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(54) **Apparatus and method for controlling vehicle by teeth-clenching**

Vorrichtung und Verfahren zur Steuerung eines Fahrzeugs durch Zusammenpressen der Zähne

Appareil et méthode de contrôle d'un véhicule par serrement des dents

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(73) Proprietor: **Electronics and Telecommunications Research Institute Daejeon 305-350 (KR)**

(72) Inventors:
• **Jeong, Hyuk Yuseong-Gu Daejeon (KR)**

• **Kim, Jong Sung Yuseong-Gu Daejeon (KR)**
• **Son, Wookho Yuseong-Gu Daejeon (KR)**

(74) Representative: **Powell, Timothy John et al Potter Clarkson LLP Park View House 58 The Ropewalk Nottingham NG1 5DD (GB)**

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Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to an apparatus and method for controlling a vehicle by teeth-clenching, and more particularly, to an apparatus and method for controlling a vehicle according to electromyogram generated from a temporalis muscle when a quadriplegic disabled person clenches teeth.

Description of the Related Art

[0002] Disabled persons have various types of impairments. Generally, a person who has suffered spinal cord damage may become quadriplegic, which means the person is paralyzed in all four limbs. Various vehicles and driving methods thereof have been introduced for quadriplegic disabled persons. For example, an electric wheelchair and various driving methods thereof have been introduced.

[0003] As a conventional method of controlling an electric wheelchair for a quadriplegic disabled person, a joystick based controlling method and a sip-puff based controlling method were introduced. According to the joystick based controlling method, a disabled person is allowed to control the electric wheelchair by arranging a joystick under the jaw and moving the joystick using the jaw. However, the disabled person may suffer discomfort in his neck because the disabled person consistently controls the joystick through moving his neck while driving the electric wheelchair. Also, the sight of the disabled person is limited because he must hold his neck while controlling the electric wheelchair in one direction. Therefore, the method of controlling the electric wheelchair using the joystick has a safety problem.

[0004] According to the sip-puff based controlling method, a disabled person controls the electric wheelchair by inhaling or exhaling air through a breath controlling device having a shape of a straw. The sip-puff controlling method is not good for the disabled person in a view of sanitation because the disabled person must bite the breath controlling device. Also, the sensation of controlling the electric wheelchair is not enjoyable. In particular, the disabled person needs to learn how to control the electric wheelchair with the breath controlling device and it requires plenty of time to be familiar with this since it is not intuitive to control the electric wheelchair in this fashion.

[0005] Hereinafter, shortcomings of conventional apparatuses and methods for controlling a vehicle for a disabled person will be described.

[0006] A first conventional method of controlling the vehicle for disabled persons by moving the shoulder was introduced in Korea Patent Application No. 10-2003-00118856. In the conventional method using the shoulder,

a driving control device is disposed in a coat or a jacket of a disabled person having spinal cord impairment and the disabled person controls the electric wheelchair by moving his shoulder. That is, the driving control device senses the moving direction and the level of the shoulder and controls the electric wheelchair according to the sensed movements of the shoulder. However, such a conventional method cannot be applied when a disabled person cannot move his shoulder. Also, the disabled person may suffer pain in his shoulder because the disabled person must lift up the shoulder while driving the electric wheelchair in a forward direction.

[0007] A second conventional method of controlling the vehicle for disabled person was disclosed in Korea Patent Application No. 10-2003-0005471 entitled "ELECTRIC WHEELCHAIR INTERFACE DEVICE AND METHOD USING ELECTROMYOGRAM SIGNAL AND ELECTRIC WHEELCHAIR." The second conventional method obtains the electromyogram signal generated from a sternocleidomastoid muscle and a trapezius muscle when a disabled person moves his neck and controls the electric wheelchair according to the obtained electromyogram signal. In order to use the second conventional method, the disabled person must wear a sensor for obtaining the electromyogram signal on his neck. Therefore, the disabled person may be uncomfortable and have discomfort in his neck since the disabled person consistently moves his neck to control the electric wheelchair.

[0008] A third conventional method of controlling the vehicle using a head-band type sensor and a bite switch for the disabled person was disclosed in Korea Patent Application No. 10-2003-0088730. In order to use the third conventional method, a disabled person must wear a head-band type slope detecting sensor on his head to sense the direction and tilting angle of the head and holds a bite switch in his mouth to drive the electric wheelchair. Such a bite switch makes the disabled person uncomfortable.

[0009] US 6,636,763 discloses an apparatus for providing biopotential-based control of devices in response to gestures made by a user. The apparatus of US 6,636,763 is suitable to operate small devices normally actuated by hand. Examples include the mouse of a computer, or a switch. The apparatus is also suitable for control of switches of vehicles of all types by persons having one or more mental or physical disabilities. The above said gesture can be a jaw clench.

[0010] US 2003/0046254 discloses an apparatus for accurately receiving, conditioning and amplifying bio-signal voltages for use in a virtual reality apparatus so that the user's hands and feet are free to perform other operations.

SUMMARY OF THE INVENTION

[0011] According to the invention in a first aspect there is provided an apparatus for controlling a vehicle by a

teeth clenching motion made by a disabled person comprising: an electromyogram signal obtaining unit including electromyogram sensors disposed at both sides of the person respectively for generating an electromyogram signal according to a predetermined muscle moved when the disabled person clenches his/her teeth, and a ground electrode connected to the body of the disabled person for providing a reference voltage; a signal processing unit including a control command generating unit for generating a vehicle driving command according to the electromyogram signal by classifying the electromyogram signal based on the side of teeth clenching, the duration of the teeth clenching and the sequence of teeth clenching motions made by the disabled person; and a control command interface for generating a predetermined level of voltage according to the created vehicle driving command, and a vehicle driving unit for driving the vehicle according to the generated voltage, characterized in that the control command generating unit operates by dividing the electromyogram signal by a predetermined time; obtaining a difference of absolute mean values (DAMV) of each channel as feature value from the divided electromyogram signals obtained from two channels by the expression

$$\text{DAMV} = \frac{1}{N-1} \sum_{i=2}^N |x(i) - x(i-1)|, \text{ where } N \text{ denotes the}$$

number of samples in each of the divided electromyogram signals and $x(i)$ represents the digital electromyogram signal value at an index i ; classifying the electromyogram signals into four basic patterns by comparing the obtained feature values of the electromyogram signals with a predetermined threshold value, classifying the electromyogram signals into an ON state if the feature value is greater than the predetermined threshold value and classifying the electromyogram signals into an OFF state if the feature value is smaller than the predetermined threshold value; and generating a vehicle driving command based on a classified pattern by setting a previous motion of vehicle as a reference value and analyzing the classified pattern based on the reference value.

[0012] In another aspect of the present invention, there is provided a method for controlling a vehicle by a teeth clenching motion including the steps of: a) sensing an electromyogram signal of a predetermined muscle moved in a teeth clenching motion made by a user; b) generating a vehicle driving command according to the sensed electromyogram signal by classifying the sensed electromyogram signal based on the side of teeth clenching, the duration of teeth clenching and the sequence of teeth clenching motions made by the user at a control command generating unit; c) generating a predetermined level of voltage according to the created vehicle driving command; and d) driving the vehicle according to the generated voltage, characterized in that the step b) includes dividing the electromyogram signal by a predetermined time; obtaining a difference of absolute mean values (DAMV) of each channel as feature value from

the divided electromyogram signals obtained from two channels by the expression

$$\text{DAMV} = \frac{1}{N-1} \sum_{i=2}^N |x(i) - x(i-1)|, \text{ where } N \text{ deno-}$$

tes the number of samples in each of the divided electromyogram signals and $x(i)$ represents the digital electromyogram signal value at an index i ; classifying the electromyogram signals into four basic patterns by comparing the obtained feature values of the electromyogram signals with a predetermined threshold value, classifying the electromyogram signals into an ON state if the feature value is greater than the predetermined threshold value and classifying the electromyogram signals into an OFF state if the feature value is smaller than the predetermined threshold value; and generating a vehicle driving command based on a classified pattern by setting a previous motion of vehicle as a reference value and analyzing the classified pattern based on the reference value.

[0013] Accordingly, the present invention is directed to an apparatus and method for controlling a vehicle by teeth clenching, which substantially obviates one or more problems due to limitations and disadvantages of the related art.

[0014] It is an advantage of the invention to provide an apparatus for controlling a vehicle such as an electric wheelchair by teeth clenching, which is designed as a headgear such as a hat or a hair-band, by sensing and analyzing electromyogram signals generated by a teeth clenching motion of the disabled person, distinguishing the teeth clenching motion of the disabled person into a left side teeth clenching motion, a right side teeth clenching motion or a both sides teeth clenching motion, and driving the vehicle according to the distinguished teeth clenching motion and a duration time for clenching of the teeth so as to allow the disabled person intuitively to control the vehicle and to minimize discomfort when the disabled person wears the vehicle driving apparatus.

[0015] It is another advantage of the invention to provide a method of controlling a vehicle based on teeth clenching

[0016] Additional advantages, objects, and features of the invention will be set forth in part in the description which follows and in part will become apparent to those having ordinary skill in the art upon examination of the following or may be learned from practice of the invention. The objectives and other advantages of the invention may be realized and attained by the structure particularly pointed out in the written description and claims hereof as well as the appended drawings.

[0017] It is to be understood that both the foregoing general description and the following detailed description of the present invention are exemplary and explanatory and are intended to provide further explanation of the invention as claimed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] The accompanying drawings, which are included to provide a further understanding of the invention, are incorporated in and constitute a part of this application, illustrate embodiments of the invention and together with the description serve to explain the principle of the invention. In the drawings:

FIG. 1 is a conceptual view illustrating an apparatus for controlling a vehicle by teeth clenching according to an embodiment of the present invention;

FIG. 2 is a view depicting a disabled person wearing the vehicle controlling apparatus shown in FIG. 2;

FIG. 3 is a flowchart showing a method for controlling a vehicle by teeth clenching according to an embodiment of the present invention;

FIG. 4 is a flowchart showing a method of processing a signal transmitted from the vehicle controlling apparatus according to an embodiment of the present invention;

FIGS. 5A to 5D are flowcharts of a method of controlling an electric wheelchair according to an embodiment of the present invention; and

FIG. 6 shows a control panel of the vehicle controlling apparatus shown in FIG. 1 with control commands being displayed.

DETAILED DESCRIPTION OF THE INVENTION

[0019] Reference will now be made in detail to the preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings.

[0020] A vehicle controlling apparatus according to the present invention controls a vehicle according to a teeth clenching motion made by a user. The teeth clenching motion can be made by a disabled person having serious impairment by distinguishing a right teeth clenching motion, a left teeth clenching motion and a both sides teeth clenching motion. Muscles used for clenching teeth include a masseter muscle around the jaw and a temporalis muscle at the temple. Since the masseter muscle is located at both sides of jaw, it is not easy to attach sensors around the masseter muscle. Although a sensor can be attached at the masseter muscle, a user may be uncomfortable. In the invention, the sensors are attached around the temples of the side of the head to obtain an electromyogram signal from the temporalis muscle. Since the sensors are disposed in headgear such as a hair band or a hat, the invention minimizes the discomfort of users and maximizes convenience.

[0021] FIG. 1 is a conceptual view illustrating an apparatus for controlling a vehicle by teeth clenching according to an embodiment of the present invention. As an embodiment of the present invention, the vehicle controlling apparatus has the form of a hair-band.

[0022] As shown in FIG. 1, the vehicle controlling apparatus according to the present embodiment includes

a signal obtaining and transmitting unit 10 for obtaining an electromyogram signal and a signal processing unit 20 for processing the obtained electromyogram signals.

[0023] The signal obtaining and transmitting unit 10 includes two electromyogram sensors 100 for sensing electromyogram signals generated from a temporalis muscle when a teeth clenching motion made by a disabled person; a ground electrode 110 for measuring a reference voltage; and an amplifying and transmitting unit 120 for amplifying the sensed signal, transforming the amplified signal to a digital signal and transmitting the digital signal via a wireless link.

[0024] The electromyogram sensors 100, the ground electrode 110 and the amplifying and transmitting unit 120 are disposed in a hair-band 130. It is preferable to design the hair-band 130 to be easily wearable according to ability of the disabled person. For example, Velcro is attached at an inside surface of the hair-band 130 to easily adjust the position of the electromyogram sensors 100 corresponding to features of a disabled person such as the shape of the head in order accurately to sense the electromyogram signal. In the present embodiment, the signal obtaining and transmitting unit 10 is disposed in the hair-band 130. However, the signal obtaining and transmitting unit 10 may be disposed in various types of headgear such as a hat or a cap.

[0025] The electromyogram sensor 100 uses voltage differences between two pairs of electrodes to obtain the electromyogram generated by the teeth clenching motion of the disabled person so as to secure safety against signal generation caused by an eye blinking motion and to minimize the influence of electroencephalogram signals transferred from the brain. In the present embodiment, two sensors 100 are included. However, the present invention is not limited to the number of the electromyogram sensors disclosed.

[0026] The signal processing unit 20 includes a control command generating unit 200, a control command interface 210 and a wheelchair driving unit 220.

[0027] The control command generating unit 200 receives an electromyogram signal transmitted through a wireless link, processes the received signal and generates a command to drive the wheelchair. The control command interface 210 transfers the generated command to the wheelchair driving unit 220 by transforming the generated command into a suitable form for the wheelchair driving unit 220. The wheelchair driving unit 220 controls driving devices such as a left motor and/or a right motor according to the generated command to drive the wheelchair.

[0028] In the present embodiment, the signal obtaining and transmitting unit 10 and the signal processing unit 20 communicate with one another through a wireless communication link. However, they may communicate through a wired link.

[0029] Also, the apparatus for controlling a vehicle by teeth clenching according to the present embodiment may further include a display unit 230 to display the gen-

erated command and related information.

[0030] FIG. 2 is a view showing a disabled person wearing the apparatus for controlling a vehicle by teeth clenching shown in FIG. 1

[0031] Referring to FIG. 2, the electromyogram sensors 100 and the ground electrode 110 are disposed inside of the hair-band 30 in parallel at appropriate positions so that the ground electrode 110 is arranged at the centre of the forehead of a disabled person and the electromyogram sensors 100 are arranged at both sides of the head of the disabled person when the disabled person wears the hair-band 30. Since the electromyogram signal generated by the teeth clenching motion is easily detected around the temples that are spaced about 10cm from the end of the eyebrow formed on the temporalis muscle, the disabled person adjusts the hair-band to arrange the electromyogram sensors 100 around the temples after putting on the hair-band 30.

[0032] Hereinafter, a method of controlling a vehicle by teeth clenching according to the present invention will be described with reference to accompanying drawings.

[0033] FIG. 3 is a flowchart of a method for controlling a vehicle by teeth clenching according to an embodiment of the present invention.

[0034] Referring to FIG. 3, the electromyogram sensors 100 sense the electromyogram signal generated from the temporalis muscles when a user makes a teeth clenching motion. Then, the amplifying and transmitting unit 120 amplifies the sensed electromyogram signal, transforms the amplified signal into a digital signal and transmits the digital signal through a wireless link at step S10.

[0035] The control command generating unit 200 receives the transmitted signal from the signal obtaining and transmitting unit 10 and generates a command to control the wheelchair by processing the received signal at step S20. Herein, the generated wheelchair control command is displayed on the display unit 230 at step S30 and the control command interface 210 transfers the wheelchair control command to the wheelchair driving unit 220 at step S40. The wheelchair driving unit 220 drives the left motor or the right motor according to the wheelchair control command at step S50.

[0036] FIG. 4 shows a method of processing a signal transmitted from the vehicle controlling apparatus according to an embodiment of the present invention. That is, the flowchart shown in FIG. 4 describes the step S20 shown in FIG. 3 in detail.

[0037] Referring to FIG. 4, the signal processing unit 20 receives the electromyogram signal from the signal obtaining and transmitting unit 10 at step S210. Since the signal obtaining and transmitting unit 10 and the signal processing unit 20 communicate with one another based on a short range wireless communication scheme, a Bluetooth protocol consuming comparatively less power may be used.

[0038] The received signal is processed through a preprocessing step. In the preprocessing step, the electro-

myogram signals inputted from two channels, i.e., a left channel and a right channel, are divided by 100ms at step S202 because electromyogram signals longer than 100ms can be assumed as stationary. However, the length of the divided electromyogram signal may vary according to its condition. While transforming the electromyogram signal into a digital signal, about 1kHz of sampling frequency is used. Therefore, 100 samples are obtained from each of the divided electromyogram signals.

[0039] The preprocessing step includes a step for detecting poor contacts of the electromyogram sensor 100 or the ground electrode 110 and generating the wheelchair driving command based on the detected poor contacts. The poor contacts maximize the amplitude of the electromyogram signal as a square wave. Accordingly, the signal processing unit 20 observes the electromyogram signals and determines whether the maximum amplitudes greater than a predetermined threshold value are continuously generated or not at step S203. If the maximum amplitudes are continuously generated, the vehicle controlling apparatus according to the present invention notifies the error of detecting the electromyogram signal to the user by creating an error message or reproducing a predetermined sound at step S204. Then, the user adjusts the hair-band, or the vehicle controlling apparatus is checked at step S205.

[0040] After the step S203, a minimum value and a maximum value of the electromyogram signal are compared to a minimum threshold value and a maximum threshold value and the frequency of the minimum and the maximum values identical to the minimum and the maximum threshold value is calculated at step S206. If the frequency is greater than a predetermined frequency, the wheelchair driving command for stopping the wheelchair is generated at step S209 without performing a step for extracting features from the electromyogram signal. According to the stopping command, the wheelchair stops or is maintained in a stopped state.

[0041] After the preprocessing step, features are extracted from the electromyogram signals at step S207. That is, a difference of absolute mean values is extracted from electromyogram signals obtained from two channels based on following equation.

$$DAMV = \frac{1}{N-1} \sum_{i=2}^N |x(i) - x(i-1)|$$

[0042] Herein, N denotes the number of samples in each of the divided electromyogram signals and $x(i)$ represents the digital electromyogram signal value at an index i . Since the DAMV represents the characteristics of electromyogram signal which is rapidly changed and does not include direct current (DC) components, it does not require a step for eliminating the DC components.

[0043] Using the DAMV value, a pattern classification

is performed at step S208. In the pattern classification, the feature values of electromyogram signals from two channels are compared with a predetermined threshold value. If the feature value is greater than the predetermined threshold value, the electromyogram signal from corresponding channel is classified into an ON state. On the contrary, if the feature value is smaller than the predetermined threshold value, the electromyogram signal is classified into an OFF state. That is, the electromyogram signals obtained from two channels are classified into four different state signals such as 1) the electromyogram signals from a first and a second channel are OFF states; 2) the electromyogram signal obtained from a first channel arranged at the left temple is the ON state and the electromyogram signal obtained from a second channel arranged at the right temple is the OFF state; 3) the electromyogram signal obtained from the first channel is the OFF state and the electromyogram signal obtained from the second channel is the ON state; and 4) the electromyogram signals obtained from the first and the second channels are both ON states. Such classified patterns are defined as REST, LEFT, RIGHT and BOTH. As described above, four basic commands can be created based on electromyogram signals from two channels.

[0044] Then, a command for driving a wheelchair is generated using the defined pattern in the pattern classifying step. Although the defined four basic commands may be used to control the wheelchair, more commands are required to smoothly and finely control the wheelchair such as to move the wheelchair in a reverse direction and to turn the wheelchair to a right or a left side while driving in a forward direction. Therefore, various commands are created according to previous moving directions of wheelchair and a history of recognizing basic patterns in the present embodiment. Such a method of creating the various commands is shown in FIGS. 5A to 5D.

[0045] FIGS. 5A to 5D are flowcharts of a method of controlling an electric wheelchair according to an embodiment of the present invention.

[0046] FIGS. 5A through 5D shows steps for creating various commands to drive the wheelchair based on the basic patterns such as REST, LEFT, RIGHT and BOTH. Hereinafter, definition of commands shown in FIGS 5A to 5D will be described at first.

[0047] Pat is a variable denoting a currently recognized basic teeth-clenching pattern or a switch. The Pat has one of the values of REST, LEFT (L), RIGHT (R) and BOTH.

[0048] PrePat[i] denotes a basic teeth-clenching pattern recognized at i^{th} stage ($i=0, 1, 2, \dots, n1$) where $n1$ is a predetermined natural number that denotes a number of divided electromyogram signals of the past pattern.

[0049] Act is a variable denoting motions of the wheelchair. There are 13 wheelchair motions as follows.

1. STOP: stop

2. GF: move in forward direction
3. GB: move in reverse direction
4. TL: turn left
5. TR: turn right
6. GFL1: make a short turn to the left (counterclockwise) while moving in forward direction.
7. GFL2: make a large turn to the left while moving in forward direction
8. GFL3: make a quick turn to the left while moving in forward direction. It is a command to drive the wheelchair in a narrow road bent at 90 degree.
9. GFR1: make a short turn to the right (clockwise) while moving in forward direction
10. GFR2: make a large turn to the right while moving in forward direction
11. GFR3: make a quick turn to the right while moving in forward direction
12. GBL1: make a left turn (counterclockwise) while moving in reverse direction
13. GBR1: make a right turn (clockwise) while moving in reverse direction

[0050] PreAct is a variable denoting a motion of the wheelchair at a previous stage.

[0051] Dir is a variable for determining whether a moving direction of the wheelchair is a forward direction or a backward direction. In case of the forward direction, the Dir has a value of Forward. In case of the reverse direction, the Dir has a value of Reverse.

[0052] bCheck is a variable for determining how many times a user clenches the teeth. If the user clenches the teeth one time, the bCheck has a value of TRUE. If the user clenches teeth two or more times, the bCheck has a value of FALSE. The bCheck is used to change a direction of moving the wheelchair when the user clenches his/her teeth for a predetermined time and then releases the teeth two times. Herein, if the user does not clench and release two times, the value of bCheck is transformed to FALSE. Therefore, this prevents the wheelchair from being turned when the wheelchair is stopped for a short time.

[0053] During an initial state of driving the wheelchair, the PrePat and the PreAct are set as REST and STOP, respectively. Then, features are extracted the electromyogram signals and the patterns of electromyogram signals are classified as follows.

[0054] FIG. 5A shows a wheelchair controlling algorithm when the pattern (Pat) is left (L). Referring to FIG. 5A, the left pattern (Pat = L) is received at step S301. Then, the previous motion (PreAct) of wheelchair is determined at step S302. If the previous motion (PreAct) is TL, TR or STOP at step S302, a wheelchair driving command is set as TL at step S303. If the previous motion (PreAct) is not TL, TR or STOP at step S302, the motion of wheelchair (Act) is set as the previous wheelchair motion (PreAct) at step S304.

[0055] FIG. 5B shows a wheelchair controlling algorithm when the pattern Pat is a right (R). Referring to FIG.

5B, the right pattern (Pat = R) is received at step S311. Then, the previous motion (PreAct) of wheelchair is determined at step S312. If the previous motion (PreAct) is TL, TR or STOP at step S312, a wheelchair driving command is set as TR at step S313. If the previous motion (PreAct) is not TL, TR or STOP at step S312, the motion of wheelchair (Act) is set as the previous wheelchair motion (PreAct) at step S314.

[0056] FIG. 5C shows a wheelchair controlling algorithm when the pattern (Pat) is BOTH. Referring to FIG. 5C, the BOTH pattern is received at step S321. Then, the previous motions (PreAct[0 to n1]) of the wheelchair from the stage 0 to the stage n1 are determined at step S322. If the previous motions (PreAct[0 to n1]) are BOTH at step S322, the method determines whether Dir is Forward or not at step S333. If the Dir is Forward at step S333, the Act of the wheelchair is set as GF at steps S324. If the Dir is Backward at step S333, the Act of the wheelchair is set as GB at step S325. Therefore, a user must consistently clench the teeth on both sides for a predetermined time to move the wheelchair in the forward direction or the backward direction. By checking previous motions of wheelchair, the method of the invention prevents the wheelchair from being moved when the user accidentally clenches his/her teeth on both sides. If the previous motions (PreAct[0 to n1]) are not BOTH at step S322, the motion of the wheelchair (Act) is set as STOP at step S326.

[0057] FIG. 5D shows a wheelchair controlling algorithm when the pattern (Pat) is REST.

[0058] Referring to FIG. 5D, the REST pattern (Pat = REST) is received at step S332. Then, the PreAct is checked at steps S332, S338, S348, S358, S368 and S372. If the PreAct is one of GF, GFL1, GFL2, GRF1 and GFR2, it denotes that the wheelchair is moving in a forward direction. In order to make turns to the left or right, the user clenches his/her teeth on the left side or the right side for a short period. Then, the moving direction of the wheelchair changes. In case of the PreAct being GF, the wheelchair turns to the right at the moment the user releases the teeth after clenching the right side teeth for a predetermined time. By repeatedly clenching and releasing the right side teeth, the wheelchair turns to the right little by little. On the contrary, the wheelchair turns to the left at the moment the user releases his/her teeth after clenching the left side teeth for a predetermined time. For example, if the user releases the teeth after clenching the teeth on the right or the left side for a predetermined time, i.e., about 0.2 to 1 sec, the wheelchair changes direction according to the side clenched. That is, the turning level is changed sequentially through GFL2 → GFL1 → GF → GFR1 → GFR2 or GFR2 → GRF1 → GF → GFL1 → GFL2. If a user clenches his/her teeth on the right or left side for a predetermined time, i.e., about 1 sec, while , changing the direction, the wheelchair makes a quick turn as GFL3 or GFR3 without regard to the previous moving direction such as GF, GFL1, GFR1, GFL2 and GFR2.

[0059] In FIG. 5D, L/R or R/L denotes optionality of the command as between "left" and "right" versions at the same position in the flowchart. In the following the vehicle controlling method will be described for one of L/R.

[0060] Referring to FIG. 5D, the REST pattern is received at step S331. Then, a previous motion (PreAct) is determined at step S332. If the PreAct is GF at step S332, the previous patterns from the stage 0 to the stage n0 (PrePat[0, 1,...,n0]) are determined at steps S333 and S334. If the PrePat[0] is L and PrePat[1 to n0] are L at steps S333 and S334, the algorithm determines how long the user clenches his/her teeth. If the user clenches the teeth for longer than a predetermined time, the motion (Act) of wheelchair is set to GFL3 at step S335. If the user clenches the teeth for no longer than the predetermined time, the Act is set to GFL1 a step S336. At the step S355, if PrePat[0] is not 'L', the Act is set to PreAct at step S337.

[0061] Meanwhile, if the PreAct is GFL1 at step S338 after receiving the REST pattern at step S331, the previous patterns from the stage 0 to the stage n0 (PrePat [0, 1,...,n0]) are determined at steps S339 and S340. If the PrePat[0] is L and PrePat[1 to n0] are L at steps S339 and S340, the algorithm determines how long the user clenches the teeth. If the user clenches the teeth for longer than a predetermined time, the motion (Act) of wheelchair is set to GFL3 at step S341. If the user clenches the teeth for no longer than the predetermined time, the Act is set to GFL2 at step S342. If PrePat[0] is not L at the step S339 and if PrePat [0] is R at step S343, the PrePat [1 to n0] are determined at step S344. If the PrePat [1 to n0] are R and if the user clenches the teeth for longer than the predetermined time, the Act is set to GFL3 at step S345. If not at the step S344, the Act is set to GF at step S346. Also, if PrePat[0] is not R a step S343, the Act is set to the PreAct at step S347.

[0062] If the PreAct is GFL2 at step S348 after receiving the REST pattern at step S331, the previous patterns from the stage 0 to the stage n0 (PrePat[0, 1,...,n0]) are determined at steps S349 and S350. If the PrePat[0] is L and PrePat[1 to n0] are L at steps S349 and S350, the method, determines how long a user clenches the teeth. If the user clenches the teeth for longer than a predetermined time, the-motion (Act) of wheelchair is set to GFL3 at step S351. If the user clenches the teeth for no longer than the predetermined time, the Act is set to GFL3 a step S352. If PrePat[0] is not L at the step S349 and if PrePat [0] is R at step S353, the PrePat [1 to n0] are determined at step S354. If the PrePat[1 to n0] are R and if the user clenches the teeth for longer than the predetermined time, the Act is set to GFL3 at step S355. If not at the step S354, the Act is set to GFL1 at step S356. Also, if PrePat[0] is not R a step S353, the Act is set to the PreAct at step S357.

[0063] If the PreAct is GFL3 at step S358 after receiving the REST pattern at step S331, the previous patterns from the stage 0 to the stage n0 (PrePat[0, 1,...,n0]) are determined at steps S359 and S360. If the PrePat[0] is

L and PrePat[1 to n0] are L at steps S359 and S360, the algorithm determines for how long the user clenches the teeth. If the user clenches the teeth for longer than a predetermined time, the motion (Act) of wheelchair is set to GFL3 at step S361. If the user clenches the teeth for no longer than the predetermined time, the Act is set to GF a step S362. If PrePat[0] is not L at the step S359 and if PrePat [0] is R at step S363, the PrePat [1 to n0] are determined at step S364. If the PrePat [1 to n0] are R and if the user clenches the teeth for longer than the predetermined time, the Act is set to GFL3 at step S365. If not at the step S364, the Act is set to GFL2 at step S366. Also, if PrePat[0] is not R a step S363, the Act is set to the PreAct at step S367.

[0064] In FIG. 5D, the algorithm determines whether PrePat [0] is 'L' or not when PreAct is 'GF' in order to prevent the wheelchair from being turned in error. That is, the wheelchair makes turns only when patterns LEFT or RIGHT are constantly detected at least for more than two "blocks" (time periods). Such a prevention mechanism is performed when the PreAct is GF as well as during forward movement and backward movement of the wheelchair.

[0065] While making the quick turn shown in FIG. 5D, the wheelchair moves in the forward direction if the user clenches and releases his/her teeth on the opposite side to the turning direction.

[0066] If the PreAct is GB at step S368, the wheelchair makes a right turn or a left turn at steps S369 to S371 as a result of clenching and releasing of the teeth on the right side or the left side, respectively. It is preferable for safety reasons not to provide a command for a quick turn while the wheelchair is moving in reverse direction. However, such a quick turn command may be created according to the present invention.

[0067] If the PreAct is STOP at steps S372 to S373 and a user repeatedly clenches and releases the teeth, the moving direction of the wheelchair is changed from the forward to the reverse or from the reverse to the forward direction at steps S374 to S380. If a user clenches and releases the teeth on both sides once, the clenching motion of the user after a predetermined time is deleted from the memory of the apparatus. This is conceptually similar to the distinction between a single click and a double click of a computer mouse.

[0068] As described above, if the control command generating unit 200 generates a command to control the wheelchair by recognizing a pattern of electromyogram signals, the display unit 230 displays the created command or outputs e.g. as corresponding audio information. The display unit 230 may include a display panel for showing the created command and the recognized pattern, a control panel for setting threshold values for each channel to recognize a pattern and a memory for storing and reading the threshold values.

[0069] FIG. 6 shows a control panel of the vehicle controlling apparatus shown in FIG. 1 with control commands displayed.

[0070] Referring to FIG. 6 the display unit 230 displays a created wheelchair driving command. The display unit 230 also displays changes of moving direction and the recognized patterns.

[0071] Typical electric wheelchairs include an additional wheelchair driving unit 22 for driving the wheelchair. The wheelchair driving unit 220 drives the wheelchair by supplying a predetermined level of power according to commands inputted through a joystick or various switches. The joystick is generally used to input the commands. The joystick supplies different levels of power to the wheelchair driving unit 220 according to the input command. The vehicle controlling apparatus according to the present invention includes the control command interface unit 210 for transferring a wheelchair driving command created by a teeth clenching motion because the vehicle controlling apparatus uses the teeth clenching motion as an inputting means instead of a joystick. The control command interface 210 converts the wheelchair control command to a predetermined level of voltage and the predetermined level of voltage is supplied to the wheelchair driving unit 220 to control the wheelchair according to the wheelchair control command.

[0072] As described above, the vehicle controlling apparatus and method according to the present invention allow a disabled person conveniently to control the wheelchair by embodying the vehicle controlling apparatus as a form of wearable headgear such as a hair-band or a hat and sensing the electromyogram signals generated from the temporalis muscles of the disabled person. Also, the vehicle controlling apparatus and method according to the present invention allow the disabled person smoothly to control the wheelchair by generating various driving commands based on the current teeth clenching pattern and the previous teeth clenching patterns.

[0073] It will be apparent to those skilled in the art that various modifications and variations can be made in the present invention. Thus, it is intended that the present invention covers the modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents.

45 Claims

1. An apparatus for controlling a vehicle by a teeth clenching motion made by a disabled person comprising:

an electromyogram signal obtaining unit (10) including electromyogram sensors (100) disposed at both sides of the person respectively for generating an electromyogram signal according to a predetermined muscle moved when the disabled person clenches his/her teeth, and a ground electrode(110) connected to the body of the disabled person for providing a reference

voltage;
 a signal processing unit (20) including a control command generating unit (200) for generating a vehicle driving command according to the electromyogram signal by classifying the electromyogram signal based on the side of teeth clenching, the duration of the teeth clenching and the sequence of teeth clenching motions made by the disabled person; and
 a control command interface (210) for generating a predetermined level of voltage according to the created vehicle driving command, and a vehicle driving unit (220) for driving the vehicle according to the generated voltage, **characterized in that** the control command generating unit (200) operates by dividing the electromyogram signal by a predetermined time; obtaining a difference of absolute mean values (DAMV) of each channel as feature value from the divided electromyogram signals obtained from two channels by the expression

$$\text{DAMV} = \frac{1}{N-1} \sum_{i=2}^N |x(i) - x(i-1)|, \text{ where } N \text{ de-}$$

notes the number of samples in each of the divided electromyogram signals and $x(i)$ represents the digital electromyogram signal value at an Index i ;

classifying the electromyogram signals into four basic patterns by comparing the obtained feature values of the electromyogram signals with a predetermined threshold value, classifying the electromyogram signals into an ON state if the feature value is greater than the predetermined threshold value and classifying the electromyogram signals into an OFF state if the feature value is smaller than the predetermined threshold value; and

generating a vehicle driving command based on a classified pattern by setting a previous motion of vehicle as a reference value and analyzing the classified pattern based on the reference value.

2. The apparatus of claim 1, wherein the electromyogram signal obtaining unit (10) further includes an amplifying/transmitting unit (120) for amplifying the sensed electromyogram signal and transforming the amplified electromyogram signal to a digital signal, and the signal processing unit (20) further includes a receiving/amplifying unit (120) for receiving the electromyogram signal transferred from the electromyogram signal obtaining unit and amplifying the received signal.
3. The apparatus of claim 2, wherein the amplifying/transmitting unit (120) includes a differential ampli-

fying unit for calculating a voltage difference between the electromyogram sensors.

4. The apparatus of claim 2, wherein the electromyogram signal obtaining unit (10) and the amplifying/transmitting unit (120) are disposed at a fixing means selected from the list including a hair-band (130) and a hat.
5. The apparatus of claim 4, wherein the electromyogram sensors are fixed at the fixing means using an attachable/detachable member.
6. The apparatus of claim 1, wherein the control command generating unit (200) further includes a display unit (230) for displaying the command created by the control signal generating unit (200).
7. The apparatus of claim 1, wherein the electromyogram sensors (100) are provided in plurality.
8. A method for controlling a vehicle by a teeth clenching motion comprising the steps of:

a) sensing an electromyogram signal of a predetermined muscle moved in a teeth clenching motion made by a user;

b) generating a vehicle driving command according to the sensed electromyogram signal by classifying the sensed electromyogram signal based on the side of teeth clenching, the duration of teeth clenching and the sequence of teeth clenching motions made by the user at a control command generating unit (200);

c) generating a predetermined level of voltage according to the created vehicle driving command; and

d) driving the vehicle according to the generated voltage, **characterized in that** the step b) includes dividing the electromyogram signal by a predetermined time;

obtaining a difference of absolute mean values (DAMV) of each channel as feature value from the divided electromyogram signals obtained from two channels by the expression

$$\text{DAMV} = \frac{1}{N-1} \sum_{i=2}^N |x(i) - x(i-1)|, \text{ where } N \text{ denotes}$$

the number of samples in each of the divided electromyogram signals and $x(i)$ represents the digital electromyogram signal value at an index i ;

classifying the electromyogram signals into four basic patterns by comparing the obtained feature values of the electromyogram signals with a predetermined threshold value, classifying the electromyogram signals into an ON state if the feature value is

greater than the predetermined threshold value and classifying the electromyogram signals into an OFF state if the feature value is smaller than the predetermined threshold value; and

generating a vehicle driving command based on a classified pattern by setting a previous motion of vehicle as a reference value and analyzing the classified pattern based on the reference value.

9. The method of claim 8, further comprising the steps of:

amplifying the sensed electromyogram signal and transforming the amplified signal to a digital signal at an amplifying/transmitting unit (120) after the step a); and

receiving and amplifying the transmitted electromyogram signal at a receiving/amplifying unit (120) before performing the step b).

10. The method of claim 8, wherein in the step of generating the vehicle driving command when the vehicle is stopped, the vehicle is controlled to make a left turn or a right turn if the vehicle driving command is generated by receiving the electromyogram signal transferred from one of channels, and the vehicle is controlled to move in a forward direction or a reverse direction if the vehicle driving command is generated by receiving the electromyogram signals from both channels for longer than a predetermined time.

11. The method of claim 10, wherein the moving direction of the vehicle is switchable from the forward direction to the reverse direction or vice versa if the vehicle driving command is generated by receiving the electromyogram signals from both channels in two time periods.

12. The method of claim 8, wherein in the step of generating the command, the vehicle makes a turn to a corresponding side according to a vehicle driving command generated by receiving the electromyogram signal transferred from one of channels while moving in a forward direction.

13. The method of claim 12, wherein the vehicle makes a turn with a turning angle varied widely according to the number of commands transferred from each channel.

14. The method of claim 12, wherein the vehicle makes a turn with a maximum turning angle if the number of commands transferred from each channel is greater than a predetermined number or a time of inputting commands transferred from each channel is longer than a predetermined time.

15. The method of claim 12, wherein the vehicle makes

a turn with a smaller turning angle than a current turning angle when the command transferred from each channel is a command to turn the vehicle to an opposite direction.

16. The method of any one of claims 12 and 15, wherein the vehicle makes a turn after receiving the same commands for more than a predetermined period in order to prevent the vehicle from being turned in error.

17. The method of claim 8, wherein the step of dividing the electromyogram signal includes the step of detecting a loss of contact in the electromyogram sensors (100) and the ground electrode (110) by determining whether maximum amplitudes are detected more than a predetermined number of times from the signal obtained from the electromyogram sensors (110).

18. The method of claim 8, wherein a stop command is generated by converting the electromyogram signal In to a digital signal, measuring a frequency of generating values identical to a maximum threshold and a minimum threshold value, and generating the stop command if the measured frequency is greater than a predetermined threshold value.

19. The method of claim 8, wherein the step b) includes the step of displaying the created command.

20. The method of claim 19, wherein the step of displaying the created command further includes the step of reproducing voice information denoting 'turn to left' or 'turn to right'.

Patentansprüche

1. Vorrichtung zur Steuerung eines Fahrzeugs durch eine Zahnzusammenpressbewegung einer behinderten Person mit:

einer Elektromyogramm-Signalerhaltungseinheit (10), die Elektromyogramm-Sensoren (100), die an beiden Seiten der Person angeordnet sind, um ein Elektromyogramm-Signal zu erzeugen, entsprechend einem vorbestimmten Muskel, der bewegt wird, wenn die behinderte Person ihre/seine Zähne zusammenbeißt, und einer Masseelektrode (110), die mit dem Körper der behinderten Person zur Bereitstellung einer Bezugsspannung verbunden ist, umfasst; einer Signalverarbeitungseinheit (20) mit einer Steuerbefehlserzeugungseinheit (200) zum Erzeugen eines Fahrzeugfahrbefehls entsprechend dem Elektromyogramm-Signal durch Klassifizieren des Elektromyogramm-Signals

beruhend auf der Seite des Zusammenpressens der Zähne, der Dauer des Zusammenpressens der Zähne und der Folge der Zusammenpressbewegungen der Zähne, die von der behinderten Person vorgenommen werden; und einer Steuerungsbefehlsschnittstelle (210) zum Erzeugen eines vorgegebenen Spannungspiegels entsprechend dem erzeugten Fahrzeugfahrbefehl, und eine Fahrzeugfahreinheit (220) zum Fahren des Fahrzeugs entsprechend der erzeugten Spannung, **dadurch gekennzeichnet, dass** die Steuerbefehlserzeugungseinheit (200) durch Teilen des Elektromyogramm-Signals durch eine vorgegebene Zeit arbeitet; Erhalten einer Differenz des Absolutmittelwertes (DAMV; Difference of Absolute Mean Value) für jeden Kanal als Merkmalswert aus den geteilten Elektromyogramm-Signalen, die von zwei Kanälen erhalten werden, mittels der Gleichung

$$\text{DAMV} = \frac{1}{N-1} \sum_{i=2}^N |x(i) - x(i-1)|$$

wobei N die Anzahl der Proben in jedem der geteilten der Elektromyogramm-Signale und x (i) den digitalen Elektromyogramm-Signalwert bei einem Index i darstellt;

Klassifizieren der Elektromyogramm-Signale in vier grundlegende Muster durch Vergleichen der erhaltenen Merkmalswerte der Elektromyogramm-Signale mit einem vorgegebenen Schwellenwert, Klassifizieren der Elektromyogramm-Signale in einem AN-Zustand, wenn der Merkmalswert größer als der vorgegebene Schwellenwert ist, und Klassifizieren der Elektromyogramm-Signale in einem AUS-Zustand, wenn der Merkmalswert kleiner als der vorgegebene Schwellenwert ist; und

Erzeugen eines Fahrzeugfahrbefehls beruhend auf dem klassifizierten Muster durch Einstellen einer vorhergehenden Bewegung des Fahrzeugs als ein Bezugswert und durch Analysieren der klassifizierten Muster beruhend auf dem Bezugswert.

2. Vorrichtung nach Anspruch 1, bei dem die Elektromyogramm-Signalerhaltungseinheit (10) des Weiteren eine Verstärker/Transmittereinheit (120) zum Verstärken des erfassten Elektromyogramm-Signals und zum Übertragen des verstärkten Elektromyogramm-Signals an ein Digitalsignal enthält, wobei die Signalverarbeitungseinheit (20) des Weiteren eine Empfangs/Verstärkungseinheit (120) umfasst, um das Elektromyogramm-Signal zu empfangen, das von der Elektromyogramm-Signalerhal-

tungseinheit übertragen wurde, und zum Verstärken des empfangenen Signals.

3. Vorrichtung nach Anspruch 2, bei der die Verstärkungs/Übertragungseinheit (120) eine Differentialverstärkungseinheit zum Berechnen einer Spannungsdifferenz zwischen den Elektromyogramm-Sensoren umfasst.
4. Vorrichtung nach Anspruch 2, bei der die Elektromyogramm-Signalerhaltungseinheit (10) und die Verstärkungs/Übertragungseinheit (120) an einem Befestigungsmittel angebracht sind, dass aus der Liste einschließlich eines Haarbandes (120) und eines Huts ausgewählt ist.
5. Vorrichtung nach Anspruch 4, bei der die Elektromyogramm-Sensoren an den Befestigungsmitteln mittels eines abnehmbaren/befestigbaren Elementes angebracht sind.
6. Vorrichtung nach Anspruch 1, bei der die Steuerbefehlserzeugungseinheit (200) des Weiteren eine Anzeigeeinheit (230) zum Anzeigen des erzeugten Befehls durch die Steuersignalerzeugungseinheit (200) umfasst.
7. Vorrichtung nach Anspruch 1, bei der die Elektromyogramm-Sensoren (100) in einer Vielzahl vorgesehen sind.
8. Verfahren zum Steuern eines Fahrzeugs mittels einer Zahnzusammenpressbewegung mit den Schritten:
 - a) Erfassen eines Elektromyogramm-Signals eines bestimmten Muskels, der bei einer Zahnzusammenpressbewegung von einem Benutzer bewegt wird,
 - b) Erzeugen eines Fahrzeugfahrbefehls entsprechend dem erfassten Elektromyogramm-Signal durch Klassifizieren des Elektromyogramm-Signals beruhend auf der Seite des Zusammenpressens der Zähne, der Dauer des Zusammenpressens der Zähne und der Folge der Zusammenpressbewegungen der Zähne, die von dem Benutzer gemacht werden bei der Steuerbefehlserzeugungseinheit (200);
 - c) Erzeugen eines vorgegebenen Spannungspiegels entsprechend dem erzeugten Fahrzeugfahrbefehl; und
 - d) Fahren des Fahrzeugs entsprechend der erzeugten Spannung, **dadurch gekennzeichnet, dass** der Schritt b) das Teilen des Elektromyogramm-Signals durch eine vorgegebene Zeit umfasst;

Erhalten einer Differenz von Absolutmittelwerten

(DAMV; Difference of Absolute Mean Values) für jeden Kanal als Merkmalswert von den geteilten Elektromyogramm-Signalen, die von den zwei Kanälen erhalten werden, durch Verwenden der Gleichung

$$DAMV = \frac{1}{N-1} \sum_{i=2}^N |x(i) - x(i-1)|$$

wobei N die Anzahl der Proben in jedem der geteilten Elektromyogramm-Signale ist, und wobei x(i) den digitalen Elektromyogramm-Signalwert bei einem Index i darstellt;

Klassifizieren der Elektromyogramm-Signale in vier Grundmuster durch Vergleichen der erhaltenen Merkmalswerte der Elektromyogramm-Signale mit einem vorgegebenen Schwellenwert, Klassifizieren der Elektromyogramm-Signale in einem AN-Zustand, wenn der Merkmalswert größer als der vorgegebene Schwellenwert ist, und Klassifizieren der Elektromyogramm-Signale in einem AUS-Zustand, wenn der Merkmalswert kleiner als der vorgegebene Schwellenwert ist; und

Erzeugen eines Fahrzeugfahrbefehls beruhend auf einem klassifizierten Muster durch Einstellen einer vorgegebenen Bewegung des Fahrzeugs als ein Bezugswert und durch Analysieren des klassifizierten Musters beruhend auf dem Bezugswert.

9. Verfahren nach Anspruch 8, des Weiteren mit den Schritten:

Verstärken des erfassten Elektromyogramm-Signals und Umwandeln des verstärkten Signals in ein Digitalsignal bei einer Verstärkungs/Übertragungseinheit (120) nach dem Schritt a) und Empfangen und Verstärken des übertragenen Elektromyogramm-Signals bei einer Empfangs/Verstärkungseinheit (120) vor dem Durchführen des Schritts b).

10. Verfahren nach Anspruch 8, bei dem bei dem Schritt des Erzeugens des Fahrzeugfahrbefehls, wenn das Fahrzeug gestoppt ist, das Fahrzeug gesteuert wird, um nach links oder nach rechts zu drehen, wenn der Fahrzeugfahrbefehl durch Empfangen des Elektromyogramm-Signals erhalten wird, das von einem der Kanäle übertragen wird, und wobei das Fahrzeug gesteuert wird, um nach vorne oder rückwärts zu fahren, wenn der Fahrzeugfahrbefehl durch Empfang der Elektromyogramm-Signale von beiden Kanälen über mehr als eine vorgegebene Zeit erzeugt wird.
11. Verfahren nach Anspruch 10, bei dem die Bewegungsrichtung des Fahrzeugs von der Vorwärtsrichtung in die Rückwärtsrichtung oder umgekehrt um-

schaltbar ist, wenn der Fahrzeugfahrbefehl erzeugt wird, durch Empfangen der Elektromyogramm-Signale von beiden Kanälen in zwei Zeitabschnitten.

12. Verfahren nach Anspruch 8, bei dem in dem Schritt des Erzeugens des Befehls das Fahrzeug eine Kehre zu einer entsprechenden Seite entsprechend eines Fahrzeugfahrbefehls durchführt, der durch Empfang des Elektromyogramm-Signals erzeugt wird, das von einem der Kanäle übertragen wird, während es sich in der Vorwärtsrichtung bewegt.
13. Verfahren nach Anspruch 12, bei dem das Fahrzeug eine Kehre mit einem Kehrwinkel macht, der im großen Ausmaß entsprechend der Anzahl der Befehle variiert, die für jeden Kanal übertragen werden.
14. Verfahren nach Anspruch 12, bei dem das Fahrzeug eine Kehre mit einem maximalen Kehrwinkel macht, wenn die Anzahl der Befehle, die für jeden Kanal übertragen werden, größer als eine vorgegebene Zahl ist, oder eine Zeit zum Eingeben der Befehle, die für jeden Kanal übertragen werden, länger als eine vorgegebene Zeit ist.
15. Verfahren nach Anspruch 12, bei dem das Fahrzeug eine Kehre mit einem kleineren Kehrwinkel macht, als der gegenwärtige Kehrwinkel, wenn der übertragene Befehl von jedem Kanal ein Befehl ist, das Fahrzeug in eine entgegengesetzte Richtung zu drehen.
16. Verfahren nach einem der Ansprüche 12 bis 15, bei dem das Fahrzeug eine Kehre macht, nach dem die gleichen Befehle über mehr als eine vorgegebene Zeitspanne empfangen werden, um zu verhindern, dass das Fahrzeug versehentlich gedreht wird.
17. Verfahren nach Anspruch 8, bei dem der Schritt des Teilens des Elektromyogramm-Signals den Schritt des Erfassen eines Verlustes des Kontakts in den Elektromyogramm-Sensoren (100) und der Masselektrode (110) umfasst, durch Bestimmen, ob die maximalen Amplituden über mehr als eine vorgegebene Anzahl von Malen von dem Signal erfasst werden, das von den Elektromyogrammsensoren (110) erhalten wird.
18. Verfahren nach Anspruch 8, bei dem ein Stoppbefehl erzeugt wird, indem das Elektromyogramm-Signal in ein Digitalsignal gewandelt wird, eine Frequenz der erzeugten Werte identisch zu einem maximalen Schwellenwert und einem minimalen Schwellenwert gemessen wird, und wobei der Stoppbefehl erzeugt wird, wenn die gemessene Frequenz größer als ein vorgegebener Schwellenwert ist.
19. Verfahren nach Anspruch 8, bei dem der Schritt b)

den Schritt des Anzeigens des erzeugten Befehls umfasst.

20. Verfahren nach Anspruch 19, bei dem der Schritt des Anzeigens des erzeugten Befehls des Weiteren den Schritt des Wiedergebens von Sprachinformation umfasst, die bezeichnen "Kehren nach links" oder "Kehren nach rechts".

Revendications

1. Appareil de commande d'un véhicule par un mouvement de serrement des dents effectué par une personne handicapée comprenant :

une unité d'obtention de signal d'électromyogramme (10) incluant des capteurs d'électromyogramme (100) disposés des deux côtés de la personne respectivement pour générer un signal d'électromyogramme selon un muscle prédéterminé déplacé lorsque la personne handicapée serre les dents, et une électrode de masse (110) connectée au corps de la personne handicapée pour fournir une tension de référence ;

une unité de traitement de signal (20) incluant une unité de génération d'ordre de commande (200) permettant de générer un ordre de conduite de véhicule selon le signal d'électromyogramme en classant le signal d'électromyogramme en se basant sur le côté de serrement de dents, la durée du serrement de dents et la séquence des mouvements de serrement de dents effectués par la personne handicapée ; et une interface d'ordre de commande (210) permettant de générer un niveau prédéterminé de tension selon l'ordre de conduite de véhicule créé, et une unité de conduite de véhicule (220) permettant de conduire le véhicule selon la tension générée, **caractérisé en ce que** l'unité de génération d'ordre de commande (200) fonctionne en divisant le signal d'électromyogramme par un temps prédéterminé ;

en obtenant une différence de valeur moyenne absolue (DAMV) de chaque canal comme valeur caractéristique à partir des signaux d'électromyogramme divisés obtenus à partir de deux canaux par l'expression

$$DAMV = \frac{1}{N-1} \sum_{i=2}^N |x(i) - x(i-1)|,$$

où N désigne le nombre d'échantillons dans chacun des signaux d'électromyogramme divisés et $x(i)$ représente la valeur de signal d'électromyogramme numérique à un indice i ;

en classant les signaux d'électromyogramme en quatre motifs de base en comparant les valeurs

caractéristiques obtenues des signaux d'électromyogramme avec une valeur de seuil prédéterminée, en classant les signaux d'électromyogramme en un état de MARCHE si la valeur caractéristique est supérieure à la valeur de seuil prédéterminée et en classant les signaux d'électromyogramme en un état d'ARRET si la valeur caractéristique est plus petite que la valeur de seuil prédéterminée ; et

en générant un ordre de conduite de véhicule basée sur un motif classé en établissant un mouvement antérieur du véhicule comme une valeur de référence et en analysant le motif classé en se basant sur la valeur de référence.

2. Appareil selon la revendication 1, dans lequel l'unité d'obtention de signal d'électromyogramme (10) inclut en outre une unité d'amplification/transmission (120) permettant d'amplifier le signal d'électromyogramme détecté et de transformer le signal d'électromyogramme amplifié en un signal numérique, et l'unité de traitement de signal (20) inclut en outre une unité de réception/amplification (120) permettant de recevoir le signal d'électromyogramme transféré depuis l'unité d'obtention de signal d'électromyogramme et d'amplifier le signal reçu.
3. Appareil selon la revendication 2, dans lequel l'unité d'amplification/transmission (120) inclut une unité d'amplification différentielle permettant de calculer une différence de tension entre les capteurs d'électromyogramme.
4. Appareil selon la revendication 2, dans lequel l'unité d'obtention de signal d'électromyogramme (10) et l'unité d'amplification/transmission (120) sont disposées au niveau d'un moyen de fixation choisi dans la liste comprenant un bandeau pour la tête (130) et un chapeau.
5. Appareil selon la revendication 4, dans lequel les capteurs d'électromyogramme sont fixés au niveau du moyen de fixation à l'aide d'un organe attachable/détachable.
6. Appareil selon la revendication 1, dans lequel l'unité de génération d'ordre de commande (200) inclut en outre une unité d'affichage (230) permettant d'afficher l'ordre créé par l'unité de génération de signal de commande (200).
7. Appareil selon la revendication 1, dans lequel les capteurs d'électromyogramme (100) sont fournis en pluralité.
8. Procédé de commande d'un véhicule par un mouvement de serrement de dents comprenant les étapes de :

- a) détection d'un signal d'électromyogramme (10) d'un muscle prédéterminé déplacé dans un mouvement de serrement de dents réalisé par un utilisateur ;
- b) génération d'un ordre de conduite de véhicule selon le signal d'électromyogramme détecté en classant le signal d'électromyogramme détecté en se basant sur le côté de serrement de dents, la durée du serrement de dents et la séquence des mouvements de serrement de dents effectués par l'utilisateur au niveau d'une unité de génération d'ordre de commande (200) ;
- c) génération d'un niveau prédéterminé de tension selon l'ordre de conduite de véhicule créé ; et
- d) conduite du véhicule selon la tension générée, **caractérisé en ce que** l'étape b) inclut la division du signal d'électromyogramme par un temps prédéterminé ;

l'obtention d'une différence de valeur moyenne absolue (DAMV) de chaque canal comme valeur caractéristique à partir des signaux d'électromyogramme divisés obtenus à partir de deux canaux par l'expression

$$DAMV = \frac{1}{N-1} \sum_{i=2}^N |x(i) - x(i-1)|,$$

où N désigne le nombre d'échantillons dans chacun des signaux d'électromyogramme divisés et $x(i)$ représente la valeur de signal d'électromyogramme numérique à un indice i ;

le classement des signaux d'électromyogramme en quatre motifs de base en comparant les valeurs caractéristiques obtenues des signaux d'électromyogramme avec une valeur de seuil prédéterminée, le classement des signaux d'électromyogramme dans un état de MARCHE si la valeur caractéristique est supérieure à la valeur de seuil prédéterminée et le classement des signaux d'électromyogramme dans un état d'ARRET si la valeur caractéristique est plus petite que la valeur de seuil prédéterminée ; et la génération d'un ordre de conduite de véhicule basée sur un motif classé en établissant un mouvement antérieur du véhicule comme une valeur de référence et en analysant le motif classé en se basant sur la valeur de référence.

9. Procédé selon la revendication 8, comprenant en outre les étapes de :

amplification du signal d'électromyogramme détecté et transformation du signal amplifié en un signal numérique au niveau d'une unité d'amplification/transmission (120) après l'étape a) ; et
réception et amplification du signal d'électromyogramme transmis au niveau d'une unité de

réception/amplification (120) avant réalisation de l'étape b).

10. Procédé selon la revendication 8, dans lequel dans l'étape de génération de l'ordre de conduite de véhicule lorsque le véhicule est arrêté, le véhicule est commandé pour faire un virage à gauche ou un virage à droite si l'ordre de conduite de véhicule est généré par la réception du signal d'électromyogramme transféré depuis l'un des canaux, et le véhicule est commandé pour se déplacer vers l'avant ou vers l'arrière si l'ordre de conduite de véhicule est généré par la réception des signaux d'électromyogramme depuis les deux canaux pendant un temps plus long qu'un temps prédéterminé.
11. Procédé selon la revendication 10, dans lequel la direction de déplacement du véhicule peut être permutee de ladite direction vers l'avant à la direction vers l'arrière ou vice versa si l'ordre de conduite de véhicule est généré par la réception des signaux d'électromyogramme depuis les deux canaux en deux périodes de temps.
12. Procédé selon la revendication 8, dans lequel, dans l'étape de génération de l'ordre, le véhicule fait un virage vers un côté correspondant selon un ordre de conduite de véhicule généré par la réception du signal d'électromyogramme transféré depuis l'un des canaux tout en se déplaçant dans une direction vers l'avant.
13. Procédé selon la revendication 12, dans lequel le véhicule fait un virage avec un angle de braquage variant grandement selon le nombre d'ordres transférés depuis chaque canal.
14. Procédé selon la revendication 12, dans lequel le véhicule fait un virage avec un angle de braquage maximal si le nombre d'ordres transférés depuis chaque canal est plus grand qu'un nombre prédéterminé ou qu'une durée d'entrée d'ordres transférés depuis chaque canal est plus longue qu'un temps prédéterminé.
15. Procédé selon la revendication 12, dans lequel le véhicule fait un virage avec un angle de braquage plus petit qu'un angle de braquage actuel lorsque l'ordre transféré depuis chaque canal est un ordre pour faire tourner le véhicule dans une direction opposée.
16. Procédé selon l'une quelconque des revendications 12 et 15, dans lequel le véhicule fait un virage après réception des mêmes ordres pendant plus d'une période prédéterminée afin d'empêcher le véhicule de tourner par erreur.

17. Procédé selon la revendication 8, dans lequel l'étape de division du signal d'électromyogramme inclut l'étape de détection de perte de contact dans les capteurs d'électromyogramme (100) et l'électrode de masse (110) par le fait de déterminer si des amplitudes maximales sont détectées plus d'un nombre de fois prédéterminé à partir du signal obtenu par les capteurs d'électromyogramme (110). 5
18. Procédé selon la revendication 8, dans lequel un ordre d'arrêt est généré en convertissant le signal d'électromyogramme en un signal numérique, en mesurant une fréquence de valeurs de génération identique à un seuil maximal et une valeur de seuil minimale, et en générant l'ordre d'arrêt si la fréquence mesurée est plus grande qu'une valeur de seuil prédéterminée. 10 15
19. Procédé selon la revendication 8, dans lequel l'étape b) inclut l'étape d'affichage de l'ordre créé. 20
20. Procédé selon la revendication 19, dans lequel l'étape d'affichage de l'ordre créé inclut en outre l'étape de reproduction d'informations vocales précisant « tourner à gauche » ou « tourner à droite ». 25

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FIG. 1

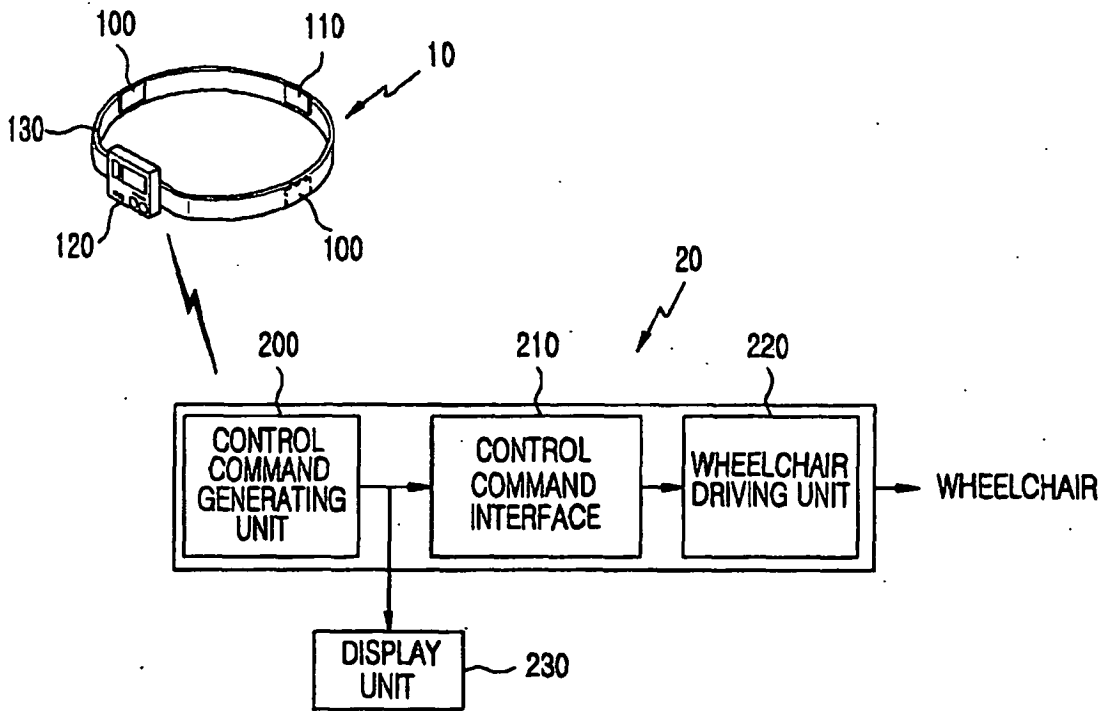


FIG. 2

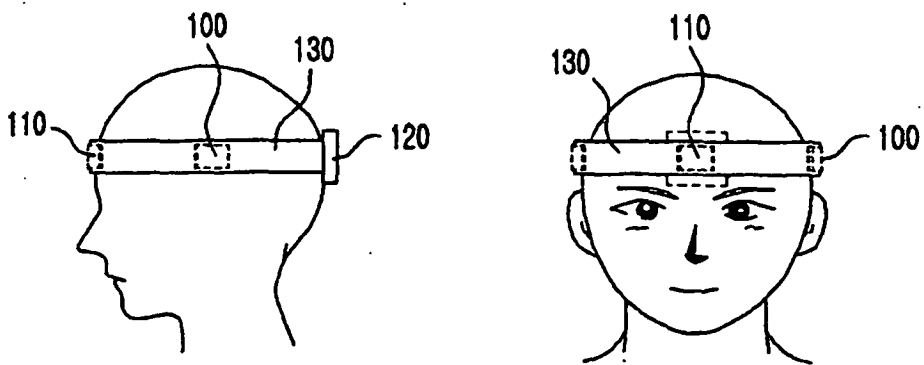


FIG. 3

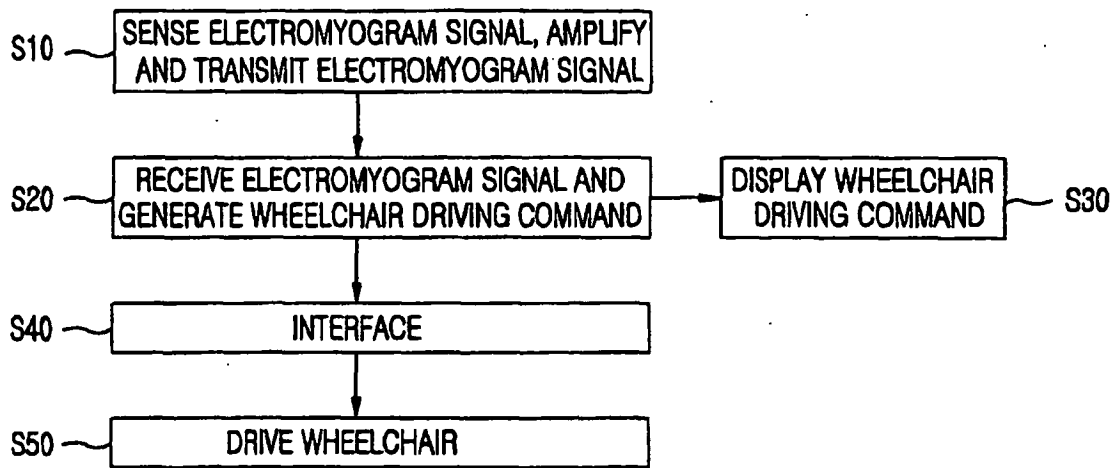


FIG. 4

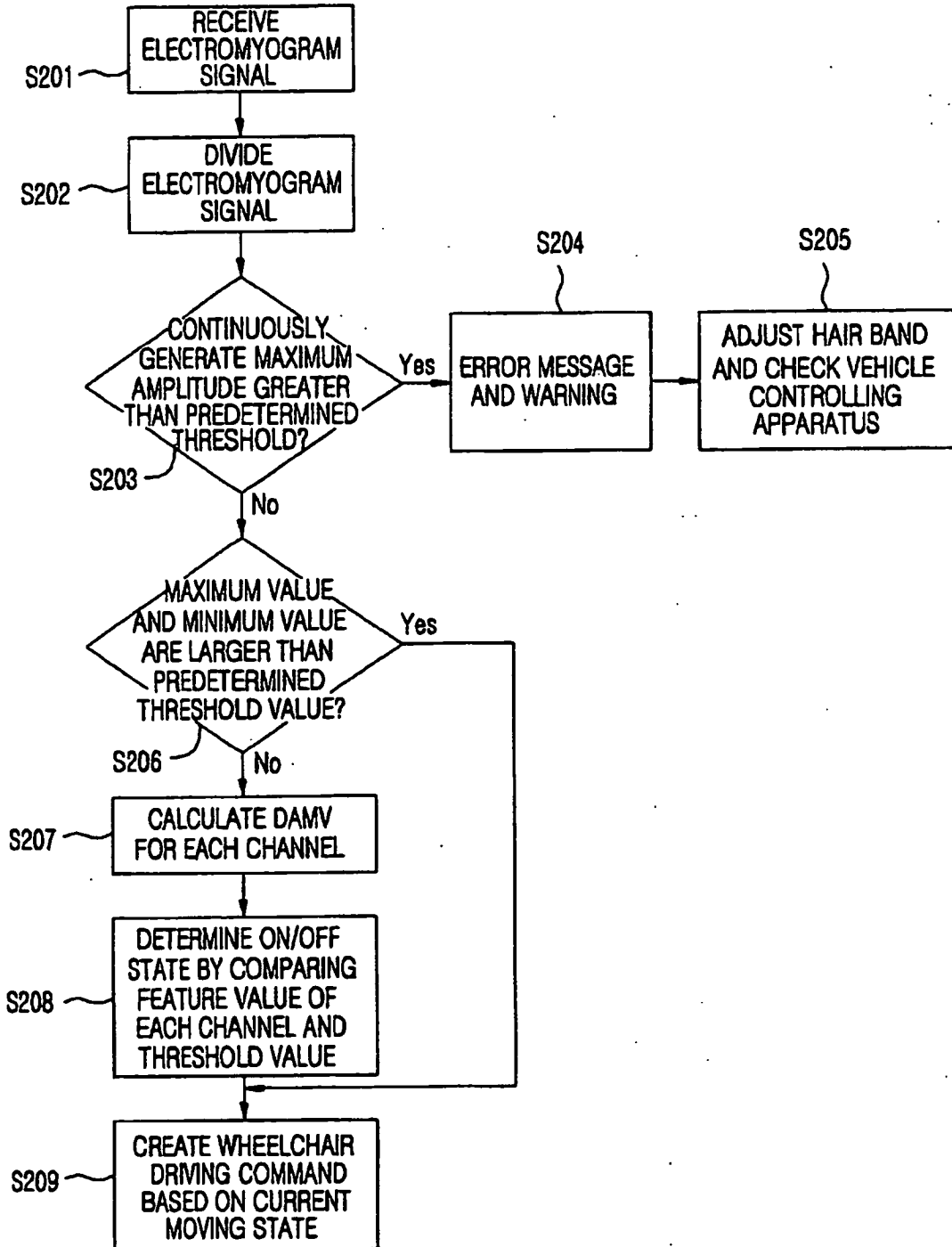


FIG. 5a

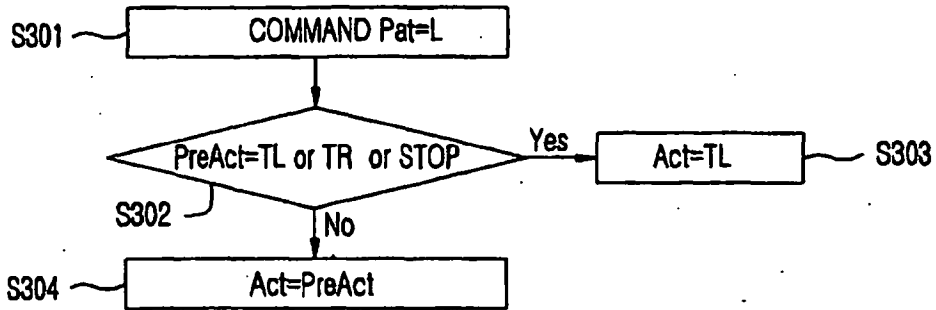


FIG. 5b

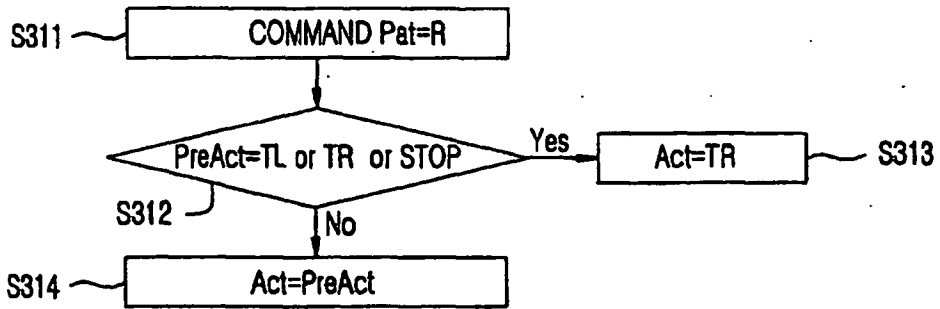


FIG. 5c

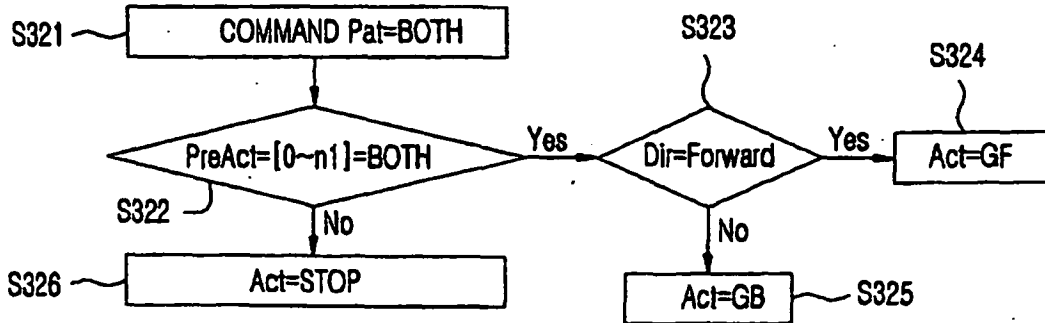


FIG. 5d

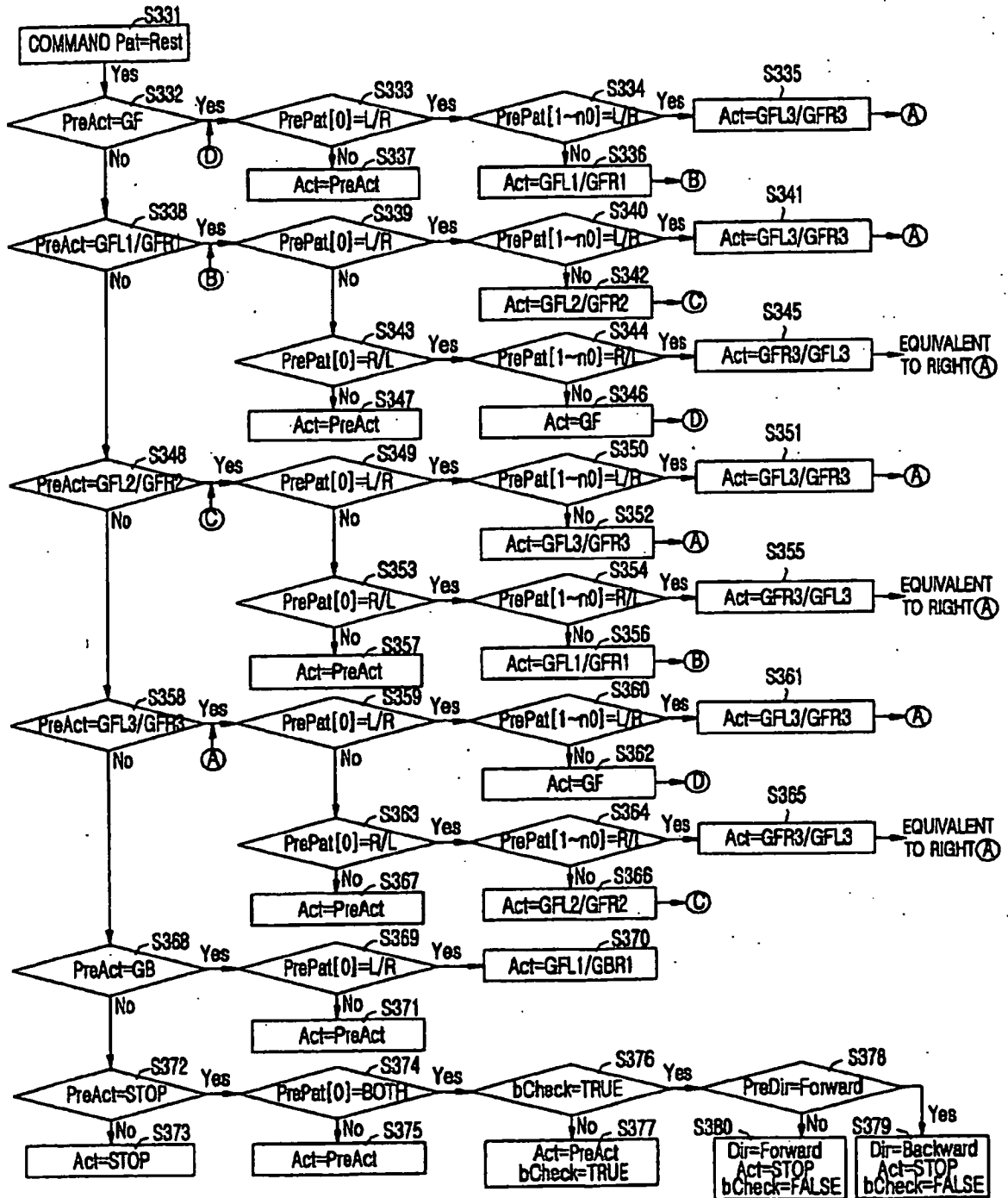
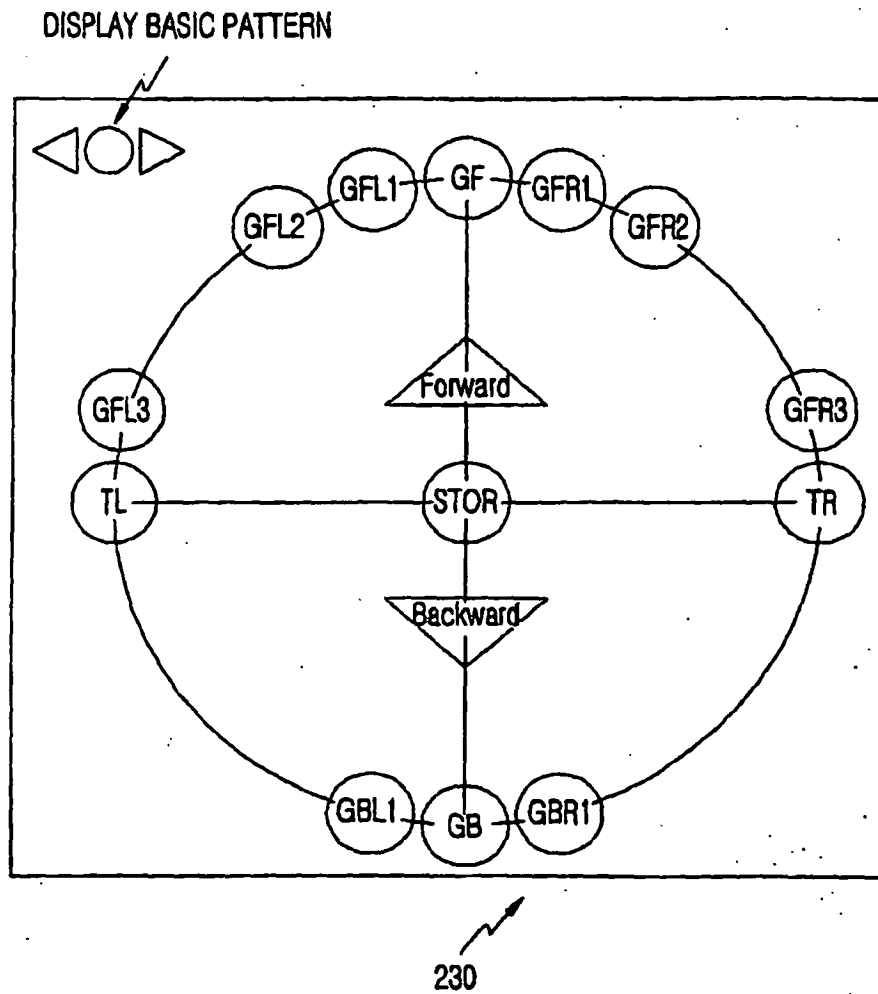


FIG. 6



REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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专利名称(译)	用于通过牙齿咬合来控制车辆的装置和方法		
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申请(专利权)人(译)	电子通信研究院		
当前申请(专利权)人(译)	电子通信研究院		
[标]发明人	JEONG HYUK KIM JONG SUNG SON WOOKHO		
发明人	JEONG, HYUK KIM, JONG SUNG SON, WOOKHO		
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摘要(译)

提供了一种用于通过牙齿咬合来控制车辆的设备和方法。该装置包括：肌电信号获取单元，包括设置在两侧的肌电图传感器，用于根据当残疾人咬牙时移动的预定肌肉产生肌电信号；以及接地电极，连接到残疾人的身体以提供参考电压；以及车辆驱动单元，包括控制指令产生单元，用于根据所述肌电图信号通过基于握紧的牙齿侧的肌电信号分类产生车辆驱动命令，用于咬紧牙齿的持续时间和由此产生的一系列牙齿咬合作：残疾人，用于根据所创建的车辆驾驶命令生成预定电压水平的控制命令界面，以及用于根据所生成的电压驱动车辆的车辆驱动单元。

$$DAMV = \frac{1}{N-1} \sum_{i=1}^N |x(i) - x(i-1)|$$