SPECIFICATION

AGING ANALYSIS METHOD AND AGING ANALYSIS DEVICE

TECHNICAL FIELD

[0001]

The present invention relates to an aging analysis technique.

BACKGROUND ART

[0002]

Aging care or anti-aging is a matter of concern to males as well as females, and various dedicated products such as cosmetics or foodstuffs are widely available. Many persons care about their aging state such as a perceived age or an aging condition of each part. Patent Document 1 suggests a method of distinguishing an aging pattern of a face using five features of (1) a change direction of the shape of the face, (2) a degree of depression of an upper eyelid, (3) a degree of wrinkling around a corner of the mouth, (4) a degree of nasolabial folds and (5) a shape of the lower jaw, which are acquired from a two-dimensional face image, as indices. Patent Document 2 suggests a method of calculating a weighting factor of a base vector related to the face of a subject by using the base vector acquired by performing multivariate analysis on three-dimensional morphological information of a face surface, and acquiring a degree of the trends in impressions of features of the face of the subject based on the weighting factor.

RELATED DOCUMENT

PATENT DOCUMENT

[0003]

[Patent Document 1] Japanese Unexamined Patent Application Publication No. 2001-331791

[Patent Document 2] Japanese Patent No. 5231685

SUMMARY OF THE INVENTION

[0004]

An aging analysis method according to a first aspect includes: acquiring a feature vector of a subject which is related to a plurality of morphological features correlated to age; determining a factor expression pattern indicating expressed states of a plurality of common aging factors in the subject by using the plurality of common aging factors extracted by performing factor analysis on a set of feature vectors related to a population including a plurality of persons and the feature vector of the subject; and acquiring aging information of the subject based on the factor expression pattern of the subject.

[0005]

An aging analysis apparatus according to a second aspect includes: an acquisition unit that acquires a feature vector of a subject related to a plurality of morphological features correlated to age; a determination unit that determines a factor expression pattern indicating expressed states of a plurality of common aging factors in the subject by using the plurality of common aging factors extracted by performing factor analysis on a set of feature vectors related to a population including a plurality of persons and the feature vector of the subject; and an output unit that outputs aging information of the subject based on the factor expression pattern

of the subject.

[0006]

As another aspect of the present invention, there is an aging care counseling method that includes the aging analysis method according to the first aspect, a program causing at least one computer to execute the aging analysis method according to the first aspect, or a computer readable recording medium that records such a program. The recording medium includes a non-transitory tangible medium.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007]

The above-described objects, other objects, features and advantages will become further apparent from the preferred embodiments to be described below, and the accompanying drawings as follows.

[0008]

FIG. 1 is a diagram showing an aging analysis method according to a first embodiment.

FIG. 2 is a conceptual diagram showing a hardware configuration example of an aging analysis apparatus according to the first embodiment.

FIG. 3 is a conceptual diagram showing a processing configuration example of the aging analysis apparatus according to the first embodiment.

FIG. 4 is a diagram showing an example (first pattern determining method) of a perceived age analysis method (analysis method) according to a second embodiment.

FIG. 5 is a conceptual diagram showing a processing

configuration example of a perceived age analysis apparatus (analysis apparatus) according to the second embodiment.

FIG. 6 is a diagram showing another processing configuration example of the perceived age analysis apparatus (analysis apparatus) according to the second embodiment.

FIG. 7 is a diagram showing an example (second pattern determining method) of a perceived age analysis method (analysis method) according to a third embodiment.

FIG. 8 is a diagram showing a perceived age analysis method (analysis method) according to a modification example.

FIG. 9 is a diagram showing a processing configuration example of a perceived age analysis apparatus (analysis apparatus) according to the modification example.

FIG. 10A is a diagram showing an example of morphological features and common aging factors.

FIG. 10B is a diagram for describing the morphological features illustrated in FIG. 10A.

FIG. 10C is a diagram showing the correlation of the respective factors shown in FIG. 10A with the perceived age.

FIG. 11 is a diagram showing another example of the morphological features and the common aging factors.

FIG. 12 is a diagram showing an example of multiple regression equations for acquiring factor scores from the feature vector.

FIG. 13 is a diagram showing the factor scores of the respective subjects acquired from the multiple regression equations shown in FIG. 12 and expressed states of the common aging factors.

FIG. 14 is a diagram showing factor scores of the respective

subjects acquired by performing factor analysis on a set of feature vectors of a population (497 persons) including the subject and expressed states of common aging factors.

FIG. 15 is a diagram showing a method of determining the factor expressed state according to the present example.

FIG. 16 is a diagram showing classification states of individual samples for the respective ages of the perceived age.

FIG. 17 is a diagram showing a classification example of the factor expression pattern.

FIG. 18 is a diagram showing an example of aging information based on the classification of the factor expression pattern.

DESCRIPTION OF EMBODIMENTS

[0009]

Hereinafter, embodiments of the present invention will be described. The following embodiments are respectively examples, and the present invention is not limited to the configurations of the following embodiments.

[0010]

[First Embodiment]

FIG. 1 is a diagram showing an aging analysis method according to a first embodiment. As shown in FIG. 1, the aging analysis method according to the first embodiment includes acquiring a feature vector of a subject related to a plurality of morphological features correlated with age (S11), determining a factor expression pattern in the subject, which indicates expressed states of a plurality of common aging factors extracted by performing factor analysis on a set of feature vectors of a population which are related to the

plurality of morphological features by using the feature vector of the subject (S13), and acquiring aging information of the subject based on the factor expression pattern of the subject (S15).

[0011]

The age is a perceived age or an actual age. The respective feature quantities included in the feature vector acquired in (S11) are information items regarding the shapes of parts of the body correlated with the age. That is, the feature vector acquired in (S11) is morphological information items of a plurality of parts of the body.

[0012]

The “feature quantity” and the “morphological feature classification” are distinguishably used as follows. The “morphological feature classification” is information common to the respective individuals, which indicates the shape of a specific part of a person, and the “feature quantity” is a physical quantity that reflects the feature of each individual in the morphological features. For example, the “morphological feature classification” is the philtrum length, the relative size of the eyes with respect to the width between cheeks, and the slant (angle) of the eye in the vertical direction, and the “feature quantity” indicating the “morphological feature classification” is the measured value of each individual, such as 20 mm (millimeters), 0.32, or 2 degrees. The part of the body having the shape is not limited as long as such a “morphological feature classification” is morphological information correlated with the age. For example, the “morphological feature classification” is the shape of a part of the face and the head (including the neck)

other than the face. The “morphological feature classification” may be the shape of the abdomen, the back of the hand, and a leg other than the head. Each feature quantity may be represented in various units such as a length, an angle, the curvature of a curved surface or a curved line, and a ratio. Here, the head refers to the neck and an upper part above the neck in the human body.

[0013]

In (S13), a plurality of common factors acquired by performing factor analysis on a set of feature vectors related to a population including a plurality of persons is used. The common factor is described as a common aging factor. Feature vectors of the respective individual samples (respective individuals) included in the set of feature vectors correspond to the same plurality of morphological features as that of the feature vector of the subject acquired in (S11). In (S13), the factor expression pattern indicating the expressed states of the plurality of common aging factors are determined for the subject by using the feature vector of the subject acquired in (S11). For example, the factor expression pattern may represent whether or not the factors are expressed for the respective common aging factors. However, the method of representing the factor expression pattern is not limited. The factor expression pattern may respectively represent the degrees of expression for the respective common aging factors, and may represent only the expressed common aging factors or only the unexpressed common aging factors.

[0014]

In (S15), the aging information of the subject is acquired based on the factor expression pattern of the subject determined in (S13).

The acquired aging information may represent the age impression (perceived age) of the subject, or may represent the degree of aging (hereinafter, referred to as morphological age in some cases) indicating rough age which the morphological feature indicated by the feature vector overall corresponds to. Here, the acquiring of the aging information in (S15) may be performed in various aspects. For example, the aging information items may be previously assigned to the factor expression patterns. There may exist as many factor expression patterns as there are combinations of the common aging factors. In this case, the aging information assigned to the factor expression pattern of the subject is acquired. In (S15), a person may ascertain the aging information of the subject. For example, in (S15), the aging information may be acquired by providing a table that represents the aging information items of the acquired factor expression patterns in comparison with the factor expression pattern of the subject determined in (S13). In this case, the person can ascertain the aging information of the subject by comparing the factor expression pattern of the subject with the table. A specific aspect of acquiring the aging information in (S15) will be described below.

[0015]

The aging analysis method according to the first embodiment may be performed in at least one computer such as an aging analysis apparatus to be described below. However, processes in which at least a part thereof is performed by the person may be included in the above-described aging analysis method. For example, in (S13), an intermediate process may be performed by the computer, and only the final determination of the factor expression pattern may be performed

by the person based on information calculated by the computer. In (S15), only the final acquisition (ascertainment) of the aging information of the subject may be performed by the person such that the person ascertains the aging information of the subject by comparing the factor expression pattern of the subject and the table. The aging analysis method according to the first embodiment is a method achieving repeatedly and continuously a specific degree of effect of acquiring the aging information of a subject without actually comparing the subject's information items with information items of many others, or actually holding hearing from many people for judging the subject, by using the correlation between the age and the morphological features of a person and the correlation between the age and the common factor between the morphological features. Accordingly, for example, even though the process performed by the person is included, the aging analysis method according to the first embodiment means a creation of technical ideas utilizing a law of nature as a whole.

[0016]

FIG. 2 is a conceptual diagram showing a hardware configuration example of an aging analysis apparatus 10 according to the first embodiment. The aging analysis apparatus 10 is a so-called computer, and includes, for example, a central processing unit (CPU) 11, a memory 12, an input and output interface (I/F) 13, a communication unit 14, and the like which are connected to each other through a bus. The memory 12 is a random access memory (RAM), a read only memory (ROM), a hard disk, or the like. The communication unit 14 exchanges signals with another computer or apparatus. The communication unit 14 may

be connected to a portable recording medium, or the like.

[0017]

The input and output I/F 13 may be connected to a user interface device such as a display device 15 or an input device 16. The display device 15 is a device, such as a liquid crystal display (LCD) or a cathode ray tube (CRT) display, which displays a screen corresponding to drawing data processed by the CPU 11, a graphics processing unit (GPU), or the like (not shown). The input device 16 is a device that receives an input of a user operation such as a keyboard or a mouse. The display device 15 and the input device 16 may be realized as one device, and may be realized as a touch panel. The hardware configuration of the aging analysis apparatus 10 is not limited.

[0018]

FIG. 3 is a conceptual diagram showing a processing configuration example of the aging analysis apparatus 10 according to the first embodiment. As shown in FIG. 3, the aging analysis apparatus 10 includes an acquisition unit 21 that acquires a feature vector of a subject which is related to a plurality of morphological features correlated to the age, a determination unit 22 that determines a factor expression pattern in the subject, which indicates expressed states of a plurality of common aging factors extracted by performing factor analysis on a set of feature vectors of a population related to the plurality of morphological features by using the feature vector of the subject, and an output processing unit 23 that outputs aging information of the subject based on the factor expression pattern of the subject. For example, these respective processing units are realized by executing programs stored

in the memory 12 by means of the CPU 11. For example, the programs may be installed from a portable recording medium such as a compact disc (CD) or a memory card, or another computer over a network through the input and output I/F 13 or the communication unit 14, and may be stored in the memory 12.

[0019]

The acquisition unit 21 performs the above-described (S11). The acquisition unit 21 may acquire the feature vector of the subject from information input through the operation of the user on the input device 16 based on an input screen or the like, or may acquire the feature vector of the subject from the portable recording medium or another computer through the communication unit 14 or the input and output I/F 13.

[0020]

The acquisition unit 21 may generate the feature vector of the subject for itself from information regarding the subject. For example, the aging analysis apparatus 10 further includes at least one of a contact type measurement unit and a non-contact type measurement unit (both are not shown), and the acquisition unit 21 may automatically calculate the feature vector of the subject, which is related to the plurality of morphological features, from three-dimensional coordinate information of a predetermined part of the subject acquired from the measurement unit. As the contact type measurement unit, a contact type three-dimensional digitizer is exemplified. As the non-contact type measurement unit, a three-dimensional laser scanner, a distance and image sensor, or the like are exemplified. The acquisition unit 21 may directly acquire

the feature vector from a two-dimensional image on which the subject is photographed. Alternatively, the acquisition unit may calculate three-dimensional coordinate information of a predetermined part of the subject from a plurality of two-dimensional images acquired by photographing the subject in different directions by the known method, and may automatically calculate the feature vector of the subject by using the three-dimensional coordinate information. In the calculating of the feature vector from the three-dimensional coordinate information, normalization based on homology modeling may be used.

[0021]

In order to directly acquire the feature vector from the two-dimensional image, the known method such as a method using a luminance distribution near each pixel or a method using the arrangement of face parts may be used. The feature vector of the subject may be automatically and approximately calculated from the two-dimensional image by using such a known method. It might be difficult to detect feature points depending on the morphological feature in some cases. In this case, the feature points may be predicted from the average value of the respective feature points which are automatically acquired from the population.

[0022]

For example, in the following reference document, a method of estimating (interpolating) coordinates of directly unmeasurable points of an unknown individual from the correspondence relationship between coordinates of measurable points near the unmeasurable points and the statistical average of many already-known shape measurement

values has been suggested in the measuring of feature points of a maxillofacial skeleton shape. In this method, the coordinates (6 points) of morphological feature points on soft tissues are estimated from coordinates of measurable points (25 points) near the unmeasurable points and a coordinate average of a population including samples.

Reference Document: Aoki Yoshimitsu et. al, Medical Imaging Technology, 22(5), 250-258(2004)

As stated above, in the present embodiment, the method of acquiring the feature vector of the subject by means of the acquisition unit 21 is not limited.

[0023]

The determination unit 22 performs the above-described (S13).

[0024]

The output processing unit 23 performs the above-described (S15), and outputs the acquired aging information. However, an aspect of outputting the aging information by means of the output processing unit 23 is not limited. The output processing unit 23 generates output data indicating the aging information, and outputs the output data to another output device such as the display device 15 or a printing device through the input and output I/F 13. The output processing unit 23 may transmit the output data to another apparatus through the communication unit 14, or may record the output data in the portable recording medium.

[0025]

[Operation and Effect of First Embodiment]

As in the method suggested in Patent Document 1, in most methods

of determining the aging state based on a shape change of each part of the head, an aging tendency is determined using the value as is acquired from the shape information of each part. As a result, the aging state of each person might not be appropriately analyzed in some cases. This is because an original morphological feature of each person is reflected in the aging tendency. In these methods, the age impression (perceived age) of each person is not determined.

[0026]

The present inventors select the plurality of morphological features correlated with the age from all the morphological features of the person, find the plurality of common factors (common aging factors) from the feature vector which is related to the selected morphological features, and verify that the respective common factors are correlated with the age. As stated above, the present inventors investigates the relationship between the age and the expression pattern of the extracted common aging factor in each person, and finds that the factor expression pattern represents the aging tendency.

[0027]

Therefore, according to the first embodiment, the factor expression pattern is determined from the feature vector of the subject, and thus, the aging information of the subject can be acquired. Here, since the factor expression pattern is determined not from only the feature quantity of each specific part but also from the feature vector of the subject which is related to the plurality of morphological features, the aging information acquired from the factor expression pattern is hardly affected by an inherent morphological features of each individual. According to the first

embodiment, the information of the perceived age of the subject can be acquired. As mentioned above, according to the first embodiment, the aging state of the subject can be objectively analyzed by using the morphological feature quantity of the subject.

[0028]

The present inventors respectively associate each common aging factor to a part of the person by classifying the plurality of morphological features for each common aging factor having a high dependency based on the factor loading of the common aging factor, and find that a specific change of each part strongly affects the age. Accordingly, according to the factor expression pattern, the aging information of each part of the subject can be acquired.

[0029]

Hereinafter, the first embodiment will be described in more detail. As a specific embodiment, a perceived age analysis method (hereinafter, abbreviated as an analysis method in some cases) and a perceived age analysis apparatus (hereinafter, abbreviated as an analysis apparatus in some cases) according to a second embodiment are exemplified below. That is, in the following second embodiment, information of the perceived age is acquired as the aging information. However, similarly to the above-described first embodiment, information of a shape age may also be acquired as the aging information in the following second embodiment. Hereinafter, the contents different from the above-described first embodiment will be mainly described, and the same contents as those in the above-described first embodiment will not be appropriately repeated.

[0030]

[Second Embodiment]

The analysis method according to the second embodiment includes the same processes as those of the aging analysis method in the first embodiment illustrated in FIG. 1. In the second embodiment, the respective processes will be described in more detail. Hereinafter, the analysis method according to the second embodiment will be described with reference to FIGS. 1 and 4.

[0031]

The feature vector acquired in (S11) is personal information of the subject which is related to a plurality of morphological features correlated with the perceived age. Such a morphological feature includes at least one of the philtrum length and the thinness of the lip, the size of the eye, the slant of the eye, the slant of the eyebrow, and the swelling of the lower jaw, and particularly includes at least two of these items. The morphological features are shape information items of the respective parts of the head, which are extracted through the examination of the present inventors and indicate a high correlation with the perceived age. However, in the present embodiment, the parts of the body indicated by the morphological feature are not limited as long as the plurality of morphological features is correlated with the perceived age.

[0032]

Here, the feature vector of the subject and the plurality of morphological features corresponding to the feature vectors of the respective individual samples included in the population are selected from many morphological features on the head surface of the person as follows. That is, the plurality of morphological features

correlated with the age is selected based on a multiple correlation coefficient of each morphological feature acquired by performing multiple regression analysis using the feature vector related to many morphological features as an explanatory variable group and the age as an objective variable. For example, the morphological feature in which the multiple correlation coefficient of each morphological feature is greater than a limit value having a significance level with respect to the number of samples of the population in the multiple regression analysis is selected. In the present embodiment, the perceived age is used as the age.

[0033]

The plurality of common aging factors is extracted by performing the factor analysis on the set of feature vectors of the population related to the plurality of morphological features selected in this manner. For example, the number of factors for use in the factor analysis may be determined depending on the selected morphological feature classification. In the respective extracted common aging factors, a correlation efficient between the age and the factor score (for example, average) of the common aging factor in the individual sample included in the population in the factor analysis is preferably greater than a limit value having a significance level of 1% in the number of samples of the population. However, the magnitude reference of the correlation coefficient is not limited to only the aforementioned reference, and may be appropriately set.

[0034]

The method of determining the factor expression pattern of the subject in (S13) includes a method (referred to as a first pattern

determining method) which uses the factor score, and a method (hereinafter, referred to as a second pattern determining method) which does not use the factor score. The second pattern determining method will be described in a third embodiment.

[0035]

FIG. 4 is a diagram showing an example (first pattern determining method) of the analysis method according to the second embodiment. In a case where the first pattern determining method is used, the analysis method according to the second embodiment includes (S41), (S43), and (S45) instead of (S13) in the first embodiment, as shown in FIG. 4. That is, in the second embodiment, a process (S13) of determining the factor expression pattern of the subject is specified into (S41), (S43) and (S45).

[0036]

In (S41), the factor scores of the subject which are respectively related to the plurality of common aging factors are respectively calculated by using the feature vector of the subject acquired in (S11).

In (S43), the expressed state of the common aging factor of the subject is determined by comparing a threshold indicating a predetermined position in the factor score distribution of the population and the factor score of the subject with respect to each of the plurality of common aging factors.

In (S45), the factor expression pattern indicating at least one common aging factor determined to be expressed as the expressed state in (S43) is determined for the subject.

[0037]

As the method of calculating the factor score of the subject in (S41), there are various methods. Firstly, there is a method of estimating the factor score of each common aging factor of the subject from the feature vector of the subject by using the multiple regression analysis. Specifically, the respective factor scores of the common aging factors of the subject can be calculated by respectively applying the feature vector of the subject to the respective multiple regression equations acquired by respectively applying the multiple regression analyses of the respective common aging factors with the feature vector related to the plurality of morphological features as the explanatory variable group and the factor score as the objective variable to the set of feature vectors related to the population. This method is described as a first factor score calculating method.

[0038]

In the factor analysis for extracting the common aging factors, the respective factor loadings of the common aging factors are respectively calculated for the morphological features corresponding to the feature quantities. The respective factor scores of the common aging factors are respectively calculated for the respective individual samples of the population used as the samples of the factor analysis. The respective factor loadings of the common aging factors and the respective factor scores of the common aging factors for the respective individual samples of the population, which are the outcomes of the factor analysis are stored together with the set of feature vectors in the population in the computer.

[0039]

In the first factor score calculating method, the multiple

regression equations of the respective common aging factors are previously acquired by performing the multiple regression analysis using the respective factor scores of the common aging factors and the feature vector which are related to the respective individual samples of the population, and the multiple regression equations are further stored in the computer such as an analysis apparatus 30, to be described below. The respective multiple regression equations are respectively equations for describing the respective factor scores of the common aging factors of the individual. In the first factor score calculating method, the factor scores of the subject which are respectively related to the plurality of common aging factors are respectively calculated by respectively assigning the feature vector of the subject to the respective multiple regression equations stored in the computer. As stated above, in the first factor score calculating method, the factor scores of the subject can be rapidly calculated by using the multiple regression equations which are previously acquired in the multiple regression analyses for the set of feature vectors of the population which does not include the subject.

[0040]

After the factor scores of the subject are calculated in this manner in the first factor score calculating method, the multiple regression analyses of the respective common aging factors may be newly applied to a new set of feature vectors acquired by adding the feature vector of the subject to the set of feature vectors of the original population, and the respective original multiple regression equations acquired from the original population may be respectively

replaced (updated) with the acquired multiple regression equations. By doing this, whenever the number of subjects is increased, the number of population is increased, and the accuracy of the multiple regression equations stored in the computer can be improved.

[0041]

As another method of calculating the factor scores of the subject, there is a method of applying the factor analysis to the new population by adding the subject to the population. According to this method, in a state in which the feature vector of the subject is added, the respective factor loadings of the common aging factors can be respectively calculated, and the respective factor scores of the common aging factors can be calculated for the subject as the individual sample of one person included in the population. In this method, the respective factor scores of the common aging factors related to the subject included in the population can be calculated by multiplying a matrix A, an inverse matrix of a matrix B and a matrix C by using a set (matrix A) of feature vectors related to a new population which includes the subject, a correlation coefficient group (matrix B) between a plurality of morphological features, and a factor loading group (matrix C) which is newly acquired through the factor analysis. According to this method, the factor scores of the subject can be calculated.

[0042]

The threshold which is used in (S43) and indicates a predetermined position in the factor score distribution of the population is determined for each of the common aging factors. One threshold or a plurality of thresholds may be set for each of the

common aging factors. For example, as the threshold, the average value of the factor score distribution may be used, or the value acquired by adding or subtracting a certain value to or from the average value may be used. In (S43), as the expressed states, whether or not the common aging factors are expressed may be respectively determined. For example, it may be determined that the common aging factor is expressed in the subject in a case where a factor score of a certain common aging factor of the subject is greater than a threshold for the common aging factor, and it may be determined that the common aging factor is not expressed in the subject in a case where the factor score thereof is equal to or less than the threshold. In (S43), an expression score indicating the degree of expression may be determined for each of the common aging factors. For example, an expression score of a certain common aging factor in the subject may be set to +1 in a case where a factor score of the common aging factor of the subject is greater than a first threshold for the common aging factor, the expression score may be set to -1 in a case where the factor score is less than a second threshold, and the expression score may be set to 0 in a case where the factor score is equal to or less than the first threshold and is equal to or greater than the second threshold.

[0043]

In (S45), the factor expression pattern of the subject is determined depending on the expressed states determined in (S43). In the second embodiment, the factor expression pattern is represented as an aspect indicating at least one common aging factor determined to be expressed. In this case, the pattern number of all

the factor expression patterns is equal to the number (value acquired by repeatedly multiplying 2 as much as the number of common aging factors) of all combinations of the common aging factors. As stated above, the aspect of representing the factor expression pattern is not limited.

[0044]

In the second embodiment, in (S15), perceived age information of the subject is acquired based on the factor expression pattern of the subject determined in (S45). Here, the perceived age information is previously determined for each factor expression pattern. For example, the perceived ages may be respectively evaluated for the respective individual samples of the population through sensory evaluation performed by an expert. Through the same method described above, the factor expression patterns are respectively acquired for the respective individual samples of the population in advance, the population is classified according to the factor expression pattern, and the averages of the perceived ages are respectively calculated for the respective factor expression patterns. By doing this, the averages of the perceived ages may be previously prepared for the respective factor expression patterns. In this case, in (S15), the average of the perceived ages of the factor expression pattern of the subject is acquired as the perceived age information. However, the method of acquiring the perceived age information is not limited to this example.

[0045]

As another example, all the factor expression patterns may be previously classified into a plurality of groups according to the

commonality of the aging information (perceived age information), and the aging information items (perceived age information items) may be respectively assigned to the respective groups. For example, all the factor expression patterns may be classified into the plurality of groups based on at least one of the actual age or perceived age, the factor score, and the number of expressed factors of each of the individual samples having the same factor expression pattern.

[0046]

According to the examination of the present inventors, it can be generally found that the smaller the number of expressed common aging factors, the younger the perceived age, and the larger the number of expressed common aging factors, the older the perceived age. Thus, for example, if all the factor expression patterns are classified into the plurality of groups according to the number of expressed common aging factors, it is possible to assign perceived age groups to the respective groups. Specifically, the factor expression patterns in which only one common aging factor is expressed may be classified as the youngest age group of the plurality of groups, and the factor expression patterns in which all the common aging factors are expressed and the factor expression patterns in which the number of common aging factors which is one less than that of all the common aging factors is expressed may be classified as the oldest age group of the plurality of groups.

[0047]

As stated above, in a case where the factor expression patterns are previously classified, in (S15), the group corresponding to the factor expression pattern of the subject is selected from the

plurality of groups, and the perceived age information assigned to the selected group can be acquired. However, the classification of the factor expression patterns is not limited to only the classification based on the number of expressed common aging factors. For example, as mentioned above, the respective groups acquired through the classification based on the number of expressed common aging factors may be classified into subgroups through cluster analysis based on the factor scores of the respective individual samples belonging to the group. According to such further classification, the factor expression pattern group classified as the same age group can be further grouped according to the tendency of the factor scores, and the perceived age information according to the tendency of the factor scores as well as the perceived age group can be acquired.

[0048]

[Apparatus Configuration]

Hereinafter, the content of the analysis apparatus according to the second embodiment different from that of the first embodiment will be mainly described. The same content as that of the first embodiment will not be appropriately repeated. The analysis apparatus according to the second embodiment has the same hardware configuration as that of the aging analysis apparatus 10 according to the first embodiment shown in FIG. 2, and performs the analysis method according to the above-described second embodiment by using a hardware configuration like this and the following processing configuration. The above-described content related to the analysis method according to the second embodiment is also applied to the

analysis apparatus according to the second embodiment.

[0049]

FIG. 5 is a conceptual diagram showing a processing configuration example of the analysis apparatus 30 according to the second embodiment. As shown in FIG. 5, the analysis apparatus 30 includes an acquisition unit 31, a determination unit 32, an output processing unit 33, and the like. The determination unit 32 includes a calculation unit 34. The acquisition unit 31, the determination unit 32 and the output processing unit 33 correspond to the acquisition unit 21, the determination unit 22 and the output processing unit 23 according to the first embodiment, respectively. Similarly to the respective processing units in the first embodiment, the respective processing units are realized by executing programs stored in the memory 12 by means of the CPU 11.

[0050]

The acquisition unit 31 performs (S11). The acquisition unit 31 may acquire a set of feature vectors related to the population, a correlation coefficient group between a plurality of morphological features, a factor loading group acquired through factor analysis, and a factor score group of each individual sample included in the population, if necessary. The analysis apparatus 30 itself may retain these information items, or may acquire these information items from the portable recording medium, another computer, or the like.

[0051]

As stated above, the determination unit 32 includes the calculation unit 34 that respectively calculates the factor scores

of the subject which are respectively related to the plurality of common aging factors by using the feature vector of the subject acquired by the acquisition unit 31, and determines the factor expression pattern of the subject based on the factor scores of the common aging factors of the subject calculated by the calculation unit 34. That is, the determination unit 32 performs (S41), (S43) and (S45). Among these steps, (S41) is performed by the calculation unit 34.

[0052]

As mentioned above, the calculation unit 34 may calculate the factor scores of the subject by various methods. For example, the calculation unit 34 can use the above-described first factor score calculating method.

In this case, the calculation unit 34 may calculate the respective factor scores of the common aging factors of the subject by respectively applying the feature vector of the subject to the respective multiple regression equations which are respectively acquired by applying the multiple regression analyses of the respective common aging factors with the feature vector related to the plurality of morphological features as the explanatory variable group and the factor score as the objective variable to the set of feature vectors related to the population.

[0053]

The calculation unit 34 may use the multiple regression equations of the previously retained common aging factors, or may use the multiple regression equations acquired from anther apparatus. The calculation unit 34 may replace the respective original multiple

regression equations acquired from the original population with the respective multiple regression equations which are respectively acquired by applying the multiple regression analyses of the respective common aging factors to the set of feature vectors related to the population and the feature vector of the subject.

[0054]

The calculation unit 34 may calculate the respective factor scores of the common aging factors of the subject by newly performing the factor analysis on a new population acquired by adding the subject to the original population. In the factor analysis, the calculation unit 34 updates the factor loading group, and further respectively calculates the respective factor scores of the common aging factors for the respective individual samples (including the subject) of the new population. In this case, the calculation unit 34 may calculate the respective factor scores of the common aging factors related to the subject included in the population by performing the above-described multiplication of the matrices based on the set of feature vectors, correlation coefficient group and factor loading group which are acquired by an acquisition unit.

[0055]

The determination unit 32 determines the common aging factors expressed in the subject, by comparing the threshold indicating the predetermined position in the factor score distribution of the population and the factor score of the subject with respect to each of the plurality of common aging factors, and determines the factor expression pattern indicating at least one common aging factor determined to be expressed for the subject. The determination unit

32 may previously retain the threshold of each of the common aging factors, or may acquire the threshold from another computer. A specific method of determining the factor expression pattern is described above.

[0056]

The output processing unit 33 performs (S15), and outputs the acquired perceived age information of the subject as the aging information. For example, the output processing unit 33 outputs the respective names assigned to the plurality of common aging factors and the aging information indicating the factor expression pattern of the subject. For example, the names of the respective common aging factors may be assigned so as to represent a feature tendency common to the morphological features in which the respective factor loadings of the common aging factors are large. As a result, according to the output aging information, the feature tendency of the subject related to the perceived age can be represented. The output processing unit 33 may add the average of the perceived ages of the respective factor expression patterns previously prepared as stated above to the perceived age information. An output aspect by means of the output processing unit 33 is the same as that by means of the output processing unit 23.

[0057]

The output processing unit 33 may output the aging information assigned to the group selected depending on the factor expression pattern of the subject. In this case, as stated above, all the factor expression patterns are classified into the plurality of groups based on at least one of the age, the factor scores, and the number of

expressed factors of each of the individual samples having the same factor expression pattern, and the aging tendency information related to the perceived age according to the classification method is previously assigned to each group. The output processing unit 33 outputs perceived age information related to the subject by acquiring group classification information of the factor expression pattern and perceived age information (aging information) assigned to each group. The group classification information of the factor expression pattern and the perceived age information assigned to each group may be previously retained by a selection unit 35 to be described below, or may be acquired from another computer.

[0058]

In a case where the factor expression patterns are classified in this manner, the analysis apparatus 30 further includes the selection unit 35 in addition to the configuration shown in FIG. 5, as shown in FIG. 6.

FIG. 6 is a diagram showing another processing configuration example of the analysis apparatus 30 according to the second embodiment.

The selection unit 35 selects the group corresponding to the factor expression pattern of the subject from the plurality of groups, which are obtained by classifying all the factor expression patterns corresponding to all the combinations of the expressed states of the respective common aging factors according to the commonality of aging. The output processing unit 33 outputs the perceived age information assigned to the group selected by the selection unit 35 as the aging information of the subject.

[0059]

[Operation and Effect of Second Embodiment]

As stated above, in the second embodiment, the factor scores of the subject which are respectively related to the plurality of common aging factors are respectively calculated using the feature vector of the subject, and the factor expression pattern is determined based on the calculated factor scores. Here, since the respective factor scores of the subject respectively represent the degree of expression of the common aging factors in the subject and the respective common aging factors have a high correlation with the perceived age, it is considered that the factor expression pattern of the subject acquired from the factor scores represents the occurrence condition of any cause which affects the perceived age in the subject. Thus, according to the second embodiment in which the perceived age information of the subject is acquired based on the factor expression pattern, the perceived age of the subject can be analyzed with high accuracy.

[0060]

In the first factor score calculating method which is one of the methods of calculating the factor scores of the subject, the factor scores of the subject can be rapidly acquired by assigning the feature vector of the subject to the previously acquired multiple regression equations. The expressed states of the common aging factors of the subject are determined, by comparing the factor score of the subject with a threshold indicating the predetermined position in the factor score distribution of the population, and the factor expression pattern of the subject is determined by the expressed states. As

stated above, the objectivity of the factor expression pattern of the subject can be improved by determining the expressed states of the common aging factors of the subject through the addition of the factor score distribution of the population, and the objectivity and reliability of the aging information (perceived age information) acquired from the factor expression pattern can be improved.

[0061]

In the second embodiment, the respective factor expression patterns are classified into the plurality of groups based on at least one of age, factor scores, and the number of expressed factors of each of the individual samples having the same factor expression pattern, and the group corresponding to the factor expression pattern of the subject is selected. The perceived age information assigned to the selected group is acquired as the information of the subject. By doing this, the factor expression tendency and the perceived age group assigned as the perceived age information to each group can be acquired as the perceived age information of the subject.

[0062]

[Third Embodiment]

In the above-described second embodiment, the factor expression pattern of the subject is determined based on the respective factor scores of the common aging factors of the subject (a first pattern determining method). In a third embodiment, the factor expression pattern of the subject is determined based on the feature vector of the subject without using the factor scores of the subject (a second pattern determining method). Hereinafter, the content of the third embodiment different from those of the above-described embodiments

will be mainly described, and the same content will not be appropriately repeated.

[0063]

An analysis method according to the third embodiment includes the same processes as those of the aging analysis method according to the first embodiment shown in FIG. 1. In the third embodiment, the respective processes will be described in more detail. Hereinafter, the analysis method according to the third embodiment will be described with reference to FIG. 7.

[0064]

FIG. 7 is a diagram showing an example (the second pattern determining method) of the analysis method according to the third embodiment. In a case where the second pattern determining method is used, the analysis method according to the third embodiment includes (S71), (S73) and (S75) in place of (S13) of the first embodiment, as shown in FIG. 7. That is, in the third embodiment, the process (S13) of determining the factor expression pattern of the subject is specified into (S71), (S73) and (S75).

[0065]

In (S71), the representative values of the feature vectors are respectively acquired for the plurality of factor expression patterns. In the third embodiment, the factor expression patterns are respectively determined for the individual samples of the population according to the respective factor scores of the common aging factors of the individual samples, and the representative values of the feature vectors of the individual samples having the same factor expression pattern are respectively determined for all the factor

expression patterns. The respective representative values of the factor expression patterns are data items (vectors having elements of the same number as that of the feature vector) indicating representative positions in a feature quantity space which are determined from the feature vectors of the respective individual samples having the same factor expression pattern, and are, for example, data items indicating the median point of the feature vectors. However, the representative value is not limited to the median point.

[0066]

In (S73), the distances between the feature vector of the subject acquired in (S11) and the respective representative values of the factor expression patterns acquired in (S71) are respectively calculated. As mentioned above, the representative value is a vector having elements of the same number as that of the feature vector, and the Euclid distance is calculated in (S73).

[0067]

In (S75), the factor expression pattern of the subject is determined based on the distances between the representative values of the factor expression patterns and the feature vector of the subject which are calculated in (S73). Specifically, the factor expression pattern indicating the minimum distance is determined as the factor expression pattern of the subject.

[0068]

[Apparatus Configuration]

Hereinafter, the content of the analysis apparatus according to the third embodiment different from the first embodiment will be mainly described. The same content as that of the first embodiment

will not be appropriately repeated. The analysis apparatus according to the third embodiment has the same hardware configuration as that of the aging analysis apparatus 10 according to the first embodiment shown in FIG. 2, and performs the above-described analysis method according to the third embodiment by using a hardware configuration like this and the following processing configuration. The above-described content related to the analysis method according to the third embodiment is also applied to the analysis apparatus according to the third embodiment.

[0069]

The analysis apparatus 30 according to the third embodiment has the same processing configuration as that of the second embodiment shown in FIG. 5 or 6. However, the following processing units perform processes different from those of the second embodiment.

[0070]

The acquisition unit 31 further performs the above-described (S71) in addition to (S11). The acquisition unit 31 may retain the representative values of the respective feature vectors of the factor expression patterns, or may acquire the representative values from the portable recording medium, another computer, or the like.

[0071]

The calculation unit 34 performs the above-described (S73). The determination unit 32 performs the above-described (S75).

[0072]

[Operation and Effect of Third Embodiment]

As described above, in the third embodiment, the distances between the feature vector of the subject and the previously

calculated representative values of the feature vectors of the factor expression patterns are calculated, and the factor expression pattern of the subject is determined based on the distances. Therefore, according to the third embodiment, the factor expression pattern of the subject can be rapidly determined by calculating only the distances without calculating the factor scores of the subject.

[0073]

[Modification Example]

The factor analysis based on the above-described common aging factor may be performed by the above-described aging analysis apparatus 10 according to the first embodiment and the analysis apparatus 30 according to the second embodiment and the third embodiment, or may be performed by another computer. The population of the factor analysis may be updated by successively introducing subjects as analyzing targets of the aging analysis apparatus 10 and the analysis apparatus 30. In this case, as shown in FIG. 8, (S17), (S18) and (S19) are newly performed. FIG. 8 shows an example in which a new processing process is added to the analysis method according to the second embodiment shown in FIG. 4, but the new processing process may be add to the aging analysis method according to the first embodiment shown in FIG. 1 or the analysis method according to the third embodiment shown in FIG. 7.

[0074]

FIG. 8 is a diagram showing an analysis method according to a modification example. The analysis method further includes acquiring a feature vector of a new individual sample, which is not included in the population, related to the plurality of morphological

features , performing the factor analysis using the number of common aging factors on the feature vector of the new individual sample and a set of feature vectors of the original population (S17), newly calculating factor scores of common aging factors related to individual samples of a new population acquired by adding the new individual sample to the original population by using the factor loading group which is newly acquired through the factor analysis of (S17) (S18), and updating the original information acquired from the original population by the newly acquired factor loading group and the respective factor scores related to the individual samples of the new population (S19). In FIG. 8, the feature vector of the subject is used as the feature vector of the new individual sample (S11). However, the new individual sample may be a sample other than the subject.

[0075]

FIG. 9 is a diagram showing a processing configuration example of the analysis apparatus 30 according to the modification example. In this case, the analysis apparatus 30 further includes an analysis processing unit 37 that performs factor analysis using the number of common aging factors on the feature vectors of the plurality of individual samples which are related to the plurality of morphological features. The acquisition unit 31 further acquires the feature vector of the new individual sample which is not included in the original population which are related to the plurality of morphological features. The analysis processing unit 37 performs the factor analysis on the feature vector of the new individual sample and the set of feature vectors of the original population, newly

calculating the respective factor scores of the common aging factors related to the individual samples of the new population acquired by adding the new individual sample to the original population by using the factor loading group which is newly acquired through the factor analysis, and updating the original information acquired from the original population by the newly acquired factor loading group and the respective factor scores related to the individual samples of the new population. The factor loading group and the factor score group acquired from the original population and the new population may be retained by the analysis apparatus 30, or may be retained by another computer. The acquisition unit 31 may use the feature vector of the subject as the feature vector of the new individual sample.

[0076]

According to the modification example, since a feature vector of a new person (including the subject) which is not included in the original population is added to the set of feature vectors of the original population, the factor analysis is performed again, the original information is updated using the newly acquired factor loading group and factor score group, whenever a feature vector of a new person is acquired, learning progresses, and thus, analytical precision can be improved.

[0077]

Hereinafter, the above-described embodiments will be described in detail in conjunction with an example. The present invention is not limited to the following example.

[Example]

[0078]

FIG. 10A is a diagram showing an example of the morphological features and common aging factors. FIG. 10A shows an example in which 5 common factors are extracted by performing the factor analysis on the feature quantities of 13 morphological features in a population including 497 Japanese females having an actual age from 20's to 60's. In FIG. 10A, 5 common factors are described by Factor 1 to Factor 5. Further, 13 morphological features are represented as numbers 1 to 13. A suffix y in FIG. 10A means a component in the vertical direction (the direction perpendicular to the ground). For example, "(outer end of eyebrow – inner end of eyebrow)y" means a difference (vertical distance) from the outer end of the eyebrow to the inner end of the eyebrow in the vertical direction.

[0079]

FIG. 10B is a diagram for describing the morphological features illustrated in FIG. 10A.

A vertical width y of the eye indicates the length of the longest part of the eye in the vertical direction, and the area of the eye is an exposed area of the ocular mucosa. A cheek breadth is different from a bizygomatic breadth, and is a width between cheekbones positioned lower than the outer canthi at a line intersection of a plane surface perpendicular to the ground which passes through the left and right outer canthi of the person when viewed from the front and a surface of the face of the subject.

A degree of slanting of the eye is an angle formed by a straight line that connects the entocanthion (the inner canthus) with the ectocanthion (the outer canthus) and a straight line that horizontally extends to the ground from the entocanthion. A perceived degree of

slanting of the eye is an angle formed by a straight line that connects a perceived outer eye point with the entocanthion (the inner canthus) and a straight line that horizontally extends to the ground from the entocanthion. For example, the perceived outer eye point means an outer eye point based on the visual aspect, and corresponds to an end of the upper eyelid positioned lower than the ectocanthion, which is close to the ectocanthion.

(outer end of eyebrow – peak of eyebrow arch)y indicates a difference (vertical distance) from the outer end of the eyebrow to the peak of the eyebrow arch in the vertical direction, (outer end of eyebrow – inner end of eyebrow)y indicates a difference (vertical direction) from the outer end of the eyebrow to the inner end of the eyebrow in the vertical direction.

A degree of slanting of eye in depth direction indicates an inclination of a straight line that connects the entocanthion with the ectocanthion in the forth and back direction. The degree of slanting of eye in depth direction is referred to as a degree of recession of outer canthus.

"Tragion - mandibular angle point / mandibular angle point – chin point" is a value acquired by dividing a distance between the tragion and the mandibular angle point by a distance between the mandibular angle point and the chin point.

A mandible breadth is a width between re-projections near left and right mandibular angle point.

(crista philth [left or right] – labrale inferius)y/mouth breadth indicates an aspect ratio of the lip, and specifically, indicates a value acquired by dividing a difference (vertical distance) from the upper end of the lip to the lower end of the lip

in the vertical direction by the mouth breadth. (subnasale – crista philth [left or right]/ subnasale – submental area)y indicates the philtrum length, and specifically, indicates a value acquired by dividing a difference from the subnasale to the upper end of the lip in the vertical direction by a difference from the subnasale to the submental area .

Although not shown in FIG. 10B, a left cheek angle is an angle formed by a straight line that connects a left tragion with a left cheek breadth point and a straight line that connects the left cheek breadth point with a left alare. A left cheek minimum curvature is a minimum curvature of a curved line which passes from the philtrum through a cheekbone position lower than the ectocanthion at a line intersection of a plane surface perpendicular to the ground which passes through the ectocanthion of the left or right eye of the person when viewed from the front and a surface of the face of the subject. In other words, a left cheek minimum curvature is a minimum curvature of the cheek in cross section of the head which passes through three points of a left cheek breadth point, a subnasale and a right cheek breadth point.

[0080]

The present inventors extract such 13 morphological features as follows. The present inventors has derived the relationship (morphological feature classification) between 60 feature points, which are estimated to be related to the perceived age by using data points (feature points) equal to or greater than 4,000 in homology modeling, based on analysis of a change amount of the feature points correlated to the perceived age and a modeling expert’s knowledge

of deeply reading the linkage relationship of the feature points. In this procedure, the morphological features are excluded such that a plurality of morphological features having a high correlation is not present. The present inventors statistically analyzes the relationship between feature quantities of 60 morphological features and the perceived age, and extracts 13 morphological features as described above having a high correlation (multiple correlation coefficient of more than 0.200) with the perceived age. As the statistic analysis, multiple regression analysis using the feature vector related to 60 morphological features as an explanatory variable and the perceived age as an objective variable is used.

[0081]

FIG. 10C is a diagram showing the correlation between the respective factors shown in FIG. 10A and the perceived age. The present inventors calculate the correlation coefficients between the factor score and the perceived age in the individual sample included in the population for to the respective common factors, and checks that the correlation coefficients of the respective common factors are respectively greater than a limit value having a significance level of 1% in the number of samples in the population, as shown in FIG. 10C. By doing this, the common aging factors related to the perceived age are found as in the example of FIG. 10A.

[0082]

Meanwhile, when the factor loadings of the morphological features are compared with the respective common factors, 13 morphological features can be classified according to the strongly affected common aging factors, as shown in FIG. 10A. Specifically, the morphological

features 1 to 3 (the degree of slanting of the eye, the perceived degree of slanting of the eye, and the degree of slanting of eye in depth direction) largely depend on Factor 1, the morphological features 4 and 5 largely depend on Factor 2, the morphological features 6 and 7 largely depend on Factor 3, the morphological features 8 and 9 largely depend on Factor 4, and the morphological features 10 and 11 largely depend on Factor 5. From this relationship, Factor 1 is a factor corresponding to the slant of the eye, Factor 2 is a factor corresponding to the slant of the eyebrow, Factor 3 is a factor corresponding to the size of the eye, Factor 4 is a factor corresponding to the swelling of the lower jaw, and Factor 5 is a factor corresponding to the philtrum length and the thinness of the lip.

[0083]

However, the number of common aging factors and the morphological features are not limited to those illustrated in FIG. 10A. For example, the feature vector related to the plurality of morphological features correlated with the perceived age may include (A) a plurality of feature quantities indicating the philtrum length and the thinness of the lip, (B) a plurality of feature quantities indicating the relative size of the eye with respect to the cheek breadth, (C) a plurality of feature quantities indicating the slant of the eye in the vertical direction and the forth and back direction, (D) a plurality of feature quantities indicating the drooping of the eyebrow with respect to the cheek breadth, and (E) a plurality of feature quantities indicating a size of the bigonial breadth with respect to the cheek breadth, and the positional relationship between

a chin, an ear, and a gonion.

[0084]

FIG. 11 is a diagram showing another example of the morphological features and the common aging factors. In the example of FIG. 11, the example in which 5 common aging factors are extracted in 12 morphological features different from those of FIG. 10A is illustrated. In the example of FIG. 11, it is checked that the correlation coefficients between the common aging factors and the perceived age are respectively greater than the limit value having a significance level of 1% in the number of samples in the population.

[0085]

Hereinafter, a specific example of a method (refer to the second embodiment) of calculating the respective factor scores of the common aging factors of the subject by respectively applying the feature vector of the subject to the multiple regression equation of the common aging factors will be described. In the present specific example, an example in which the multiple regression equation is acquired and the evaluation of the factor scores of the subject acquired through the multiple regression equation will be described. Here, the morphological features and the common aging factors shown in FIG. 10A are used.

[0086]

In the present specific example, five persons of the respective ages are randomly extracted as a subject from the population including 497 Japanese females from having an actual age from 20’s to 60’s described above, and the factor analysis is performed on a set of feature vectors of a temporary population including 472 persons in

which the subject is excluded. Thus, the factor loadings of the common aging factors for 13 morphological features are respectively calculated, and the factor scores of the common aging factors are respectively calculated for the respective individual samples of the temporary population. Subsequently, the multiple regression equations of the common aging factors shown in FIG. 12 are calculated by performing the multiple regression analysis using the factor scores of the common aging factors and the feature vector which are related to the respective individual samples of the temporary population.

[0087]

FIG. 12 is a diagram showing an example of the multiple regression equation for acquiring the score factors from the feature vector. In FIG. 12, partial regression coefficients of the morphological features are respectively represented for the respective common aging factors (Factor 1 to Factor 5).

[0088]

FIG. 13 is a diagram showing the expressed states of the common aging factors and the factor scores of the respective subjects acquired from the multiple regression equations shown in FIG. 12. In FIG. 13, the factor scores of the common aging factors of the respective subjects of 25 persons are respectively represented. The expressed states of the respective common aging factors are represented by an expression score of -1, 0 and +1, and the factor scores having an expression score of -1 or +1 are represented by a mesh pattern. The ages of the subjects are represented as the ages (20’s) in the leftmost column of FIG. 13, the numbers of the subjects

are represented in the second column from the left, and the numbers of the common aging factors having an expression score of -1 or +1 are represented in the rightmost column.

[0089]

FIG. 14 is a diagram showing the expressed states of the common aging factors and the factor scores of the respective subjects acquired by performing the factor analysis on the set of feature vectors of the population (497 persons) including the subject. In FIG. 14, since the factor scores acquired by performing the factor analysis on the population including the subject are represented, the expressed states of the common aging factors and the factor scores of the respective subjects shown in FIG. 14 is a state (correct answer) to be originally acquired. Thus, when the expressed states of the respective common aging factors are compared in FIGS. 13 and 14, only the expressed state of Factor 1 of the subject (309) is different in FIGS. 13 and 14. The expression score of Factor 1 of the subject (309) estimated in FIG. 13 is +1, whereas the expression score of the correct answer shown in FIG. 14 is 0. However, it is verified that since the expressed states of the common aging factors related to other 24 subjects match with each other, the factor scores estimated in the method of FIG. 13 represent a high precision of 24/25.

[0090]

The present inventors perform the factor analysis using the number of common factors as 4 on the set of feature vectors of 9 morphological features in the population including 248 persons, and determine the factor expression patterns of the respective individual samples of the population. Meanwhile, the present inventors classify

the respective individual samples into the factor expression patterns (16 patterns), calculate the median point in the feature quantity space (nine-dimension) for the respective factor expression patterns, calculate respectively the distances from the median point of the factor expression patterns for the respective individual samples, and determine the factor expression patterns having the smallest distance as the factor expression patterns of the respective individual samples. As a result, it is checked that the factor expression patterns determined using the distances match with the factor expression patterns determined through the factor analysis at a percentage of 81.1%.

[0091]

FIG. 15 is a diagram showing a method of determining the factor expressed state according to the present example. In the present example, as the threshold for acquiring the factor expressed state from the factor score, a first threshold (+0.25σ) acquired by adding 0.25σ (σ is a standard deviation) to the average of the factor scores of the common aging factor, and a second threshold (-0.25σ) acquired by subtracting 0.25σ from the average. Since the standard deviation σ is calculated for the respective common aging factors, the first threshold and the second threshold are provided to each of the common aging factors. In the present example, the expression score of a certain common aging factor of the subject is determined to be +1 in a case where a factor score of the common aging factor of the subject is greater than the first threshold for the common aging factor, the expression score is determined to be -1 in a case where the factor score is less than the second threshold, and the expression score

is determined to be 0 in a case where the factor score is equal to or less than the first threshold and is equal to or greater than the second threshold.

[0092]

In order to verify the correlation between the perceived age and the expressed states of the common aging factors, the present inventors classify the respective individual samples acquired by performing the factor analysis on the above-described population (497 persons) into the following four types (Group S, Group N, Group X, and Group Y) based on the expression scores of the common aging factors. Group S is a type in which the number of expression scores of +1 is equal or greater than the number expression scores of -1 by 2, and Group N is a type in which the number of expression scores of +1 is equal or less than 1, the number of expression scores of -1 is equal to or less than 1, and the difference between the number of expression scores of +1 and the number of expression scores of -1 is equal to or less than 1. Group X is a type in which the number of expression scores of +1 is equal or greater than 2, the number of expression scores of -1 is equal to or greater than 2, and the difference between the number of expression scores of +1 and the number of expression scores of -1 is equal to or less than 1, and Group Y is a type in which the number of expression scores of -1 is equal to or greater than the number of expression scores of +1 by 2.

[0093]

The present inventors arrange the classification state of the individual samples for the ages of the perceived age, and verify that the expressed states of the common aging factors are correlated with

the perceived age, as shown in FIG. 16. FIG. 16 is a diagram showing the classification state of the individual sample for the ages of the perceived age. Referring to FIG. 16, the older the perceived age, the higher the percentage of individual samples belonging to Group S, and the younger the perceived age, the higher the percentage of individual samples belonging to Group Y. Accordingly, it is verified that the expressed states of the common aging factors are correlated with the perceived age and the persons in which many common aging factors are expressed have older perceived age.

[0094]

FIG. 17 is a diagram showing a classification example of the factor expression patterns. For each of the factor expression patterns, the present inventors calculate the average of the perceived ages of the individual samples having the factor expression pattern by using the factor expression patterns of the respective individual samples determined in the example of FIG. 10A, and classify the factor expression patterns into three groups (described as Area 1, Area 2 and Area 3) by using the average age. In FIG. 17, a number enclosed within a circle indicates a number of the common aging factor determined to be expressed, a square surrounding at least one number enclosed within the circle indicates one factor expression pattern, a number enclosed within parentheses placed under the square indicates the average age, and a number on the right side of the number enclosed within parentheses indicates the number of individual samples belonging to the factor expression pattern.

[0095]

As shown in FIG. 17, it can be seen that the respective groups

correspond to the perceived age groups such as 30’s, 40’s and 50’s. The factor expression patterns in which only one common aging factor is expressed are classified as the youngest age group of the plurality of groups, and the factor expression patterns in which all the common aging factors (five) are expressed and the factor expression patterns in which (four) common aging factors less than all the common aging factors by 1 are expressed are classified as the oldest age group of the plurality of groups.

[0096]

The present inventors performed a cluster analysis on the factor expression patterns belonging to the respective groups described as Area 2 and Area 3 by using the factor scores of the respective individual samples, and thus classified these factor expression patterns into smaller groups. In FIG. 17, the factor expression patterns surrounded by the circle belong to the same group.

[0097]

FIG. 18 is a diagram showing an example of the aging information based on the classification of the factor expression patterns. The names, the factor expression patterns, the number of expressed common aging factors, the average value of perceived ages, and the number of persons are respectively assigned to the respective groups generated by the classification of the factor expression patterns. The aging state information can be provided to the subject by presenting such a table together with the factor expression pattern determined for the subject to the subject. For example, to the subject expressing only one common aging factor, it is possible to presenting an analyzing result in which there are causes of older

perceived age in the part (the eye, the eyebrow, the lower jaw, the philtrum, and the lip) corresponding to the expressed common aging factor. As stated above, if a part having a cause of older perceived age can be specified, it is possible to suggest a beauty treatment technique according to the specified part. It is also possible to present the average of perceived ages assigned to the corresponding group as the perceived age of the subject.

[0098]

As mentioned above, it is possible to use the methods and apparatuses according to the above-described respective embodiments for aging care counseling. In this case, if beauty technique information items are associated with the respective factor expression patterns or the respective groups into which the factor expression patterns are classified, it is possible to present the beauty technique information together with the aging information of the subject.

[0099]

In the plurality of flowcharts used in the above descriptions, the plurality of processes is sequentially described, but the order of performing the processes performed in the respective embodiments is not limited to the described order. In the respective embodiments, the order of the illustrated processes may be changed without affecting the content thereof. The above-described respective embodiments and respective modification examples may be combined without conflicting each other.

[0100]

Some or all of the above-described respective embodiments and

the respective modification examples may be specified as follows. However, the above-described respective embodiments and the respective modification examples are not limited to the following descriptions.

[0101]

<1> An aging analysis method includes acquiring a feature vector of a subject which is related to a plurality of morphological features correlated to age, determining a factor expression pattern indicating expressed states of a plurality of common aging factors in the subject by using the plurality of common aging factors extracted by performing factor analysis on a set of feature vectors related to a population including a plurality of persons and the feature vector of the subject, and acquiring aging information of the subject based on the factor expression pattern of the subject.

[0102]

<2> In the aging analysis method according to <1>, the determining of the factor expression pattern includes calculating factor scores of the subject which are respectively related to the plurality of common aging factors by using the feature vector of the subject, and the factor expression pattern of the subject is determined based on the respective factor scores of the common aging factors of the subject.

<3> In the aging analysis method according to <2>, the determining of the factor expression pattern includes determining the expressed states of the common aging factors in an individual sample or the subject by comparing a threshold indicating a predetermined position in a factor score distribution of the

population and the factor score of the individual sample included in the population or the subject with respect to each of the plurality of common aging factors, and determining the factor expression pattern indicating at least one common aging factor determined to be expressed as the expressed state for the subject or the individual sample.

<4> In the aging analysis method according to <2> or <3>, in the calculating of the factor scores of the subject, the feature vector of the subject is applied to the respective multiple regression equations acquired by respectively applying multiple regression analyses of the respective common aging factors using the feature vector related to the plurality of morphological features as an explanatory variable group and the factor score as an objective variable to a set of feature vectors related to the population.

<5> In the aging analysis method according to <4>, the population does not include the subject, and the aging analysis method further includes applying the multiple regression analyses of the respective common aging factors to the set of feature vectors related to the population and the feature vector of the subject, and replacing the original multiple regression equations acquired from the population with multiple regression equations which are acquired by performing the multiple regression analyses of the respective aging morphological factors.

<6> In the aging analysis method according to <2> or <3>, the population includes the subject, and in the calculating of the factor scores of the subject, the factor scores of the common aging factors related to the respective individual samples of the population are

respectively calculated by using the set of feature vectors related to the population, a correlation coefficient group between the plurality of morphological features, and a factor loading group acquired through the factor analysis.

<7> In the aging analysis method according to <1>, factor expression patterns are respectively determined for the respective individual samples of the population depending on the factor scores of the common aging factors of the individual samples, the determining of the factor expression pattern includes acquiring representative values of the feature vectors of the individual samples having the same factor expression pattern for the plurality of respective factor expression patterns determined for the population, and calculating distances between the feature vector of the subject and the representative values of the respective factor expression patterns, and the factor expression pattern of the subject is determined based on the distances.

<8> In the aging analysis method according to any one of <1> to <7>, correlation coefficients between the age and the factor scores related to the respective common aging factors in the individual samples included in the population are respectively greater than a limit value having a significance level of 1% in the number of samples of the population.

<9> In the aging analysis method according to any one of <1> to <8>, in the acquiring of the aging information includes selecting a group corresponding to the factor expression pattern of the subject from a plurality of groups acquired by classifying all factor expression patterns corresponding to all combinations of the

expressed states of the respective common aging factors according to commonality of the aging information.

<10> In the aging analysis method according to <9>, the factor expression patterns are respectively determined for each of the individual samples of the population depending on the respective factor scores of the common aging factors of the individual sample, and all the factor expression patterns are classified into the plurality of groups based on at least one of the age, the factor scores, and the number of expressed factors of each of the samples having the same factor expression pattern.

<11> In the aging analysis method according to <9> or <10>, the plurality of groups are formed according to age groups, and the factor expression patterns in which the common aging factors are not expressed or only one common aging factor is expressed are classified into the youngest age group of the plurality of groups, and the factor expression patterns in which all the common aging factors are expressed and the factor expression patterns in which the number of common aging factors which is one less than that of all the common aging factors is expressed are classified into the oldest age group of the plurality of groups.

<12> In the aging analysis method according to any one of <9> to <11>, the acquiring of the aging information further includes acquiring aging information assigned to the group selected depending on the factor expression pattern of the subject.

<13> The aging analysis method according to any one of <1> to <12> further includes acquiring a feature vector of a new individual sample which is not included in the population, which are related

to the plurality of morphological features, performing factor analysis using the number of common aging factors on the feature vectors of the new individual sample and a set of feature vectors of the population, newly calculating respective factor scores of common aging factors related to the respective individual samples of a new population acquired by adding the new individual sample to the population by using a factor loading group newly acquired through the factor analysis, and updating original information acquired from the population by the newly acquired factor loading group and the factor scores related to the respective individual samples of the new population.

<14> In the aging analysis method according to any one of <1> to <13>, the plurality of morphological features correlated with the age includes at least two elements of: at least one of a philtrum length and a thinness of a lip; a size of an eye; a slant of the eye; a slant of an eyebrow; and swelling of a lower jaw.

<15> In the aging analysis method according to any one of <1> to <14>, the age is a perceived age, the number of common aging factors is 5, and the feature vector related to the plurality of morphological features correlated to the perceived age includes a plurality of feature quantities indicating the philtrum length and the thinness of the lip, a plurality of feature quantities indicating a relative size of the eye with respect to a cheek breadth, a plurality of feature quantities indicating slants of the eye in a vertical direction and a forth and back direction, a plurality of feature quantities indicating drooping of the eyebrow with respect to the cheek breadth, and a plurality of feature quantities indicting a size of the bigonial

breadth respect to the cheek breadth, and the positional relationship between a chin, an ear, and a gonion.

<16> In the aging analysis method according to any one of <1> to <15>, the plurality of morphological features correlated to the age is selected from many morphological features on a head surface of a person, based on multiple correlation coefficients of morphological features acquired by multiple regression analyses using a feature vector related to the many morphological features as an explanatory variable group and the age as an objective variable.

<17> An aging analysis apparatus includes an acquisition unit that acquires a feature vector of a subject related to a plurality of morphological features correlated to age, a determination unit that determines a factor expression pattern indicating expressed states of a plurality of common aging factors in the subject by using the plurality of common aging factors extracted by performing factor analysis on a set of feature vectors related to a population including a plurality of persons and the feature vector of the subject, and an output unit that outputs aging information of the subject based on the factor expression pattern of the subject.

<18> In the aging analysis apparatus according to <17>, the determination unit includes a calculation unit that respectively calculates factor scores of the subject which are respectively related to the plurality of common aging factors by using the feature vector of the subject, and the factor expression pattern of the subject is determined based on the respective factor scores of the common aging factors of the subject.

<19> In the aging analysis apparatus according to <18>, the

determination unit determines common aging factors expressed in the subject, by comparing a threshold indicating a predetermined position in a factor score distribution of the population and the factor score of the subject with respect to each of the plurality of common aging factors, and the factor expression pattern indicating at least one common aging factor determined to be expressed is determined for the subject.

<20> In the aging analysis apparatus according to <18> or <19>, the calculation unit applies the feature vector of the subject to multiple regression equations acquired by applying multiple regression analyses of the respective common aging factors using the feature vector related to the plurality of morphological features as an explanatory variable and the factor score as an objective variable to the set of feature vectors related to the population.

<21> In the aging analysis apparatus according to <20>, the population does not include the subject, the acquisition unit further acquires the set of feature vectors related to the population and the calculation unit applies the multiple regression analyses of the respective common aging factors to the set of feature vectors related to the population and the feature vector of the subject, and replaces the original multiple regression equations acquired from the population with the multiple regression equations which are respectively acquired by performing the multiple regression analyses of the respective aging morphological factors.

<22> In the aging analysis apparatus according to <18> or <19>, the population includes the subject, the acquisition unit further acquires a set of feature vectors related to the population, a

correlation coefficient group between the plurality of morphological features, a factor loading group acquired through the factor analysis, and respectively calculates the respective factor scores of the common aging factors related to the respective individual samples of the population by using the set of feature vectors, the correlation coefficient group and the factor loading group.

<23> In the aging analysis apparatus according to <17>, factor expression patterns are respectively determined for the respective individual samples of the population depending on the factor scores of the common aging factors of the individual sample, the acquisition unit further acquires representative values of the feature vectors of the individual samples having the same factor expression pattern for the plurality of factor expression patterns determined for the population, the determination unit includes a calculation unit that calculates distances between the feature vector of the subject and the respective representative values of the factor expression patterns, and the factor expression pattern of the subject is determined based on the distances.

<24> In the aging analysis apparatus according to any one of <17> to <23>, correlation coefficients between the age and the factor scores related to the respective common aging factors in the individual samples included in the population are respectively greater than a limit value having a significance level of 1% in the number of samples of the population.

<25> In the aging analysis apparatus according to any one of <17> to <24>, the output unit outputs the aging information indicating names which are respectively assigned to the plurality of common aging

factors and the factor expression pattern of the subject.

<26> The aging analysis apparatus according to any one of <17> to <25> further includes a selection unit that selects a group corresponding to the factor expression pattern of the subject from a plurality of groups acquired by classifying all factor expression patterns corresponding to all combinations of expressed states of the respective common aging factors according to commonality of the aging information.

<27> In the aging analysis apparatus according to <26>, the factor expression patterns are respectively determined for the respective individual samples of the population depending on the factor scores of the common aging factors of the individual samples, and all the factor expression patterns are classified into the plurality of groups based on at least one of the age, the factor scores, and the number of expressed factors of each of the samples having the same factor expression pattern.

<28> In the aging analysis apparatus according to <26> or <27>, the plurality of groups are formed according to age groups, and the factor expression patterns in which the common aging factors are not expressed or only one common aging factor is expressed are classified into the youngest age group of the plurality of groups, and the factor expression patterns in which all the common aging factors are expressed and the factor expression patterns in which the number of common aging factors which is one less than that of all the common aging factors is expressed are classified into the oldest age group of the plurality of groups.

<29> In the aging analysis apparatus according to any one of

<26> to <28>, the output unit outputs the aging information assigned to the group selected depending on the factor expression pattern of the subject.

<30> The aging analysis apparatus according to any one of <17> to <29> further includes an analysis processing unit that performs factor analysis using the number of common aging factors on feature vectors of a plurality of individual samples, which are related to the plurality of morphological features. In the aging analysis apparatus, the acquisition unit further acquires a feature vector of a new individual sample which is not included in the population, which is related to the plurality of morphological features, and the analysis processing unit performs the factor analysis on the feature vector of the new individual sample and the set of feature vectors of the population, newly calculates respective factor scores of common aging factors related to the respective individual samples of a new population acquired by adding the new individual sample to the population by using a factor loading group newly acquired through the factor analysis, and updates original information acquired from the population by the newly acquired factor loading group and the factor scores related to the respective individual samples of the new population.

<31> In the aging analysis method according to any one of <17> to <30>, the plurality of morphological features correlated with the age includes at least two elements of: at least one of a philtrum length and a thinness of a lip; a size of an eye; a slant of the eye; a slant of an eyebrow; and swelling of a lower jaw.

<32> In the aging analysis apparatus according to any one of

<17> to <31>, the age is a perceived age, the number of common aging factors is 5, and a plurality of feature quantities indicating the philtrum length and the thinness of the lip, a plurality of feature quantities indicating a relative size of the eye with respect to a cheek breadth, a plurality of feature quantities indicating slants of the eye in a vertical direction and a forth and back direction, a plurality of feature quantities indicating drooping of the eyebrow with respect to the cheek breadth, and a plurality of feature quantities indicting a size of the bigonial breadth with respect to the cheek breadth, and the positional relationship between a chin, an ear, and a gonion are included.

<33> In the aging analysis apparatus according to any one of <17> to <32>, the plurality of morphological features correlated to the age is selected from many morphological features on a head surface of a person, based on multiple correlation coefficients of morphological features acquired by multiple regression analyses using a feature vector related to the many morphological features as an explanatory variable group and the age as an objective variable.

<34> An aging care counseling method includes the aging analysis method according to any one of <1> to <16>.

<35> A program causes at least one computer to execute the aging analysis method according to any one of <1> to <16>.

[0103]

This application is based upon and claims the benefit of priority from Japanese Patent Application No. 2014-033374; filed on February 24, 2014; the entire contents of which are incorporated herein by reference.

CLAIMS

1. An aging analysis method comprising:

acquiring a feature vector of a subject which is related to a plurality of morphological features correlated to age;

determining a factor expression pattern indicating expressed states of a plurality of common aging factors in the subject by using the plurality of common aging factors extracted by performing factor analysis on a set of feature vectors related to a population including a plurality of persons and the feature vector of the subject; and

acquiring aging information of the subject based on the factor expression pattern of the subject.

2. The aging analysis method according to claim 1,

wherein the determining of the factor expression pattern includes calculating respective factor scores of the subject which are related to the plurality of common aging factors by using the feature vector of the subject, and

the factor expression pattern of the subject is determined based on the respective factor scores of the common aging factors of the subject.

3. The aging analysis method according to claim 2,

wherein the determining of the factor expression pattern includes

determining expressed states of the common aging factors in an individual sample or the subject by comparing a threshold indicating a predetermined position in a factor score distribution of the population and the factor score of the individual sample included in the population or the subject with respect to each of the plurality of common aging factors, and

determining the factor expression pattern indicating at least one common aging factor determined to be expressed as the expressed state for the subject or the individual sample.

4. The aging analysis method according to claim 2 or 3,

wherein, in the calculating of the factor scores of the subject, the feature vector of the subject is applied to the respective multiple regression equations acquired by respectively applying multiple regression analyses of the respective common aging factors using the feature vector related to the plurality of morphological features as an

explanatory variable group and the factor score as an objective variable to a set of feature vectors related to the population.

5. The aging analysis method according to claim 4,

wherein the population does not include the subject, and the aging analysis method further includes

applying the multiple regression analyses of the respective common aging factors to the set of feature vectors related to the population and the feature vector of the subject, and

replacing the original multiple regression equations acquired from the population with multiple regression equations which are respectively acquired by performing the multiple regression analyses of the respective common aging factors.

6. The aging analysis method according to claim 2 or 3,

wherein the population includes the subject, and

in the calculating of the factor scores of the subject, the respective factor scores of the common aging 5 factors related to respective individual samples of the population are calculated by using the set of feature vectors related to the population, a correlation coefficient group between the plurality of morphological features, and a factor loading group acquired through the factor analysis.

7. The aging analysis method according to claim 2,

wherein the factor expression pattern is determined for each of the individual samples of the population depending on the respective factor scores of the common aging factors of the individual sample,

the determining of the factor expression pattern includes acquiring representative values of the feature vectors of the individual samples having the same factor expression pattern for the plurality of respective factor expression patterns determined for the population, and

calculating distances between the feature vector of the subject and the respective representative values of the factor expression patterns, and

the factor expression pattern of the subject is determined based on the distances.

8. The aging analysis method according to any one of claims 2 to 7,

wherein correlation coefficients between the age and the factor scores related to the respective common aging factors in the individual samples included in the

population are respectively greater than a limit value having a significance level of 1% in the number of samples of the population.

9. The aging analysis method according to any one of claims 2 to 8,

wherein the acquiring of the aging information includes selecting a group corresponding to the factor expression pattern of the subject from a plurality of groups acquired by classifying all factor expression patterns corresponding to all combinations of the respective expressed states of the common aging factors according to commonality of the aging information.

10. The aging analysis method according to claim 9,

wherein the factor expression pattern is determined for each of the individual samples of the population depending on the respective factor scores of the common aging factors of the individual sample, and

all the factor expression patterns are classified into the plurality of groups based on at least one of the age, the factor scores, and the number of expressed factors of each of the samples having the same factor expression pattern.

11. The aging analysis method according to claim 9 or 10,

wherein the plurality of groups are formed according to age groups, and

the factor expression patterns in which the common aging factors are not expressed or only one common aging factor is expressed are classified into the youngest age group of the plurality of groups, and the factor expression patterns in which all the common aging factors are expressed and the factor expression patterns in which the number of common aging factors which is one less than that of all the common aging factors is expressed are classified into the oldest age group of the plurality of groups.

12. The aging analysis method according to any one of claims 9 to 11,

wherein the acquiring of the aging information further includes acquiring aging information assigned to the group selected depending on the factor expression pattern of the subject.

13. The aging analysis method according to any one of claims 1 to 12,

wherein the plurality of morphological features correlated with the age includes at least two elements of: at least one of a philtrum length and a thinness of a lip; a size of an eye; a slant of the eye; a slant of an eyebrow; and swelling of a lower jaw.

14. The aging analysis method according to any one of claims 1 to 13,

wherein the age is a perceived age,

the number of common aging factors is 5, and

the feature vector related to the plurality of morphological features correlated to the perceived age includes a plurality of feature quantities indicating the philtrum length 5 and the thinness of the lip, a plurality of feature quantities indicating a relative size of the eye with respect to a cheek breadth, a plurality of feature quantities indicating slants of the eye in a vertical direction and a forth and back direction, a plurality of feature quantities indicating drooping of the eyebrow with respect to the cheek breadth, and a plurality of feature quantities indicating a size of a mandible breadth with respect to the cheek breadth, and the positional relationship between a chin, an ear and a mandibular angle point.

15. The aging analysis method according to any one of claims 1 to 14,
wherein the plurality of morphological features correlated to the age is selected from many morphological features on a head surface of a person, based on multiple correlation coefficients of morphological features acquired by multiple regression analyses using a feature vector related to the many morphological features as an explanatory variable group and the age as an objective variable.

16. An aging care counseling method that includes the aging analysis method according to any one of claims 1 to 15.

17. An aging analysis apparatus comprising:
an acquisition unit that acquires a feature vector of a subject related to a plurality of morphological features correlated to age; a determination unit that determines a factor expression pattern indicating expressed states of a plurality of common aging factors in the subject by using the plurality of common aging 5 factors extracted by performing factor analysis on a set of feature vectors related to a population including a plurality of persons and the feature vector of the subject; and
an output unit that outputs aging information of the subject based on the factor expression pattern of the subject.

18. The aging analysis apparatus according to claim 17,
wherein the output unit outputs the aging information indicating names which are respectively assigned to the plurality of common aging factors and the factor expression pattern of the subject.

19. The aging analysis apparatus according to claim 17 or 18,
wherein the output unit outputs the aging information assigned to the group selected depending on the factor expression pattern of the subject.

20. The aging analysis apparatus according to any one of claims 17 to 19, further comprising:

an analysis processing unit that performs factor analysis using the number of common aging factors on feature groups of a plurality of individual samples, which are related to the plurality of morphological features,

wherein the acquisition unit further acquires a feature vector of a new individual sample which is not included in the population, which is related to the plurality of morphological features, and the analysis processing unit performs the factor analysis on the feature vector of the new individual sample and 5 the set of feature vectors of the population,

newly calculates factor scores of common aging factors related to the respective individual samples of a new population acquired by adding the new individual sample to the population by using a factor loading group newly acquired through the factor analysis, and updates original information acquired from the population by the newly acquired factor loading group and the factor scores related to the respective individual samples of the new population.

21. A program causing at least one computer to execute the aging analysis method according to any one of claims 1 to 15.