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Hwang

(54) **TOOTH BRUSHING PATTERN ANALYZING/MODIFYING DEVICE, METHOD AND SYSTEM FOR INTERACTIVELY MODIFYING TOOTH BRUSHING BEHAVIOR**

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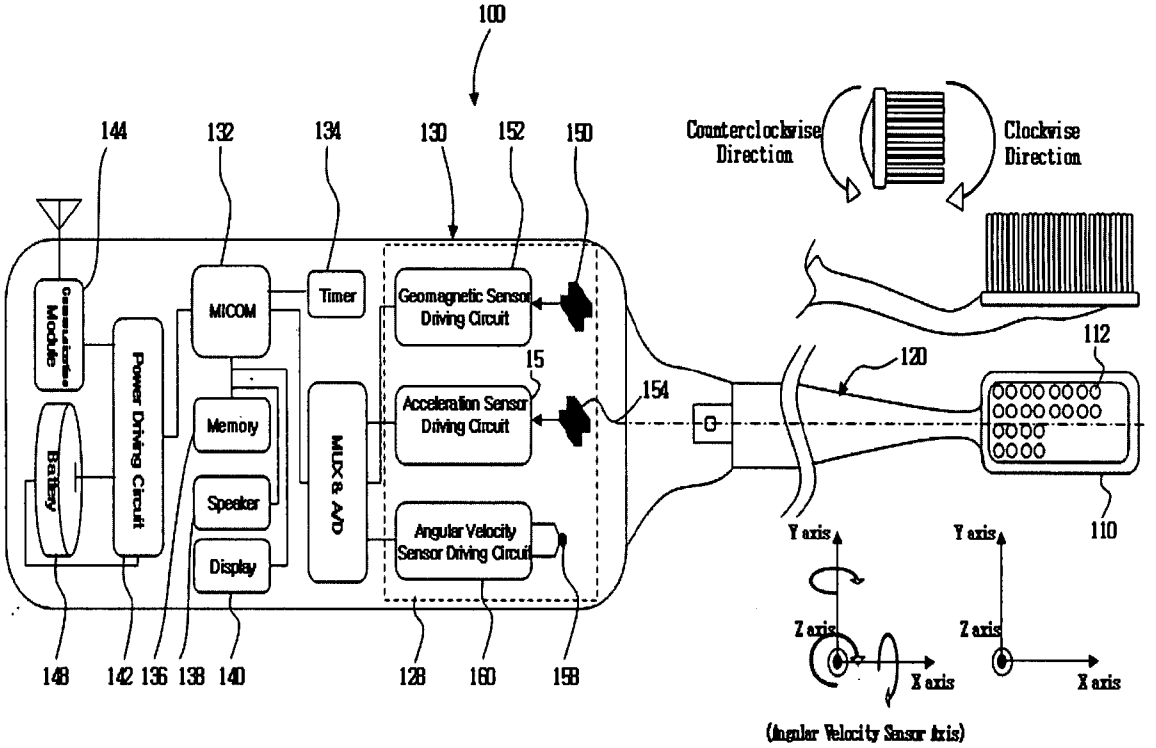
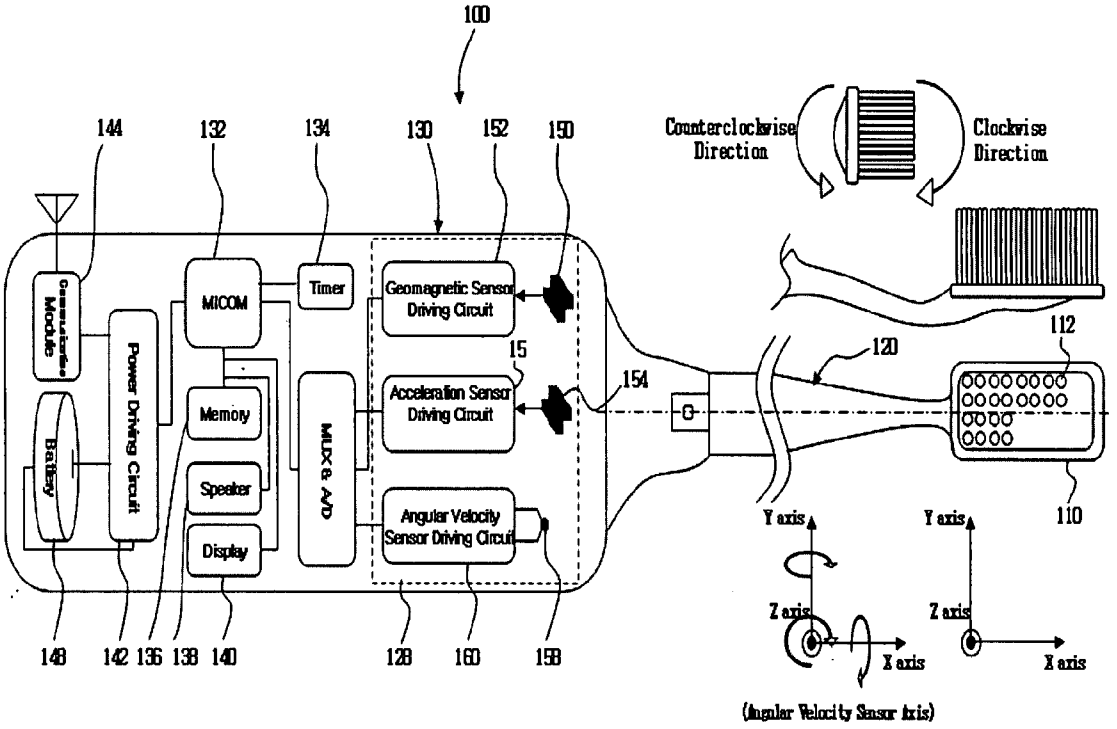
(57) **ABSTRACT**

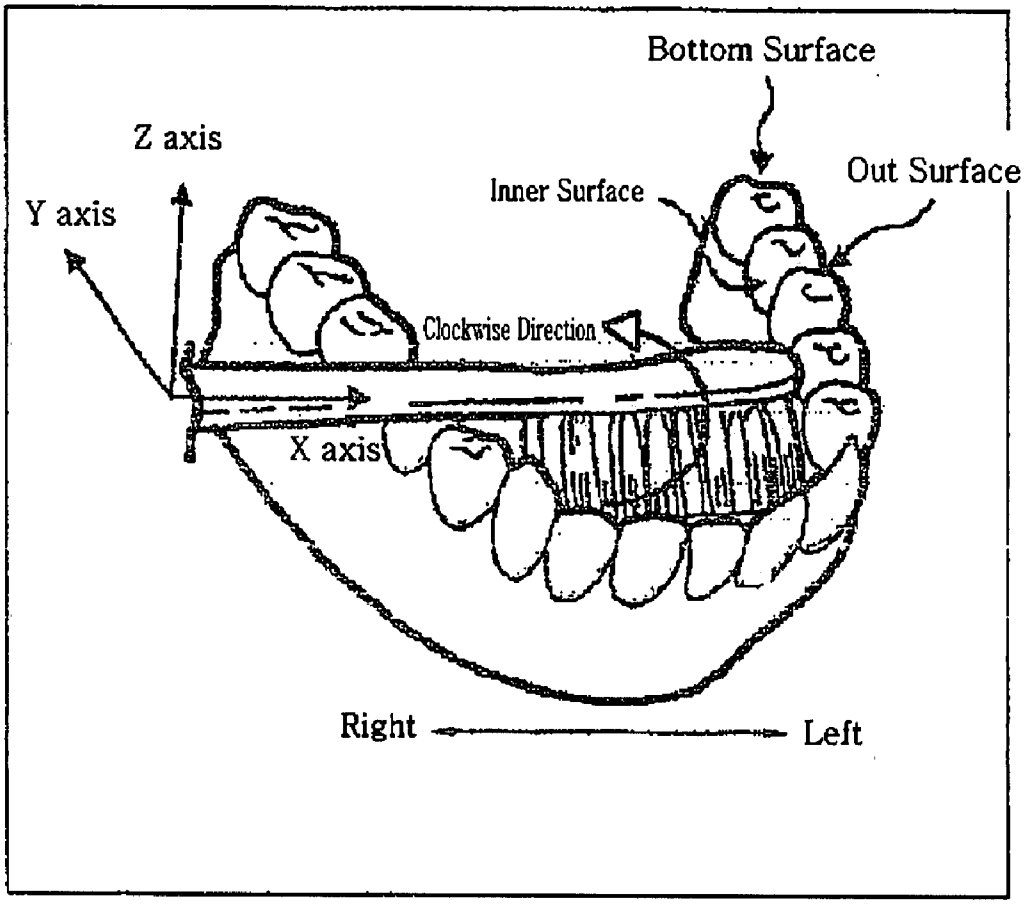
Disclosed are a toothbrushing pattern analyzing/correcting device, a toothbrushing pattern analyzing/correcting method, a method and a system for interactively correcting toothbrushing behavior. The toothbrushing pattern analyzing/correcting device of the present invention includes: a body part formed in the same direction as a toothbrush surface; a sensing unit having a sensor with at least one or more axes for sensing a user's toothbrushing motion and a sensor with one or more axes for sensing two or more toothbrushing positions; and a controller for operating signals input from the sensing unit to classify a user's toothbrushing motion into at least two or more patterns and at least two or more toothbrushing parts. Further, the toothbrushing pattern analyzing/correcting method includes the steps of: detecting the start of a user's toothbrushing; displaying a guiding screen in response to the start of a user's toothbrushing; detecting a user's toothbrushing pattern; analyzing the user's detected toothbrushing pattern; and providing a toothbrushing correction screen with the intention of increasing compliance in accordance with the analyzed result. Accordingly, toothbrushing behavior correction compliance can be further enhanced with a method of interactively correcting a user's toothbrushing behavior through multimedia image substances in real time, and more systematic management and health consultation are possible by building a database of information of the user's toothbrushing behavior.



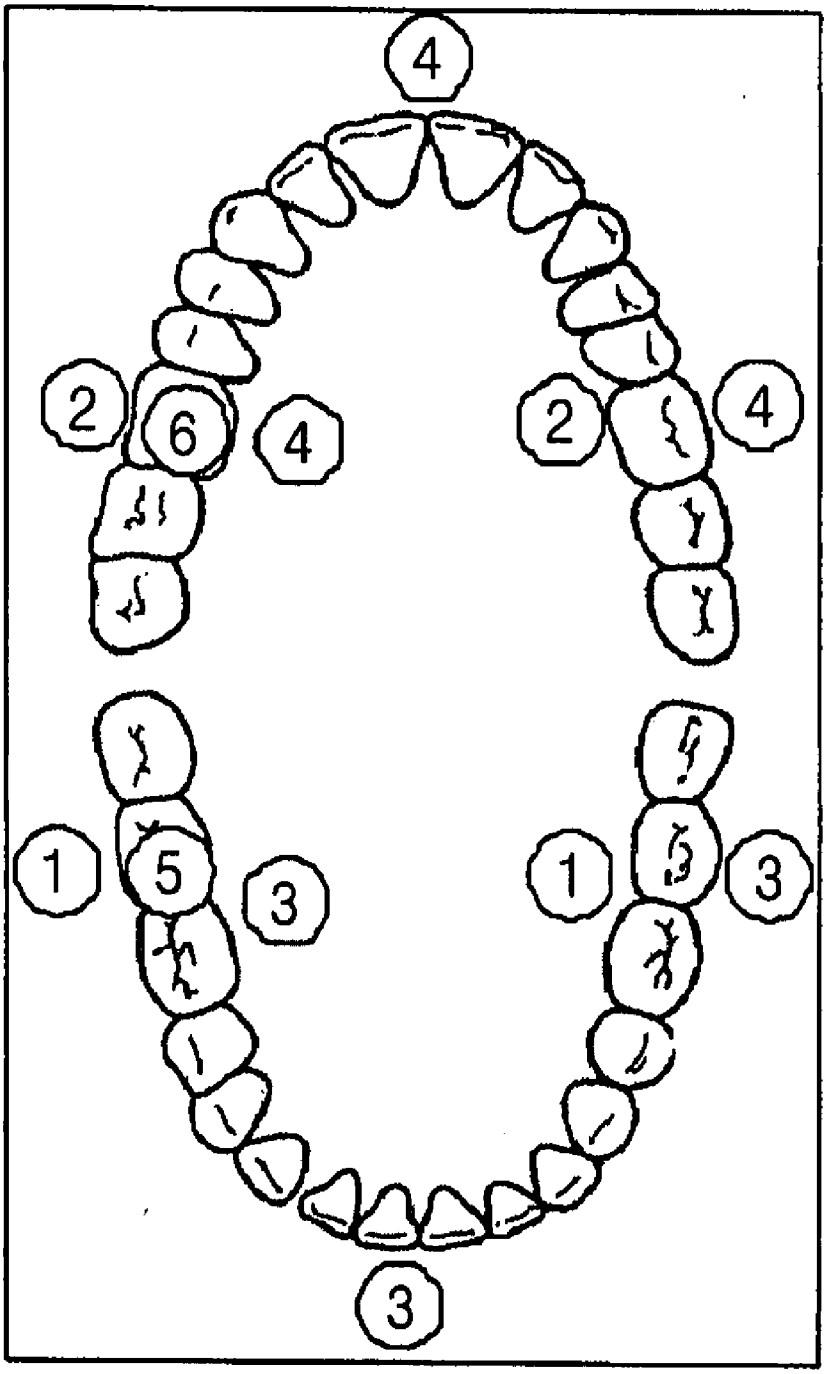
【Fig. 1】


100
144
132
134
130
152
150
Counterclockwise Direction
Clockwise Direction
Communication Module
Power Driving Circuit
MICOM
Timer
Geomagnetic Sensor Driving Circuit
15
Acceleration Sensor Driving Circuit
154
120
112
Memory
Speaker
Display
MUX & A/D
Angular Velocity Sensor Driving Circuit
110
148
142
136
138
140
128
160
158
Y axis
Z axis
X axis
(Angular Velocity Sensor Axis)

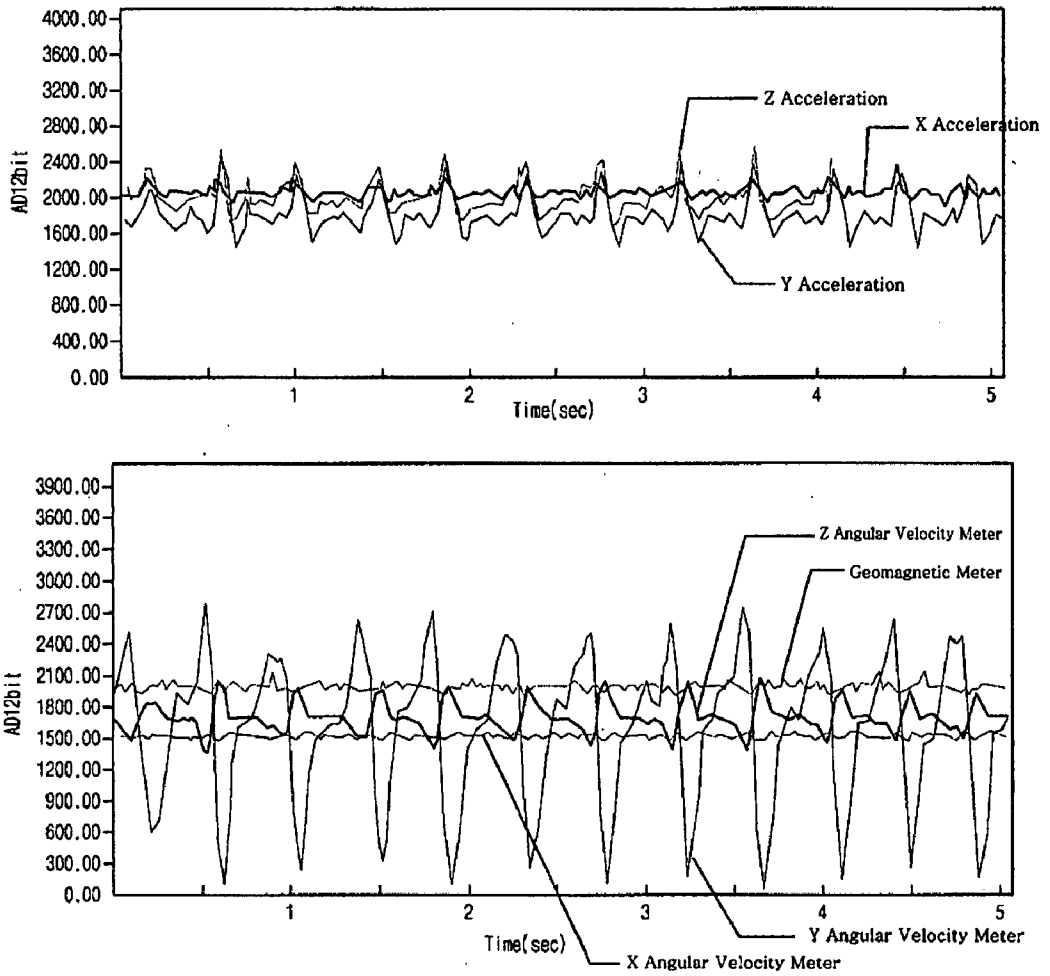
【Fig. 2】


Bottom Surface
Z axis
Out Surface
Inner Surface
Y axis
Clockwise Direction
X axis
Right
Left

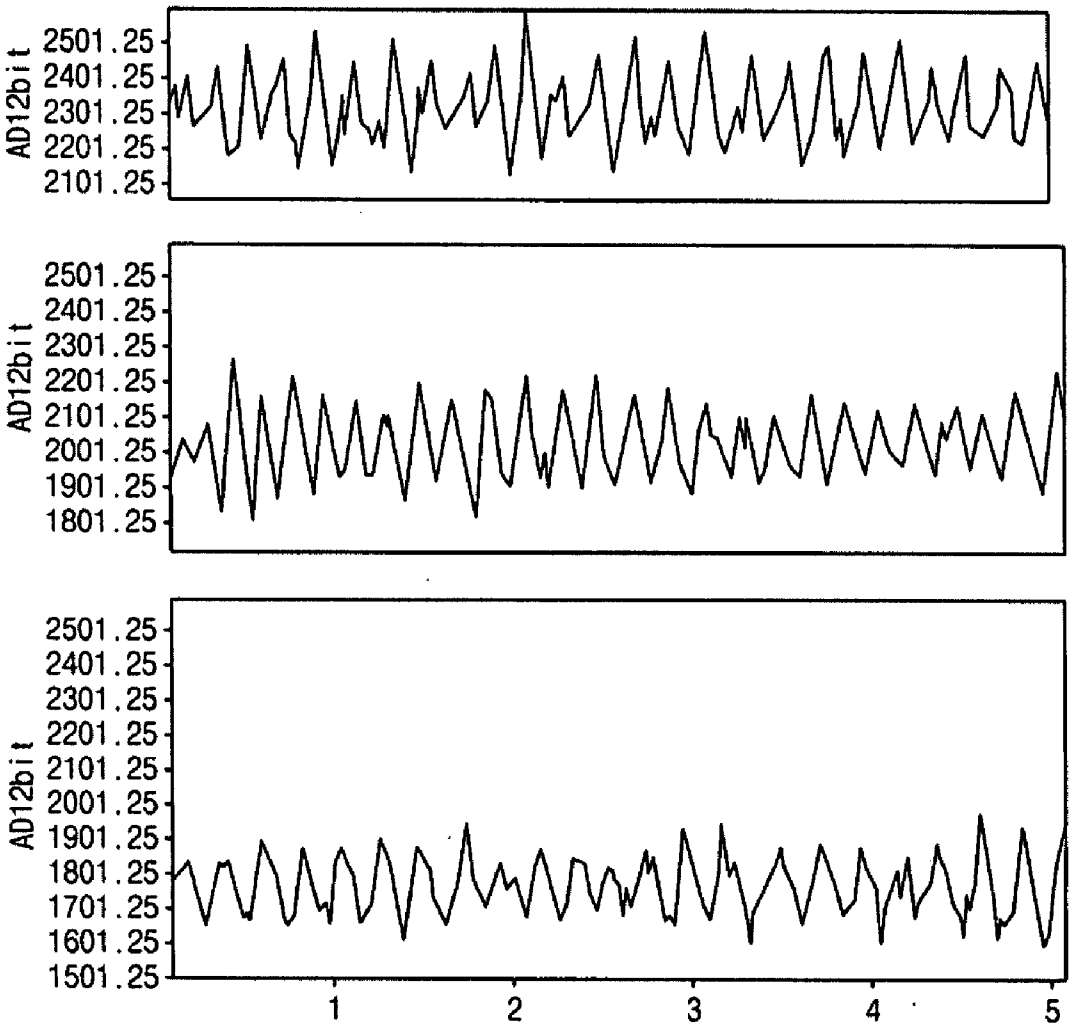
【Fig. 3】



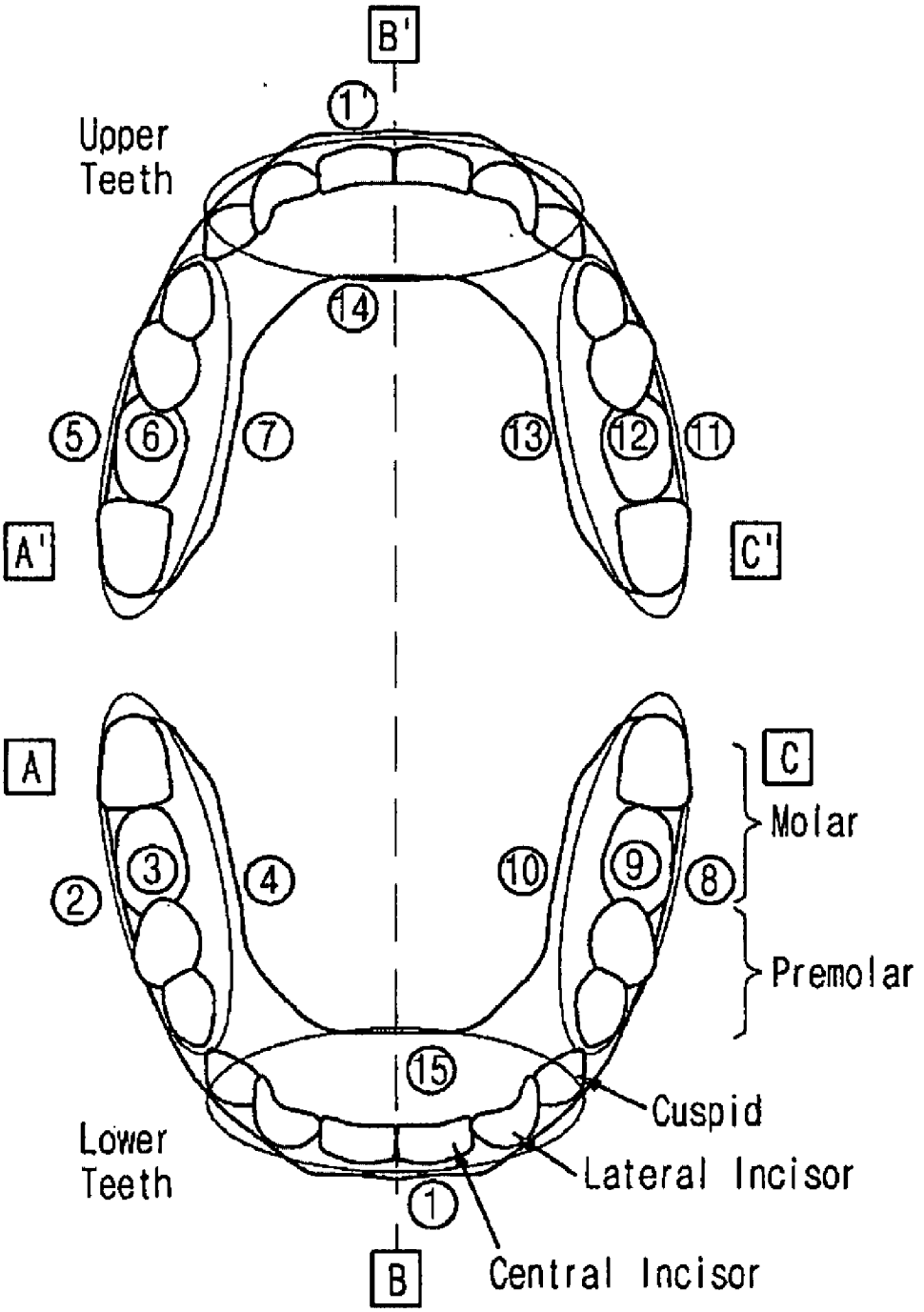
【Fig. 4】


4000.00
3600.00
3200.00
2800.00
2400.00
2000.00
1600.00
1200.00
800.00
400.00
0.00
AD12bit
Z Acceleration
X Acceleration
Y Acceleration
1
2
3
4
5
Time(sec)
3900.00
3600.00
3300.00
3000.00
2700.00
2400.00
2100.00
1800.00
1500.00
1200.00
900.00
600.00
300.00
0.00
AD12bit
Z Angular Velocity Meter
Geomagnetic Meter
Y Angular Velocity Meter
X Angular Velocity Meter
1
2
3
4
5
Time(sec)

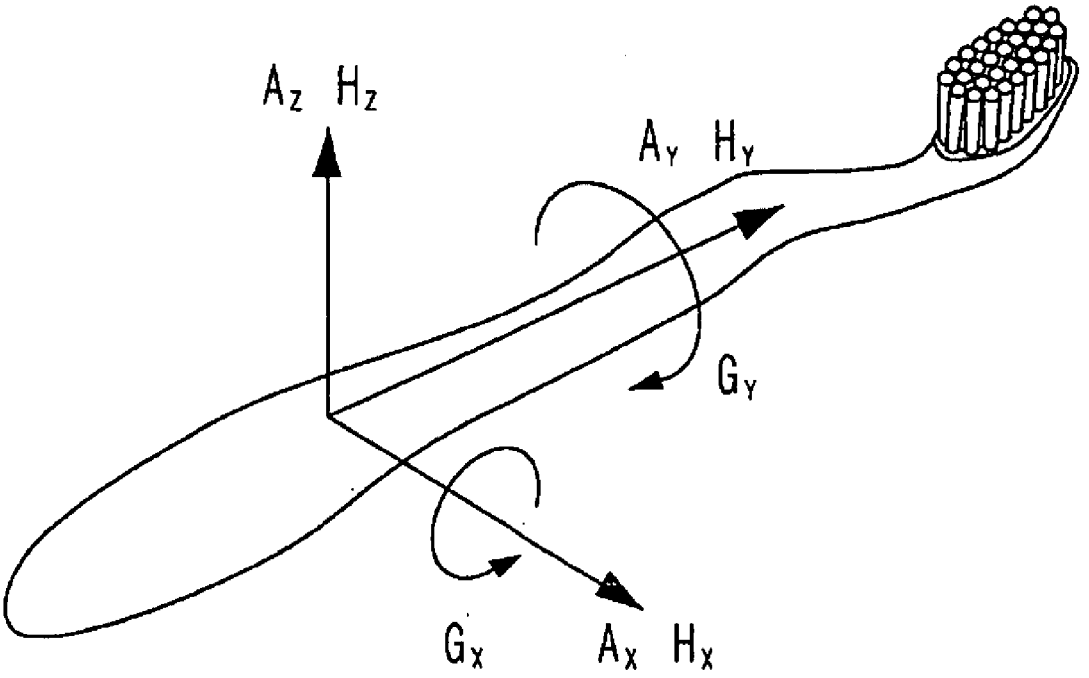
【Fig. 5】


AD12bit
2501.25
2401.25
2301.25
2201.25
2101.25
AD12bit
2501.25
2401.25
2301.25
2201.25
2101.25
2001.25
1901.25
1801.25
AD12bit
2501.25
2401.25
2301.25
2201.25
2101.25
2001.25
1901.25
1801.25
1701.25
1601.25
1501.25
1
2
3
4
5

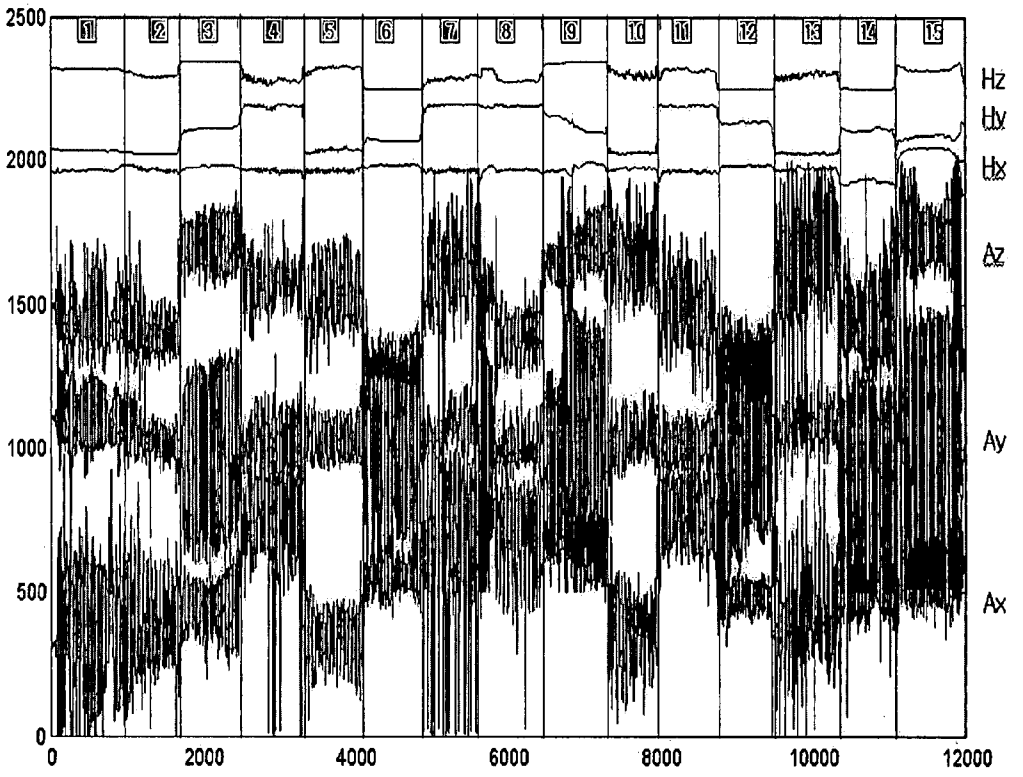
【 Fig. 6】


B'
1'
Upper Teeth
14
5
6
7
13
12
11
A'
C'
A
C
Molar
2
3
4
10
9
8
Premolar
15
Cuspid
Lower Teeth
Lateral Incisor
1
B
Central Incisor

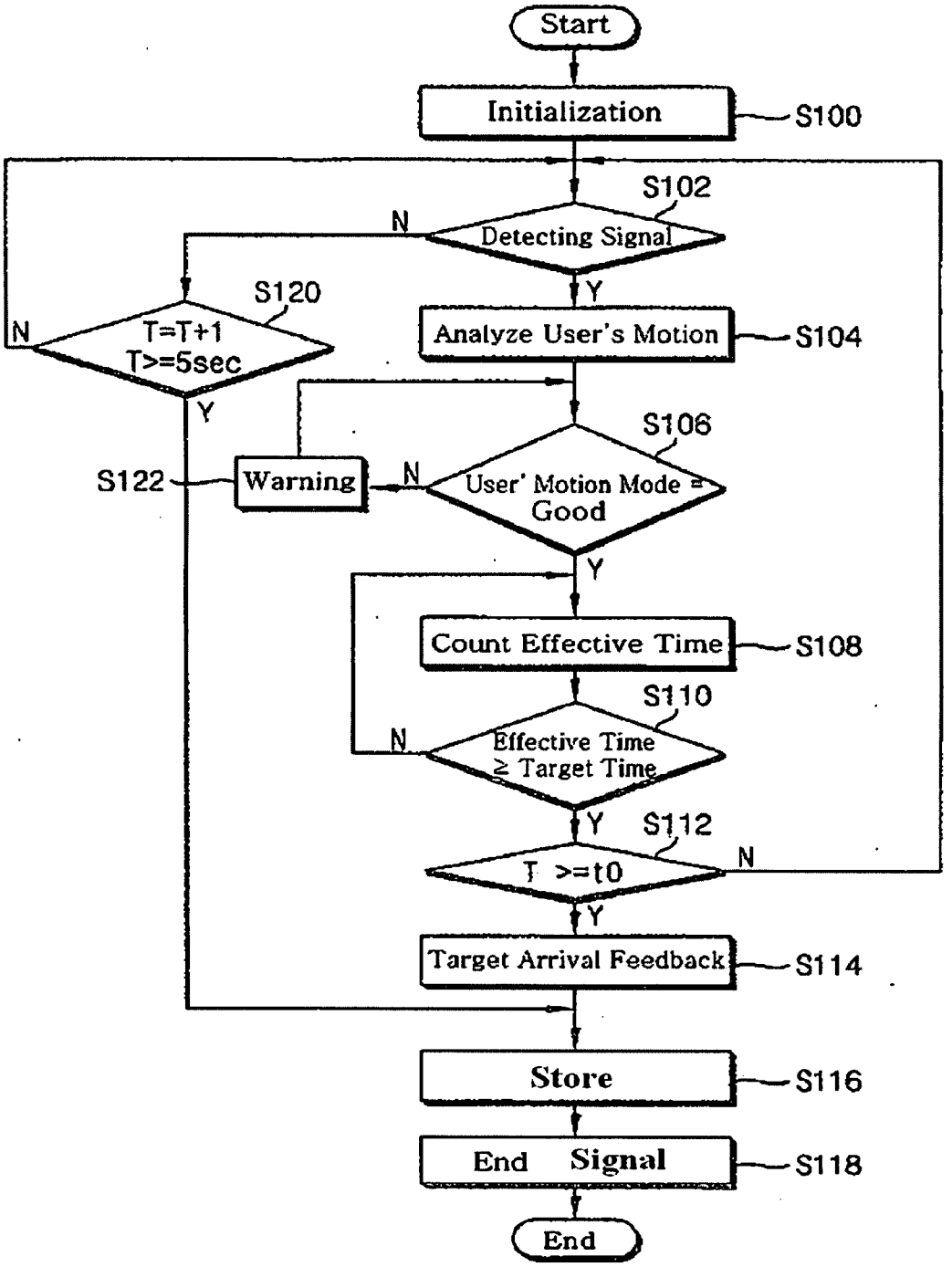
【Fig. 7】



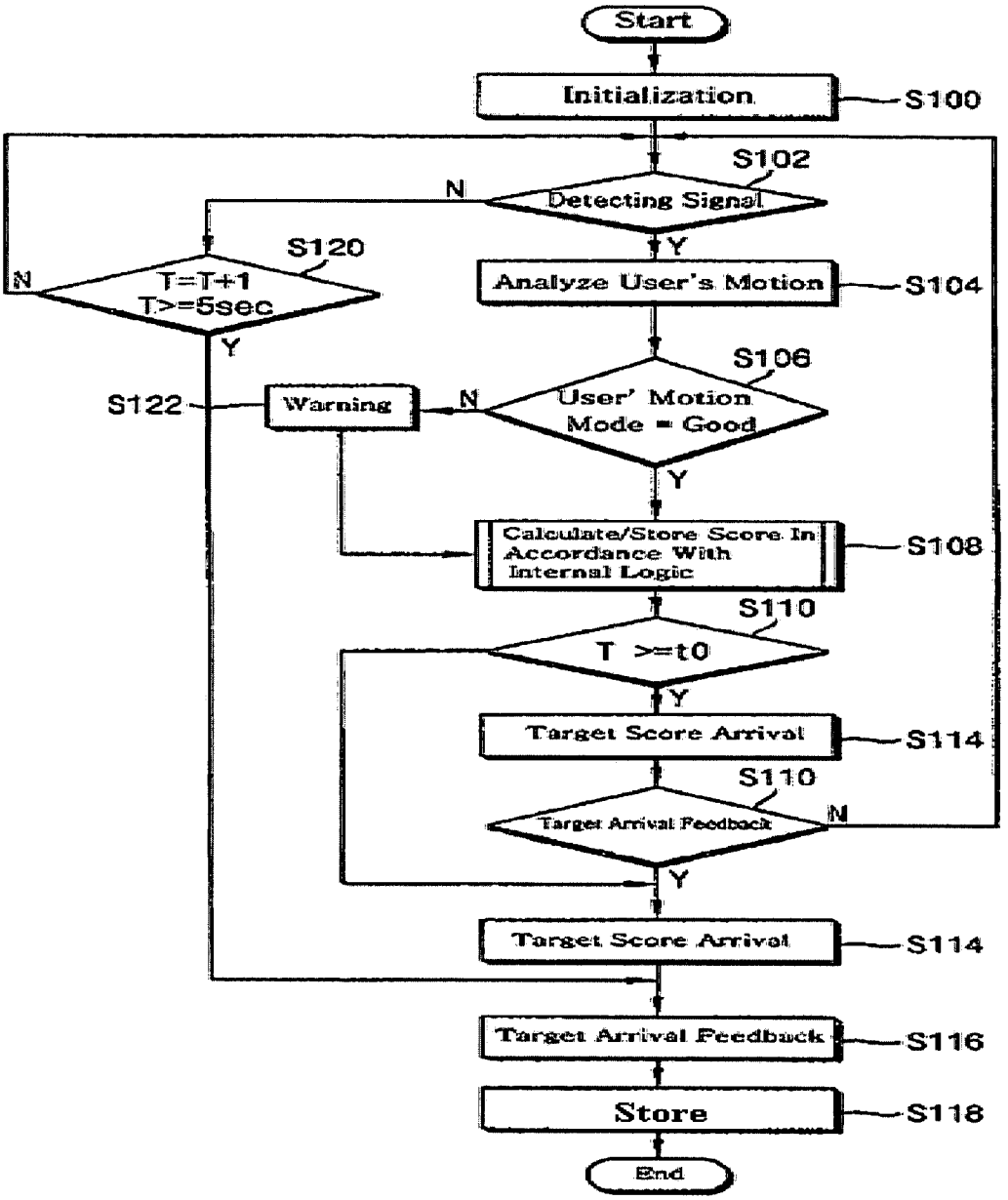
【Fig. 8】


2500
2000
1500
1000
500
0
0
2000
4000
6000
8000
10000
12000
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
Hz
Hy
Hx
Az
Ay
Ax

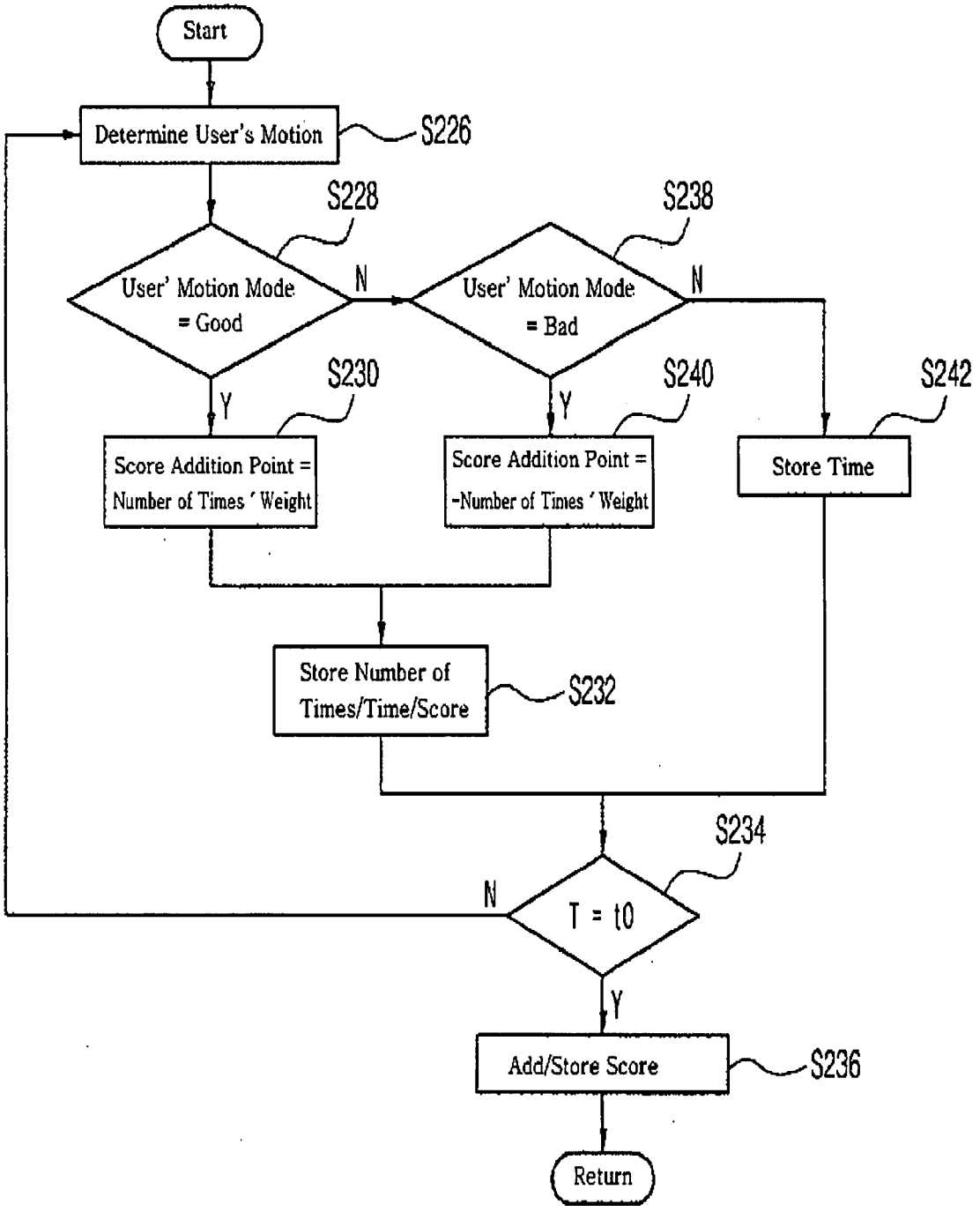
【Fig. 9】


Start
Initialization
S100
S102
Detecting Signal
N
Y
S120
T=T+1
T>=5sec
N
Y
Analyze User's Motion
S104
S106
User' Motion Mode = Good
N
S122
Warning
Y
Count Effective Time
S108
S110
Effective Time ≥ Target Time
N
Y
S112
T >=t0
N
Y
Target Arrival Feedback
S114
Store
S116
End Signal
S118
End

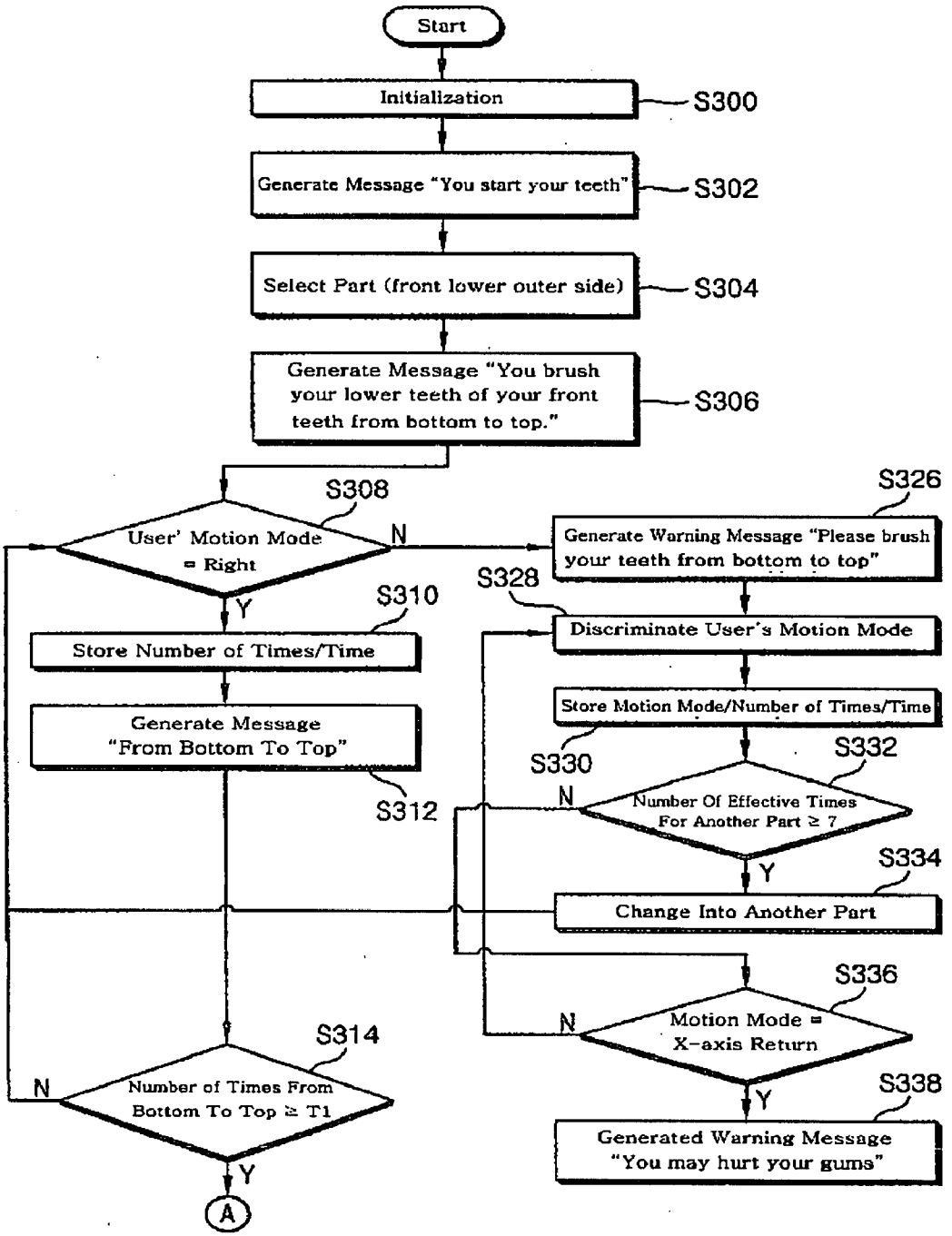
【Fig. 10】


Start
Initialization
S100
S102
Detecting Signal
N
Y
S120
T=T+1
T>=5sec
N
Y
Analyze User's Motion
S104
S106
User' Motion Mode = Good
N
Y
S122
Warning
Calculate/Store Score In Accordance With Internal Logic
S108
S110
T >=t0
Y
Target Score Arrival
S114
S110
Target Arrival Feedback
N
Y
Target Score Arrival
S114
Target Arrival Feedback
S116
Store
S118
End

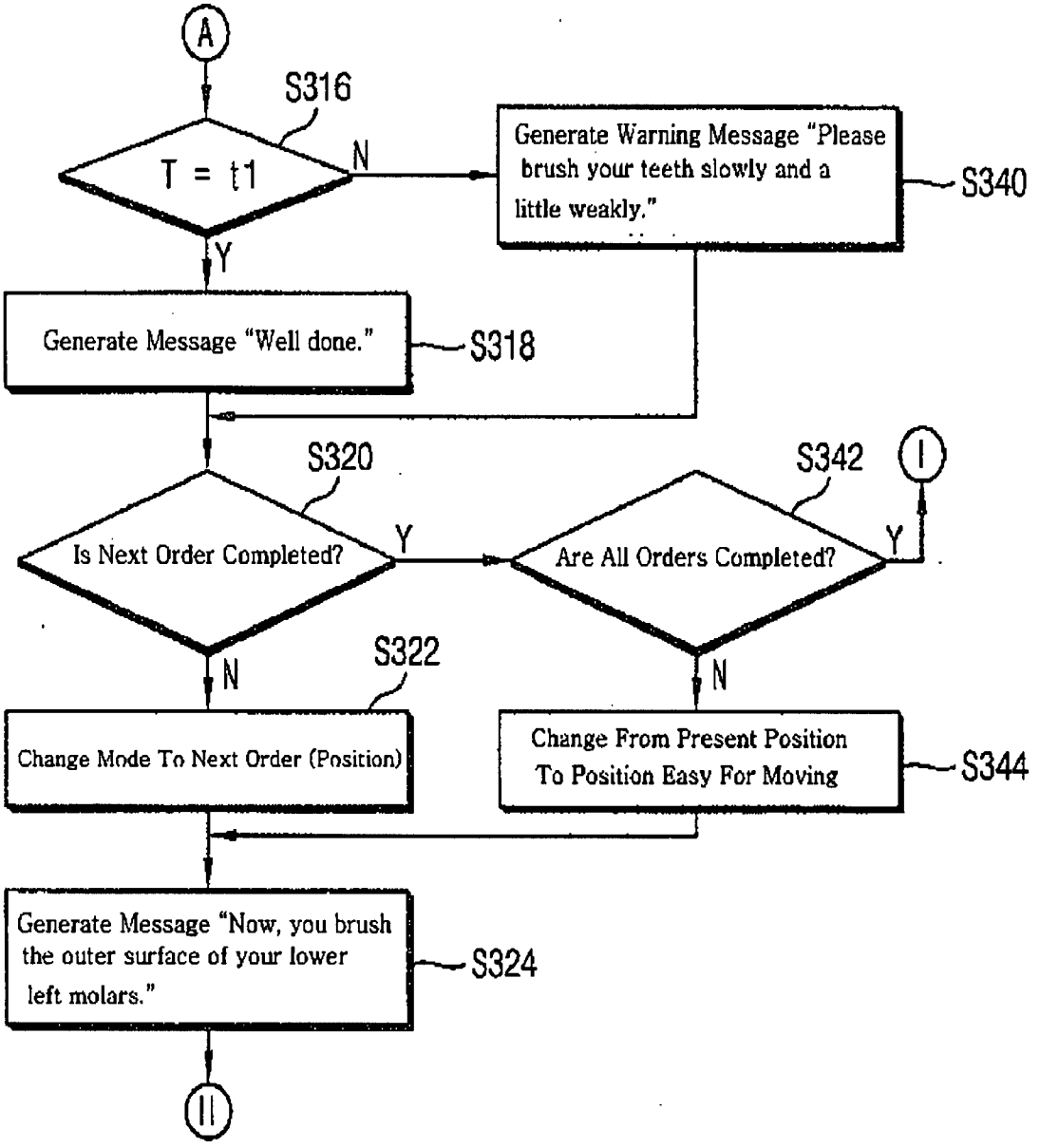
【Fig. 11】


Start
Determine User's Motion
S226
S228
User' Motion Mode = Good
N
S238
User' Motion Mode = Bad
N
Y
S230
Score Addition Point = Number of Times ' Weight
Y
S240
Score Addition Point = -Number of Times ' Weight
S242
Store Time
Store Number of Times/Time/Score
S232
S234
N
T = t0
Y
Add/Store Score
S236
Return

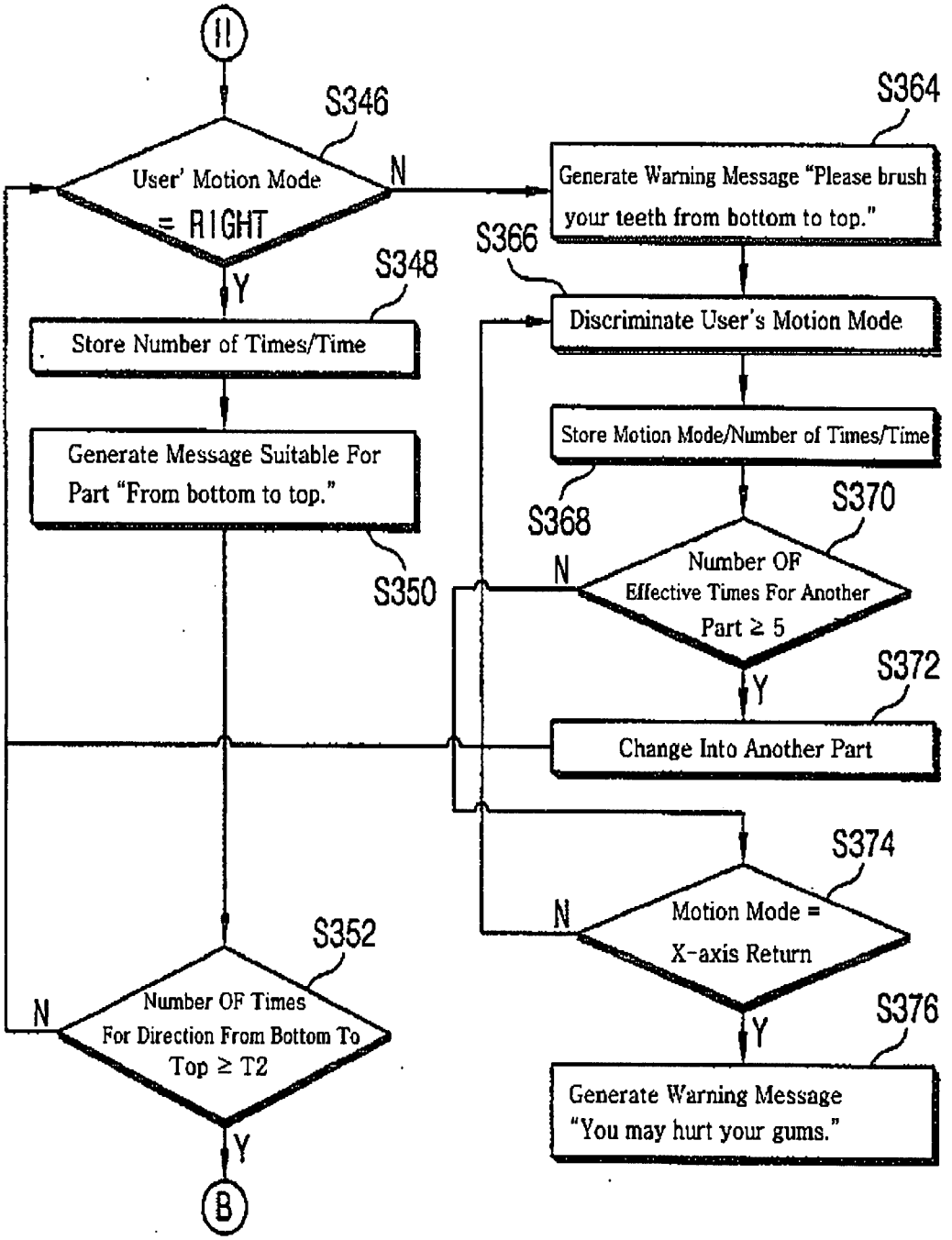
【Fig. 12】


Start
Initialization
S300
Generate Message "You start your teeth"
S302
Select Part (front lower outer side)
S304
Generate Message "You brush your lower teeth of your front teeth from bottom to top."
S306
S308
User' Motion Mode = Right
N
Y
S310
Store Number of Times/Time
Generate Message "From Bottom To Top"
S312
S314
Number of Times From Bottom To Top ≥ T1
N
Y
A
S326
Generate Warning Message "Please brush your teeth from bottom to top"
S328
Discriminate User's Motion Mode
Store Motion Mode/Number of Times/Time
S330
S332
Number Of Effective Times For Another Part ≥ 7
N
Y
S334
Change Into Another Part
S336
Motion Mode = X-axis Return
N
Y
S338
Generated Warning Message "You may hurt your gums"

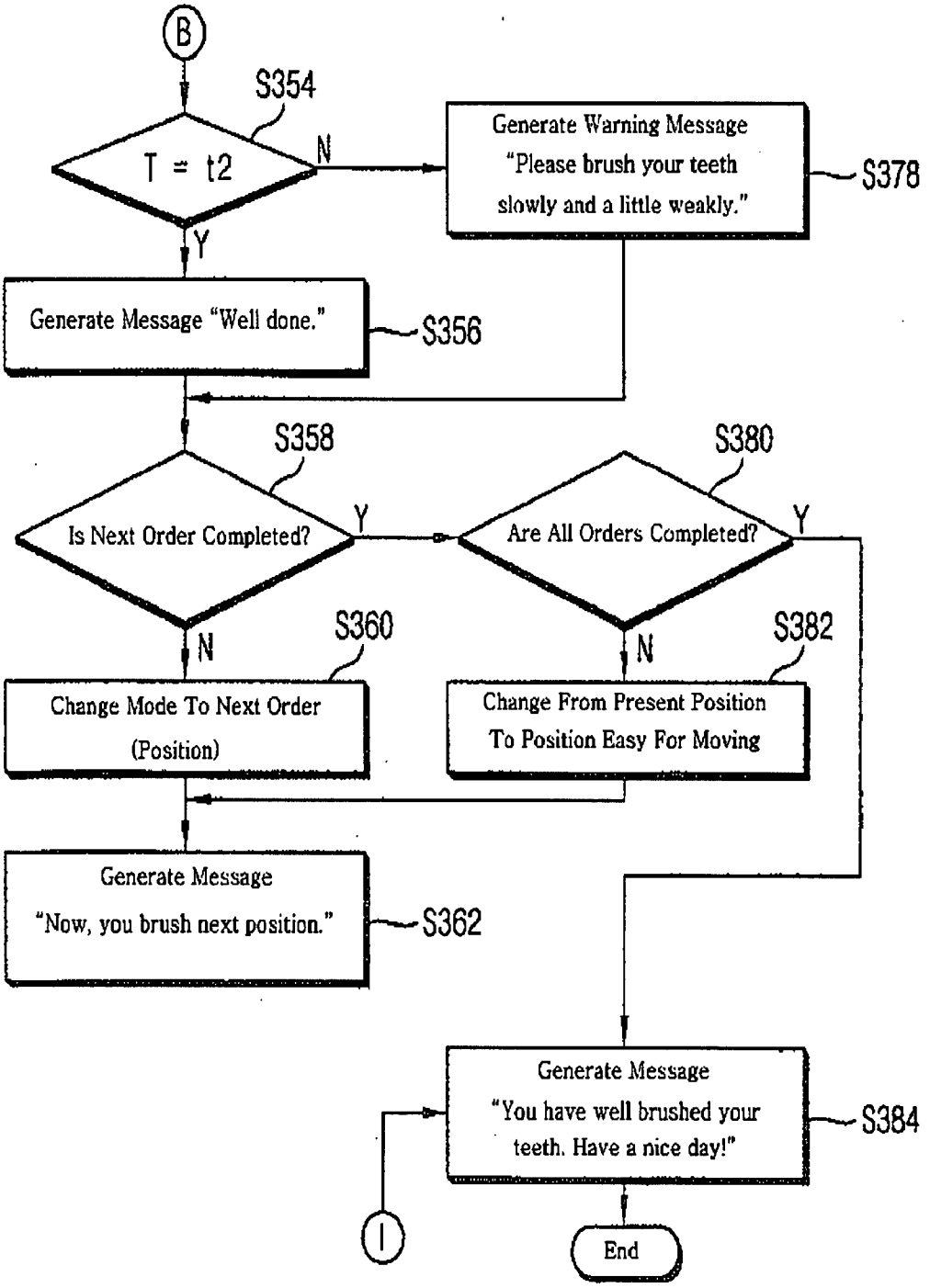
【Fig. 13】


A
S316
T = t1
N
Y
Generate Warning Message "Please brush your teeth slowly and a little weakly."
S340
Generate Message "Well done."
S318
S320
Is Next Order Completed?
Y
N
S342
Are All Orders Completed?
Y
N
I
S322
Change Mode To Next Order (Position)
Change From Present Position To Position Easy For Moving
S344
Generate Message "Now, you brush the outer surface of your lower left molars."
S324
II

【Fig. 14】


II
S346
User' Motion Mode = RIGHT
N
Y
S348
Store Number of Times/Time
Generate Message Suitable For Part "From bottom to top."
S350
S352
Number OF Times For Direction From Bottom To Top ≥ T2
N
Y
B
S364
Generate Warning Message "Please brush your teeth from bottom to top."
S366
Discriminate User's Motion Mode
Store Motion Mode/Number of Times/Time
S368
S370
Number OF Effective Times For Another Part ≥ 5
N
Y
S372
Change Into Another Part
S374
Motion Mode = X-axis Return
N
Y
S376
Generate Warning Message "You may hurt your gums."

【Fig. 15】


B
S354
T = t2
N
Y
Generate Warning Message
"Please brush your teeth
slowly and a little weakly."
S378
Generate Message "Well done."
S356
S358
Is Next Order Completed?
Y
N
S380
Are All Orders Completed?
Y
N
S360
Change Mode To Next Order
(Position)
S382
Change From Present Position
To Position Easy For Moving
Generate Message
"Now, you brush next position."
S362
Generate Message
"You have well brushed your
teeth. Have a nice day!"
S384
I
End

【Fig. 16】

Health Toothbrushing Diary

Name (Age): Na, Geon Gang	2005. 5. 5

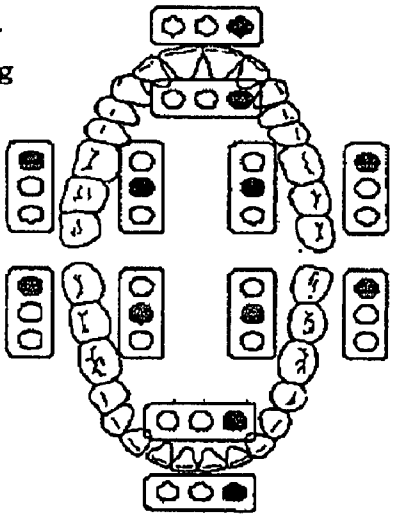
Yesterday, Na, Geon Gang very well brushed your teeth tree times. Although the mean toothbrushing time is rather good as 2 minutes and 10 seconds, you should prolong your toothbrushing time.
Also, you tend to brush your teeth back and forth when you brush right and left sides of your molars. In this case, you are likely to hurt your gums, so please brush your teeth above and below, your lower teeth from bottom to top, and your upper teeth from top to bottom.

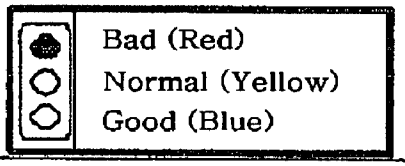
Toothbrushing Time/Elapsing Time

Toothbrushing time	07:00	12:45	19:00	-	-
Elapsing Time	2min 10sec	1min 20sec	1min 0sec	-	-

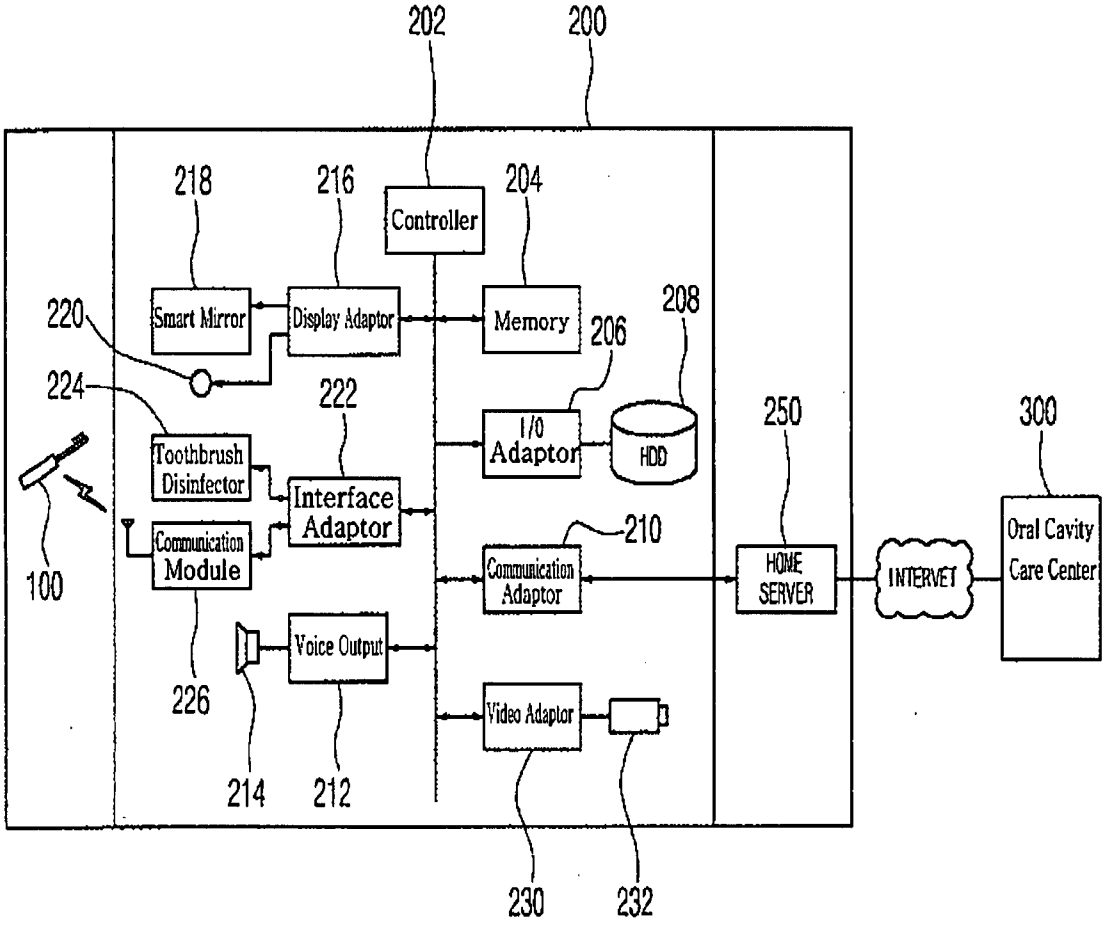
Toothbrushing Behavior Analysis

Please brush both side parts of your molars above and below, and prolong the toothbrushing times for both the side parts of your molars by 5 seconds, respectively.

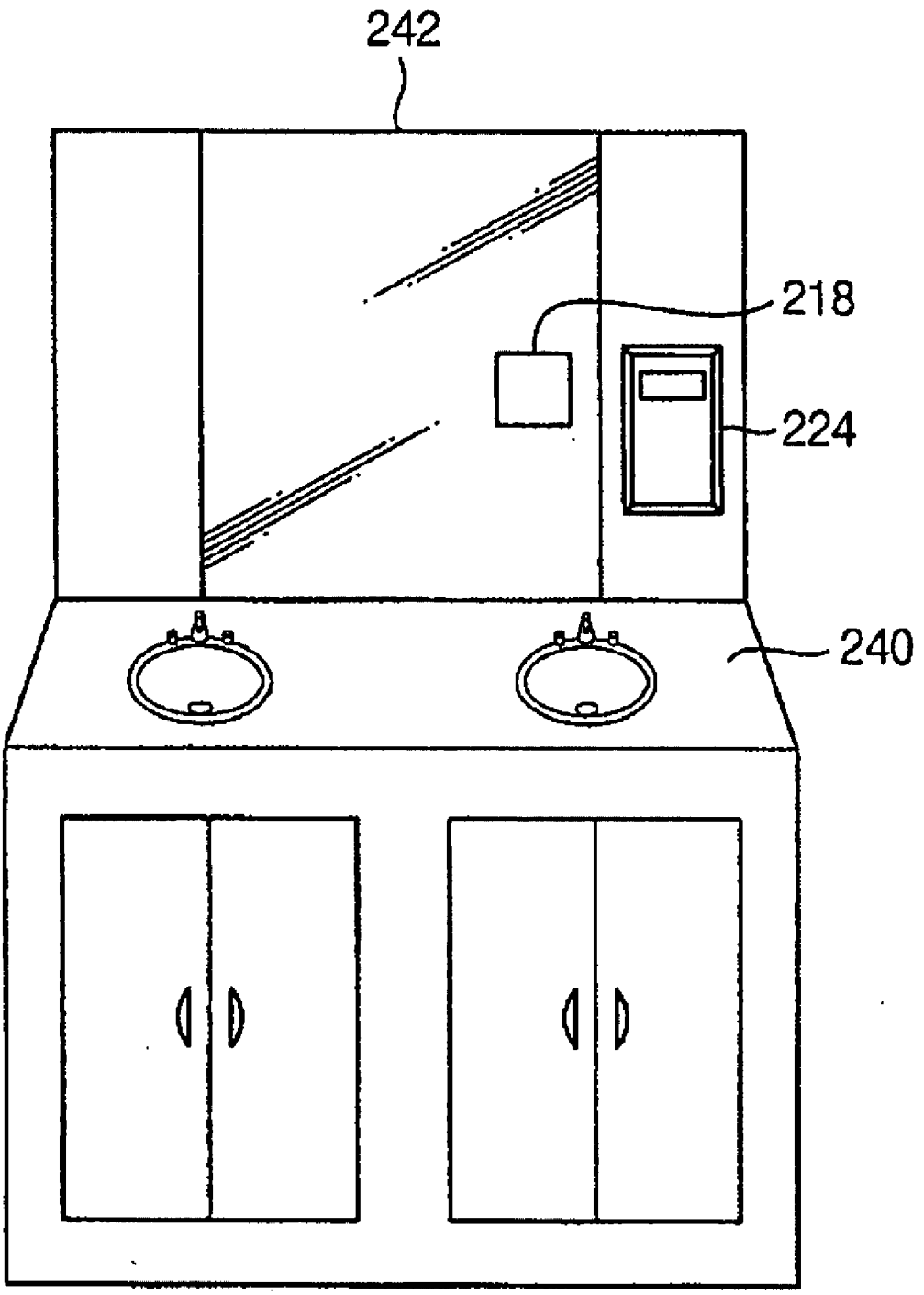




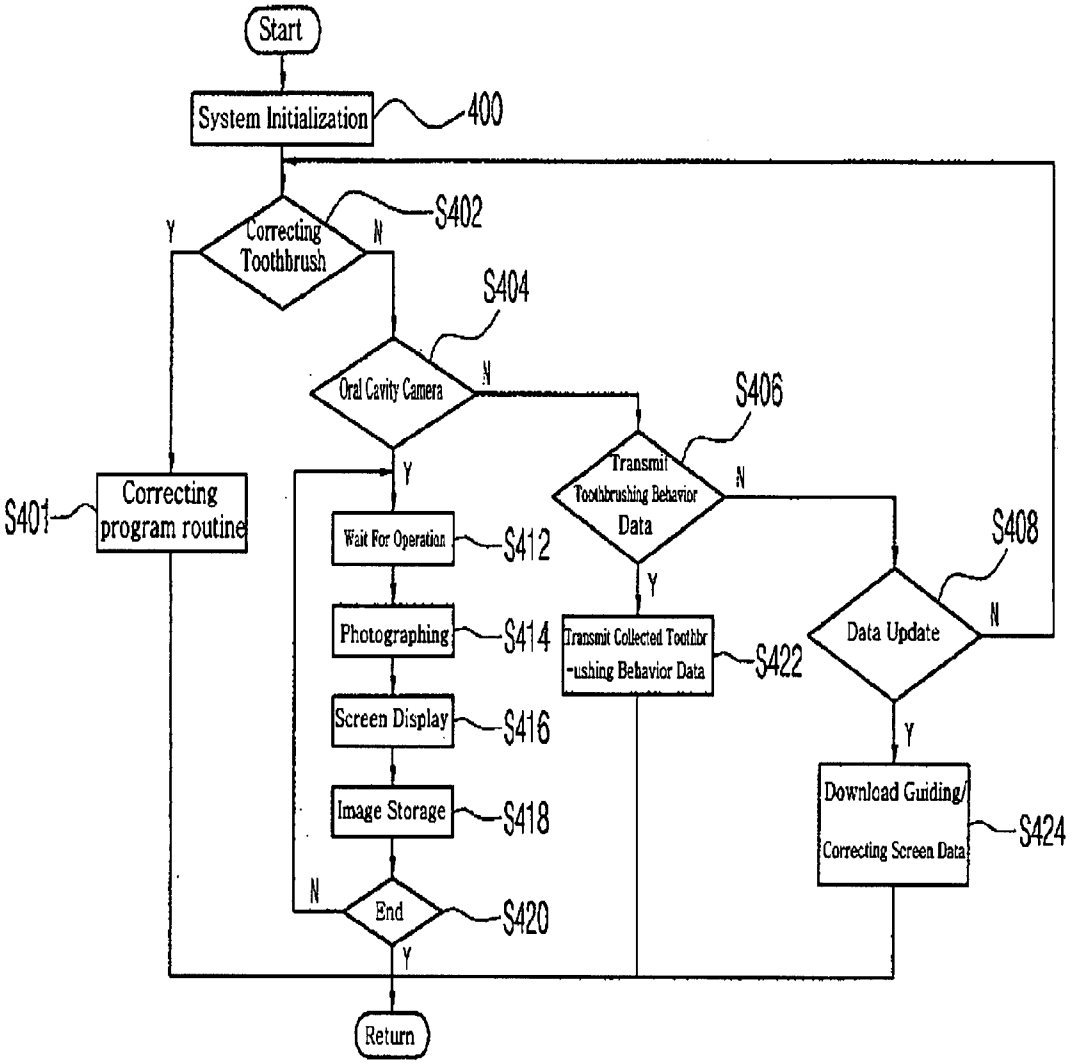
【Fig. 17】


202
200
218
216
204
Controller
Smart Mirror
Display Adaptor
Memory
220
208
206
224
222
Toothbrush Disinfector
I/O Adaptor
HDD
250
300
Interface Adaptor
100
Communication Module
210
Communication Adaptor
HOME SERVER
INTERVET
Oral Cavity Care Center
Voice Output
226
Video Adaptor
214
212
230
232

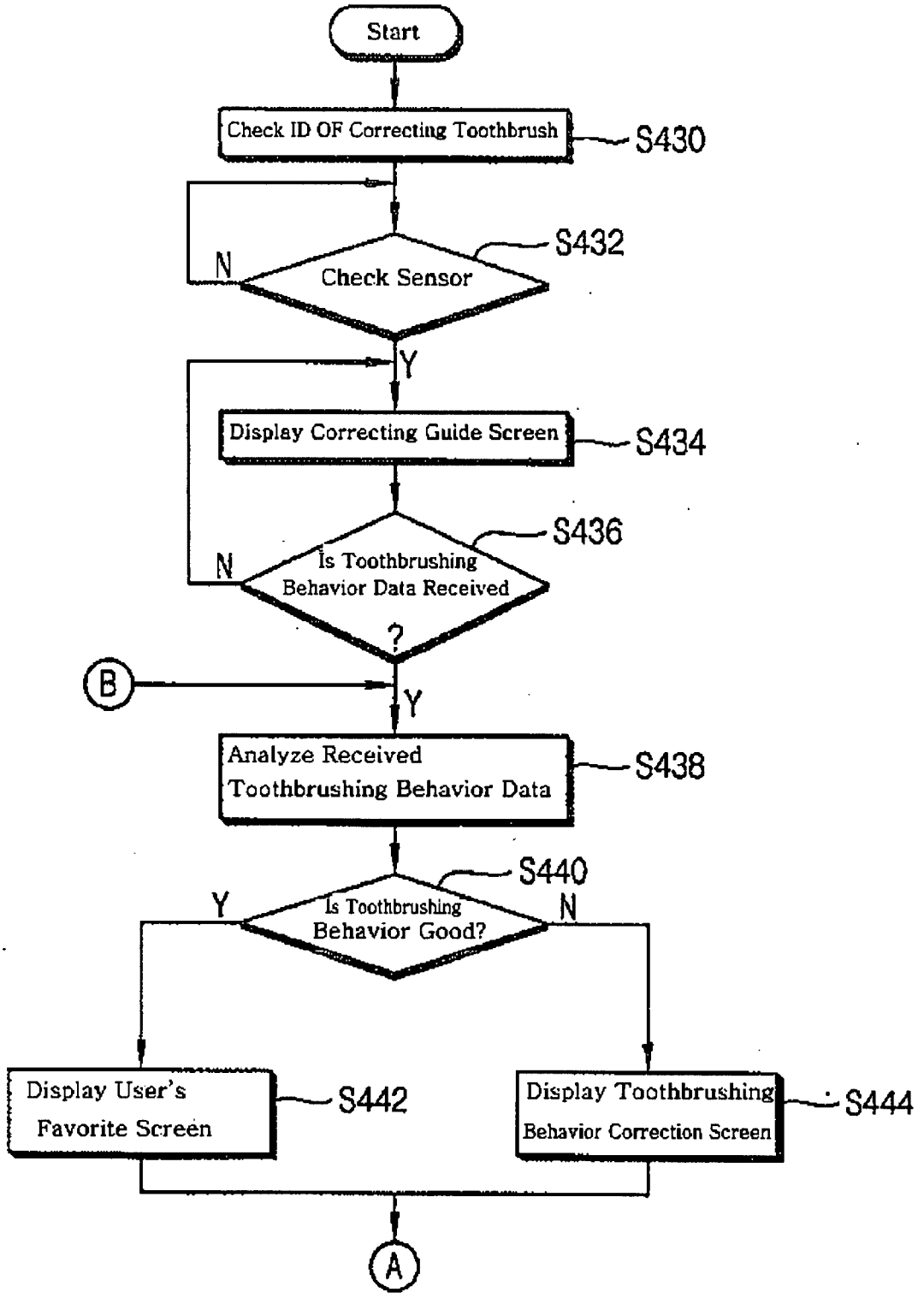
【Fig. 18】



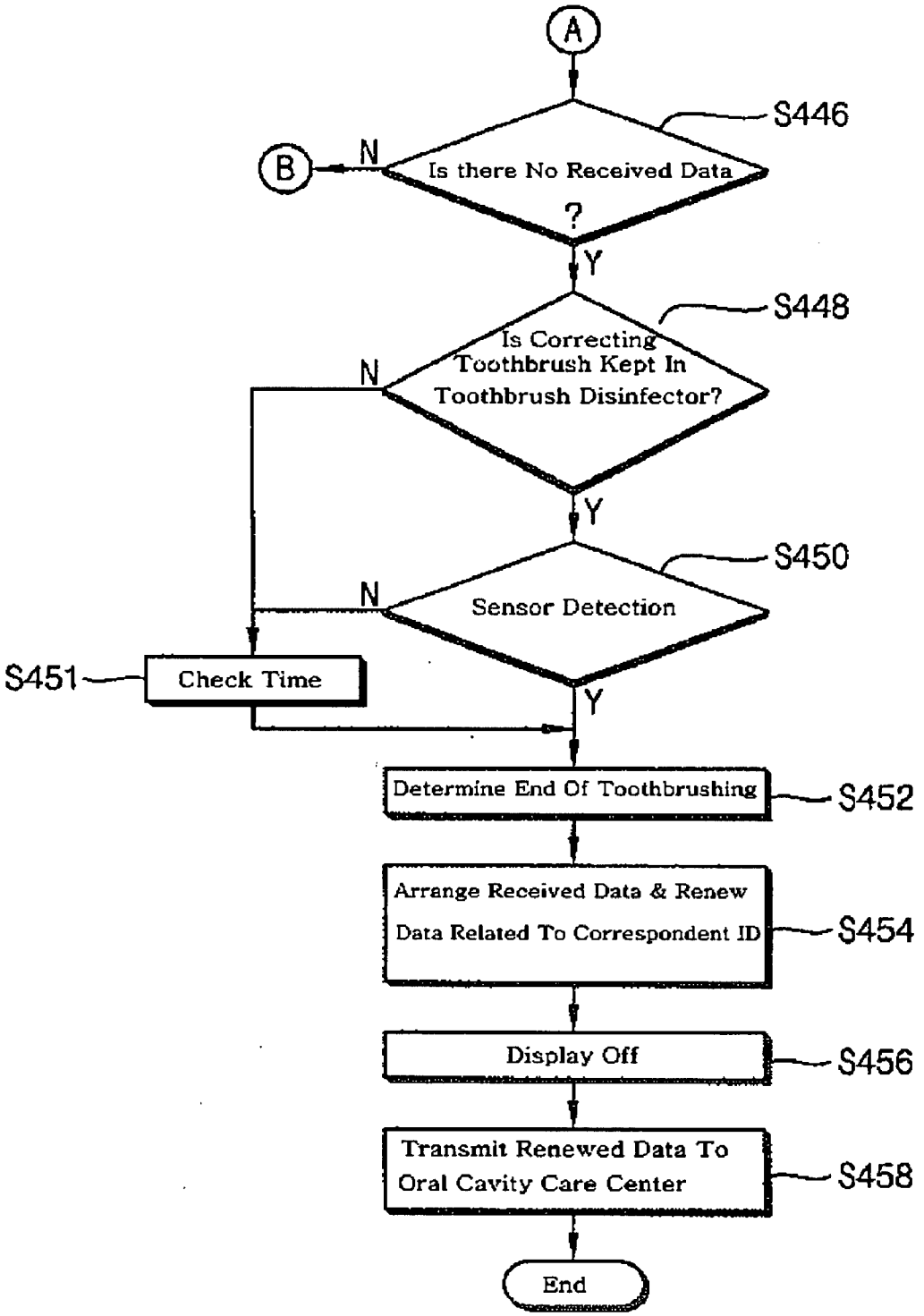
【Fig. 19】


Start
System Initialization
400
Correcting Toothbrush
S402
Y
N
S404
Oral Cavity Camera
N
S406
Transmit Toothbrushing Behavior Data
N
Y
S401
Correcting program routine
Wait For Operation
S412
Photographing
S414
Screen Display
S416
Image Storage
S418
End
S420
N
Y
Transmit Collected Toothbr-ushing Behavior Data
S422
S408
Data Update
N
Y
Download Guiding/ Correcting Screen Data
S424
Return

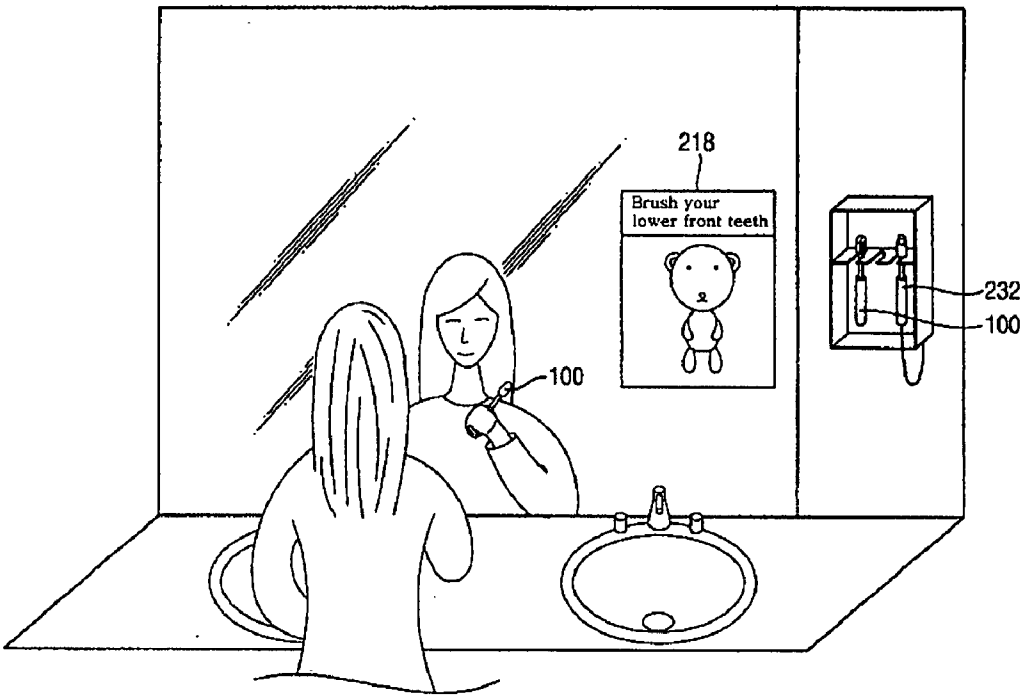
【Fig. 20】


Start
Check ID OF Correcting Toothbrush
S430
S432
N
Check Sensor
Y
Display Correcting Guide Screen
S434
S436
N
Is Toothbrushing Behavior Data Received ?
B
Y
Analyze Received Toothbrushing Behavior Data
S438
S440
Y
Is Toothbrushing Behavior Good?
N
Display User's Favorite Screen
S442
Display Toothbrushing Behavior Correction Screen
S444
A

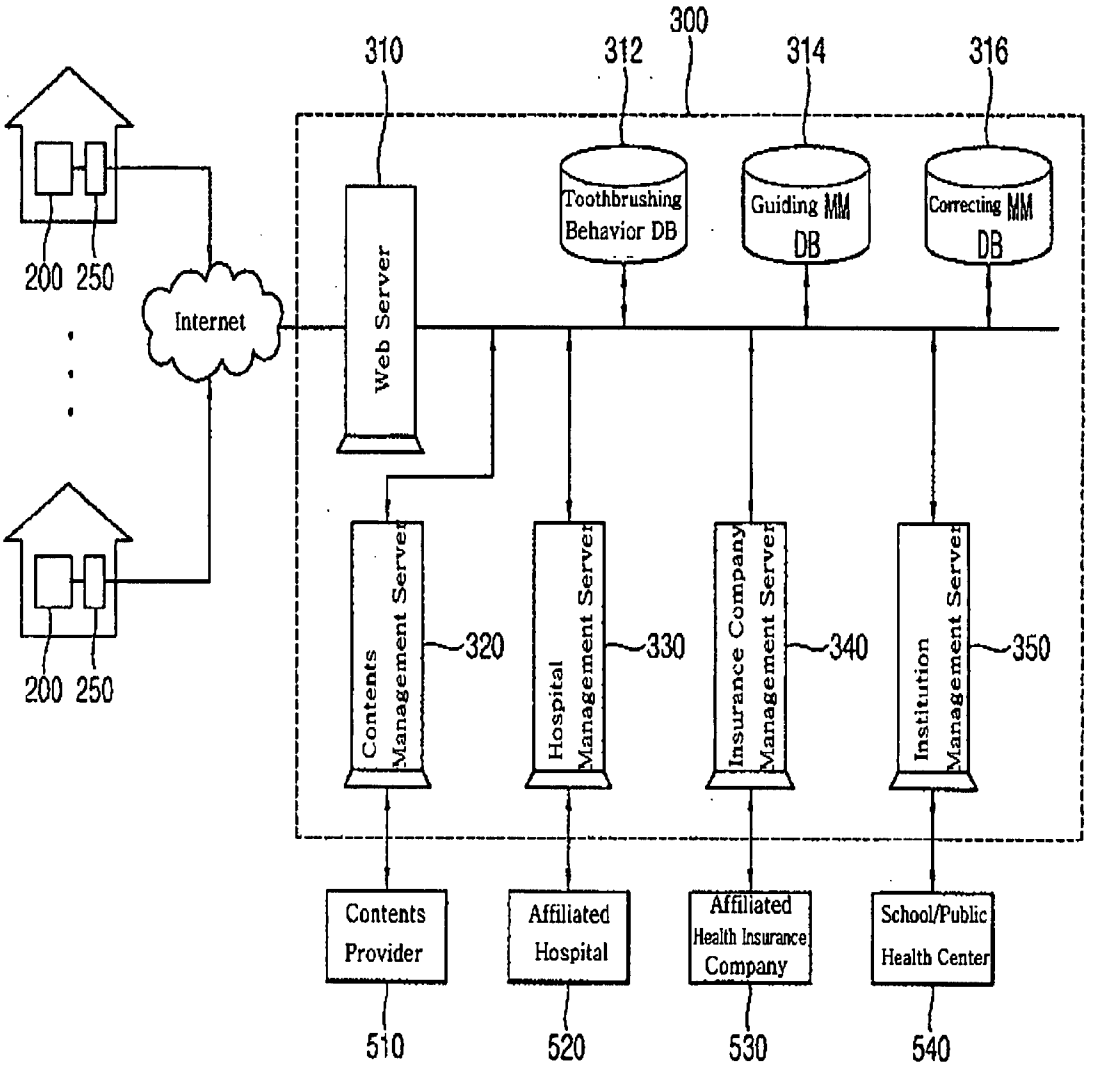
【Fig. 21】


A
S446
B
N
Is there No Received Data
?
Y
S448
Is Correcting
Toothbrush Kept In
Toothbrush Disinfector?
N
Y
S450
N
Sensor Detection
S451
Check Time
Y
Determine End Of Toothbrushing
S452
Arrange Received Data & Renew
Data Related To Correspondent ID
S454
Display Off
S456
Transmit Renewed Data To
Oral Cavity Care Center
S458
End

【Fig. 22】



【Fig. 23】


300
310
312
314
316
Toothbrushing Behavior DB
Guiding MM DB
Correcting MM DB
Web Server
Internet
200 250
200 250
Contents Management Server
320
Hospital Management Server
330
Insurance Company Management Server
340
Institution Management Server
350
Contents Provider
Affiliated Hospital
Affiliated Health Insurance Company
School/Public Health Center
510
520
530
540

TOOTH BRUSHING PATTERN ANALYZING/MODIFYING DEVICE, METHOD AND SYSTEM FOR INTERACTIVELY MODIFYING TOOTH BRUSHING BEHAVIOR

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of Korean Application Nos. 10-2005-0053269, filed Jun. 20, 2005, and 10-2005-0108830, filed Nov. 15, 2005, and PCT Application No. PCT/KR2006/002174, filed Jun. 7, 2006 in the Korean Intellectual Property Office, the disclosures of which are incorporated herein by reference.

BACKGROUND

[0002] 1. Field

[0003] One or more embodiments relate to a tooth brushing pattern analyzing and behavior correcting device used for forming correct tooth brushing behavior, and more particularly to a tooth brushing pattern analyzing and behavior correcting device, which can promote a user to form correct tooth brushing behavior by analyzing the user's tooth brushing behavior and allowing the results to be fed back to the user or a third person.

[0004] Further, the embodiments relate to a method and a system for interactively correcting tooth brushing behavior, and more specifically to a method and a system for interactively correcting the user's tooth brushing behavior in real time.

[0005] 2. Description of the Related Art

[0006] Teeth are one of parts of the human body that are not reproduced naturally, and it goes without saying that correct dental care is important. Tooth brushing is the most basic method of correct dental care and can function not only to prevent tooth decay and gum disease but also as a remedy.

[0007] Tooth brushing functions not only to clean but also to make gums healthy by massaging the gums. Although it is most desirable to brush one's teeth after every meal, it is still effective and highly recommended to brush one's teeth at least after breakfast and before going to bed.

[0008] Although there are various methods of brushing one's teeth, correct tooth brushing is to basically brush from gums to teeth rubbing up and down, as advised by dentists. That is, it is most preferable to brush from top to bottom when brushing the upper teeth and from bottom to top for the lower teeth. Such a tooth brushing method can have an effect even when tooth brushing is carried out only for molar teeth on both sides of the oral cavity.

[0009] However, such a correct tooth brushing method is a method difficult to practice unless a person has been thoroughly educated and conventionalized since childhood, and it is true that most people have poor recognition of this. As such, a tooth brushing method used as a basic method by most people will be discussed. The tooth brushing method is to brush their teeth in horizontally, i.e. in a front to rear direction. Such a tooth brushing method has the problem of the teeth getting worn away in some cases, and the occurrence of various kinds of diseases due to unnecessary stimuli.

[0010] Meanwhile, studies on such tooth brushing, i.e. as carried out by people regardless of age and gender, have been conducted for a long period of time. For more effective tooth brushing, there has been suggested a variety of techniques in which toothbrush bristles are improved to be softer and thinner; the shape of a head having bristles formed thereon or a handle are improved; or the like so that a user can brush his/her teeth conveniently and effectively.

[0011] In Korean Utility Model Publication No. 2002-0037916 as prior art related thereto, there is disclosed a toothbrush in which a single pendulum for indicating the number of tooth brushing strokes is installed in the handle part of the toothbrush so as to correct tooth brushing behavior and prevent tooth decay. Since such a method does not provide a correct tooth brushing method, it cannot prevent abrasion of teeth or development of gum diseases.

[0012] In Japanese Patent Laid-open Publication No. Hei 9-168428, there is disclosed a device for detecting the time when a user starts brushing his teeth and informing through a guiding message after a certain time elapses so as to conventionalize tooth brushing and assist a user in brushing his/her teeth pleasantly and voluntarily.

[0013] Meanwhile, in US Patent Publication No. 2003/0017874, there is disclosed a toothbrush with a built-in electro-game device in which it is determined whether or not a user uses the toothbrush to influence the score of a game using an "operation detecting component" for helping to form good tooth brushing behavior so that the behavior of the user can be improved.

[0014] However, the conventional techniques focus on simply imparting a user's tooth brushing behavior and simply measuring the time or the number of strokes while a user brushes his/her teeth. Thus, there is a disadvantage in that a pattern of whether a user brushes his/her teeth correctly or incorrectly is not sensed and accordingly, appropriate feedback for inducing correct tooth brushing behavior is also not provided.

[0015] Further, there is also a disadvantage in that information is not provided to third persons such as parents or teachers as to whether or not a child's tooth brushing behavior is correct or not.

[0016] In U.S. Pat. No. 6,786,732, there is disclosed a technique in which a tooth brushing pattern can be monitored through a toothbrush for sensing the tooth brushing pattern. In this patent, a tooth brushing pattern is analyzed by monitoring the relative position of a toothbrush with respect to the arrangement of the teeth for each time period.

[0017] However, there has been no system for positively guiding a user to correct his/her inappropriate toothbrushing behavior through monitoring a user's tooth brushing pattern, analysis of whether or not a user's tooth brushing pattern and behavior are correct, and real-time feedback for these monitorings and analyses.

SUMMARY

[0018] Additional aspects and/or advantages will be set forth in part in the description which follows and, in part, will be apparent from the description, or may be learned by practice of the invention.

[0019] Accordingly, an embodiment has been made to solve the above-mentioned problems occurring in the prior art, and an aspect is to provide a device and a method for analyzing tooth brushing pattern and correcting tooth brushing behavior, which can be combined with a tooth brush to analyze a user's tooth brushing pattern while a user carries out simple tooth brushing.

[0020] Further, another aspect of the embodiments discussed herein enables a user to easily estimate his/her own

tooth brushing pattern by providing the user with feedback of the user's analyzed tooth brushing pattern.

[0021] Furthermore, another aspect is to provide a system for analyzing a tooth brushing pattern, which can allow a third party (parent, teacher, dentist) to precisely analyze a user's tooth brushing pattern to effectively correct the user's tooth brushing pattern.

[0022] Another aspect is to provide a method and a system for interactively correcting tooth brushing behavior, which enables a user to naturally form correct tooth brushing behavior by interactively correcting the user's tooth brushing behavior in real time.

[0023] A further aspect is to provide a method and a system for interactively correcting tooth brushing behavior, which enables a user to naturally maintain an effective tooth brushing time by providing multimedia that is of interest to the user while the user brushes his/her teeth.

[0024] Still a further aspect discussed herein is to provide a method and a system for interactively correcting tooth brushing behavior, which can enhance compliance through which a user can recognize how important correct tooth brushing behavior is by providing in real time a material screen displaying information on the negative effects of bad tooth brushing behavior.

[0025] Yet a further aspect discussed herein is to provide a method and a system for interactively correcting tooth brushing behavior, which can monitor the personal health condition throughout one's life by incorporating the analyzed results of a user's daily tooth brushing behavior into a database.

[0026] Yet another aspect discussed herein is to provide a method and a system for interactively correcting tooth brushing behavior, wherein data on the user's monitored tooth brushing behavior and an oral cavity health condition is sent in real time to an oral cavity care center connected on-line so that a remote oral cavity health consultation is possible on the basis of this data.

[0027] In order to accomplish these embodiments, there is provided a tooth brushing pattern analyzing/correcting device having a tooth brushing pattern analyzer, which includes: a body part formed in the same direction as a toothbrush surface; a sensing unit having a sensor with at least one or more axes for sensing a user's tooth brushing motion and a sensor with one or more axes for sensing two or more tooth brushing positions; and a controller for operating signals input from the sensing unit to divide the user's tooth brushing motion into at least two or more patterns and at least two or more tooth brushing parts.

[0028] In accordance with another aspect of the embodiment, there is provided a tooth brushing pattern analyzing/correcting device, which includes: a body part formed in the same direction as the toothbrush surface; a sensing unit having a sensor with at least one or more axes for sensing a user's tooth brushing motion and a sensor with one or more axes for sensing two or more tooth brushing positions; a controller for operating signals input from the sensing unit to classify a user's tooth brushing motion into at least two or more patterns and at least two or more tooth brushing parts; a storing unit for storing estimated data; and an output unit for outputting stored data.

[0029] In accordance with a further aspect of the embodiment, there is provided a tooth brushing pattern analyzing method, which includes the steps of: sensing a user's tooth brushing pattern to generate and store measurement data; generating result data by comparing/operating the measurement data and guide data in accordance with a preset tooth brushing pattern; and analyzing and storing the result data.

[0030] The tooth brushing pattern analyzing method according to an aspect of the embodiment may further include: informing of the start of tooth brushing on a user's demand; and outputting a preset tooth brushing part and/or the number of tooth brushing strokes for each part as voice or in text form. The step of storing the measurement data may include a step of sensing a user's tooth brushing part and/or the number of tooth brushing strokes for each part to store them.

[0031] Further, the tooth brushing pattern analyzing method according to an aspect may further include: analyzing and outputting the result data by comparing/operating the measurement data and the guide data such that the user's tooth brushing pattern is estimated for each operation.

[0032] A method of an embodiment includes: detecting the beginning of a user's tooth brushing; displaying a guiding screen in response to the beginning of a user's tooth brushing; detecting a user's tooth brushing pattern; analyzing the user's detected tooth brushing pattern; and providing a tooth brushing correction screen in a direction for increasing compliance in accordance with the analyzed result.

[0033] Here, the guiding screen is an image for guiding the user to a correct tooth brushing method, which may be configured by overlapping the user's favorite image material with tooth brushing guide information. For example, a correct tooth brushing order may be displayed at one side of the screen with background of a favorite animation if user is a child, the day's news or a sports image may serve as a background for adults, and a soap opera for housewives. Further, the tooth brushing correction screen may include a warning about a user's tooth brushing method, correct tooth brushing method, and advice for medical treatment plan/schedule and oral cavity health prevention/management off-line. Such guiding and tooth brushing correction screens may be renewed periodically, e.g. by the day, week or month.

[0034] According to another aspect of the embodiment, the detected tooth brushing pattern is any one or more of information on the direction of a user's tooth brushing, tooth brushing stroke/elapsing time, toothbrush velocity and oral cavity condition.

[0035] According to another aspect of the embodiment, the analyzed result of the tooth brushing pattern includes any one or more of estimations for a user's good/bad tooth brushing pattern, tooth brushing score, compliance, progressive trend and oral cavity health condition.

[0036] A system of an aspect of embodiments discussed herein includes: a tooth brushing pattern analyzing/correcting device for detecting a user's tooth brushing pattern; and a smart bath for providing a user with a guiding screen in communication with the tooth brushing pattern analyzing/correcting device, analyzing the user's received tooth brushing pattern, and providing a tooth brushing correction screen in a direction for increasing compliance in accordance with the analyzed result.

[0037] According to another aspect of the embodiment, the tooth brushing pattern analyzing/correcting device and the smart bath are connected to each other wire/or wireless to transmit and receive detected tooth brushing pattern data.

[0038] The smart bath may include a smart mirror combined with a bathroom mirror to be used as a mirror for general use and display the guiding screen and the tooth brushing correction screen in a display mode. Further, the

smart bath may further include a toothbrush disinfector for keeping the tooth brushing pattern analyzing/correcting device therein, and the toothbrush disinfector detects in-use and in-storing modes of the tooth brushing pattern analyzing/correcting device to detect a presence of use of a user's tooth brushing pattern analyzing/correcting device for each identification code. Furthermore, the smart bath may further include an oral cavity camera for photographing a user's oral cavity, and the oral cavity camera is kept in the toothbrush disinfector in a form identical with the tooth brushing pattern analyzing/correcting device.

[0039] In addition, a system for a service provider according to an aspect of the embodiment discussed herein, which includes: a tooth brushing pattern analyzing/correcting device for detecting a user's tooth brushing pattern; a smart bath for providing a user with a guiding screen in communication with the tooth brushing pattern analyzing/correcting device, analyzing the user's received tooth brushing pattern, and providing a tooth brushing correction screen in a direction for increasing compliance in accordance with the analyzed result; and an oral cavity care center connected to the smart bath so as to periodically provide contents such as the guiding and correcting screens and manage a user's tooth brushing behavior data uploaded from the smart bath.

[0040] The care center relays a link between a contents provider and the smart bath to provide the contents or a link between an affiliated hospital and the smart bath to provide a user with dental treatment consultation.

BRIEF DESCRIPTION OF THE DRAWINGS

[0041] These and/or other aspects and advantages will become apparent and more readily appreciated from the following description of the embodiments, taken in conjunction with the accompanying drawings of which:

[0042] FIG. **1** is a view showing a configuration of a tooth brushing pattern analyzing/correcting device according to an embodiment;

[0043] FIGS. **2** and **3** are views illustrating operation of an embodiment of a sensing unit in the tooth brushing pattern analyzing/correcting device according to an embodiment;

[0044] FIGS. **4** and **5** illustrate output waveforms of the sensing unit according to;

[0045] FIG. **6** is a view illustrating operation of another embodiment of a sensing unit in the tooth brushing pattern analyzing/correcting device;

[0046] FIG. **7** illustrates tooth brushing motional directions for the embodiment of FIG. **6** in the tooth brushing pattern analyzing/correcting device;

[0047] FIG. **8** illustrates an output waveform of the sensing unit in the embodiment of FIG. **6**;

[0048] FIG. **9** is a flowchart illustrating an operation of a tooth brushing pattern analyzing/correcting device according to an embodiment;

[0049] FIGS. **10** and **11** are flowcharts illustrating an operation of a tooth brushing pattern analyzing/correcting device according to another embodiment, FIG. **10** is an entire flowchart and

[0050] FIG. **11** is a flowchart illustrating the score calculation and storing routine of FIG. **10**;

[0051] FIGS. **12** to **15** are flowcharts illustrating an operation of a tooth brushing pattern analyzing/correcting device according to a further embodiment;

[0052] FIG. **16** is a chart illustrating a tooth brushing pattern analysis that can be implemented according to an embodiment;

[0053] FIG. **17** is a block diagram of a system for correcting tooth brushing behavior according to an embodiment;

[0054] FIG. **18** is a view showing the appearance of a smart bath according to an embodiment;

[0055] FIG. **19** is a flowchart illustrating an entire control program of the smart bath according to an embodiment;

[0056] FIGS. **20** and **21** are flowcharts illustrating an example of a correction program according to an embodiment;

[0057] FIG. **22** is a view showing a tooth brushing state according to an embodiment; and

[0058] FIG. **23** is a view illustrating a business model of a service provider according to an embodiment.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0059] Reference will now be made in detail to the embodiments, examples of which are illustrated in the accompanying drawings, wherein like reference numerals refer to the like elements throughout. Exemplary embodiments are described below with reference to the figures.

[0060] FIG. **1** is a view showing an embodiment in which a toothbrush is combined with a tooth brushing pattern analyzing/correcting device according to an exemplary embodiment.

[0061] As shown in FIG. **1**, the tooth brushing pattern analyzing/correcting device **100** according to an exemplary embodiment includes a body part **130** combined with a toothbrush head **110**; a sensing unit **128** built in the body part **130** to sense a signal for movement of a toothbrush moved through a user's tooth brushing; a memory **136** having data stored therein; a controller **132** for operating signals input from the sensing unit **128** to classify a user's tooth brushing operation into at least two or more patterns; and an output unit **180** for outputting result data. The head **110** and a neck, which are configured in a single body **120** can be attachable/detachable to the body part **130**.

[0062] At this time, the sensing unit **128** may include a geomagnetic sensor **150**, a geomagnetic sensor driving circuit **152**, an acceleration sensor **154**, an acceleration sensor driving circuit **156**, an angular velocity sensor **158** and an angular velocity sensor driving circuit **160** as shown in FIG. **1**. The sensing unit **128** may selectively use only one or two of these geometric, acceleration or angular velocity sensors, and may be configured as a combination of motion sensors capable of sensing human movement.

[0063] In addition, the sensing unit **128** is installed in a direction of the attaching/detaching part of the body part **130** connected to the toothbrush head **110** as close as possible so as to sense the movement of toothbrush bristles **112** moved through a user's tooth brushing as well as possible.

[0064] Further, the tooth brushing pattern analyzing/correcting device according to an exemplary embodiment is electrically operated. To this end, the tooth brushing pattern analyzing/correcting device has a power driving circuit **142** inside the body part **130** and may be implemented with a battery **148**, a heavy electric machine (not shown) or an adaptor circuit (not shown).

[0065] The controller **132** of the tooth brushing pattern analyzing/correcting device **100** is connected to respective unit circuits so as to take charge of control entirely by per-

forming a correction program that will be described later. Memory **136** may store the correction program, various kinds of analysis data, audio message information and the like.

[0066] The output unit may include a speaker **138** and a display **140**. The speaker **138** may generate a voice warning message, a warning beep and the like, and the display **140** may display warning characters, the number of measured strokes, an analyzed result or the like through characters or numbers on a liquid crystal display panel.

[0067] An communication module **144** may use a radio frequency technique, e.g. Bluetooth, Zegbee(802.15.4), WiFi, a radio LAN technique or the like. The internal communication module **144** communicates with a communication module **226** of a smart bath **200** (see FIG. **17**) to transmit a user's tooth brushing behavior analyzing data detected from the tooth brushing pattern analyzing/correcting device **100** and to receive related commands and data.

[0068] FIG. **2** is a view illustrating an operation of the sensing unit in the tooth brushing pattern analyzing/correcting device according to an exemplary embodiment, which shows tooth brushing directions. Let the longitudinal direction of the tooth brushing pattern analyzing/correcting device **100** be an X axis, the lateral direction of the toothbrush head **110** be a Y axis, and the longitudinal direction of the toothbrush bristle **112** be a Z axis.

Embodiment 1

[0069] A case where the sensing unit **128** of the tooth brushing pattern analyzing/correcting device **100** has a three-axis (X, Y, Z) acceleration sensor **154**, a three-axis (X, Y, Z) angular velocity sensor **158** and a one-axis (Z) geometric sensor **150** will be described below. In FIG. **2**, right and left can be classified using an accelerometer provided with a tilt function. Further, it can be identified whether teeth are brushed with parallel, perpendicular or rotatory motion with respect to the texture of the teeth for each part. Furthermore, it can be determined whether an inner side, upper surface or outer side is brushed. The left and right front faces can be classified using a geometric meter, and clockwise and counterclockwise directions can be classified using an angular velocity meter. Tooth brushing parts of upper/lower teeth can be classified using the peak of a waveform. Thus, after having already set each part of the teeth and then a correct tooth brushing method for each of the parts, it is possible to perform estimation in accordance with this method.

[0070] FIG. **3** is a view illustrating an operation of the sensing unit in the tooth brushing pattern analyzing/correcting device, which shows positions of teeth. In order to brush a user's teeth, a user contacts the toothbrush bristles of the toothbrush and a row of teeth with each other and then moves the toothbrush left and right, or up and down with his/her wrist as shown in FIG. **2**. Thus, tooth brushing progresses as the toothbrush head, having the toothbrush bristles attached thereon, is moved with back-and-forth and rotational motions along the respective axes shown in FIG. **1**. At this time, rotations of the x and y axes may be sensed through the angular velocity sensor, back-and-forth movements of the x and y axes may be sensed through the acceleration sensor **154**, and a rotation of the z axis may be ideally sensed through the geometric sensor **150**. Here, the directional axes of each of the sensors should be arranged constantly. Ideally correct tooth brushing methods for the respective parts of teeth and main sensing axes in accordance therewith are fully listed in the following Table 1.

TABLE 1

		Part	Correct Tooth brushing Method				
		(Toothbrush Position)	○	Δ	X	Time (sec)	Related Sensor
Lower Teeth	Right	Outer Surface (1)	Y axis, Clockwise Direction	Y axis	X axis	6	Acceleration Field (3 axes)
		Bottom Surface (5)	X, Z	X, Z	—	15	Geomagnetic Sensor (1 axis)
		Inner Surface (3)	Counter-clockwise Direction	Y axis	X axis	3	Angular Velocity (3 axes)
	Front	Outer Surface (3)	Clockwise/ Counter-clockwise Direction	—	X axis	4	
		Inner Surface (1)	Clockwise/ Counter-clockwise Direction	—	X axis	3	
	Left	Outer Surface (3)	Y axis, Counter-clockwise Direction	Y axis	X axis	6	
		Bottom Surface (5)	X, Z	X, Z	—	15	
		Inner Surface (3)	Clockwise Direction	Y axis	X axis	3	

TABLE 1-continued

		Part (Toothbrush Position)	Correct Tooth brushing Method ○	Δ	X	Time (sec)	Related Sensor
Upper Teeth	Right	Outer Surface (2)	Y axis, Counter-clockwise Direction	Y axis	X axis	6	
		Bottom Surface (6)	X, Z	X, Z	—	9	
		Inner Surface (4)	Clockwise Direction	Y axis	X axis	2	
	Front	Outer Surface (4)	Clockwise/ Counter-clockwise Direction	—	X axis	4	
		Inner Surface (2)	Clockwise/ Counter-clockwise Direction	—	X axis	2	
	Left	Outer Surface (2)	Y axis, Clockwise Direction	Y axis	X axis	6	
		Bottom Surface (6)	X, Z	X, Z	—	9	
		Inner Surface (2)	Counter-clockwise Direction	Y axis	X axis	2	
Tongue		Bottom Surface (5)	X axis, Y axis, Circular Direction	—	X axis	5	

[0071] At this time, each part of the teeth denotes a part shown in FIG. **3**.

[0072] FIGS. **4** and **5** illustrate output waveforms of the sensing unit according an exemplary embodiment.

[0073] Referring to FIG. **4**, these waveforms show a basic waveform from which the most desirable pattern of brushing molars can be extracted. For example, it is a desirable tooth brushing method to brush counterclockwise from a tooth's root at the inner side to a tooth's upper direction when brushing the part ③ in FIG. **3**. At this time, the waveform may be extracted with reference to the waveform of a y-axis angular velocity meter, and it can be determined whether the peak of the y-axis angular velocity meter is in clockwise or counter-clockwise direction in accordance with its sharp direction.

[0074] Referring to FIG. **5**, this waveform is an example that can classify a correct tooth brushing pattern and a bad tooth brushing pattern for a molar part at which tooth decay is easily generated. The waveform is a basic signal showing a bad tooth brushing pattern of ① and ②; ③ and ④ parts in FIG. **3** for each of the parts (see Table 1), which are output signals of an accelerometer by Analog Device, Co., which partially has a tilt function as a DC component. The waveforms in the upper graph are to show inappropriate tooth brushing behavior of brushing the parts ① and ② in a direction of the X axis, and the waveforms in the lower graph are to show inappropriate tooth brushing behavior of brushing the parts ③ and ④ in a direction of the X axis. Since a difference between DC voltages is shown with the middle waveform as reference to when the motion of the toothbrush bristles is changed upward and downward, its position can be grasped.

[0075] As such, the worst tooth brushing pattern can be simply classified when brushing one's molars, and a correct tooth brushing pattern or bad tooth brushing pattern can be sensed for each part as shown in FIG. **3** for example.

Embodiment 2

[0076] A case where the sensing unit **128** of the tooth brushing pattern analyzing/correcting device **100** has a three-axis (X, Y, Z) acceleration sensor and a three-axis (X, Y, Z) geometric sensor will be described in embodiment 2. In case of this embodiment, respective tooth brushing positions may be classified, and tooth brushing motions may be classified in accordance with the classified positions. Further, although the sensing unit is simply configured as only the three-axis acceleration and geometric sensors, this embodiment can monitor a variety of tooth brushing patterns occurring at several parts of various teeth.

[0077] For example, the accelerometer may be MMA7260 (three-axis, 800 mV/g), purchasable from Freescale, and the geometric meter may be HMC1055 (three-axis, 1.0 mV/V/gauss). However, they are not limited thereto.

[0078] FIG. **6** is a view illustrating an operation of the sensing unit in the tooth brushing pattern analyzing/correcting device according to an embodiment, which shows respective tooth brushing positions. FIG. **7** illustrates tooth brushing motional directions of the tooth brushing pattern analyzing/correcting device. As shown in FIG. **6**, if the tooth brushing positions of teeth are classified considering the shape of the teeth, the tooth brushing method and the like, the tooth brushing positions may be classified into a total of 6 ways as follows: right A, center B and left C of the lower jaw part, and

right A', center B' and left C' of the upper jaw part corresponding thereto. Each pair of the A and C parts there among has bottom surfaces with which food can be chewed while upper/lower teeth are arranged with each other. Thus, each of the A(A') and C(C') parts may be divided into an outer surface (**1**, **2**, **3**, **4**), a bottom surface (**5**, **6**) and an inner surface (tongue side) (**3**, **4**). Further, each of the front parts B and B' may be divided into inner and outer sides. The classification of a total of 16 positions of teeth is accomplished so that it can be grasped whether each of the parts of teeth is basically brushed.

[0079] Most tooth brushing motions occurring mainly at the respective positions are methods of horizontal scrub (perpendicular to the texture of the teeth), vertical sweeping (parallel to the texture of the teeth), rotation (clockwise/counterclockwise direction), vibration (fine vibration) and drawing a circle regardless of the classification of upper/lower teeth; and the aforementioned methods may be combined. Each of the methods can be personally applied and recommended to be suitable depending on user's age and oral cavity condition.

[0080] A principle of sensing the position and tooth brushing motion for each position according to an embodiment.

1. Method of Classifying Positions A, B and C:

[0081] In a case where an initial point starts with B, a position movement can be sensed through the DC level of the geometric sensor H_y. Further, since the DC level of the accelerometer is also changed at the same time, a partial reference is possible. For example, when starting with B and moving to A or C, the DC level value of H_y increases. Further, when moving (changing direction) from position A to C, the DC level value of H_x is changed, the changed value is maintained, and it is determined that H_y is changed at a time point where H_x is changed, so that a movement is sensed.

2. Method of Classifying Inner, Outer and Upper Portions at each of the Positions A, B and C:

[0082] Positions of 1, 5 and 3 (2, 6, 4) can be determined referring to DC levels of H_x and H_z in the geometric sensor and besides, the positions can be determined with a change in DC level of the accelerometer.

3. Method of Sensing Tooth Brushing Motion for each of the Positions:

[0083] In case of horizontal movement, a waveform of the accelerometer Y has a large size. In case of vertical movement, a waveform of the accelerometer X has a large size. For determining a clockwise/counterclockwise direction, a direction is determined referring to a waveform of H_y or H_x. If the waveform goes upward, it means that the direction is progressing from bottom to top, and vice versa. For drawing a circle, it can be determined with waveforms of X and Y axes in the accelerometer. Further, the angle of the toothbrush can be estimated from H_x and H_y, and it can be used in detecting a position.

[0084] FIG. **8** illustrates a waveform sensed when practically brushing one's teeth for each part, which is a waveform sensed when tooth brushing is consecutively performed at an interval of approximately 10 seconds or so for each part. Descriptions of waveforms at the respective intervals are as follows. The respective numerals of the waveforms correspond to the tooth brushing part numerals of FIG. **6**, respectively.

[0085] Waveform **1**: A referential position is determined when a user starts to brush his/her teeth. The user is brushing upper and lower teeth (tooth brushing part **1** and **1'** in FIG. **6**) on the front part of the teeth. The DC level is in the order $A_z>A_y>A_x$ and $H_z>H_y>H_x$. Since the user is brushing up and down, the amplitude of A_x is large. The angle of a toothbrush is almost horizontal.

[0086] Waveform **2**: It is a wave form when the user brushes an outer surface **2** of the right lower teeth up and down. The user frequently brushes this part horizontally or vertically, and it is a part that the user often brushes more carefully since he/she considers it an important part in accordance with the dentist's instruction or personal intention. Since the user tends to brush his/her teeth while slightly opening his/her mouth when brushing this part, the angle of the toothbrush goes down at 30 to 45 degrees or so from the horizontal so that this waveform can be compared with other waveforms. While moving to the right side, the level of H_y rises, and if it reaches a certain level, that certain level is maintained. If the user brushes his/her teeth through the rotation method, a waveform identical with Embodiment 1 comes out so that it can be determined as to which part of the upper or lower teeth is brushed. Further, since the amplitude of A_y increases when the user is brushing his/her teeth while closing his/her upper and lower teeth together, this can also be determined.

[0087] Waveform **3**: The DC level of A_x becomes higher than that of A_y. As the user brushes his/her teeth back and forth, the amplitude of A_y becomes high. At this time, the inclination angle of the toothbrush becomes higher than the inclination angle when is brushed part **2**.

[0088] Waveform **4**: The level of H_x rises, and the DC level is changed into the order $A_x>A_y>A_z$. Since the user brushes his/her teeth up and down, the amplitude of A_x becomes high. The reason why the level of Hx becomes high is that the inclination angle of the toothbrush is more mitigated when brushing part **4** than when brushing part **3**.

[0089] Waveform **5**: It shows a waveform similar to the Waveform **2**. When the user generally brushes his/her teeth at both sides as described in Waveform **2**, the user may brush them in back and forth; up and down; and in a rotatory motion while closing his/her upper and lower teeth. At this time, a side stroke may be divided in two such that they are allocated to the tooth brushing positions **2** and **5**. Further, in a case of the rotation method of brushing from bottom to top or from top to bottom, it is possible to divide into top and bottom. At this time, the waveform can be divided as described in Embodiment 1.

[0090] Waveform **6**: Since the levels of H_z and H_x rise as the user brushes his/her teeth back and forth, the amplitude of A_y increases.

[0091] Waveform **7**: The amplitude of A_x is large, the level of H_x rises, and the level of H_z falls.

[0092] Waveform **8**: Although the level of H_x is similar to Waveform **2**, a level difference of H_x therefrom is large, and the level of H_x is high. Further, the amplitude of A_x is large.

[0093] Waveform **9**: The level of H_z falls. As the toothbrush becomes more inclined, the level of H_x falls.

[0094] As for the remainder of the waveforms, tooth brushing positions, tooth brushing strokes for each of the parts and tooth brushing patterns can be classified according to the same method as described above. Other parts that are not sensed may all be processed as "Unknown" and as such they are recognized as bad tooth brushing patterns.

[0095] FIG. **9** is a flowchart illustrating an operation of a tooth brushing pattern analyzing/correcting device according to an embodiment.

[0096] If a user first turns on the power source of the tooth brushing pattern analyzing/correcting device, an internal system is initialized by the controller **132** (S**100**). Subsequently, when the user starts to brush his/her teeth, the controller **132** checks for the presence of a detecting signal provided from the sensing unit **128** to recognize that the user starts to brush his/her teeth (S**102**). The controller **132** analyzes the detecting signal to analyze whether the user's tooth brushing motion is good (S**104**). As an analyzed result, the controller **132** checks whether a user's tooth brushing motion is good (S**106**).

[0097] In a case where the user's tooth brushing motion is bad, the controller **132** warns the user with voice signals through the speaker **138** or displays warnings for a bad condition on the display **140** (S**122**).

[0098] In a case where the user's tooth brushing motion is good, the controller **132** counts this as an effective session (S**108**) and checks whether the number of effective sessions reaches the number of preset target sessions (S**110**). In a case where the number of effective sessions reaches the number of target sessions, the controller **132** checks the tooth brushing time (S**112**). In a case where a fixed time does not elapsed, the controller **132** repeatedly performs operations S**102** to S**112**. If the fixed time elapses at operation S**112**, i.e. the tooth brushing continues for a predetermined time, the controller **132** sends target arrival feedback to the user (S**114**). The target arrival feedback indicates whether the score has reached the target score. At this time, the target arrival feedback may be sent through a voice or visually, and a music desirable to the user may be reproduced and output from the memory **136** so as to impart an incentive to the user. Further, the controller **132** stores a user's monitored tooth brushing data in the memory **136** (S**116**) and sends end signal to the user (S**118**). The end signal may also be provided as a voice notice or visual display.

[0099] If a detecting signal provided from the sensing unit **128** is not checked at operation S**102**, the controller **132** counts the time (S**120**). If there is no detecting signal for a predetermined time, e.g. 5 seconds, the controller **132** stores the detected condition (S**116**) and sends end signal to the user (S**118**).

[0100] FIGS. **10** and **11** are flowcharts illustrating an operation of a tooth brushing pattern analyzing/correcting device according to another embodiment, FIG. **10** is a flowchart, and FIG. **11** is a flowchart illustrating the score calculation and storing operation of FIG. **10**.

[0101] This is a method of assigning scores for user's tooth brushing patterns and feeding the assigned scores back to the user. Since a previous 10-time tooth brushing scores are stored and then fed back on a user's demand to analyze the user's tooth brushing behavior trend, a third person can monitor the user's recent tooth brushing behavior afterwards, and the user can immediately view an estimation for his/her own tooth brushing behavior. There is an advantage in that the method has a great influence on improving ones tooth brushing behavior. Descriptions identical with the aforementioned embodiment of FIG. **9** will be omitted, and those different therefrom are as follows.

[0102] Referring to FIG. **10**, the controller **132** senses a user's tooth brushing motion to determine whether the tooth brushing motion is good. In a case where the tooth brushing motion is good, the controller **132** estimates the tooth brushing motion and assigns a score (S**208**) and displays the score (S**212**). If the score reaches a target score within a certain time (S**214**), the controller **132** sends a target score arrival feedback to the user (S**216**) and stores the score (S**218**). If the user stops brushing his/her teeth when the user's score has not reached the target score, only the score having been stored in operation S**208** is stored.

[0103] Referring to FIG. **11**, if a user's tooth brushing motion is good, the controller **132** increases the user's score (S**230**). If a user's tooth brushing motion is bad, the controller **132** decreases the user's score (S**240**). Further, the controller **132** stores the detected number of good and bad sessions, the duration, the yielded score and the like (S**232**). If a fixed time elapses when checking time (S**234**), the controller **132** adds and stores the scores and then returns to a main program (S**236**).

[0104] The following Table 2 illustrates an example in which the positions of FIG. **3** in Embodiment 1 are awarded scores. That is, it is a table in that a correct tooth brushing method for each of the parts is preset and it is then estimated whether or not the correct tooth brushing method is performed for each of the parts. For example, in a case where a user is a left-handed person, it is assumed that the user mainly brushes his/her teeth from right to left starting with front teeth. Otherwise, assuming that it is initially set that the user brushes his/her teeth from right to left, it means that a toothbrush moves practically. In Table 2 is shown that the best tooth brushing method in, when the user brushes the lower outer surface of the teeth on the right, the user moves the toothbrush along the Y axis and brushes while rotating the toothbrush clockwise. At this time, a sensor for sensing this may be configured as a three-axis acceleration sensor, a three-axis angular velocity sensor and a one-axis geometric sensor.

[0105] Moreover, in other embodiments, the respective portions of teeth are classified into certain parts by the method described below, good and bad tooth brushing patterns for each of the parts are set, and an estimation may be then progressed.

TABLE 2

		Part (Toothbrush Position)	Correct Tooth brushing Method ○	Δ	X	Evaluation Contents Sec (Target Difference)	Method
Lower Teeth	Right	Outer Surface (1)	Y axis, Clockwise Direction	Y axis (+)	X axis	5 (1)	Good
		Bottom Surface (5)	X(+/−), Z	X(+/−), Z	—	15 (0)	Normal

TABLE 2-continued

		Part (Toothbrush Position)	Correct Tooth brushing Method ○	Δ	X	Evaluation Contents Sec (Target Difference)	Method
		Inner Surface (3)	Counter-clockwise Direction	Y axis	X axis	0	(3) Bad
	Front	Outer Surface (3)	Clockwise/ Counter-clockwise Direction	—	X axis	4	(0) Good
		Inner Surface (1)	Clockwise/ Counter-clockwise Direction	—	X axis	0	(3) Good
	Left	Outer Surface (3)	Y axis, Counter-clockwise Direction	Y axis	X axis	2	(4) Bad
		Bottom Surface (5)	X, Z	X, Z	—	13	(2) Good
		Inner Surface (3)	Clockwise Direction	Y axis	X axis	0	(3) Bad
Upper Teeth	Right	Outer Surface (2)	Y axis, Counter-clockwise Direction	Y axis	X axis	5	(1) Good
		Bottom Surface (6)	X, Z	X, Z	—	7	(2) Normal
		Inner Surface (4)	Clockwise Direction	Y axis	X axis	0	(2) Bad
	Front	Outer Surface (4)	Clockwise/ Counter-clockwise Direction	—	X axis	4	(0) Good
		Inner Surface (2)	Clockwise/ Counter-clockwise Direction	—	X axis	2	(0) Good
	Left	Outer Surface (2)	Y axis, Clockwise Direction	Y axis	X axis	2	(6) Bad
		Bottom Surface (6)	X, Z	X, Z	—	8	(1) Good
		Inner Surface (2)	Counter-clockwise Direction	Y axis	X axis	0	(5) Bad
Tongue		Bottom Surface (5)	X axis, Y axis, Circular Direction	—	X axis	3	(2) Normal

[0106] Referring to Table 2, there are shown examples of the respective sensors capable of classifying into good and bad tooth brushing methods for each of the parts. Accordingly, Table 2 shows examples in which scores can be calculated depending on tooth brushing time and the method for each of the parts.

[0107] FIGS. **12** to **15** are flowcharts illustrating an entire operation of a tooth brushing pattern analyzing/correcting device according to a further embodiment.

[0108] For example, if a referential tooth brushing pattern is specified by outputting an initial tooth brushing part to a user through a voice, the user starts to brush the specified tooth brushing part above and below or left and right referring to this. Accordingly, the toothbrush head **110** moves right and left/above and below or rotates. As described above, the sensing unit **128** senses its movement to output a signal to the controller **132**, and the controller **132** analyzes the input signal to determine whether it is a good tooth brushing pattern. If the effective time or number of strokes reaches a predetermined time or the number of target strokes, the controller **132** informs the user of tooth brushing completion for the corresponding part and then a notice for the next tooth brushing part and tooth brushing method.

[0109] At this time, the controller **132** outputs message data having previously been input to the storing unit as a voice or characters through the output unit **180**.

[0110] Further, tooth brushing pattern analyzing/correcting may have a timer **138** built into the device for measuring user's tooth brushing time. The timer **134** may be used for measuring the length of the tooth brushing time to refer to when the aforementioned comparison and measurement data are compared/operated and for storing the user's tooth brushing time zone to monitor the user's tooth brushing motion pattern shown in FIG. **1**.

[0111] Referring to FIGS. **12** to **15**, if a user completes tooth brushing preparation operation, the controller **132** initializes a system (S**300**) and generates a message of a voice such as "You have started to brush your teeth" using the output unit **180** such that the user recognizes the start of tooth brushing (S**302**).

[0112] Thereafter, in a few seconds, the controller **132** outputs a message informing the user of the part that the user should brush first (S**304**). That is, the controller **132** outputs a message such as "Brush your lower front teeth" such that the user recognizes the part that the user should brush first. Thus, if the user starts to brush the corresponding part referring to the aforementioned message, the controller **132** outputs a message informing the user of a tooth brushing pattern for the corresponding part, such as "Please brush your teeth from bottom to top" (S**306**).

[0113] Thereafter, the user performs tooth brushing based on the aforementioned tooth brushing pattern (S**308**). In a case of the same direction, the controller **132** stores the number of strokes and (S**310**) and again generates a message such as "From bottom to top" (S**312**). This is repeated a certain number of times until the user performs the tooth brushing in a correct direction (S**314**). If a predetermined time elapses when measuring the time (S**316**), the controller **132** generates a message such as "Well done." (S**318**) and checks whether the next operation has been completed (S**320**). If the next operation has not been completed, the controller **132** changes into the mode for the next operation (S**322**) and generates a message for the next operation such as "Now, brush the outer surface of your lower left molars" (S**324**).

[0114] If the controller **132** determines that the user performs tooth brushing through a method different from that in the aforementioned message, e.g. from top to bottom at the operation S**308**, it generates a message such as "Please brush your teeth from bottom to top." (S**326**), determines the user's motion mode (S**328**), and stores the motion mode, the number of strokes and time (S**330**). Subsequently, the controller **132** checks whether the number of strokes is more that the number of effective strokes for a given part (S**332**). In case the number of strokes is more than the number of effective strokes for another part, the controller **132** changes to another part (S**334**) and returns to operation S**328**.

[0115] If the number of strokes is less than the predetermined number of strokes at step S**332**, the controller **132** checks, whether the motion mode is the return direction in the X-axis direction(S**336**). If it is the return direction at operation S**336**, the controller **132** generates a warning message such as "You may hurt your gums." (S**338**) and return to step S**328**. If it is not the return direction at operation S**336**, the controller **132** returns to operation S**308**.

[0116] If a predetermined amount of time does not elapse at step **316**, the controller **132** generates a warning message such as "Please brush your teeth slowly and a little more softly." and performs operation **320**.

[0117] If the next step has been completed at operation S**320**, the controller **132** checks whether all the operation have been completed (S**342**). If not, the controller **132** changes from the present position to a position easy for moving (S**344**) and performs step operation.

[0118] As for the position changed at operation S**324**, the controller **132** performs steps S**346** to S**382** in the same manner as described above.

[0119] If tooth brushing for all the positions is completed at the operations S**342** and S**380**, the controller **132** generates a message such as "You have brushed your teeth well. Have a nice day!" (S**384**) and ends the entire operation.

[0120] As described above, the controller **132** immediately feeds back a result comparing and displaying preset and measured values of the referential data to the user in real time so as to advice a correct tooth brushing pattern or allow the user to correct his/her tooth brushing pattern into an effective tooth brushing pattern. At the same time, the controller **132** stores success or failure for each tooth brushing part as a binary value such as "1" or "0" based on a condition in that the measured value is larger than or identical with the referential value for each of the compared results and a correct tooth brushing pattern in which movement to a direction of each axis is not in excess of the preset value. After a user's tooth brushing has been completed, the controller **132** adds the compared result values for the respective tooth brushing parts and stores the resulting value.

[0121] Accordingly, after having completed tooth brushing, whether a third person or a user has performed correct tooth brushing can be identified by outputting the stored result as a voice or displaying it.

[0122] FIG. **16** is a chart illustrating a tooth brushing pattern analysis that can be implemented according to an embodiment.

[0123] It is possible to output a tooth brushing time zone for each user, the tooth brushing time, and the consumed time for each pattern, which are detected and analyzed using the system of the present invention. In a case where the output data is sent to a person such as a dentist who deals with tooth brushing correction and tooth remedy through computers, Internet or wireless networks, an analysis table shown in FIG. **16** can be viewed through an additional program. Such an analysis table may give a user's personal health details, the tooth brushing period, tooth brushing time and feedback therefor, and may give a detailed analysis and feedback for the tooth brushing behavior for each part.

[0124] Tooth brushing behavior data collected from the tooth brushing pattern analyzing/correcting device **100** configured in such a manner is transmitted to a smart bath **200**, and the data transmitted to the smart bath **200** is transmitted to an oral cavity care center **300** through a home server **250**.

[0125] FIG. **17** is a block diagram of a system for correcting tooth brushing behavior according to an exemplary embodiment, and FIG. **18** illustrates the appearance of a smart bath.

[0126] Referring to these figures, the system for correcting tooth brushing behavior of an embodiment includes a tooth brushing pattern analyzing/correcting device **100**, a smart bath **200** and an oral cavity care center **300**. The smart bath **200** is connected to the oral cavity care center **300** through a home server **250**.

[0127] Referring to FIG. **17**, the smart bath **200** includes a controller **202**, a memory **204**, an I/O adaptor **206**, a storing device **208**, a communication adaptor **210**,_an audio output **212**, a speaker **214**, a display adaptor **216**, a smart mirror **218**, a sensor **220**, an interface adaptor **222**, a toothbrush disinfec-

tor **224**, a communication module **226**, a video adaptor **230** and an oral cavity camera **232**.

[0128] Referring to FIGS. **17** and **18**, the smart mirror **218** is installed within a bathroom such that it is combined as a part of a mirror **242** of a washing stand **240**. The toothbrush disinfector **224** is mounted on a wall of the washing stand **240**. The oral cavity camera **232** has a structure in that a small-sized camera is attached to its tip together with a lighting device and configured in a toothbrush shape with no bristles for better photographing. In a case where the oral cavity camera **232** is not used, it is kept in the toothbrush disinfector **224**. The smart mirror **218** is combined with the mirror **242** to be used as a normal mirror and also display an image in a screen display mode. Therefore, a user can simultaneously see the image while viewing his/her own reflection brushing his/her teeth through the mirror.

[0129] The controller **202** includes a CPU (Control Processor Unit) and runs a tooth brushing behavior correcting program the memory **204** may include DRAM, SRAM, EEPROM and/or the like, and is provided as a main memory for operation and data processing. The I/O adaptor **206** connects to the hard disk **208** that is a storage device for the controller **202**. The hard disk **208** may store a tooth brushing behavior correcting program, relative moving picture contents, tooth brushing behavior monitoring data for each user, correcting data and the like.

[0130] The communication adaptor **210** is used to connect the home server **250** and the smart bath **200**, which may physically connects communication protocols such as LAN, USB, or RS232. It is understood that it can be electronically or optically connected to each other.

[0131] The display adaptor **216** provides video data to the smart mirror **218**, e.g. a flat display such as LCD, PDP or OLED. Further, the sensor **220** is an infrared or ultrasonic wave human body detecting sensor, which detects human movements and provides a detection result to the controller **202** through the display adaptor **216**.

[0132] The interface adaptor **222** connects the toothbrush disinfector **224** and the communication module **226** to the controller **202**. The toothbrush disinfector **224** is a place for keeping the tooth brushing pattern analyzing/correcting device **100** and the oral cavity camera **232** when they are not being used. The toothbrush disinfector **224** detects whether or not either of the tooth brushing pattern analyzing/correcting devices **100** is being used and provides a detected result to the controller **202**. The communication module **226** communicates with the tooth brushing pattern analyzing/correcting device **100** by radio to send received tooth brushing behavior monitoring data to the controller **202**, and transmits tooth brushing correcting data or voice data provided from the controller **202** to the tooth brushing pattern analyzing/correcting device **100**.

[0133] The voice output **212** drives the speaker **214** in response to the voice data provided from the controller **202** to control the voice output **212**. The video adaptor **230** connects the oral cavity camera **232** to the controller **202**.

[0134] FIG. **19** is a flowchart illustrating control program of the smart bath **200** according to an exemplary embodiment, and FIGS. **20** and **21** are flowcharts illustrating an example of a correction program. FIG. **22** is a view showing a tooth brushing state according to an embodiment.

[0135] Referring to FIG. **19**, the smart bath **200** initializes a system when a power source is applied (S**400**) and whose tooth brushing pattern analyzing/correcting device **100** is being used in the toothbrush disinfector **224** (S**402**). Otherwise, the smart bath **200** checks whether the oral cavity camera **232** is being used (S**404**). If motion is not sensed from the toothbrush disinfector **224**, the smart bath checks whether it is time for transmission (S**406**), and transmits the collected tooth brushing behavior data and compliance check data (S**422**). Otherwise, the smart bath **200** checks whether it is time for updating data (S**408**). If it is time for updating data, the smart bath **200** downloads guiding screen data, correcting screen data and the likes from the oral cavity care center or a contents provider server so as to periodically update relevant data (S**424**). The relevant data means a correcting multimedia data or a guiding multimedia data. However, it is not limited thereto. The relevant data may be prepared for based upon the collected tooth brushing behavior data.

[0136] When the oral cavity camera **232** is being used at operation **404**, the smart bath **200** detects this and supplies a power source to the oral cavity camera **232**, for it to be available for operation but in a standby state (S**412**). Subsequently, if a user presses a photographing switch (not shown), the smart bath **200** turns on the lighting unit **233** to start photographing (S**414**). The smart bath **200** displays the photographed image on the smart mirror **218** (S**416**) and stores the displayed image (S**418**). If the photographing is completed (S**420**), the smart bath **200** performs an end process and returns.

[0137] The correcting program of an embodiment checks whether the tooth brushing pattern analyzing/correcting device **100** is being used and then operates (S**410**).

[0138] Referring to FIG. **20**, the smart bath **200** checks an identification code (ID) allocated to the used tooth brushing pattern analyzing/correcting device **100** to identify which user's it is (S**430**). Subsequently, the smart bath **200** displays a guiding screen appropriate for the identified user on the smart mirror **218** as shown in FIG. **22** (S**434**). For example, if where the user is a child, the smart bath **200** could display the child's favorite animation, "Iruyama" while guiding the child to the correct tooth brushing behavior in a simple way. If children are watching their favorite programs, i.e. animations, at the same time as they brush their teeth, they brush their teeth for a longer. Then, pictures or characters for guiding the child to the correct tooth brushing behavior are displayed at one side of the screen. The child brushes his/her teeth in accordance with the operations it is instructed to follow, while watching the animation. If the smart bath **200** receives tooth brushing behavior data detected from the tooth brushing pattern analyzing/correcting device **100** while the child brushes his/her teeth (S**436**). The smart bath **200** analyzes the received tooth brushing behavior data(S**438**). As an analyzed result of the received tooth brushing behavior data, the displayed pictures vary in accordance with whether or not the child follows the instructed steps well.

[0139] If the user is an adult, a variety of contents such as news programs, dramas or movies may be provided. The user may choose his/her favorite program while brushing his/her teeth.

[0140] That is, if tooth brushing behavior is good (S**440**), the animation is continuously displayed (S**442**). However, if the user does not follow the instructed tooth brushing operations well, the smart bath **200** displays a warning picture, a picture of tooth decay caused by improper tooth brushing behavior or the like to guide the user to correct tooth brushing behavior (S**444**).

[0141] Referring to FIG. **21**, the smart bath **200** checks whether data is received from the tooth brushing pattern analyzing/correcting device **100** (S**446**) and returns to the node B when received data continuously. If there is no received data at operation S**446**, the smart bath **200** checks whether or not the tooth brushing pattern analyzing/correcting device **100** is located in the toothbrush disinfector **224** (S**448**). If the tooth brushing pattern analyzing/correcting device **100** is located and no movement is detected by the sensor, the smart bath **200** determines that the tooth brushing has ended (S**452**). Further, if a state in which there is no received data for a predetermined time period or more even though the tooth brushing pattern analyzing/correcting device **100** is not kept and the sensor detection is continued at operation S**452**, the smart bath **200** checks this (S**451**) and automatically determines that the tooth brushing has ended. The smart bath **200** arranges tooth brushing behavior data received after operation S**452** and renews data related to the correspondent ID (S**454**). Subsequently, the smart bath **200** turns off the smart mirror **218**, transmits the renewed data to the oral cavity care center **300** and then ends.

[0142] FIG. **23** is a view illustrating a configuration of an oral cavity care center according to an embodiment.

[0143] Referring to FIG. **23**, the oral cavity care center **300** is a host system of a service provider of an embodiment, which may be connected to a smart bath at each home through the Internet. However it is not limited thereto.

[0144] The oral cavity care center **300** may include a web server **310**, a tooth brushing behavior database **312**, a guiding multimedia database **314** and a correcting multimedia database **316**.

[0145] The web server **310** is connected to the smart bath **200** through the home server **250** at each home so as to transmit mutual data. The oral cavity care center **300** receives tooth brushing behavior data uploaded in real time to store it for each user ID in the database **312**, and loads guiding multimedia data or correcting multimedia data from the databases **314** and **316** periodically, e.g. by the day, week or month so as to download them to each of the smart baths **200**.

[0146] Further, the oral cavity care center **300** includes a contents management server **320**, a hospital management server **330**, an insurance company management server **340** and an institution management server **350**.

[0147] The contents management server **320** manages guiding multimedia data and correcting multimedia data provided from a contents provider **510** to renew/or update the guiding multimedia database **314** and correcting multimedia database **316** or manage a link between a home server **350** and a contents provider server (not shown).

[0148] The hospital management server **330** manages dental treatment data for each user and the like provided by an affiliated hospital **520** to renew/or update the guiding multimedia database **314** for a user's personal case history management, and manages a link between a home server **250** and an affiliated hospital server (not shown) to directly relay a telemedicine capability between a patient and a dentist.

[0149] The insurance company management server **340** transmits a user's health related data to an affiliated insurance company **530** to manage a user's insurance data.

[0150] The institution management server **350** transmits the user's health related data to a governmental institution such as a school or a public health center so as to systematically manage students' tooth brushing behavior by linking homes and the school.

[0151] The oral cavity care center **300** configured in such a manner receives guiding pictures, a variety of a user's multimedia content, multimedia contents related to tooth brushing and the like, which are provided from the contents provider **510** to a correcting program to manage the guiding multimedia database **314** and correcting multimedia **316**.

[0152] The guiding multimedia database **312** is built with a user's profile, case history and brief record data such that the oral cavity care center **300** can collect and manage it. Thus, based on tooth brushing behavior analyzation data and feedback data in the database **312**, it is possible to supply custom-made information to each user or to provide each user with a rental service of a smart bath system, an oral disease prevention service, a custom-made medical/management organ introduction and location information service, a dental care-related product information and selling service, and a tooth brushing pattern analysis correction device and expendables selling service, etc.

[0153] The oral cavity care center **300** may introduce a dentist suitable for a user and provide a service such as the relevant insurance guidance in connection with school, an affiliate hospital, or an affiliated health insurance company. That is, the oral cavity care center **300** provides a solution to the school and the public health center, and a nurse-teacher, a dental hygienist and a dentist perform remote and off-line monitoring related to the tooth brushing health of users (students, local residents) as a care provider. The oral cavity care center **300** may be managed with a governmental subsidy and a certain fee paid in return for using the service. Further, the oral cavity care center **300** can monitor behavior and use data on a health care insurance premium related to dental services in accordance with user compliance. Furthermore, the center **300** can provide a solution in connection with dental services and be used in children's tooth brushing tests, automatic analysis or the like. In addition, such users' tooth brushing data is transmitted in real time to parents, nurse-teachers, dentists or the like to be care providers for users through SMS (short message service), so that more effective feedback can be provided.

[0154] Here, compliance refers to the degree to which a general person obeys the advice of dentists or care providers. The tooth brushing guide screen may mean guiding a user to a correct tooth brushing method, the feedback may mean guiding a user to develop correct tooth brushing behavior, and the subtitles (including image, voice, subtitles) may mean an educational message about people's incorrect tooth brushing patterns, which is displayed in the lower portion of the display.

[0155] For example, a user's incorrect tooth brushing behavior for a part that cannot be covered mechanically and electrically can be corrected by generating a message such as "If you brush your teeth too roughly, you may hurt your gums quickly".

[0156] Further, in these embodiments, a strain gauge (not shown) is positioned at the neck of the toothbrush to measure the user's tooth brushing intensity so that it can be additionally incorporated into the embodiments.

[0157] As described above, in a case where tooth brushing is performed using a tooth brushing pattern analyzing and behavior correcting device according to the present invention, the most effective tooth brushing part can be seen through a preset tooth brushing pattern, and since it is fed back through an output unit whether or not tooth brushing for each part of

the teeth is performed using the a correct method, a user can easily determines his/her own tooth brushing pattern.

[0158] Further, since whether tooth brushing for each part of the teeth is performed using the correct tooth brushing pattern is stored as a result value or a score in the case of children, parents can easily identify afterwards whether their children brush their teeth or whether the children brush their teeth using the correct tooth brushing pattern.

[0159] Furthermore, since a patient's tooth brushing pattern can be easily evaluated by a dentist or a person working in the field of oral cavity health, medical treatment is improved and prevention is possible by identifying the cause of a patient's toothache and correcting the patient's tooth brushing pattern.

[0160] In a case where an oral cavity health improvement system according to the embodiments is used, since real-time or remote feedback suitable for correction of a user's tooth brushing pattern is possible, it is effective for correcting a user's behavior, and since it is possible to analyze a user's accumulated data and feed back a correcting method suitable for each user, a correcting function can be enhanced.

[0161] Further, the embodiments make children more interested in developing correct tooth brushing behavior and adults to analyze and correct their tooth brushing behavior through real-time or remote feedback. In addition, dentists or dental hygienists short on manpower can gain support through networks of remote feedback, so that the efficiency of governmental oral cavity health business can be raised and it can create a new income source for dentists at the same time.

[0162] Although the embodiment have been described for illustrative purposes, those skilled in the art will appreciate that various modifications, additions and substitutions are possible, without departing from the scope and spirit of the embodiment as disclosed in the accompanying claims.

[0163] ast two or more tooth brushing parts.

1. A tooth_brushing pattern analyzing device, comprising:
- a tooth brush head;
- a body part combined with the tooth brush head;
- a sensing unit having a motion sensor with at least one or more axes to sense a user's tooth brushing motion and a position sensor with one or more axes to sense two or more tooth brushing positions; and
- a controller to analyze signals input from the sensing unit to divide a user's tooth brushing motion into at least two or more patterns and at least two or more tooth brushing positions.

2. The device as claimed in claim **1**, further comprising a transmission module to transmit the analyzed pattern data to receiver.

3. The device as claimed in claim **1**, wherein the sensing unit comprising a three-axis accelerometer and a three-axis geometric sensor.

4. (canceled)

5. The device as claimed in claim **1**, wherein the motion sensor is two-axes accelerometer to output a tilt signal, the position sensor is two-axes accelerometer to output a tilt signal.

6. The device as claimed in claim **1**, further comprising a timer to calculate a user's tooth brushing time.

7. The device as claimed in claim **1**, further comprising a controller to store at least one of a user's past tooth brushing patterns, a tooth brushing behavior estimation score and a tooth brushing guide message.

8. A tooth brushing pattern analyzing method, comprising:
- detecting a user's tooth brushing motion;
- determining whether the user's tooth brushing motion is a correct tooth brushing motion;
- comparing a user's motion amount with a target motion amount; and
- informing the user of the arrival of the target amount when the effective motion amount reaches the target amount.

9. The method as claimed in claim **8**, further comprising giving the user a warning in a case where the user's tooth brushing motion is determined to be an incorrect tooth brushing pattern.

10. A tooth brushing pattern analyzing and behavior correcting method, comprising:
- setting tooth brushing parts of teeth;
- setting a correct tooth brushing pattern for each of the set tooth brushing parts and storing it;
- sensing a user's tooth brushing pattern for each of the parts;
- comparing the stored correct tooth brushing pattern with the user's tooth brushing pattern to determine the quality of the tooth brushing pattern; and
- estimating tooth brushing behavior with at brushing part, a tooth brushing pattern and tooth brushing time as reference.

11. The method as claimed in claim **10**, further comprising giving the user a warning in a case where it is determined that the user's tooth brushing motion is not a correct tooth brushing motion.

12. The method as claimed in claim **10**, further comprising: counting a user's tooth brushing motion as an effective stroke if it is determined to be good; and checking whether the number of effective strokes reaches the predetermined number of target strokes.

13. The method as claimed in claim **12**, further comprising checking tooth brushing time in a case where the number of effective strokes reaches the predetermined number of target strokes.

14. A tooth brushing pattern analyzing method, comprising:
- sensing a user's tooth brushing;
- guiding the user to a first tooth brushing operation;
- determining whether the first tooth brushing operation is completed; and
- guiding the user to the next tooth brushing operation if the first tooth brushing operation is completed.

15. A method for interactively correcting tooth brushing behavior, comprising:
- detecting the start of a user's tooth brushing
- displaying a guiding screen in response to the user's tooth brushing;
- detecting a user's tooth brushing pattern;
- analyzing the user's detected tooth brushing pattern; and
- providing a tooth brushing correction screen in accordance with the analyzed result.

16. The method as claimed in claim **15**, wherein the guiding screen is an image for guiding the user to a correct tooth brushing method.

17. The method as claimed in claim **15**, wherein the guiding screen is periodically renewed.

18. The method as claimed in claim **15**, wherein the detected tooth brushing pattern is any one or more of information on a direction of user's tooth brushing, tooth brushing stroke/elapsing time, toothbrush velocity, oral cavity condition, and combinations thereof.

19. The method as claimed in claim **15**, wherein the analyzed result of the tooth brushing pattern includes any one or more of estimations for user's good/bad tooth brushing pattern, tooth brushing score, compliance, progressive trend and oral cavity health condition.

20. The method as claimed in claim **15**, wherein the tooth brushing correction screen includes a warning about a user's tooth brushing method, correct tooth brushing method, and advice for medical treatment plan/schedule and oral cavity health prevention/management off-line.

21. A system for interactively correcting tooth brushing behavior, comprising:

a tooth brushing pattern analyzing/correcting device for detecting a user's tooth brushing pattern; and

a smart bath for providing a user with a guiding screen in communication with the tooth brushing pattern analyzing/correcting device, analyzing the user's received tooth brushing pattern, and providing a tooth brushing correction screen in accordance with the analyzed result.

22. The system as claimed in claim **21**, wherein the tooth brushing pattern analyzing/correcting device and the smart bath are communicated each other by wire or wireless to transmit detected tooth brushing pattern data.

23. The system as claimed in claim **21**, wherein the smart bath includes a smart mirror combined with a mirror to be used as a mirror for general use and also display the guiding screen and/or the tooth brushing correction screen in a display mode.

24. The system as claimed in claim **21**, wherein the smart bath further includes a toothbrush disinfector for keeping the tooth brushing pattern analyzing/correcting device therein, and detecting in-use and storing modes of the brushing pattern analyzing/correcting device to detect the presence of use of a user's tooth brushing pattern analyzing/correcting device for each identification code.

25. The system as claimed in claim **21**, wherein the smart bath further includes an oral cavity camera for photographing a user's oral cavity, and the oral cavity camera is kept in the toothbrush disinfector in a form identical with the tooth brushing pattern analyzing/correcting device.

26-28. (canceled)

29. A smart bath including a smart mirror to be used as a mirror for general use and also display the guiding screen and the tooth brushing correction screen in a display mode, wherein the smart bath provides a user with a guiding screen in communication with the tooth brushing pattern analyzing/correcting device, analyzes the user's received tooth brushing pattern, and provides a tooth brushing correction screen with the intention of increasing compliance in accordance with the analyzed result.

30. (canceled)

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