phone and various informing sounds, automatically playing the performance data in the MIDI format, and automatically creating music. A code/decode (CODEC) **45** encodes and decodes an analog signal. For example, in the case when a sound signal is the data in the MP3 format, the CODEC **45** compresses the data into a MP3 file and also decodes the MP3 file into a WAV file. A speaker or an earphone **46** outputs a sound signal or a music sound signal. A microphone **47** inputs a sound signal. The speaker or earphone **46** and the microphone **47** both are connected to the CPU **41** through the CODEC **45**. A reference numeral **48** denotes a display. An operation panel **49** includes a transparent touch panel placed over the display **48** and mechanical contact switches.

[0097] A transmission/reception section **50** is designed to connect to the mobile phone network. An antenna **51** is connected to the transmission/reception section **50**. A wireless LAN transmission/reception section **52** (its antenna is not shown) operates in accordance with the Wi-Fi, Bluetooth, or other standard. Reference numerals **53** and **54** respectively denote an acceleration sensor and a GPS sensor (its antenna is not shown). The acceleration sensor **53** detects a repetition tempo of repetitive exercise. The GPS sensor **54** detects position information, such as longitude and latitude. A heart rate sensor detects a heart rate (pulse rate) and transmits the detected heart rate waves or heart rate data to the CPU **41** through the Bluetooth in the wireless LAN transmission/reception section **52**.

[0098] The functions of the notification signal control apparatuses **27***a* and **27***b* shown in FIG. **2** are achieved by the CPU **41**' by executing the program stored in the memory **43**. The functions of the notification signal generators **28***a* and **28***b* shown in FIG. **2** are achieved by the sound source section **44** and the CODEC **45** by using music or other data stored in the memory **43**. The notification signal controllers **27***a* and **27***b* and the notification signal generators **28***a* and **28***b* may be formed into separate, devices that are physically away from each other.

[0099] FIG. **4** is a flowchart that principally illustrates an operation for controlling a notification signal as part of the operations to be performed in the CPU **41** in FIG. **3**. The power source is switched-ON to start the processing and perform initialization at step S**61**. The CPU **41** receives user's operation and performs processing of the application program (FIG. **5**A) at step S**62**, and then performs processing for telephone communication at step S**63**. If there is an incoming call, an incoming call sound is output even during the execution of the application program to allow a user to have a conversation through the user's operation. A phone call is made upon the user's operation. The CPU **41** returns the processing to the step S**62** from the step S**63** to repeat the processing until the power is turned off.

[0100] FIG. **5**A is a flowchart of a routine to execute an application program. The application program that embodies the present invention is for example named "combining exercise and music." At step S**71**, if the user operates or selects the "combining exercise and music" program, the CPU **41** starts-up the "combining exercise and music" program and advances the processing to step S**74**. If the "combining exercise and music" program has already started-up, the CPU **41** also advances the processing to the step S**74**. In other cases, the CPU **41** performs processing for other application programs at steps S**76** and S**77** in the same manner as described above. The CPU **41** sets the "combining exercise and music" program (FIG. **5**B) at the step S**74**, and executes the "combining exercise and music" program (FIG. **6**) at step S**75**.

[0101] FIG. **5**B is a flowchart to perform processing for setting the "combining exercise and music" program at the step S**74** in FIG. **5**A. At step S**81**, a screen of the current processing is displayed. A screen designed to receive a setting input from the user is first displayed. Subsequently a screen designed to display various information obtained during outputting the music and the repetitive exercise is displayed.

[0102] At step S**82**, the apparatus of the invention (the first notification signal generation apparatus **2***a* or the second notification signal generation apparatus **2***b*) is connected to the exercise information management center (hereinafter referred to as server) **9** to receive data transmitted from the server **9** or transmit data to the server **9**, if necessary.

[0103] The data received from or transmitted to the server **9** includes exercise information, exercise selection information (e.g. running/jogging/walking), music mode, exercise time, exercise conditions such as exercise distance, exercise performance results (ranking and record), and other information.

[0104] At step S**83**, if data is input through the user's operation, the CPU **41** receives the input data, and performs setting of the apparatus of the invention based on the input data. The input data that needs to be transmitted to the server **9** is temporally held, and is then transmitted to the server **9** later when the processing goes through the flowchart and comes back to step S**82**.

[0105] At step S**85**, if any of the modes is selected through the user's operation, the CPU **41** performs the mode setting. For example, the CPU **41** sets the music mode or sets the selected exercise and exercise conditions. At step S**87**, if the user provides an instruction to start the program, the CPU **41** sets a start flag for the preset music mode. In the subsequent

processing, whether the processing is being performed is determined depending on whether the start flag is set.

[0106] At step S**89**, if the user provides an instruction to stop the program through the user's operation, the CPU **41** clears the start flag for the preset music mode. At step S**91**, the CPU **41** performs processing in response to any other instruction from the user.

[0107] FIG. **6**A is a flowchart to perform processing for executing the "combining exercise and music" program at the step S**75** in FIG. **5**A. If the start flag has been already set for the "combining exercise and music" program in the previous step S**88**, the CPU **41** advances the processing from step S**101** to either one of the steps for the music modes **1**, **2**, **3**A, and **3**B according to the music mode that has been preset in the previous step S**86**.

[0108] FIG. **6**B is a flowchart of a routine to perform interrupt processing in parallel with the processing according to the main flowchart in FIG. **4**. The interrupt processing starts-up with a short time interval. Exercise information on a person him or herself (e.g. second exercising person **1***b*) and exercise information on another person (e.g. first exercising person **1***a*) are obtained by the interrupt processing.

[0109] If the start flag has been already set for the "combining exercise and music" program in the previous step S**88**, the CPU **41** advances the processing from the step S**111** to its subsequent steps.

[0110] At step S**112**, if the acceleration sensor **53** (FIG. **3**) detects any impact, the CPU **41** goes to steps S**113** to S**115**. The CPU **41** obtains an elapsed time from a timer A, and calculates a repetition tempo value based on the moving average of the elapsed time. The CPU **41** then resets the timer A to start counting the elapsed time again.

[0111] At step S**116**, if a heart rate is detected, the CPU **41** calculates a value of the heart rate at steps S**117** to S**119** in the same manner as at steps S**113** to S**115**. The exercise intensity is calculated based on the heart rate.

[0112] At step S**120**, if there are variations in the latitude-longitude (position) data that is output from the GPS sensor **54**, the CPU **41** calculates the travel of the exercising person from the previous position at step S**121** based on the difference between the current position data and the previously-obtained position data that has been obtained in the previous processing step S**122**, and updates the position data that indicates the current position at step S**122**. The travel of the exercising person from the previous position is divided by the difference between the previous point in time and the current point in time to calculate the exercise speed. In addition, the travels thus obtained during the period from the exercise starting point in time to the current point in time are added together to calculate the exercise distance from the exercise starting point to the current location during the above period. Alternatively, the aforementioned exercise speed may be integrated with respect to time from the exercise starting point in time to the current point in time to calculate the exercise distance as described above.

[0113] If either one of the values of the exercise information, including the repetition tempo, heart rate (exercise intensity), and exercise speed (and exercise distance), is calculated at step S**123**, the calculated value, together with the current point in time or the elapsed time from the previous calculation, are recorded in the internal memory and concurrently transmitted to the server **9**, and then transmitted through the server **9** to an exercising person who exercises simultaneously (and/or may be recorded in the storage device **30** in the server **9**) at step S**124**. It should be understood that exercising persons have different heart rate values depending on their athletic abilities and other abilities. Therefore, the heart rate values are converted into exercise intensity, a common indicator among the exercising persons, to be transmitted.

[0114] The second notification signal generation apparatus **2***b* for the second exercising person **1***b* in the dependent mode, as shown in FIG. **2**, needs to obtain exercise information on another exercising person. In such a case of obtaining exercise information on another exercising person in real time, the CPU **41** advances the processing from S**125** to S**126** to receive the exercise information on the other exercising person via the server **9**, and then advances the processing to step S**127** to obtain a value of the exercise information on the other exercising person.

[0115] In contrast, exercise results (sequence data of variable exercise information relative to the elapsed time or exercise distance) of an exercising person him or herself are saved in the memory **43** of the apparatus of the invention by the recording processing at step S**124**. In addition, exercise results of another exercising person are saved in the exercise information storage device **30** in the server **9**. The past exercise results of another exercising person may be downloaded to the memory **43** (FIG. **3**) from the server **9** prior to starting exercise. Thus, an additional function (playback) may be provided to sequentially read the exercise information on the exercising person him or herself or the exercise information on the other exercising person, which are stored in the memory **43**. If the playback function is used, the CPU **41** advances the processing from step S**128** to step S**129** to read the exercise result file saved in the memory **43**, and obtains a value of the exercise information on the other exercising person (including the past exercise information on the exercising person him or herself) at step S**127**.

[0116] It should be understood that as a modification example for step S**128**, the exercise results of the other exercising person may also be received from the exercise information storage device **30** in the server **9** at each time when the exercise information is generated (at event timing), as if the exercising person receives the exercise information in real time.

[0117] FIGS. **7**A to **7**D are flowcharts that illustrate processing in the respective music modes in FIG. **6**A. FIG. **7**A is a flowchart that illustrates operation in the "music mode **1**." This mode corresponds to the "free workout mode" discussed in the description of BACKGROUND and is designed to output music with a music tempo that matches the repetition tempo of the exercising person's running.

[0118] At step S**131**, if there is new "record/transmit" processing at step S**124** in FIG. **6**B, the CPU **41** goes to step S**132** to perform the following processing. If the "recorded exercise information" is the "repetition tempo value" obtained at step S**114** and this "repetition tempo value" is varied by a predetermined amount (predetermined rate or predetermined difference) or more from the current "repetition tempo value," the CPU **41** advances the processing to step S**134**.

[0119] It should be understood that in the case when the notification information is music and the music is selected from plural pieces of music stored in the storage device, if there is no music stored in the memory **43** with a specified music tempo value, the CPU **41** selects music with a tempo value close to the specified music tempo value at step S**135** that will be described later. Thus, at step S**136** that will be described later, a music tempo value of the currently-output

music does not always coincide with the currently-specified music tempo value at the step **S134**. Therefore, the "music tempo value" of the currently-output music (however, if the music is output by setting to "half tempo," the music tempo is twice as fast as the "half tempo") is more preferably used as the current "repetition tempo value," instead of using the currently-specified music tempo value.

[0120] At the step **S134**, the CPU **41** additionally specifies the varied repetition tempo value as a music tempo value.

[0121] At the step **S135**, an additional music piece is selected or produced as followings.

[0122] (1) In the case of selecting an additional music piece, any music with a music tempo value that is the same as or close to the additionally-specified music tempo value is selected from plural pieces of music stored in the memory **43** in FIG. **3**. The selected music is loaded to a cache memory (included in the memory **43** in FIG. **3**).

[0123] (2) In the case of automatically producing an additional music piece (see Japanese Patent Publication No. 4306754 (JP 4306754B), for example).

[0124] In the case of automatically producing an additional music piece, the performance pattern part data and template data stored in the memory **43** in FIG. **3** are used to automatically produce a music piece with a music tempo value that is the same as the additionally-specified music tempo value. Data of the produced music piece is loaded to the cache memory.

[0125] The music loaded to the cache memory is output at the step **S136**. If there is no new "record/transmit" processing at the step **S131** or the "repetition tempo value" does not meet the predetermined condition at the step **S132**, the CPU **41** advances the processing to the step **S133**. In this step, if the current music data output is completed (the music song ends), the CPU **41** advances the processing to the step **S134**. At this time, at the step **S134**, the specified music tempo value remains unchanged. In contrast, if the current music data output is not completed yet (in the middle of playing the music song), the CPU **41** advances the processing to the step **S136**.

[0126] It should be understood that when the processing is advanced to the step **S134** via the step **S133**, if the "repetition tempo value" is varied by a smaller predetermined amount (smaller predetermined rate or smaller predetermined difference) or more, compared the "predetermined amount" at the step **S132**, the CPU **41** may additionally specify this varied "repetition tempo value" as a music tempo value.

[0127] FIG. **7**B is a flowchart that illustrates operation in the "music mode **2**." This mode corresponds to the "fitness mode" discussed in the description of BACKGROUND and is designed to specify a music tempo value such that the user's heart rate reaches a "target heart rate," and to output music with the specified tempo value. The "target heart rate" has been preset in the exercise program. It should be understood that the "target heart rate" and the "heart rate" can be converted into "target exercise intensity" and "exercise intensity."

[0128] At step **S141**, if there is new "record/transmit" processing at the step **S124** in FIG. **6**B, the CPU **41** goes to step **S142** to perform the following processing. If the "recorded exercise information" is the "heart rate value" that is obtained at the step **S118** and that falls out of a predetermined range of the current "target heart rate value" (target heart rate value±predetermined ratio or±predetermined difference), the CPU **41** advances the processing to step **S144**.

[0129] At the step **S144**, if the obtained "heart rate value" is larger than the "target heart rate value," the CPU **41** additionally specifies a music tempo value that is smaller (e.g. decreased by 5%) than the music tempo value of the currently-output music. In contrast, if the obtained "heart rate value" is smaller than the "target heart rate value," the CPU **41** additionally specifies a music tempo value that is larger (e.g. increased by 5%) than the music tempo value of the currently-output music.

[0130] At step **S145**, music is additionally selected or produced, and is loaded to the cache memory. The music loaded to the cache memory is output at step **S146**.

[0131] As described for the step **S136** in FIG. **7**A, at the step **S146**, a music tempo value of the currently-output music does not always coincide with the currently-specified music tempo value at the step **S144**. Thus, at the step **S144**, desirably the determination is made based on the "music tempo value of the currently-output music".

[0132] If there is no new "record/transmit" processing at the step **S141** or the "heart rate value" does not meet the predetermined condition at the step **S142**, the CPU **41** advances the processing to the step **S143** to perform the same processing as at the step **S133** in FIG. **7**A. In other words, the processing is advanced to the following step **S144**. At this time, at the step **S144**, the specified music tempo value remains unchanged. In contrast, if the current music data output is not completed yet (in the middle of playing the music song), the CPU **41** advances the processing to the step **S146**. The music tempo value thus specified allows the heart rate value to be controlled to fall within the range of the target heart rate.

[0133] It should be understood that when the processing is advanced to the step **S144** via the step **S143**, the CPU **41** determines whether the "heart rate value" is varied over a smaller "predetermined range" (target heart rate value±smaller predetermined ratio or±smaller predetermined difference) than the "predetermined range" at the step **S142**. If the determination is affirmative, the CPU **41** may specify a music tempo value in exactly the same manner as when the processing is advanced to the step. **S144** via the step **S142**.

[0134] FIG. **7**C is a flowchart that illustrates operation in the "music mode **3**A." This mode is designed to output music with a music tempo value that is the same as the repetition tempo value of another exercising person (first exercising person **1***a*) so that the exercising person can perform the repetitive exercise with the same repetition tempo value as the other exercising person.

[0135] In the case when the value of the exercise information on the other exercising person, which is obtained at the step **S127** in FIG. **6**B, is a repetition tempo value obtained in real time at the step **S126**, if this repetition tempo value is varied from the current value by a predetermined amount (predetermined ratio or predetermined value) or more at step **S152**, the CPU **41** advances the processing to step **S154**. At the step **S154**, the CPU **41** additionally specifies the varied repetition tempo value as a music tempo value. Similar to the step **S132** in FIG. **7**A, when music is selected from plural pieces of music stored in the storage device, the "music tempo value of the currently-output music" is used preferably as the "current value" of the repetition tempo. The processing at steps **S155**, **S156**, and **S153** is performed in the same manner as the processing at the steps **S135**, **S136**, and **S133** in FIG. **7**A, respectively.

[0136] FIG. **7**D is a flowchart that illustrates operation in the "music mode **3**B." This mode is designed to output music with a music tempo value that is the same as the repetition tempo value converted from the exercise speed, so that the exercising person can perform repetitive exercise at the same exercise speed as the other exercising person.

[0137] The processing at steps S**161** and S**162** is performed in the same manner as the processing at the steps S**151** and S**152** in FIG. **7**C, respectively. At step S**164**, a value of the varied exercise speed is divided by a stride to obtain a repetition tempo value, and the CPU **41** additionally specifies the obtained repetition tempo value as a music tempo value. The processing at steps S**163** to S**166** is performed in the same manner as the processing at steps S**153** to S**156** in FIG. **7**C, respectively.

[0138] At the step S**155** in FIG. **7**C when music is selected by specifying the music tempo value, the output music (hereinafter more specifically referred to as music song) can be the same as the music song to be output for the other exercising person. This helps the exercising person feel more togetherness with the other exercising person. Thus, not only the exercise information, but also other information required for identifying the music song to be output for the other exercising person, such an a reference number of the music song, may also be supplied from the other exercising person to the exercising person via the server.

[0139] In this case, if the same music song is also stored in the storage device for the exercising person, this same music song is output, or if the same music song is not stored, an alternative music song with a music tempo value that coincides with or approximately coincides with the specified value may be output. It should be understood that the exercising person may select a music song from his or her favorite music songs stored in the storage device for him or her, independently from the music song to be output for the other exercising person.

[0140] The approach (3) in which "values of certain exercise information are compared between the first and second exercising persons **1***a* and **1***b*" is now additionally described, although it has been already described with reference to FIG. **2**. In order to more specifically carry out this approach, the "target heart rate" value at the step S**142** in FIG. **7**B may be replaced with a value of certain exercise information on another exercising person (first exercising person **1***a*), while the "heart rate" value may be replaced with a value of the certain exercise information on an exercising person him or herself (second exercising person **1***b*).

[0141] FIG. **8** is a flowchart to perform processing in the server connected to the communication network. After step S**171** for initialization, the processing of following steps S**172**-S**179** is repeated.

[0142] At step S**172**, the server **9** is on standby until an individual exercising person (hereinafter referred to as user), a membership of the "combining exercise and music" application program, requests for connection to the server. Upon a connection request from any one of the individual users, the server **9** receives an input of user ID and password to authenticate the user at step S**174**.

[0143] If the user is not authenticated, the server **9** performs processing for canceling the request for connection to the server at step S**179**. If the user is authenticated, the server **9** creates display screen data associated with the individual user and transmits the display screen data to the notification signal generation apparatus for the authenticated user at step S**175**. An initial display screen shows the service menu selection available for the authenticated user.

[0144] At step S**176**, the server **9** receives data transmitted from the user. For example, the data transmission includes a real-time request for the exercise information on another user during his or her repetitive exercise, a request transmitted from the user who makes a selection on the display screen, a request input by letters transmitted from the user, a real-time supply of the exercise information on the user during his or her repetitive exercise, a supply of a file containing the exercise results from the exercise performed, and supplies of the exercise history, the output music history, and so forth.

[0145] At step S**177**, the server **9** performs various processing. Upon receipt of a request from the user, the server **9** performs processing in response to the request. Upon a request for suggested music, the server **9** selects music with a music tempo that matches the user's personal information and exercise history, creates a music list to be presented to the user, and prepares for downloading the music. The exercise information on the user during his or her repetitive exercise is stored in the exercise information storage device **30**.

[0146] The exercise information on the other user during his or her repetitive exercise, the music list, and the music can be provided to the user at the step S**175** of the subsequent processing, if necessary.

[0147] The server **9** can distribute the exercise information on a single user (e.g. first exercising person **1***a*) in real time to the second notification signal generation apparatuses **2***b* for plural users (e.g. second exercising persons **1***b*).

[0148] The first exercising person **1***a* can decide who can utilize his or her exercise information. For example, the first exercising person **1***a* can perform setting to permit anyone to utilize his or her exercise information, or permit only a user in a specific group or a specific user to utilize his or her exercise information, or not to permit anyone to utilize his or her exercise information.

[0149] Upon receipt of the exercise history or the music playback history, the server **9** analyzes which music the user preferably listens to under which physical conditions (exercise-related personal information). Moreover, the server **9** compiles the exercise history and the music playback history of the user with the exercise history and the music playback history of the other user to find the user's relative statistical values and preferences, and stores this information as user's personal data. This helps the server **9** provide services that match the user's statistical values and preferences.

[0150] If the user transmits "termination request" data at step S**178**, the server **9** performs processing for canceling the connection to the server at step S**179**. The server **9** returns the processing to the step S**172** to wait for another request from the user for connection to the server.

[0151] FIGS. **9**A and **9**B illustrate specific examples to which the embodiment of the invention is applied. The embodiment of the invention is provided as services to mobile terminals, such as smart phones. A repetition tempo value is detected based on an output from the acceleration sensor built in the mobile terminal. The "combining exercise and music" program is an application program to be executed by using one of the functions of the application program "GAME CENTER (trademark)" preinstalled in the "iPhone (registered trademark) 4G", one of the smart phones. Sharing a repetition tempo value between plural exercising persons and communication are achieved by the function "Multi Player Game" of the "Game Center (trademark)."

[0152] FIG. **9**A illustrates a screen for the user on which the user's nickname "TORU" is displayed. On this screen, reference numerals **181**, **182**, **183**, and **184** respectively denote a smart-phone housing, a touch panel screen, a switch, and a speaker. On the illustrated touch panel screen **182**, a "combining exercise and music" display **185** is provided. Tapping the display **185** allows the "combining exercise and music" application program to start.

[0153] On a setting start screen (not shown), the user enters the "combining exercise and music" program via the server **9** on the communication network **8**, and selects friends whom the user desires to exercise together (group members who exercise together) as well as specifies a target person (named a "pace maker"), from whom the user obtains target exercise information, among the group members. In other words, the target person is a member (exercising person) or a coach (exercising person) whom the user desires to follow the example for the repetitive exercise.

[0154] If one of the exercising persons, who is selected by the user as a member, has already started exercising, the member selection screen displays values of one or more kinds of the current exercise information on the selected member, such as repetition tempo value and exercise distance (running distance) value, in real time. If one of the exercising persons, who is selected by the user as a member, has not yet started exercising, the member selection screen displays values of one or more kinds of the past exercise information on the selected member, which are read from his or her history. Desirably, the user's own exercise information is also displayed in the same manner. This allows the user to select a partner that fits the user's exercise goal and athletic level and to share the exercise information with the selected partner. The user can select target exercise information among plural kinds of exercise information.

[0155] While viewing the display screen described above, the user can cancel the selection of the member who has been selected once or can make the user him or herself outside the group. Even after the user starts exercising by selecting the member, the user can switch the display screen to the member selection screen to know the exercise conditions of the other members in real time.

[0156] FIG. **9**B illustrates a screen to start executing the "combining exercise and music" program. A reference numeral **191** denotes a display of a timer that measures time (hour: minute: second). Reference numerals **192**, **193***a*, **193***b*, **194***a*, and **194***b* respectively denote a start button, a pace-maker member's repetition-tempo display, a user's (own) repetition-tempo display, a user's (own) running distance (exercise distance), and a user's (own) calorie consumption. In the illustrated example, the repetition tempo is selected as a target. An additional area may be provided to display values of common exercise information on the pace-maker member and the user.

[0157] The user taps the start button **192** to start executing the program. On a touch panel screen **182** in FIG. **9**B, a displayed numerical value is varied. Simultaneously, a repetition tempo value of the pace-maker exercising person is obtained through the server **9** to output music with a music tempo value corresponding to the obtained repetition tempo value. The software sound source (software synthesizer) installed in the "combining exercise and music" application program is used to automatically produce music with the corresponding music tempo. This music is output from the speaker **184** or the external earphone.

[0158] As described above, when a certain exercising person (e.g. second exercising person **1***b*) finishes exercising, the sequence data of the exercise information (values of the exercise information relative to the elapsed time or elapsed travel distance) on the second exercising person **1***b* is saved in the memory **43** in the second notification signal generation apparatus **2***b* (the step S**124** in FIG. **68**) or is stored in the exercise information storage device in the exercise information management center (server) **9** (the step S**177** in FIG. **8**) as the exercise results.

[0159] After finishing exercising, the second exercising person **1***b* views the aforementioned exercise results on the display screen or the like to compare the exercise results among the plural exercising persons or with the other exercising person and review the exercise. At this time, the exercise information management center (server) **9** automatically performs the comparison processing so that the second notification signal generation apparatus **2***b* can make evaluations on the exercise results (with score or ranking). The exercise results recorded in the memory **43** in the second notification signal generation apparatus **2***b* may be uploaded to the exercise information management center (server) **9** after the exercise is finished. The exercise results stored in the exercise information management center (server) **9** are compared with the exercise results of the other exercising persons for ranking. The exercise results thus stored may also be utilized by the other exercising persons.

[0160] In the case when the second notification signal generation apparatus (music playback apparatus) **2***b* reads music with a specified repetition notification tempo (music tempo) from plural pieces of music stored in a storage device to output the music in FIG. **2**, the storage device is built in the notification signal generator (music generation section) **28***b*. In this case, the first notification signal generation apparatus (music playback apparatus) **2***a* may supply a reference number to identify the music together with the exercise information.

[0161] There is a case when a "repetition tempo" value is shared as the exercise information, and a repetition notification tempo (music tempo) is specified corresponding to the "repetition tempo" value. In this case, if music data associated with the supplied reference number is stored in the storage device built in the notification signal generator (music generation section) **28***b*, the second notification signal generation apparatus (music playback apparatus) **2***b* can output the music data. This allows the first and second exercising persons **1***a* and **1***b* to share the music data as well. However, if any music data associated with the supplied reference number is not stored in the storage device built in the notification signal generator (music generation section) **28***b*, music data with a music tempo value according to the specified music tempo value may be selected from plural pieces of music data stored in a repetition notification tempo storage device, so that the second notification signal generation apparatus **2***b* may output the selected music data.

[0162] Alternatively, the streaming reproduction technology or other technology may be used to supply the music data from the first notification signal generation apparatus (music playback apparatus) **2***a* via the exercise information management center **9** and the communication network **8** to the second notification signal generation apparatus (music playback apparatus) **2***b* to output the music data. Further alternatively, plural pieces of music data may be shared in advance between the first notification signal generation apparatus (music play-

back apparatus) **2***a* and the second notification signal generation apparatus (music playback apparatus) **2***b*. It should be understood that the communication network **8** is not limited to the Internet, but may be any wireless or wired network. In addition, the server **9** may be omitted so that the exercise information on the first exercising person **1***a* can be directly supplied to the second notification signal generation apparatus (music playback apparatus) **2***b* for the second exercising person **1***b*.

[0163] This application is based on, and claims priority to, JP PA 2011-035606 filed on 22 Feb. 2011. The disclosure of the priority application, in its entirety, including the drawings, claims, and the specification thereof, are incorporated herein by reference.

What is claimed is:

1. A notification signal control apparatus for providing a notification synchronized with repetitive exercise performed by a first exercising person to a second exercising person, the apparatus comprising:

an exercise information obtaining section that obtains exercise information related to the exercise performed by the first exercising person in order for the second exercising person to utilize the exercise information;

a repetition-notification-tempo specifying section that specifies, based on the obtained exercise information, a repetition notification tempo synchronized with repetitive exercise performed by the first exercising person in order for the second exercising person to perform repetitive exercise; and

a notification signal generation controller that controls a notification signal generator to generate a notification signal with a tempo corresponding to the repetition notification tempo specified by the repetition-notification-tempo specifying section.

2. The notification signal control apparatus according to claim **1**, wherein the exercise information obtaining section obtains the exercise information related to the exercise performed by the first exercising person in real time, while the second exercising person performs repetitive exercise.

3. The notification signal control apparatus according to claim **1**, wherein the exercise information indicates a repetition tempo of the repetitive exercise performed by the first exercising person, and

wherein the repetition-notification-tempo specifying section specifies a repetition notification tempo corresponding to the repetition tempo of the first exercising person, the repetition tempo being indicated by the exercise information.

4. The notification signal control apparatus according to claim **1**, wherein the repetition-notification-tempo specifying section calculates a repetition tempo for the second exercising person based on the obtained exercise information, and specifies a repetition notification tempo corresponding to the calculated repetition tempo.

5. The notification signal control apparatus according to claim **4**, wherein the obtained exercise information includes an exercise speed, and

wherein the repetition-notification-tempo specifying section calculates a repetition tempo for the second exercising person by dividing the exercise speed that is included in the obtained exercise information by a stride of the second exercising person.

6. The notification signal control apparatus according to claim **4**, wherein the obtained exercise information includes an exercise distance and an elapsed exercise time, and

wherein the repetition-notification-tempo specifying section obtains an average exercise speed based on the exercise distance and the elapsed exercise time that are included in the obtained exercise information, and calculates a repetition tempo for the second exercising person by dividing the average exercise speed by the stride of the second exercising person.

7. The notification signal control apparatus according to claim **4**, wherein the obtained exercise information includes exercise intensity, and

wherein the repetition-notification-tempo specifying section refers to an exercise-intensity versus repetition-tempo table for the second exercising person according to the exercise intensity that is included in the obtained exercise information to obtain a repetition tempo for the second exercising person.

8. The notification signal control apparatus according to claim **1**, wherein the exercise information obtaining section receives first exercise information related to repetitive exercise performed by the first exercising person in real time during the exercise performed by the first exercising person.

9. The notification signal control apparatus according to claim **1**, wherein the exercise information obtaining section obtains first exercise information related to repetitive exercise performed by the first exercising person from a database.

10. The notification signal control apparatus according to claim **8**, wherein the exercise information obtaining section receives the first exercise information related to repetitive exercise performed by the first exercising person via a communication network.

11. The notification signal control apparatus according to claim **8**, wherein the exercise information obtaining section further obtains second exercise information related to repetitive exercise performed by the second exercising person in real time during the exercise performed by the second exercising person, and

wherein the repetition-notification-tempo specifying section compares a value indicated by the first exercise information and a value indicated by the second exercise information, and increases or decreases a current value of the repetition notification tempo to reduce a difference between the compared values.

12. The notification signal control apparatus according to claim **1**, further comprising:

a detector that detects at least one of motion performed by the second exercising person and a physical reaction of the second exercising person in real time during the exercise performed by the second exercising person; and

an own exercise information generation section that generates exercise information related to the exercise performed by the second exercising person based on an output from the detector,

wherein the exercise information related to the exercise performed by the second exercising person can be transmitted externally.

13. The notification signal control apparatus according to claim **1**, wherein the exercise information related to the exercise performed by the first exercising person which is obtained by the exercise information obtaining section is virtual information.

14. The notification signal control apparatus according to claim **1**, wherein the notification signal is music, while the repetition notification tempo is a music tempo, and

wherein the notification signal generation controller controls the notification signal generator to produce music with a tempo corresponding to the music tempo specified by the repetition-notification-tempo specifying section.

15. A portable music playback apparatus comprising:

the notification signal control apparatus according to claim **1**, and

a notification signal generator that generates the notification signal according to control by the notification signal generation controller.

16. A computer-implemented method of providing a notification synchronized with repetitive exercise performed by a first exercising person to a second exercising person, the method comprising:

obtaining exercise information related to exercise performed by the first exercising person in order for the second exercising person to utilize the exercise information;

specifying, based on the obtained exercise information, a repetition notification tempo synchronized with repetitive exercise performed by the first exercising person in order for the second exercising person to perform repetitive exercise; and

generating a notification signal with a tempo corresponding to the specified repetition notification tempo.

17. A non-transitory computer-readable medium containing instructions to cause a processor to perform a method of providing a notification synchronized with repetitive exercise performed by a first exercising person to a second exercising person, the method comprising:

obtaining exercise information related to exercise performed by the first exercising person in order for the second exercising person to utilize the exercise information;

specifying, based on the obtained exercise information, a repetition notification tempo synchronized with repetitive exercise performed by the first exercising person in order for the second exercising person to perform repetitive exercise; and

controlling a notification signal generator to generate a notification signal with a tempo corresponding to the specified repetition notification tempo.

18. A system that provides a notification synchronized with repetitive exercise performed by a first exercising person to a second exercising person, the system comprising:

a first terminal carried by the first exercising person, comprising:

a detector that detects at least one of motion performed by the first exercising person and a physical reaction of the first exercising person in real time during the exercise performed by the first exercising person;

an own exercise information generation section that generates exercise information related to the exercise performed by the first exercising person based on an output from the detector; and

a communication section that transmits first exercise information related to the exercise performed by the first exercising person, the first exercise information being generated by the own exercise information obtaining section; and

a second terminal carried by the second exercising person, comprising:

an exercise information obtaining section that receives the first exercise information;

a repetition-notification-tempo specifying section that specifies, based on the received exercise information, a repetition notification tempo synchronized with repetitive exercise performed by the first exercising person in order for the second exercising person to perform repetitive exercise; and

a notification signal generator that generates a notification signal with a tempo corresponding to the repetition notification tempo specified by the repetition-notification-tempo specifying section.

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