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(54) **SIMILARITY CALCULATION METHOD AND DEVICE**

ÄHNLICHKEITSBERECHNUNGSVERFAHREN UND EINRICHTUNG

PROCEDE ET DISPOSITIF DE CALCUL DE SIMILARITE

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Description

Technical Field

[0001] The present invention relates to a similarity calculation method, a similarity calculation apparatus, a program and a recording medium which perform pattern matching between two vectors at a high speed.

[0002] This Application claims priority of Japanese Patent application No. 2002-200481, field on July 9, 2002.

Background Art

[0003] Hitherto, in order to detect a pattern which is substantially the same as an already known pattern from an unknown input signal, or to evaluate similarity between two signals, judgment of similarity or coincidence of data is conducted in all technical fields to which signal processing is related, such as acoustic processing a technology, image processing technology, communication technology, and/or radar technology, etc. In general, for detection of analogous data, there is used a technique of allowing data to be feature vector to judge similarity by magnitude of the distance or angle (correlation) thereof.

[0004] Particularly, the so-called full search in which similarities between input value and respective all candidiates are determined thereafter to determine data where the distance is the shortest is a technology which is most simple and has no detection leakage, and is frequently used in the case where data quantity is small. However, e.g., in the case where the portion similar to input image or input voice (sound) is retrieved from a large quantity of accumulated images or voices (sounds), since the dimension of the feature vector per second is large and retrieval with respect to those feature vectors which have been accumulated by several ten to several hundred hours is conducted, there is the problem that retrieval time becomes vast when such simple full search is performed.

[0005] On the other hand, in order to retrieve large quantity of data, in such cases that complete coincidence retrieval of coded data, e.g., document retrieval is conducted, high speed operation technology such as binary tree search or Hash method is used. In accordance with this technology, data are stored in advance in the state where they are put in order, to omit comparison of branch or table different from input data at the time of retrieval to thereby realize high speed operation. However, in the case where physical signal, e.g., image or sound, etc. is taken as subject, since distortion and/or noise essentially exist in data, it is rare that coded data completely coincide with each other. As a result, in the case where high speed operation technology is used, a large number of detection leakages would take place. In addition, since data is essentially multi-dimensional, there is the problem that it is difficult to implement in advance univocal sequencing to data.

[0006] In view of the above, there is proposed, in the Japanese Patent Publication Laid Open No. H08-123460, a technology in which processing for grouping plural vectors close in distance to represent the grouped vectors by one representative vector is performed at the time of data registration to first calculate distance between input vector and representative vector at the time of retrieval to conduct comparison with all vectors within group only with respect to vectors of the group close in distance to thereby permit similar (analogous) vector retrieval to be performed at high speed, and to have ability to reflect distortion of vector at multi-dimension.

[0007] Further, there is proposed, in the Japanese Patent Publication Laid Open No. 2001-134573, a technology in which vectors are encoded to index them by short code to thereby suppress increase in the number of times of distance calculations to permit high speed similar (analogous) data retrieval.

[0008] However, in the technology described in the above-described Japanese Patent Publication Laid Open No. H08-123460, there was the problem that suitable grouping and selection of representative vector are required at the time of registration so that registration operation becomes troublesome. Moreover, there was also the problem that since it is not limited at the time of retrieval that, e.g., registered vector which is minimum distant with respect to input vector belongs to group in which representative vector which is minimum distant with respect to input vector represents, operation for determining group to be retrieved becomes troublesome.

[0009] Further, in the technology described in the above-described Japanese Patent Publication Laid Open No. 2001-134573, there was the problem that distance relationship between vectors is lost when encoding is performed, or there results in complicated distance relationship in non-additive or non-monotonous manner so that mechanism of registration and/or retrieval becomes troublesome.

[0010] Here, since image and/or sound are essentially time-series, it is desirable that registration is conducted on the real time basis, and it is desirable that time order can be reflected at the time of retrieval. In other words, there are instances where such techniques which requires registration operation to exchange time-series, and/or which requires redistribution (reshuffle) with respect to data or index of already registered data at the time of registration as in the case of the technology described in the above-described Japanese Patent Publication Laid Open No. H08-123460 and Japanese Patent Publication Laid Open No. 2001-134573 are not suitable for retrieval of time-series data.

[0011] Cha, S.-H. and Srihari. S. disclose in their article "A fast nearest neighbour search algorithm by filtration" (Pattern

Recognition, vol. 35, p. 515 - 525, 2002) a method for performing pattern matching between two vectors in which decision for match between two vectors can be made before all features in the vector are examined. A threshold value is used to reduce computation time.

[0012] Shen, G. and Liou. M. L. disclose in their article "An Efficient Codebook Post-Processing Technique and a Window-Based Fast-Search Algorithm for Image Vector Quantization" (IEEE Trans. on Circuits and systems for Video Technology, vol. 10, no. 6, pp. 990.997. 2000) a method for determining the similarity between two vectors in which the potential of a vector is used as a measure of similarity. In contrast to the methods known from prior art no principal component analysis (PCA or an orthogonal transform) has to be applied.

[0013] McNames. J. discloses in his article "Rotated Partial Distance search for Faster Vector Quantization Encoding" a method of reducing the amount of computation required for vector quantization encoding. The partial distance search (PDS) is improved by a principal components rotation (PCR) of the codebook.

[0014] That is, there is desired such a mechanism that retrieval is performed in a time extremely shorter than that at full search while satisfying the conditions where

(a) structural simplicity and robustness with respect to distortion of full search are not lost,
(b) registration and/or deletion are conducted within real time, and
(c) operation with respect to other already registered data is not required by registration or deletion.

Disclosure of the Invention

[0015] The present invention has been proposed in view of such conventional actual circumstances, and its object is to provide a similarity calculation method and a similarity calculating apparatus which perform pattern matching between two vectors at a high speed while satisfying the above-described conditions, a program for allowing computer to execute the similarity calculation processing, and a computer readable recording medium where such program is recorded.

[0016] To attain the above-described object, a similarity calculation method according to the present invention is directed to a similarity calculation method as defined in claim 1.

[0017] In such similarity calculation method, distance calculation between two vectors is conducted in a hierarchical manner, whereby in the case where integrated value of distances calculated up to a certain hierarchy is above a predetermined threshold value, it is only detected, without calculating actual distance, that the integrated value of distances is above the threshold value to thereby allow operation to be performed at a high speed.

[0018] The predetermined transform operation is, e.g., transform for performing sequencing of order of respective components constituting input vector in accordance with magnitude of dispersion of the respective components, Discrete Cosine Transform, Discrete Fourier Transform, Walsh-Hadamard Transform or Karhunen-Lueve Transform.

[0019] Further, in order to attain the above-described object, a similarity calculating apparatus according to the present invention is directed to a similarity calculating apparatus as defined in claim 11.

[0020] Such similarity calculating apparatus performs distance calculation between two vectors in a hierarchical manner, whereby in the case where integrated value of distances calculated up to a certain hierarchy is above a predetermined threshold value, it is only detected, without calculating actual distance, that the integrated value of distances is the threshold value or larger to thereby allow operation to be conducted at a high speed.

[0021] The predetermined transform operation is, e.g., transform for performing sequencing of order of respective components which constitute input vector in accordance with magnitude of dispersion of the respective components, Discrete Cosine Transform, Discrete Fourier Transform, Walsh-Hadamard Transform, or Karhunen-Lueve Transform.

[0022] In addition, program according to the present invention serves to allow computer to execute the above-described similarity calculation processing, and recording medium according to the present invention is a computer readable recording medium where such program is recorded.

[0023] Still further objects of the present invention and practical merits obtained by the present invention will become more apparent from the description of the embodiments which will be given below.

Brief Description of the Drawings

[0024]

FIG. 1 is a view for explaining outline of the configuration of a similarity vector detecting apparatus in the first embodiment describing background art and being useful for understanding the invention.
FIG. 2 is a flowchart for explaining processing at the time of vector registration in the similarity vector detecting apparatus.
FIG. 3 is a flowchart for explaining processing at the time of vector retrieval in the similarity vector detecting apparatus.
FIG. 4 is a view for intuitively explaining processing in the first embodiment.

FIG. 5 is a view showing an example in which there exists deviation in distribution of vector within feature space.

FIG. 6 is a view for explaining outline of the configuration of a similarity vector detecting apparatus in the second embodiment describing background art and being useful for understanding the invention.

FIG. 7 is a flowchart for explaining processing at the time of vector registration in the similarity vector detecting apparatus.

FIG. 8 is a flowchart for explaining processing at the time of vector retrieval in the similarity vector detecting apparatus.

FIG. 9 is a view for explaining outline of the configuration of a similarity vector detecting apparatus in the third embodiment.

FIG. 10 is a flowchart for explaining processing at the time of vector registration in the similarity vector detecting apparatus.

FIG. 11 is a flowchart for explaining processing at the time of vector retrieval in the similarity vector detecting apparatus

FIG. 12 is a flowchart for explaining an example of processing for extracting acoustic feature vector from acoustic signal.

FIG. 13 is a view for explaining an example of processing for extracting acoustic feature vector from acoustic signal.

FIG. 14 is a view for explaining transform encoding in acoustic signal.

FIG. 15 is a flowchart for explaining an example of processing for extracting acoustic feature vector from encoded acoustic signal.

FIG. 16 is a view for explaining an example of processing for extracting acoustic feature vector from encoded acoustic signal.

FIG. 17 is a flowchart for explaining an example of processing for extracting image feature vector from video signal.

FIG. 18 is a view for explaining an example of processing for extracting image feature vector from video signal.

FIG. 19 is a flowchart for explaining another example of processing for extracting image feature vector from video signal.

FIG. 20 is a view for explaining a further example of processing for extracting image feature vector from video signal.

FIG. 21 is a flowchart for explaining a further example of processing for extracting image feature vector from encoded video signal.

FIG. 22 is a view for explaining a further example of processing for extracting image feature vector from encoded video signal.

Best Mode for Carrying Out the Invention

[0025] Explanation will be given below in detail with reference to the attached drawings in connection with practical embodiments to which the present invention is applied. In this embodiment, the present invention is applied to a similarity vector detection method and an apparatus therefor which detect, at a high speed, vectors similar to input vector from plural registered vectors.

[0026] Specifically, in the similarity vector detection method and the apparatus therefor ofs this embodiment, in calculating distance between two vectors, there is employed an approach to calculate distance when corresponding distance is below a predetermined threshold value, and to only detect, without calculating actual distance, that corresponding distance is larger than threshold value when it is above the predetermined value to thereby allow operation of similarity vector detection to be conducted at a high speed. It is to be noted that, in the similarity vector detecting apparatus in this embodiment, in the case where distance is above threshold value, -1 is assumed to be outputted for convenience.

[0027] Hereinafter, two vectors f and g for calculating distance are represented by the following formulas.

$$f = (f[1], f[2], \cdots, f[N])^t \qquad \cdots (1)$$

$$g = (g[1], g[2], \cdots, g[N])^t \qquad \cdots (2)$$

[0028] Here, in the formula (1), f[1], f[2], ··· represent respective components of vector f. In the formula (2), g[1], g[2], ··· represent respective components of vector g. In addition, t represents transposition and N represents dimension of vector.

(1) First embodiment

[0029] Outline of the configuration of the similarity vector detecting apparatus in the first embodiment is shown in FIG.

1. As shown in FIG. 1, the similarity vector detecting apparatus 1 serves to input vector f and vector g to output square distance between the vectors (or -1), and is composed of a recording unit 10, a hierarchical distance calculating unit 11, and a threshold value judgment unit 12.

[0030] The processing at the time of registration in this similarity vector detecting apparatus 1 will be explained by using the flowchart of FIG. 2. First, at step S1, the recording unit 10 (FIG. 1) inputs in advance registered vector g. In general, vector g is plural numbers and may become vast number in many cases. Further, at the subsequent step S2, the recording unit 10 records inputted vector g.

[0031] As stated above, in the first embodiment, since it is unnecessary to conduct special operation at the time of registration, the apparatus is simple and is suitable for processing on the real time basis. In this example, the recording unit 10 is, e.g., magnetic disc, optical disc or semiconductor memory, etc.

[0032] Subsequently, the processing at the time of retrieval in the similarity vector detecting apparatus 1 will be explained by using the flowchart of FIG. 3. First, at step S10, the threshold value judgment unit 12 (FIG. 1) sets threshold value S of distance. At the subsequent step S11, the hierarchical distance calculating unit 11 inputs vector f, and acquires one vector g recorded at the recording unit 10.

[0033] Subsequently, at step S12, the hierarchical distance calculating unit 11 sets component number i serving as internal variable to 1, and sets integrated value sum of distance to 0. At step S13, integrating operation as indicated by the following formula (3) is performed between the i-th component f[i] of vector f and the i-th component g [i] of vector g.

$$\mathrm{sum} = \mathrm{sum} + (f[i] - g[i])^2 \qquad \cdots (3)$$

[0034] At step S14, the threshold value judgment unit 12 discriminates whether or not integrated value sum is smaller than threshold value S. In the case where integrated value sum is smaller than threshold value S (Yes), processing proceeds to step S 16. In the case where integrated value sum is threshold value S or larger (No), the threshold value judgment unit 12 outputs -1 at step S15 to complete processing. Here, as described above, -1 which is outputted is convenient numerical value indicating that distance between inputted vector f and acquired vector g is above threshold value S, and this vector g is nullified. As stated above, the threshold value judgement unit 12 provides threshold value S and serves to truncate integrating operation at the hierarchical distance calculating unit 11 in the case where integrated value sum is above threshold value S at the middle hierarchy of integrating operation to thereby realize high speed processing.

[0035] As step S16, it is discriminated whether or not component number i is the number of dimensions N of vector f or vector g or smaller. In the case where the component number i is N or smaller (Yes), i is incremented at step S17 to return to step S13. On the other hand, in the case where the component number i is larger than N (No), the threshold value judgment unit 12 outputs integrated value sum at step S18 because integrating operation has been completed until the last component of vector f or vector g to complete processing. It is to be noted that integrated value sum at this time is square of distance between vectors.

[0036] While the processing with respect to one registered vector g has been indicated above in the flowchart of FIG. 3, similar processing is performed with respect to registered all vectors g in practice to output, as vector similar to vector f, all vectors g in which integrated value sum of distances with respect to vector f is below the threshold value S.

[0037] When the processing in the first embodiment which has been explained above is intuitively explained, this processing corresponds to the processing to calculate precise distance only with respect to registered vectors in which distance from input vector indicated by × in the figure is within the range of super sphere having radius $\sqrt{S}$ in connection with a large number of registered vectors indicated by black circle in FIG. 4, and to nullify registered vectors without the range at the time point when integrated value of distances of every respective axes is above radius.

[0038] It is to be noted that while square distance between vectors has been used in the above-described explanation, similar technique may be used with respect to arbitrary distance scale without being limited to square distance. It should be noted that in the case where square distance is used, there is no possibility that erroneous nullification is caused to take place because integrated value sum monotonously increases with respect to integrated value of distances between respective components. Moreover, since sum total of distances between respective components is in correspondence with distance between vectors, entirely the same distances as simple full search method are outputted in regard to vectors f and g in which distance is threshold value $\sqrt{S}$ or smaller so that there is no possibility that error may take place.

[0039] Further, in the case of this technique, since it is unnecessary to prepare reference table, etc. which may break the time series relationship, updating and/or deletion of data can be conducted in accordance with time series order, so processing and/or management are easy. In addition, it is also easily possible to conduct retrieval in accordance with time series order, or to designate time series range to be retrieved.

(2) Second embodiment

[0040] In the above-described first embodiment, threshold value S of distance is set, thereby making it possible to conduct retrieval equivalent to full search at a high speed. However, in the case of this technique, since from which vector component execution of retrieval begins is dependent upon arrangement order of vectors, difference takes place in retrieval speed by this arrangement order. For example, in such cases that deviation exists in distribution of vectors within feature space as shown in FIG. 5, retrieval speed greatly changes in dependency upon which of f[1] axis or f[2] axis is first integrated. In this example, employment of a method of first evaluating f[2] axis results in less extra integration to thereby realize high speed operation.

[0041] In view of the above, in the second embodiment which will be explained below, as indicated by the following formulas (4) and (5), multiplication of normal orthogonal transform matrix U is conducted with respect to input vector f and registered vector g to perform orthogonal transform operation to conduct retrieval in order of significance by using the orthogonally transformed vectors f' and g' to thereby allow retrieval to be conducted at higher speed.

$$f' = Uf \qquad \cdots (4)$$

$$g' = Ug \qquad \cdots (5)$$

[0042] It is to be noted that square distance d^2 between two vetcors g and f is not changed by normal orthogonal transform matrix U as indicated by the following formula (6).

$$d^2 = ||f' - g'||^2 = ||U(f-g)||^2 = (f-g)^t U^t U(f-g) = (f-g)^t (f-g) = ||f-g||^2 \qquad \cdots (6)$$

[0043] Outline of the configuration of the similarity vector detecting apparatus in the second embodiment is shown in FIG. 6. As shown in FIG. 6, the similarity vector detecting apparatus 2 serves to input vectors f and g to output distance between the vectors (or -1), and is composed of vector transform units 20, 21, a recording unit 22, a hierarchical distance calculating unit 23, and a threshold value judgment unit 24. Here, the vector transform units 20, 21 serve to respectively implement similar transform operations to vectors g and f. In addition, the recording unit 22 is, e.g., magnetic disc, optical disc or semiconductor memory, etc.

[0044] The processing at the time of registration in this similarity vector detecting apparatus 2 will be explained by using the flowchart of FIG. 7. First, at step S20, the vector transform unit 20 (FIG. 6) inputs registered vector g in advance. At the subsequent step S21, vector g is transformed as indicated by the above-described formula (5) to generate vector g'. Further, at step S22, the recording unit 10 records transformed vector g'.

[0045] Next, the processing at the time of retrieval in the similarity vector detecting apparatus 2 will be explained by using the flowchart of FIG. 8. First, at step S30, the threshold value judgment unit 24 (FIG. 6) sets threshold value S of distance. At the subsequent step S31, the vector transform unit 21 inputs vector f and the hierarchical distance calculating unit 23 acquires one vector g' recorded at the recording unit 22.

[0046] Subsequently, at step S32, the vector transform unit 21 transforms vector f as indicated by the above-described formula (4) to generate vector f'.

[0047] At step S33, the hierarchical distance calculating unit 23 sets component number i serving as internal variable to 1, and sets integrated value sum of distance to 0. At step S34, integrating operation as indicated by the following formula (7) is performed between the i-th component f'[i] of vector f' and the i-th component g'[i] of vector g'.

$$sum = sum + (f'[i] - g'[i])^2 \qquad \cdots (7)$$

[0048] At step S35, the threshold value judgment unit 24 discriminates whether or not integrated value sum is smaller than threshold value S. In the case where integrated value sum is smaller than threshold value S (Yes), processing proceeds to step S37. In the case where integrated value sum is threshold value S or larger (No), the threshold value judgment unit 24 outputs -1 at step S36 to complete processing.

[0049] At step S37, it is discriminated whether or not the component number i is the number of dimensions N or smaller of vector f' and vector g'. In the case where the component number i is N or smaller (Yes), i is incremented at step S38 to return to step S34. On the other hand, in the case where the component number i is larger than N (No), the threshold value judgment unit 24 outputs integrated value sum at step S39 because integrating operation is completed up to the last component of vectors f' and g' to complete processing. It is to be noted that the integrated value sum at this time is square of distance between vectors.

[0050] While the processing with respect to one registered vector g' has been indicated above in the flowchart of FIG. 8, there is employed in practice an approach to perform similar processing with respect to registered all vectors g' to output, as vector similar to vector f', all vectors g' in which integrated value sum of distance with respect to vector f' is below the threshold value S.

[0051] Here, while various matrixes may be used as the above-described normal orthogonal transform matrix U, explanation will be given below by taking four examples in practical sense.

(2-1) Practical example of orthogonal transform

(2-1-1)

[0052] Sequential matrix is mentioned as the most simple orthogonal transform. In this sequential matrix, order of vector component is caused to simply undergo sequencing. For example, sequential matrix P of the eighth order is expressed in a form as indicated by the following formula (8).

$$P = \begin{bmatrix} 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \end{bmatrix} \quad \cdots (8)$$

[0053] In the case where distribution of respective components of vectors is different as in the case of the above-described FIG. 5, it is obvious that the larger dispersion of component is, the larger distribution with respect to distance becomes. Accordingly, in determining order of sequencing, it is optimum to prepare in advance sufficient number (I) of sample vectors g_i to set sequential matrix arranged in order of magnitude of dispersion vector V calculated by the following formula (9).

$$V = \sum_{i=1}^{I} (g_i - \bar{g})^2, \bar{g} = \frac{1}{I} \sum_{i} g_i \quad \cdots (9)$$

[0054] It is to be noted that the orthogonal transform using this sequential matrix is effective in such cases that ways of spreading of respective vector components are different, and is high in speed since it is sufficient to perform sequencing so that multiplication/division and/or conditional branch are not necessary.

(2-1-2)

[0055] In feature quantity where correlation relationship between adjacent components is large, such as image feature quantity or acoustic feature quantity, etc., energy in the case where feature vector is considered as discrete signal deviates to lower frequency component.

[0056] In view of the above, Discrete Cosine Transform (DCT) represented by the following formulas (10), (11), and Discrete Fourier Transform (DFT) represented by the following formulas (12), (13) are used as orthogonal transform to conduct integration in order from low frequency component, thereby making it possible to perform integration in order from component of high significance. Thus, distance calculation is performed at a high speed.

$$D = \begin{bmatrix} D_{11} & \cdots & D_{1N} \\ \vdots & \cdots & \vdots \\ D_{N1} & \cdots & D_{NN} \end{bmatrix} \quad \cdots (10)$$

$$D_{mn} = \alpha(m-1)\cos\frac{(m-1)(2n-1)\pi}{2N}, \quad \alpha = \begin{cases} \sqrt{\frac{1}{N}} & (n=1) \\ \sqrt{\frac{2}{N}} & (n \neq 1) \end{cases} \quad \cdots (11)$$

$$F = \begin{bmatrix} F_{11} & \cdots & F_{1N} \\ \vdots & \cdots & \vdots \\ F_{N1} & \cdots & F_{NN} \end{bmatrix} \quad \cdots (12)$$

$$F_{mn} = \begin{cases} \sqrt{\frac{1}{N}} \cos\left(\frac{-2\pi(n/2-1)(m-1)}{N}\right) & (n : even) \\ \sqrt{\frac{1}{N}} \sin\left(\frac{-2\pi((n+1)/2-N/2)(m-1)}{N}\right) & (n : odd) \end{cases} \quad \cdots (13)$$

[0057] Here, since high speed transform method can be used for Discrete Cosine Transform or Discrete Fourier Transform, and since it is unnecessary to hold all transform matrixes, memory use quantity and/or operation speed in the case where operation is realized by computer are far advantageous as compared to the case where all calculations of matrix is performed.

(2-1-3)

[0058] The Walsh-Hadamard Transform is orthogonal transform where respective elements of transform matrix are constituted only by ± 1, and is suitable for high speed transform because multiplication is not required at the time of transform. Here, sequency is used as concept close to frequency and components are arranged in order from low sequency so that high speed of distance calculation can be realized with respect to vectors where correlation relationship between adjacent components is large similarly to the above-described Discrete Cosine Transform or Discrete Fourier Transform.

[0059] The Walsh-Hadmard Transform matrix is constituted in accordance with codes of Fourier Transform matrix, or is constituted by recursive expansion operation of matrix. As an example, the Walsh-Hadamard Transform matrix W of the eighth order arranged in order of sequency is indicated by the following formula (14).

$$W = \frac{1}{\sqrt{8}} \begin{bmatrix} 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & -1 & -1 & -1 & -1 \\ 1 & 1 & -1 & -1 & -1 & -1 & 1 & 1 \\ 1 & 1 & -1 & -1 & 1 & 1 & -1 & -1 \\ 1 & -1 & -1 & 1 & 1 & -1 & -1 & 1 \\ 1 & -1 & -1 & 1 & -1 & 1 & 1 & -1 \\ 1 & -1 & 1 & -1 & -1 & 1 & -1 & 1 \\ 1 & -1 & 1 & -1 & 1 & -1 & 1 & -1 \end{bmatrix} \quad \cdots (14)$$

(2-1-4)

[0060] In the case where sufficient number of sample vectors are collected in advance, and where a certain amount of cost can be required for transform operation, it is effective that optimum Karhunen-Loeve Transform (hereinafter referred to as KL transform) is used as orthogonal transform.

[0061] The KL transform matrix T is eigen matix in which dispersion matrix V of sample vectors is decomposed into eigen values, and is defined as indicated by the following formula (15) in the case where eigen value is assumed as λ_1, $\cdots$ λ_N.

$$V = T^t \Lambda T, \Lambda = \mathrm{diag}\{\lambda_1, \lambda_2, \cdots, \lambda_N\} \quad \cdots (15)$$

[0062] Here, the KL transform is orthogonal transform matrix which completely removes correlation relationship between respective components, and dispersion of transformed vector components results in eigen value λ_i. Accordingly, the KL transform matrix T is constituted so that eigen values λ_i are arranged in order of magnitude to thereby integrate all components to remove overlapping information thereafter to have ability to perform integration of distances from the axis where dispersion is the largest.

[0063] It is to be noted that, in the technique using this KL transform, since it is necessary to hold KL transform matrix T over the entire dimension in principle at the time of operation, and since it is necessary to perform matrix operation of all order with respect to all vectors, operation cost is high. However, since this operation is performed at the time of registration, it cannot be said that time required for retrieval processing for which high speed is required is particularly increased.

[0064] In addition, although slight degradation of accuracy is involved, there is employed an approach to extract only vector components having large eigen value to hold them without holding vector components having small eigen value to thereby compress vector itself, thus also making it possible to reduce memory area and/or data read-in time of the recording unit 22 (FIG. 6).

(3) Third embodiment

[0065] While the retrieval operation is caused to be conducted at a high speed by realization of high speed of distance calculation in the above-described first and second embodiments, data read-in time from the recording unit, e.g., hard disc, etc. also results in cause of large overhead in performing retrieval.

[0066] Here, the KL transform in the above-described second embodiment corresponds to analysis method called main component analysis in the multivariate analysis field, and is an operation for extracting main component constituting vector. In view of the above, in the third embodiment which will be explained below, the main component of transformed vector g' obtained in the second embodiment is recorded as index vector g_1, and the remaining component is recorded as detail vector g_2. At the time of retrieval, distance calculation is first performed with reference to index vector g_1 to acquire detail vector g_2 only in the case where that result is smaller than threshold value S to further perform distance calculation, thereby making it possible to shorten data read-in time.

[0067] Outline of the configuration of the similarity vector detecting apparatus in the third embodiment is shown in FIG. 9. As shown in FIG. 9, the similarity vector detecting apparatus 3 serves to input vector f and vector g to output square distance between vectors (or -1), and is composed of vector transform units 30, 31, an index recording unit 32, a detail recording unit 33, a hierarchical distance calculating unit 34, and a threshold value judgment unit 35. Here, the vector converting units 30, 31 serve to respectively implement transform operation similar to the above-described second embodiment to the vectors g and f. In addition, the index recording unit 32 and the detail recording unit 33 are, e.g., magnetic disc, optical disc or semiconductor memory, etc.

[0068] The processing at the time of registration in this similarity vector detecting apparatus 3 will be explained by using the flowchart of FIG. 10. First, at step S40, the vector transform unit 30 (FIG. 9) inputs registered vector g in advance. At the subsequent step S41, vector g is transformed as indicated by the above-described formula (5) to generate vector g'. Further, the vector transform unit 30 divides it into index vector g_1 having a predetermined number M ($1 \leq M < N$) of components and detail vector g_2 having the remaining component in order from component having small component number, i.e., component having large dispersion or eigen value in the above-described transform operations or low frequency component. Further, at step S42, the index recording unit 32 records index vector g_1. At step S43, the detail recording unit 33 records detail vector g_2.

[0069] Next, the processing at the time of retrieval in the similarity vector detecting apparatus 3 will be explained by using the flowchart of FIG. 11. First, at step S50, the threshold value judgment unit 35 (FIG. 9) sets threshold value S of distance. At the subsequent step S51, the vector transform unit 31 inputs vector f, and the hierarchical distance calculating unit 34 acquires one index vector g_1 recorded at the index recording unit 32.

[0070] Subsequently, at step S52, the vector transform unit 31 transforms vector f as indicated by the above-described formula (4) to generate vector f'. Further, the vector transform unit 31 divides it into index vector f_1 having a predetermined number M ($1 \leq M < N$) of components and detail vector f_2 having the remaining component in order from component having small component number.

[0071] At step S53, the hierarchical distance calculating unit 34 sets component number i serving as internal variable to 1 and sets integrated value sum of distance to 0. At step S54, integrating operation as indicated by the following formula (16) is performed between the i-th component f' [i] of vector f' and the i-th component g'[i] of vector g'.

$$\mathrm{sum} = \mathrm{sum}\,(f'[i] - g'[i])^2 \qquad \cdots (16)$$

[0072] At step S55, the threshold value judgment unit 35 discriminates whether or not integrated value sum is smaller than threshold value S. In the case where integrated value sum is smaller than threshold value S (Yes), processing proceeds to step S57. In the case where integrated value sum is threshold value S or larger (No), the threshold value judgment unit 35 outputs -1 at step S56 to complete processing. Here, as described above, -1 which is outputted is convenient numerical value indicating that distance is above the threshold value so that it is nullified.

[0073] At step S57, it is discriminated whether or not component number i is the number of dimensions M of index vector f_1 and index vector g_1 or smaller. In the case where the component number i is M or smaller (Yes), i is incremented at step S58 to return to the step S54. On the other hand, in the case where component number i is larger than M (No), the hierarchical distance calculating unit 34 acquires one detail vector g_2 recorded at the detail recording unit 33.

[0074] At step S60, the hierarchical distance calculating unit 34 performs integrating operation as indicated by the above-described formula (16) between the i-th component f'[i] of vector f' and the i-th component g'[i] of vector g'.

[0075] At step S61, the threshold value judgment unit 35 discriminates whether or not integrated value sum is smaller than threshold value S. In the case where the integrated value sum is smaller than threshold value S (Yes), processing proceeds to step S63. In the case where integrated value sum is threshold value S or larger (No), the threshold value judgment unit 35 outputs -1 at step S62 to complete processing.

[0076] At step S63, it is discriminated whether or not the component number i is the number of dimensions N of vector f' or vector g' or smaller. In the case where the component number i is N or smaller (Yes), i is incremented at step S64 to return to the step S60. On the other hand, in the case where the component number i is larger than N (No), the threshold value judgment unit 35 outputs integrated value sum at step S65 since integration is completed until the last component of vector g' to complete processing. At this time, the integrated value sum results in square of distance between vectors.

[0077] While the processing with respect to one registered vector g' is indicated above in the flowchart of FIG. 11, similar processing is performed with respect to all registered vectors g' in practice to output, as vector similar to vector f', all vectors g' in which integrated value sum of distances with respect to vector f' is below the threshold value S.

[0078] In the above-described third embodiment, as compared to the first and second embodiments, memory capacity and/or accuracy are not changed, and operating speed changes little. However, in the case where most comparisons are nullified at the stage of index vector g_1 so that it is unnecessary to acquire detail vector g_2, overhead by data access is cancelled.

[0079] While it is assumed in the above-described explanation that vector is divided into two stages of index vector and detail vector, it is a matter of course that there can be made expansion to multi-stage, such as, for example, index vector is further similarly divided into index vector of high order and detailed index vector so that three-stage configuration is provided.

(4) Extraction of feature vector

[0080] Explanation will be given below in connection with a technique of extracting feature vector from acoustic signal or video signal. In a manner described later, acoustic feature vector and/or image feature vector are extracted to use them as the above-described vectors f and g, thereby making it possible to retrieve, at a high speed, similar acoustic or video signal from registered acoustic signal or video signal by using the techniques of the above-described first to third embodiments in the case where acoustic signal or video signal is inputted.

(4-1) Extraction of acoustic feature vector

(4-1-1)

[0081] Explanation will be given by using the flowchart of FIG. 12 and FIG. 13 in connection with the example of the case where power spectrum coefficients are used as feature quantity relating to acoustic signal. First, at step S70, as shown in FIG. 13, acoustic signals with respect to each time period T are acquired from acoustic signal within object time period.

[0082] Subsequently, at step S71, spectrum operation, e.g., high speed Fourier transform, is implemented to the acquired acoustic signal to determine power spectrum coefficients Sq (q = 0, 1, ···, Q-1) with respect to each short time period. Here, q is index representing discrete frequency and Q is the maximum discrete frequency.

[0083] Subsequently, at step S72, it is discriminated whether or not calculation within object time period is completed. In the case where such calculation is completed (Yes), processing proceeds to step S73. In the case where such calculation is not completed (No), processing returns to the step S70.

[0084] At step S73, average spectrum S'q of the determined power spectrum coefficients Sq is calculated. At step S74, this average spectrum S'_q is changed into vector to generate acoustic feature vector a. This acoustic feature vector a is represented by, e.g., the following formula (17).

$$a = (S_0, \cdots, S_{Q-1}) \qquad \cdots (17)$$

[0085] It is to be noted that while explanation has been given in the above-described example on the premise that acoustic signal within object time period is divided into each time period T, spectrum operation may be implemented without dividing into each time period T in the case where the object time period is short.

[0086] In addition, while the example using power spectrum coefficient has been explained in the above-described example, the present invention is not limited to such implementation but cepstrum coefficient having equivalent information, etc., may also be used. Further, in place of Fourier transform, similar effect can also be obtained by linear predictive coefficient using AR (Auto-Regressive) model.

(4-1-2)

[0087] Since the acoustic signal is vast, there are many instances where such signal is recorded or is caused to undergo transmission after being compression-encoded. While it is possible to extract acoustic feature vector a by using the above-described technique after encoded acoustic signal is decoded into signal in the base band, extracting processing can be conducted efficiently and at a high speed if acoustic feature vector a can be extracted only by partial decoding.

[0088] Here, in the transform encoding which is encoding method generally used, acoustic signal serving as original sound is divided into frames with respect to each time period T, as shown in FIG. 14. Further, orthogonal transform such as Modified Discrete Cosine Transform (MDCT), etc. is implemented to acoustic signal with respect to each frame, and the coefficients thereof are quantized and encoded. In this instance, scale factors serving as normalization coefficient of magnitude are extracted with respect to each frequency band, and are separately encoded. In view of the above, by decoding only the scale factors, they can be used as acoustic feature vector a.

[0089] Explanation will be given by using the flowchart of FIG. 15 and FIG. 16 in connection with the example of the case where scale factors are used as feature quantity relating to acoustic signal. First, at step S80, encoded acoustic signal within the time period T in the object time period is acquired. At step S81, scale factors with respect to each frame are partially decoded.

[0090] Subsequently, at step S82, it is discriminated whether or not decoding within the object time period is completed. In the case where such decoding is completed (Yes), processing proceeds to step S83. In the case where such decoding is not completed (No), processing returns to the step S80.

[0091] At step S83, maximum scale factors are detected with respect to each band from scale factors within the object time period. At step S84, those scale factors are changed into vectors to generate acoustic feature vector a.

[0092] In this way, it is possible to extract, at a high speed, acoustic feature vector a equivalent to the above without completely decoding encoded acoustic signal.

(4-2) Extraction of image feature vector

(4-2-1)

[0093] Explanation will be given by using the flowchart of FIG. 17 and FIG. 18 in connection with the example of the case where luminance information and color information are used as feature quantity relating to video signal. First, at step S90, as shown in FIG. 18, image frame is acquired from video signal within the object time period T.

[0094] Subsequently, at step S91, time average image 100 is prepared on the basis of acquired all image frames.

[0095] Subsequently, at step S92, the prepared time average image 100 is divided into X × Y small blocks in breadth and width directions to prepare block average image 110 in which pixel values within respective blocks are averaged.

[0096] Further, at step S93, these small blocks are arranged in order of R, G, B, e.g., from the left upper direction toward the right lower direction to generate one-dimensional image feature vector v. This image feature vector v is represented by, e.g., the following formula (18).

$$v = (R_{00}, \cdots, R_{X-1,Y-1}, G_{00}, \cdots, G_{X-1,Y-1}, B_{00}, \cdots, B_{X-1,Y-1}) \qquad \cdots (18)$$

[0097] It is to be noted that explanation has been given in the above-described example in connection with the example where pixel values of the block average image 110 in which the time average image 100 is divided are rearranged to generate one-dimensional image feature vector v, however, the present invention is not limited to such implementation, but there may be employed an approach to rearrange pixel values of the time average image 100 without preparing the block average image 110 to generate one-dimensional image feature vector v.

[0098] In addition, since time change of video signal is not so rapid in the ordinary state, it is also possible to obtain the same effects/advantages by employing an approach to select, as representative image, one frame within the object time period without preparing the time average image 100 to substitute it.

(4-2-2)

[0099] There are many instances where there exist a certain relation in images where distribution of color with respect to all images are similar, e.g., studio image, etc. photographed from the same angle of news image even in the case where corresponding video signal is not entirely the same video signal. Thus, there is a demand for performing retrieval in the state where these images are considered to be the same. In such case, it is effective to employ a method of rejecting spatial dependency of image to prepare histogram of color distribution to make comparison.

[0100] In view of the above, explanation will be given by using the flowchart of FIG. 19 and FIG. 20 in connection with the example of the case where histogram of color distribution is used as feature quantity in this way. First, at step S100, as shown in FIG. 20, image frame is acquired from video signal within object time period T.

[0101] Subsequently, at step S101, histogram with respect to signal values of respective colors, e.g., R, G, B is prepared from signal values of respective image frames.

[0102] Further, at step S102, these colors are arranged in order of, e.g., R, G, B to generate one-dimensional image feature vector v. This image feature vector v is represented by the following formula (19).

$$v = (R_0, \cdots, R_{N-1}, G_0, \cdots, G_{N-1}, B_0, \cdots, B_{N-1}) \qquad \cdots (19)$$

[0103] It is to be noted that while explanation has been given in the above-described example on the premise that histogram with respect to signal values of R, G, B is prepared, it is possible to obtain similar effects/advantages even if histogram with respect to signal values of luminance (Y) and color difference (Cb, Cr) is prepared.

(4-2-3)

[0104] Since video signal is vast, there are many cases where such signal is recorded or is caused to undergo transmission after being compression-encoded. While it is possible to extract image feature vector v by using the above-described technique after employing an approach to decode encoded video signal into signal of base band, extraction processing can be performed efficiently and at a high speed if image feature vector v can be extracted only by partial decoding.

[0105] Explanation will be given by using the flowchart of FIG. 21 and FIG. 22 in connection with the example of the case where image feature vector v is extracted from video signal compression-encoded by MPEG1 (Moving Picture Experts Group 1) or MPEG2. First, at step S110, encoded video signal of encoded group (Group of pictures: GOP) proximate to object time period T to be changed into vector is acquired to acquire intra-frame encoded picture (I picture) 120 within that GOP.

[0106] Here, frame image is encoded with macro block MB (16 $\times$ 16 pixels, or 8 $\times$ 8 pixels) being as unit, and Discrete Cosine Transform (DCT) is used. These DC-transformed DC coefficients correspond to average value of pixel values of image within macro block.

[0107] In view of the above, at step S111, these DC coefficients are acquired. At the subsequent step S 112, these coefficients are arranged in order of, e.g., Y, Cb, Cr to generate one-dimensional image feature vector v. This image feature vector v is represented by, e.g., the following formula (20).

$$v = (Y_{00}, \cdots, Y_{X-1,Y-1}, Cb_{00}, \cdots, Cb_{X-1,Y-1}, Cr_{00}, \cdots, Cr_{X-1,Y-1}) \qquad \cdots (20)$$

[0108] In this way, it is possible to extract image feature vector v at a high speed without completely decoding encoded video signal.

[0109] It is to be noted that while explanation has been given in the above-described example that video signal which has been compression-encoded by the MPEG1 or the MPEG2 is assumed to be used, the present invention may also be applied to other compression-encoding system.

(5) Others

[0110] As explained above, in accordance with this embodiment, hierarchical distance integrating operation is performed in detecting analogous (similar) vector on the basis of distance between vectors to truncate distance integrating operation at the time when integrated value of distances is above threshold value with respect to distance set in advance, thereby making it possible to detect similar vector at a high speed. Particularly, in such cases that vector similar to input vector is detected from a large quantity of registered vectors, since most registered vectors are non-similar so that integrated value of distances is above threshold value, distance calculation can be truncated at the early stage. Thus, detection time can be shortened to a large extent.

[0111] In addition, by implementing sequential transform, Discrete Cosine Transform, Discrete Fourier Transform, Walsh-Hadamard Transform or KL Transform in advance to vector to perform integrating operation in order from vector component having high significance, i.e., component having large dispersion or eigen value in the above-described transform operations or in order from low frequency component, it is possible to detect similar vector efficiently and at a high speed, taking the distribution of vector components into consideration.

[0112] Accordingly, also in performing retrieval of acoustic signal or video signal, acoustic feature vector and/or image feature vector is extracted in advance to register the vector thus extracted, whereby in the case where arbitrary acoustic signal or video signal is inputted, similar acoustic or video signals can be retrieved at a high speed while maintaining structural simplicity and/or retrieval accuracy similar to full search.

[0113] While the invention has been described in accordance with certain embodiments thereof illustrated in the accompanying drawings and described in the above description in detail, it should be understood by those ordinarily skilled in the art that the invention is not limited to the embodiments, but various modifications, alternative embodiments or equivalents can be implemented without departing from the scope and spirit of the present invention as set forth and defined by the appended claims.

[0114] For example, while the present invention has been explained in the above-described embodiments as the configuration of hardware, the present invention is not limited to such implementation, but arbitrary processing may be also realized by allowing CPU (Central Processing Unit) to execute computer program. In this case, computer program may be provided in the state where it is recorded on recording medium, or may be provided by allowing it to undergo transmission through other transmission medium such as Internet.

Industrial Applicability

[0115] In accordance with the above-described present invention, there is employed such approach to perform distance calculation between two vectors in a hierarchical manner, whereby in the case where that integrated value of distances calculated up to a certain hierarchy is above a predetermined threshold value, it is only detected, without calculating actual distance, that the integrated value of distances is threshold value or larger, thereby permitting operation to be conducted at a high speed. Particularly, in such cases that vector similar to input vector is detected from a large quantity of registered vectors, since most registered vectors are non-similar and thus integrated value of distances is above threshold value, distance calculation can be truncated at the early stage. Therefore, detection time can be shortened to a large extent.

Claims

1. A similarity calculation method of determining similarity between two feature vectors, a registered vector (g) and an input vector (f), being representative of an acoustic signal or a video signal, each of the two feature vectors having N corresponding components, N being an integer greater than zero, the method including the following steps:

a transform step (S41, S52) in which a predetermined transform operation (S41, S52) is implemented to the two feature vectors (f, g.),

a division step (S41, S52) in which the two transformed feature vectors <u>(f', g')</u> are divided component-wise into a plurality of partial vectors (f_1, f_2, g_1, g_2),

a recording step (S42, S43) in which the plurality of partial vectors (g_1, g_2) constituting the transformed registered feature vector (g') are recorded,

a hierarchical distance calculation step (S53, S54, S57, S58, S60, 563. S64) in which the distance between the two feature vectors <u>(f', g')</u> transformed at the transform step (S41, S52) is calculated in a predetermined order based on the predetermined transform operation (S41, S52), wherein the distance calculation is performed between respective components constituting partial vectors (f_1, $\underline{f_2}$, g_1, g_2) in a component-wise hierarchical manner in order from the partial vector (f_1, g_1) of the uppermost component order,

a threshold value comparison step (S55, S61) in which an integrated value of distances calculated incrementally for hierarchically higher-order components (i) of the two transformed feature vectors (f', g') is compared with a threshold value (S) set in advance,

a control step (S55, S56, S57, S58, S61, S62, S63, S64) in which distance calculation is controlled in accordance with a result of the threshold value comparison at the threshold value comparison step (S55, S61), and

an output step (S65) in which, as the similarity, the integrated value of the calculated distances up to the last components (i) of the two transformed feature vectors (f', g') is outputted,

wherein, at the control step (S55, S56, S57, S58, S61, S62, S63, S64), control is conducted such that the

distance calculation is truncated in the case where the integrated value of distances calculated up to a certain component order is greater or equal to the threshold value and such that the distance calculation between next higher-order components is performed in the case where the integrated value of distances calculated up to a certain component order is below the threshold value,
and wherein distance calculation is performed such that, in a first step, only the partial vector (g_1) of the uppermost component order of the plurality of partial vectors (g_1, g_2) recorded in the recording step is retrieved and the distance calculation is performed between respective components constituting the partial vectors (f_1, g_1) of the uppermost component order in a component-wise hierarchical manner, and wherein only in the case where the integrated value of calculated distances between all components constituting the partial vectors (f_1, g_1) of the uppermost component order is below the threshold value, in a second step the partial vector (g_2) of the next lower component order of the plurality of partial vectors (g_1, g_2) of the transformed registered feature vector (g') recorded in the recording step (S42, S43) is retrieved and distance calculation between respective components constituting partial vectors (f_2, g_2) of the next lower component order is performed.

2. The similarity calculation method as set forth in claim 1, wherein the predetermined transform operation (S41, S52) is a transform operation which performs sequencing of order of respective components constituting the two feature vectors (f, g) in accordance with magnitude of dispersion of the respective components, and the distance calculation between the two feature vectors (f', g') transformed at the transform step (S41, S52) is performed in order from components of large dispersion at the hierarchical distance calculation step (S53, S54, S57, S58. S60, S63, S64).

3. The similarity calculation method as set forth in claim 1, wherein the predetermined transform operation (S41, S52) is a Discrete Cosine Transform operation or Discrete Fourier Transform operation, and the distance calculation between the two feature vectors (f', g') transformed at the transform step (S41. S52) is performed in order from low frequency component at the hierarchical distance calculation step (S53, S54, S57, S58, S60, S63, S64).

4. The similarity calculation method as set forth in claim 1, wherein, the predetermined transform operation (S41, S52) is Walsh-Hadamard Transform operation, and the distance calculation between the two transformed feature vectors (f', g') is performed in order from low frequency component at the hierarchical distance calculation step (S53, S54, S57, S58, S60, S63, S64).

5. The similarity calculation method as set forth in claim 1, wherein the predetermined transform operation (S41, S52) is a Karhunen-Loeve transform operation, and the distance calculation between the two feature vectors (f', g') transformed at the transform step is performed in order from component of large eigenvalue at the hierarchical distance calculation step (S53, S54, S57, S58, S60, S63, S64).

6. The similarity calculation method as set forth in claim 1, wherein the feature vector (a) is obtained by extracting power spectrum coefficients (S_q) within a predetermined time period of an acoustic signal, the power spectrum coefficients (S_q) being the components of the feature vector (a).

7. The similarity calculation method as set forth in claim 1. wherein the feature vector (a) is obtained by extracting linear predictive coefficients within a predetermined time period of an acoustic signal.

8. The similarity calculation method as set forth in claim 1, wherein the feature vector (a) is obtained by extracting parameters indicating intensities of frequency components within respective frames of an encoded acoustic signal, the parameters being components of the feature vector (a).

9. The similarity calculation method as set forth in claim 1, wherein the feature vector (v) is obtained by acquiring image frames from signal value of representative image within respective predetermined time periods of a video signal, preparing an average image (100) of the acquired image frames within the respective predetermined time periods, and preparing a block average image (110) by dividing the average image (100) into X × Y small blocks in breadth and width directions and averaging the values within respective small blocks and by arranging the small blocks in order of R. G, B, the values of the block average image (110) arranged in order of R. G. B being the components of the feature vector (v).

10. The similarity calculation method as set forth in claim 1, wherein the feature vector (v) is obtained by preparing histogram with respect to signal values of luminance and/or color of image frame within a predetermined time period of a video signal, the signal values of luminance and/or color being the components of the feature vector (v).

11. A similarity calculating apparatus adapted for determining similarity between two feature vectors, a registered vector (g) and an input vector (f), being representative of an acoustic signal or a video signal, comprising:

transform means (30. 31) which is adapted to implement a predetermined transform operation to the two feature vectors (f, g),
dividing means (30, 31) which is adapted to take out, in a predetermined order based on the predetermined transform operation, respective components constituting the two feature vectors (f', g') transformed by the transform means (30, 31) to divide them into a plurality of partial vectors (f_1, g_1, f_2, g_2),
recording means (32, 33) which are adapted to record the plurality of partial vectors (g_1, g_2) constituting the transformed registered feature vector (g'),
hierarchical distance calculating (34) means which is adapted to perform a distance calculation between the two feature vectors (f', g') transformed by the transform means (30, 31) in a predetermined order based on the predetermined transform operation, wherein the distance calculating means (34) is adapted to perform, in a component-wise hierarchical manner, the distance calculation between respective components constituting partial vectors (f_1, g_1, f_2, g_2) in order from the partial vector (f_1, g_1) of the uppermost component order, and
threshold value comparing means (35) which is adapted to compare an integrated value of distances calculated incrementally for hierarchically higher-order components of the two transformed vectors (f', g',) by the distance calculating means (34) with a threshold value (S) set in advance,
a control means which is adapted to control the distance calculation in accordance with a result by the threshold value comparing means (34), and
output means which is adapted to output, as the similarity, the integrated value of distances calculated up to the last components of the two transformed feature vectors (f', g'),
wherein the control means is operative so that in the case where integrated value of distances calculated up to a certain component order is above the threshold value as the result of comparison by the threshold comparing means (35), a control is performed so as to truncate the distance calculation, and in the case where the integrated value of distances calculated up to a certain component order is below the threshold value the distance calculation is performed between the next higher-order components,
and wherein the hierarchical distance calculating means (34) is operative so that, in a first step, only the partial vector (g_1) of the uppermost component order of the plurality of partial vectors (g_1, g_2) recorded in the recording means is retrieved and the distance calculation is performed between respective components constituting the partial vectors (f_1, g_1) of the uppermost component order in a component-wise hierarchical manner, and wherein only in the case where the integrated value of calculated distances calculated between all components constituting the partial vectors (f_1, g_1) of the uppermost component order is below the threshold value (S), in a second step the partial vector (g_2) of the next lower component order of the plurality of partial vectors (g_1, g_2) of the transformed registered feature vector (g') recorded in the recording means (33) is retrieved and the distance calculation between respective components constituting partial vectors (f_2, g_2) of one lower component order is performed.

12. A program for allowing a computer to execute similarity calculation processing for determining similarity between two feature vectors (f, g,), a registered vector (g) and an input vector (f), being representative of an acoustic signal or a video signal, the program comprising:

a transform step (S41, S52) in which a predetermined transform operation is implemented to the two feature vectors (f, g),
a division step (S41, S52) in which the two transformed feature vectors (f', g') are divided component-wise into a plurality of partial vectors (f_1, g_1, f_2, g_2),
a recording step (S42, S43) in which the plurality of partial vectors (g_1, g_2) constituting the transformed registered feature vector (g') are recorded,
a hierarchical distance calculation step (S53, S54, S57, S58, S60, S63, S64) in which the distance between the two feature vectors (f_1, g_1) transformed at the transform step is calculated in a predetermined order based on the predetermined transform operation (S41. S52), wherein the distance calculation is performed between respective components constituting partial vectors (f_1, g_1, f_2, g_2) in a component-wise hierarchical manner in order from the partial vector (f_1, g_1) of the uppermost component order,
a threshold value comparison step (S55, S61) in which an integrated value of distances calculated incrementally for hierarchically higher-order components (i) of the two transformed feature vectors is compared with a threshold value (S) set in advance,
a control step (S55, S56, S57, 558. S61, S62, S63, S64) in which distance calculation is controlled in accordance with a result of the threshold value comparison at the threshold value comparison step (S55, S61), and

an output step (S65) in which, as the similarity, the integrated value of the calculated distances up to the last components (i) of the two transformed feature vectors (f', g') is outputted,

wherein, at the control step (S55, S56, S57, S58, S61, S62, S63, S64), control is conducted such that the distance calculation is truncated in the case where the integrated value of distances calculated up to a certain component order is greater or equal to the threshold value (S) and the distance calculation between next higher-order components is performed in the case that the integrated value of distances calculated up to a certain component order is below the threshold value,

and wherein distance calculation is performed such that, in a first step, only the partial vector (g_1) of the uppermost component order of the plurality of partial vectors (g_1, g_2) recorded in the recording step is retrieved and the distance calculation is performed between respective components constituting the partial vectors (f_1, g_1) of the uppermost component order in a component-wise hierarchical manner, and wherein only in the case where the integrated value of calculated distances between all components constituting the partial vectors (f_1, g_1) of the uppermost component order is below the threshold value, in a second step the partial vector (g_2) of the next lower component order of the plurality of partial vectors (g_1, g_2) of the transformed registered feature vector (g') recorded in the recording step (S42, S43) is retrieved and the distance calculation between respective components constituting partial vectors (f_2, g_2) of the next lower component order is performed.

13. A computer readable medium adapted so that a program for allowing a computer to execute similarity calculation processing which determines similarity between two feature vectors (f, g), a registered vector (g) and an input vector (f), being representative of an acoustic signal or a video signal is recorded, the program including:

a transform step (S41, S52) in which a predetermined transform operation is implemented to the two feature vectors (f, g)

a division step (S41) in which the two transformed feature vectors <u>(f', g')</u> are divided component-wise into a plurality of partial vectors (f_1, g_1, f_2, g_2),

a recording step (S42, S43) in which the plurality of partial vectors (g_1, g_2) constituting the transformed registered feature vector (g') are recorded,

a hierarchical distance calculation step (S53, S54, S57, S58, S60, S63, S64) in which the distance calculation between the two feature vectors <u>(f', g')</u> transformed at the transform step is calculated in a predetermined order based on the predetermined transform operation (S41, S52), wherein the distance calculation is performed between respective components constituting partial vectors (f_1, g_1, f_2, g_2) in a component-wise hierarchical manner in order from the partial vector (f_1, g_1) of the uppermost component order,

a threshold value comparison step (S55, S61) in which an integrated value of distances calculated incrementally for hierarchically higher-order components (i) of the two transformed feature vectors (f', g') is compared with a threshold value (S) set in advance,

a control step (S55, S56, S57, S58, S61, S62, S63, S64) in which distance calculation is controlled in accordance with a result of the threshold value comparison at the threshold value comparison step (S55, S61), and

an output step (S65), in which, as the similarity, the integrated value of the calculated distances up to the last components (i) of the two transformed feature vectors (f', g') is outputted,

wherein, at the control step (S55, S56, S57, S58, S61, S62, S63, S64), control is conducted such that the distance calculation is truncated in the case where the integrated value of distances calculated up to a certain component order is greater or equal to the threshold value (S) and the distance calculation between next higher-order components is performed in the case that the integrated value of distances calculated up to a certain component order is below the threshold value,

and wherein distance calculation is performed such that, in a first step, only the partial vector (g_1) of the uppermost component order of the plurality of partial vectors (g_1, g_2) recorded in the recording step is retrieved and the distance calculation is performed between respective components constituting the partial vectors (f_1, g_1) of the uppermost component order in a component-wise hierarchical manner, and wherein only in the case where the integrated value of calculated distances between all components constituting the partial vectors (f_1, g_1) of the uppermost component order is below the threshold value (S), in a second step the partial vector (g_2) of the next lower component order of the plurality of partial vectors (g_1, g_2) of the transformed registered feature vector (g') recorded in the recording step (S42, S43) is retrieved and the distance calculation between respective components constituting partial vectors (f_2, g_2) of the next lower component order is performed.

Patentansprüche

1. Ähnlichkeitsberechnungsverfahren zum Bestimmen einer Ähnlichkeit zwischen zwei Merkmalsvektoren, einem re-

gistrierten Vektor (g) und einem Eingabevektor (f), die repräsentativ sind für ein akustisches Signal oder ein Videosignal, wobei jeder der zwei Merkmalsvektoren N entsprechende Komponenten aufweist, wobei N eine ganze Zahl größer als Null ist,
wobei das Verfahren folgende Schritte aufweist:

einen Transformationsschritt (S41, S52), bei welchem ein vorbestimmter Transformationsvorgang (S41, S52) auf die zwei Merkmalsvektoren (f, g) angewandt wird,
einen Unterteilungsschritt (S41, S52), bei welchem die zwei transformierten Merkmalsvektoren (f', g') komponentenweise in eine Mehrzahl von Teilvektoren (f_1, f_2, g_1, g_2) unterteilt werden,
einen Aufzeichnungsschritt (S42, S43), bei welchem die Mehrzahl von Teilvektoren (g_1, g_2), die den transformierten registrierten Merkmalsvektor (g') bilden, aufgezeichnet werden,
einen hierarchischen Distanzberechnungsschritt (S53, S54, S57, S58, S60, S63, S64), bei welchem die Distanz zwischen den zwei Merkmalsvektoren (f', g'), die beim Transformationsschritt (S41, S52) transformiert wurden, in einer vorbestimmten Ordnung berechnet wird, und zwar auf der Grundlage des vorbestimmten Transformationsvorgangs (S41, S52), wobei die Distanzberechnung zwischen den jeweiligen Komponenten, welche die Teilvektoren (f_1, f_2, g_1, g_2) bilden, in einer komponentenweisen hierarchischen Art in der Ordnung vom Teilvektor (f_1, g_1) der obersten Komponentenordnung durchgeführt wird,
einen Schwellwertvergleichsschritt (S55, S61), bei welchem ein integrierter Wert von Distanzen, die inkrementweise für Komponenten (i) hierarchisch höherer Ordnung der zwei transformierten Merkmalsvektoren (f', g') berechnet wurden, mit einem vorab eingestellten Schwellwert (S) verglichen wird,
einen Steuerschritt (S55, S56, S57, S58, S61, S62, S63, S64), bei welchem die Distanzberechnung gemäß einem Ergebnis des Schwellwertvergleichs beim Schwellwertvergleichsschritt (S55, S61) gesteuert wird, und
einen Ausgabeschritt (S65), bei welchem der integrierte Wert der berechneten Distanzen bis zu den letzten Komponenten (1) der zwei transformierten Merkmalsvektoren (f', g') als Ähnlichkeit ausgegeben wird,
wobei beim Steuerschritt (S55, S56, S57, S58, S61, S62, S63, S64) die Steuerung derart durchgeführt wird, dass die Distanzberechnung in dem Fall beendet wird, bei welchem der integrierte Wert von Distanzen, die bis zu einer bestimmten Komponentenordnung berechnet wurden, größer ist als der oder gleich ist zu dem Schwellwert, sowie derart, dass die Distanzberechnung zwischen Komponenten nächst höherer Ordnung in dem Fall durchgeführt wird, bei welchem der integrierte Wert von Distanzen, die bis zu einer bestimmten Komponentenordnung berechnet wurden, niedriger ist als der Schwellwert, und
wobei die Distanzberechnung derart ausgeführt wird, dass in einem ersten Schritt nur der Teilvektor (g_1) der obersten Komponentenordnung der Mehrzahl von Teilvektoren (g_1, g_2), die beim Aufzeichnungsschritt aufgezeichnet wurden, wieder gewonnen wird, und die Distanzberechnung zwischen jeweiligen Komponenten, die die Teilvektoren (f_1, g_1) der obersten Komponentenordnung bilden, in einer komponentenweisen hierarchischen Art und Weise ausgeführt wird, und
wobei nur in dem Fall, bei welchem der integrierte Wert der berechneten Distanzen zwischen allen Komponenten, die die Teilvektoren (f_1, g_1) der obersten Komponentenordnung bilden, unterhalb des Schwellwerts liegt, in einem zweiten Schritt der Teilvektor (g_2) der nächst niedrigeren Komponentenordnung der Mehrzahl von Teilvektoren (g_1, g_2) des transformierten registrierten Merkmalsvektors (g'), die im Aufzeichnungsschritt (S42, S43) aufgezeichnet wurden, wieder gewonnen und die Distanzberechnung zwischen jeweiligen Komponenten, die Teilvektoren (f_2, g_2) der nächst niedrigeren Komponentenordnung bilden, ausgeführt wird.

2. Ähnlichkeitsberechnungsverfahren nach Anspruch 1,
wobei der vorbestimmte Transformationsvorgang (S41, S52) ein Transformationsvorgang ist, welcher ein Ordnen einer Ordnung jeweiliger Komponenten, welche die zwei Merkmalsvektoren (f, g) bilden, gemäß einer Stärke der Dispersion der jeweiligen Komponenten durchführt, und
wobei die Distanzberechnung zwischen den zwei Merkmalsvektoren (f', g'), die im Transformationsschritt (S41, S52) transformiert wurden, im hierarchischen Distanzberechnungsschritt (S53, S54, S57, S58, S60, S63, S64) in der Ordnung von Komponenten einer großen Dispersion ausgeführt wird.

3. Ähnlichkeitsberechnungsverfahren nach Anspruch 1,
wobei der vorbestimmte Transformationsvorgang (S41, S52) ein diskreter Cosinus-Transformationsvorgang oder ein diskreter Fourier-Transformationsvorgang ist und
wobei die Distanzberechnung zwischen den zwei Merkmalsvektoren (f', g'), die im Transformationsschritt (S41, S52) transformiert wurden, im hierarchischen Distanzberechnungsschritt (S53, S54, S57, S58, S60, S63, S64) ausgeführt wird in der Ordnung von einer Niedrigfrequenzkomponente.

4. Ähnlichkeitsberechnungsverfahren nach Anspruch 1, wobei der vorbestimmte Transformationsvorgang (S41, S52) ein Walsh-Hadamard-Transformationsvorgang ist und wobei die Distanzberechnung zwischen den zwei transformierten Merkmalsvektoren (f', g') im hierarchischen Distanzberechnungsschritt (S53, S54, S57, S58, S60, S63, S64) in einer Ordnung von einer Niedrigfrequenzkomponente ausgeführt wird.

5. Ähnlichkeitsberechnungsverfahren nach Anspruch 1,
wobei der vorbestimmte Transformationsvorgang (S41, S52) ein Karhunen-Loeve-Transformationsvorgang ist und wobei die Distanzberechnung zwischen den zwei Merkmalsvektoren (f', g'), die im Transformationsschritt transformiert wurden, im hierarchischen Distanzberechnungsschritt (S53, S54, S57, S58, S60, S63, S64) in einer Ordnung von einer Komponente mit großem Eigenwert ausgeführt wird.

6. Ähnlichkeitsberechnungsverfahren nach Anspruch 1,
wobei der Merkmalsvektor (a) erhalten wird durch Extrahieren von Leistungsspektrumskoeffizienten (S_q) innerhalb einer vorbestimmten Zeitspanne eines akustischen Signals,
wobei die Leistungsspektrumskoeffizienten (S_q) die Komponenten des Merkmalsvektors (a) sind.

7. Ähnlichkeitsberechnungsverfahren nach Anspruch 1,
wobei der Merkmalsvektor (a) erhalten wird durch Extrahieren linearer Vorhersagekoeffizienten innerhalb einer vorbestimmten Zeitspanne eines akustischen Signals.

8. Ähnlichkeitsberechnungsverfahren nach Anspruch 1,
wobei der Merkmalsvektor (a) erhalten wird durch Extrahieren von Parametern, die Intensitäten von Frequenzkomponenten innerhalb jeweiliger Frames eines codierten akustischen Signals anzeigen,
wobei die Parameter Komponenten des Merkmalsvektors (a) sind.

9. Ähnlichkeitsberechnungsverfahren nach Anspruch 1,
wobei der Merkmalsvektor (v) erhalten wird durch Erfassen von Bildframes von einem Signalwert eines repräsentativen Bildes innerhalb jeweiliger vorbestimmter Zeitspannen eines Videosignals, durch Erzeugen eines gemittelten Bildes (100) der erfassten Bildframes innerhalb der jeweiligen vorbestimmten Zeitspannen und durch Erzeugen eines blockgemittelten Bildes (110) durch Unterteilen des gemittelten Bildes (100) in X x Y kleine Blöcke in Breiten- und Weitenrichtungen und Mitteln der Werte innerhalb jeweiliger kleiner Blöcke und Anordnen der kleinen Blöcke in einer Ordnung von R, G, B, wobei die Werte des blockgemittelten Bildes (110), die in der Ordnung von R, G, B angeordnet sind, die Komponenten des Merkmalsvektors (v) sind.

10. Ähnlichkeitsberechnungsverfahren nach Anspruch 1,
wobei der Merkmalsvektor (v) erhalten wird durch Erzeugen eines Histogramms in Bezug auf Signalwerte von Luminanz und/oder von Farbe eines Bildframes innerhalb einer vorbestimmten Zeitspanne eines Videosignals, wobei die Signalwerte von Luminanz und/oder Farbe die Komponenten des Merkmalsvektors (v) sind.

11. Ähnlichkeitsberechnungsvorrichtung,
welche ausgebildet ist zum Bestimmen einer Ähnlichkeit zwischen zwei Merkmalsvektoren, einem registrierten Vektor (g) und einem Eingabevektor (f), welche repräsentativ sind für ein akustisches Signal oder für ein Videosignal, mit:

einer Transformationseinrichtung (30, 31), welche ausgebildet ist, einen vorbestimmten Transformationsvorgang in Bezug auf die zwei Merkmalsvektoren (f, g) anzuwenden,
einer Unterteilungseinrichtung (30, 31), welche ausgebildet ist, in einer vorbestimmten Ordnung auf der Grundlage des vorbestimmten Transformationsvorgangs jeweilige Komponenten, die die zwei Merkmalsvektoren (f, g') bilden, die durch die Transformationseinrichtung (30, 31) transformiert wurden, zu entnehmen, um diese in eine Mehrzahl von Teilvektoren (f_1, g_1, f_2, g_2) zu unterteilen,
Aufzeichnungseinrichtungen (32, 33), welche ausgebildet sind, die Mehrzahl von Teilvektoren (g_1, g_2), welche den transformierten registrierten Merkmalsvektor (g') bilden, aufzuzeichnen,
einer hierarchischen Distanzberechnungseinrichtung (34), welche ausgebildet ist, eine Distanzberechnung zwischen den zwei Merkmalsvektoren (f', g'), die durch die Transformationseinrichtung (30, 31) transformiert wurden, in einer vorbestimmten Ordnung auszuführen, auf der Grundlage des vorbestimmten Transformationsvorgangs, wobei die Distanzberechnungseinrichtung (34) dazu ausgebildet ist, die Distanzberechnung zwischen jeweiligen Komponenten, welche Teilvektoren (f_1, g_1, f_2, g_2) bilden, in einer komponentenweisen hierarchischen Art und Weise in einer Ordnung vom Teilvektor (f_1, g_1) der obersten Komponentenordnung auszuführen, und

einer Schwellwertvergleichseinrichtung (35), welche ausgebildet ist, einen integrierten Wert von Distanzen, die inkrementweise für Komponenten hierarchisch höherer Ordnung der zwei transformierten Vektoren (f', g') durch die Distanzberechnungseinrichtung (34) berechnet wurden, mit einem vorab eingestellten Schwellwert (S) zu vergleichen,
einer Steuereinrichtung, welche ausgebildet ist, die Distanzberechnung gemäß einem Ergebnis der Schwellwertvergleichseinrichtung (34) zu steuern, und
einer Ausgabeeinrichtung, welche ausgebildet ist, den integrierten Wert von Distanzen, die bis zu den letzten Komponenten der zwei transformierten Merkmalsvektoren (f', g') berechnet wurden, als Ähnlichkeit auszugeben,
wobei die Steuereinrichtung so arbeitet, dass in dem Fall, bei welchem der integrierte Wert von Distanzen, die berechnet wurden bis zu einer bestimmten Komponentenordnung, oberhalb des Schwellwerts liegt, und zwar als Ergebnis des Vergleichs durch die Schwellwertvergleichseinrichtung (35), eine Steuerung ausgeführt wird, um die Distanzberechnung zu beenden, und dass in dem Fall, bei welchem der integrierte Wert von Distanzen, die bis zu einer bestimmten Komponentenordnung berechnet wurden, unterhalb des Schwellwerts liegt, die Distanzberechnung ausgeführt wird zwischen den Komponenten nächst höherer Ordnung, und
wobei die hierarchische Distanzberechnungseinrichtung (34) so arbeitet, dass in einem ersten Schritt nur der Teilvektor (g_1) der obersten Komponentenordnung der Mehrzahl von Teilvektoren (g_1, g_2), die in der Aufzeichnungseinrichtung aufgezeichnet wurden, wieder gewonnen und die Distanzberechnung zwischen jeweiligen Komponenten, die die Teilvektoren (f_1, g_1) der obersten Komponentenordnung bilden, in einer komponentenweisen hierarchischen Art und Weise ausgeführt wird, und
wobei nur in dem Fall, bei welchem der integrierte Wert von berechneten Distanzen, die zwischen sämtlichen Komponenten berechnet wurden, die die Teilvektoren (f_1, g_1) der obersten Komponentenordnung bilden, unterhalb des Schwellwerts (S) liegt, in einem zweiten Schritt der Teilvektor (g_2) der nächst niedrigeren Komponentenordnung der Mehrzahl von Teilvektoren (g_1, g_2) des transformierten registrierten Merkmalsvektors (g'), die in der Aufzeichnungseinrichtung (33) aufgezeichnet wurden, wieder gewonnen und die Distanzberechnung zwischen den jeweiligen Komponenten, die die Teilvektoren (f_2, g_2) einer niedrigeren Komponentenordnung bilden, ausgeführt wird.

12. Programm, um einem Computer zu ermöglichen, eine Ähnlichkeitsberechnungsverarbeitung auszuführen zum Bestimmen einer Ähnlichkeit zwischen zwei Merkmalsvektoren (f, g), einem registrierten Vektor (g) und einem Eingabevektor (f), welche repräsentativ sind für ein akustisches Signal oder ein Videosignal,
wobei das Programm aufweist:

einen Transformationsschritt (S41, S52), bei welchem ein vorbestimmter Transformationsvorgang auf die zwei Merkmalsvektoren (f, g) angewandt wird,
einen Unterteilungsschritt (S41, S52), bei welchem die zwei transformierten Merkmalsvektoren (f', g') komponentenweise in eine Mehrzahl von Teilvektoren (f_1, f_2, g_1, g_2) unterteilt werden,
einen Aufzeichnungsschritt (S42, S43), bei welchem die Mehrzahl von Teilvektoren (g_1, g_2), die den transformierten registrierten Merkmalsvektor (g') bilden, aufgezeichnet werden,
einen hierarchischen Distanzberechnungsschritt (S53, S54, S57, S58, S60, S63, S64), bei welchem die Distanz zwischen den zwei Merkmalsvektoren (f', g'), die beim Transformationsschritt (S41, S52) transformiert wurden, in einer vorbestimmten Ordnung berechnet wird, und zwar auf der Grundlage des vorbestimmten Transformationsvorgangs (S41, S52), wobei die Distanzberechnung zwischen den jeweiligen Komponenten, welche die Teilvektoren (f_1, f_2, g_1, g_2) bilden, in einer komponentenweisen hierarchischen Art in der Ordnung vom Teilvektor (f_1, g_1) der obersten Komponentenordnung durchgeführt wird,
einen Schwellwertvergleichsschritt (S55, S61), bei welchem ein integrierter Wert von Distanzen, die inkrementweise für Komponenten (i) hierarchisch höherer Ordnung der zwei transformierten Merkmalsvektoren berechnet wurden, mit einem vorab eingestellten Schwellwert (S) verglichen wird,
einen Steuerschritt (S55, S56, S57, S58, S61, S62, S63, S64), bei welchem die Distanzberechnung gemäß einem Ergebnis des Schwellwertvergleichs beim Schwellwertvergleichsschritt (S55, S61) gesteuert wird, und
einen Ausgabeschritt (S65), bei welchem der integrierte Wert der berechneten Distanzen bis zu den letzten Komponenten (i) der zwei transformierten Merkmalsvektoren (f', g') als Ähnlichkeit ausgegeben wird,
wobei beim Steuerschritt (S55, S56, S57, S58, S61, S62, S63, S64) die Steuerung derart durchgeführt wird, dass die Distanzberechnung in dem Fall beendet wird, bei welchem der integrierte Wert von Distanzen, die bis zu einer bestimmten Komponentenordnung berechnet wurden, größer ist als der oder gleich ist zu dem Schwellwert, sowie derart, dass die Distanzberechnung zwischen Komponenten nächst höherer Ordnung in dem Fall durchgeführt wird, bei welchem der integrierte Wert von Distanzen, die bis zu einer bestimmten Komponentenordnung berechnet wurden, niedriger ist als der Schwellwert, und
wobei die Distanzberechnung derart ausgeführt wird, dass in einem ersten Schritt nur der Teilvektor (g_1) der

obersten Komponentenordnung der Mehrzahl von Teilvektoren (g_1, g_2), die beim Aufzeichnungsschritt aufgezeichnet wurden, wieder gewonnen wird, und wobei die Distanzberechnung zwischen jeweiligen Komponenten, die die Teilvektoren (f_1, g_1) der obersten Komponentenordnung bilden, in einer komponentenweisen hierarchischen Art und Weise ausgeführt wird, und

wobei nur in dem Fall, bei welchem der integrierte Wert der berechneten Distanzen zwischen allen Komponenten, die die Teilvektoren (f_1, g_1) der obersten Komponentenordnung bilden, unterhalb des Schwellwerts liegt, in einem zweiten Schritt der Teilvektor (g_2) der nächst niedrigeren Komponentenordnung der Mehrzahl von Teilvektoren (g_1, g_2) des transformierten registrierten Merkmalsvektors (g'), die im Aufzeichnungsschritt (S42, S43) aufgezeichnet wurden, wieder gewonnen und die Distanzberechnung zwischen jeweiligen Komponenten, die Teilvektoren (f_2, g_2) der nächst niedrigeren Komponentenordnung bilden, ausgeführt wird.

13. Computerlesbares Medium, welches derart ausgebildet ist, dass ein Programm aufgezeichnet wird, welches einem Computer ermöglicht, eine Ähnlichkeitsberechnungsverarbeitung auszuführen, welche eine Ähnlichkeit bestimmt zwischen zwei Merkmalsvektoren (f, g), einem registrierten Vektor (g) und einem Eingabevektor (f), welche repräsentativ sind für ein akustisches Signal oder für ein Videosignal,
wobei das Programm aufweist:

einen Transformationsschritt (S41, S52), bei welchem ein vorbestimmter Transformationsvorgang auf die zwei Merkmalsvektoren (f, g) angewandt wird,

einen Unterteilungsschritt (S41), bei welchem die zwei transformierten Merkmalsvektoren (f, g') komponentenweise in eine Mehrzahl von Teilvektoren (f_1, f_2, g_1, g_2) unterteilt werden,

einen Aufzeichnungsschritt (S42, S43), bei welchem die Mehrzahl von Teilvektoren (g_1, g_2), die den transformierten registrierten Merkmalsvektor (g') bilden, aufgezeichnet werden,

einen hierarchischen Distanzberechnungsschritt (S53, S54, S57, S58, S60, S63, S64), bei welchem die Distanz zwischen den zwei Merkmalsvektoren (f, g'), die beim Transformationsschritt transformiert wurden, in einer vorbestimmten Ordnung berechnet wird, und zwar auf der Grundlage des vorbestimmten Transformationsvorgangs (S41, S52), wobei die Distanzberechnung zwischen den jeweiligen Komponenten, welche die Teilvektoren (f_1, f_2, g_1, g_2) bilden, in einer komponentenweisen hierarchischen Art in der Ordnung vom Teilvektor (f_1, g_1) der obersten Komponentenordnung durchgeführt wird,

einen Schwellwertvergleichsschritt (S55, S61), bei welchem ein integrierter Wert von Distanzen, die inkrementweise für Komponenten (i) hierarchisch höherer Ordnung der zwei transformierten Merkmalsvektoren (f', g') berechnet wurden, mit einem vorab eingestellten Schwellwert (S) verglichen wird,

einen Steuerschritt (S55, S56, S57, S58, S61, S62, S63, S64), bei welchem die Distanzberechnung gemäß einem Ergebnis des Schwellwertvergleichs beim Schwellwertvergleichsschritt (S55, S61) gesteuert wird, und

einen Ausgabeschritt (S65), bei welchem der integrierte Wert der berechneten Distanzen bis zu den letzten Komponenten (i) der zwei transformierten Merkmalsvektoren (f', g') als Ähnlichkeit ausgegeben wird,

wobei beim Steuerschritt (S55, S56, S57, S58, S61, S62, S63, S64) die Steuerung derart durchgeführt wird, dass die Distanzberechnung in dem Fall beendet wird, bei welchem der integrierte Wert von Distanzen, die bis zu einer bestimmten Komponentenordnung berechnet wurden, größer ist als der oder gleich ist zu dem Schwellwert (S), sowie derart, dass die Distanzberechnung zwischen Komponenten nächst höherer Ordnung in dem Fall durchgeführt wird, bei welchem der integrierte Wert von Distanzen, die bis zu einer bestimmten Komponentenordnung berechnet wurden, niedriger ist als der Schwellwert, und

wobei die Distanzberechnung derart ausgeführt wird, dass in einem ersten Schritt nur der Teilvektor (g_1) der obersten Komponentenordnung der Mehrzahl von Teilvektoren (g_1, g_2), die beim Aufzeichnungsschritt aufgezeichnet wurden, wieder gewonnen wird, und wobei die Distanzberechnung zwischen jeweiligen Komponenten, die die Teilvektoren (f_1, g_1) der obersten Komponentenordnung bilden, in einer komponentenweisen hierarchischen Art und Weise ausgeführt wird, und

wobei nur in dem Fall, bei welchem der integrierte Wert der berechneten Distanzen zwischen allen Komponenten, die die Teilvektoren (f_1, g_1) der obersten Komponentenordnung bilden, unterhalb des Schwellwerts (S) liegt, in einem zweiten Schritt der Teilvektor (g_2) der nächst niedrigeren Komponentenordnung der Mehrzahl von Teilvektoren (g_1, g_2) des transformierten registrierten Merkmalsvektors (g'), die im Aufzeichnungsschritt (S42, S43) aufgezeichnet wurden, wieder gewonnen und die Distanzberechnung zwischen jeweiligen Komponenten, die Teilvektoren (f_2, g_2) der nächst niedrigeren Komponentenordnung bilden, ausgeführt wird.

Revendications

1. Procédé de calcul de similitude pour déterminer une similitude entre deux vecteurs caractéristiques, un vecteur préenregistré (g) et un vecteur d'entrée (f), qui sont représentatifs d'un signal acoustique ou d'un signal vidéo, chacun des deux vecteurs caractéristiques ayant N composantes correspondantes, N étant un entier supérieur à zéro, le procédé comprenant les étapes suivantes :

une étape de transformation (S41, S52) dans laquelle une opération de transformation prédéterminée (S41, S52) est mise en oeuvre sur les deux vecteurs caractéristiques (f, g),
une étape de division (S41, S52) dans laquelle les deux vecteurs caractéristiques transformés (f', g') sont divisés, composante par composante, en une pluralité de vecteurs partiels (f_1, f_2, g_1, g_2),
une étape d'enregistrement (S42, S43) dans laquelle la pluralité de vecteurs partiels (g_1, g_2) constituant le vecteur caractéristique préenregistré transformé (g') est enregistrée,
une étape de calcul de distance hiérarchique (S53, S54, S57, S58, S60, S63, S64) dans laquelle la distance entre les deux vecteurs caractéristiques (f, g') transformés à l'étape de transformation (S41, S52) est calculée, dans un ordre prédéterminé sur la base de l'opération de transformation prédéterminée (S41, S52), le calcul de distance étant effectué entre les composantes respectives constituant les vecteurs partiels (f_1, f_2, g_1, g_2), dans un ordre hiérarchique, composante par composante, à partir du vecteur partiel (f_1, g_1) de l'ordre de composante le plus élevé,
une étape de comparaison à une valeur seuil (S55, S61) dans laquelle une valeur intégrée des distances calculées de façon incrémentielle pour les composantes (i), d'ordre hiérarchique croissant, des deux vecteurs caractéristiques transformés (f', g') est comparée à une valeur seuil (S) définie à l'avance,
une étape de contrôle (S55, S56, S57, S58, S61, S62, S63, S64) dans laquelle le calcul de distance est contrôlé d'après un résultat de la comparaison à une valeur seuil obtenu à l'étape de comparaison à une valeur seuil (S55, S61), et
une étape de sortie (S65) dans laquelle la valeur intégrée des distances calculées jusqu'aux dernières composantes (i) des deux vecteurs caractéristiques transformés (f', g') est produite en sortie en tant que similarité,
le contrôle à l'étape de contrôle (S55, S56, S57, S58, S61, S62, S63, S64) étant effectué de façon que le calcul de distance soit tronqué lorsque la valeur intégrée des distances calculées jusqu'à un certain ordre de composante est supérieure ou égale à la valeur seuil, et de façon que le calcul de distance entre les composantes d'ordres plus élevés suivants soit effectué lorsque la valeur intégrée des distances calculées jusqu'à un certain ordre de composante est inférieure à la valeur seuil,
et le calcul de distance étant effectué de façon que, dans une première étape, seul soit récupéré le vecteur partiel (g_1) de l'ordre de composante le plus élevé de la pluralité de vecteurs partiels (g_1, g_2) enregistrée à l'étape d'enregistrement et que le calcul de distance soit effectué entre les composantes respectives constituant les vecteurs partiels (f_1, g_1) de l'ordre de composante le plus élevé, dans un ordre hiérarchique, composante par composante, et que, seulement lorsque la valeur intégrée des distances calculées entre toutes les composantes constituant les vecteurs partiels (f_1, g_1) de l'ordre de composante le plus élevé est inférieure à la valeur seuil, dans une deuxième étape, le vecteur partiel (g_2) de l'ordre de composante inférieur suivant de la pluralité de vecteurs partiels (g_1, g_2) du vecteur caractéristique préenregistré transformé (g') enregistrée à l'étape d'enregistrement (S42, S43) soit récupéré et que le calcul de distance entre les composantes respectives constituant les vecteurs partiels (f_2, g_2) de l'ordre de composante inférieur suivant soit effectué.

2. Procédé de calcul de similitude selon la revendication 1, dans lequel l'opération de transformation prédéterminée (S41, S52) est une opération de transformation qui exécute une mise en ordre des composantes respectives constituant les deux vecteurs caractéristiques (f, g) selon la valeur de dispersion des composantes respectives, et le calcul de distance entre les deux vecteurs caractéristiques (f', g') transformés à l'étape de transformation (S41, S52) est effectué dans l'ordre à partir des composantes ayant une grande dispersion à l'étape de calcul de distance hiérarchique (S53, S54, S57, S58, S60, S63, S64).

3. Procédé de calcul de similitude selon la revendication 1, dans lequel l'opération de transformation prédéterminée (S41, S52) est une Transformée en Cosinus Discrète ou une Transformée de Fourier Discrète, et le calcul de distance entre les deux vecteurs caractéristiques (f', g') transformés à l'étape de transformation (S41, S52) est effectué dans l'ordre à partir d'une composante ayant une basse fréquence à l'étape de calcul de distance hiérarchique (S53, S54, S57, S58, S60, S63, S64).

4. Procédé de calcul de similitude selon la revendication 1, dans lequel l'opération de transformation prédéterminée (S41, S52) est une Transformée de Walsh-Hadamard, et le calcul de distance entre les deux vecteurs caractéristiques transformés (f', g') est effectué dans l'ordre à partir d'une composante ayant une basse fréquence à l'étape de calcul de distance hiérarchique (S53, S54, S57, S58, S60, S63, S64).

5. Procédé de calcul de similitude selon la revendication 1, dans lequel l'opération de transformation prédéterminée (S41, S52) est une Transformée de Karhunen-Loeve, et le calcul de distance entre les deux vecteurs caractéristiques (f', g') transformés à l'étape de transformation est effectué dans l'ordre à partir d'une composante ayant une grande valeur propre à l'étape de calcul de distance hiérarchique (S53, S54, S57, S58, S60, S63, S64).

6. Procédé de calcul de similitude selon la revendication 1, dans lequel le vecteur caractéristique (a) est obtenu par extraction de coefficients de spectre de puissance (Sq) dans un intervalle de temps prédéterminé d'un signal acoustique, les coefficients de spectre de puissance (Sq) étant les composantes du vecteur caractéristique (a).

7. Procédé de calcul de similitude selon la revendication 1, dans lequel le vecteur caractéristique (a) est obtenu par extraction de coefficients prédictifs linéaires dans un intervalle de temps prédéterminé d'un signal acoustique.

8. Procédé de calcul de similitude selon la revendication 1, dans lequel le vecteur caractéristique (a) est obtenu par extraction de paramètres indicatifs des intensités de composantes de fréquence dans des trames respectives d'un signal acoustique codé, les paramètres étant les composantes du vecteur caractéristique (a).

9. Procédé de calcul de similitude selon la revendication 1, dans lequel le vecteur caractéristique (v) est obtenu par acquisition de trames d'image à partir d'une valeur de signal d'une image représentative dans des intervalles de temps prédéterminés respectifs d'un signal vidéo, préparation d'une image moyenne (100) des trames d'image acquises dans les intervalles de temps prédéterminés respectifs, et préparation d'une image moyenne à blocs (110) par division de l'image moyenne (100) en X x Y petits blocs dans les sens de la hauteur et de la largeur et calcul de la moyenne des valeurs contenues dans les petits blocs respectifs, puis classement des petits blocs dans un ordre R, G, B, les valeurs de l'image moyenne à blocs (110) classées dans l'ordre R, G, B étant les composantes du vecteur caractéristique (v).

10. Procédé de calcul de similitude selon la revendication 1, dans lequel le vecteur caractéristique (v) est obtenu par préparation d'un histogramme en relation avec des valeurs de signaux de luminance et/ou de couleur d'une trame d'image dans un intervalle de temps prédéterminé d'un signal vidéo, les valeurs de signaux de luminance et/ou de couleur étant les composantes du vecteur caractéristique (v).

11. Appareil de calcul de similitude adapté pour déterminer une similitude entre deux vecteurs caractéristiques, un vecteur préenregistré (g) et un vecteur d'entrée (f), qui sont représentatifs d'un signal acoustique ou d'un signal vidéo, l'appareil comprenant :

des moyens de transformation (30, 31) qui sont adaptés pour mettre en oeuvre une opération de transformation prédéterminée sur les deux vecteurs caractéristiques (f, g),
des moyens de division (30, 31) qui sont adaptés pour prélever, dans un ordre prédéterminé sur la base de l'opération de transformation prédéterminée, des composantes respectives constituant les deux vecteurs caractéristiques (f', g') transformés par les moyens de transformation (30, 31) pour les diviser en une pluralité de vecteurs partiels (f_1, g_1, f_2, g_2),
des moyens d'enregistrement (32, 33) qui sont adaptés pour enregistrer la pluralité de vecteurs partiels (g_1, g_2) constituant le vecteur caractéristique préenregistré transformé (g'),
des moyens de calcul de distance hiérarchique (34) qui sont adaptés pour effectuer un calcul de distance entre les deux vecteurs caractéristiques (f, g') transformés par les moyens de transformation (30, 31), dans un ordre prédéterminé sur la base de l'opération de transformation prédéterminée, les moyens de calcul de distance (34) étant adaptés pour effectuer le calcul de distance entre les composantes respectives constituant les vecteurs partiels (f_1, g_1, f_2, g_2), dans un ordre hiérarchique, composante par composante, à partir du vecteur partiel (f_1, g_1) de l'ordre de composante le plus élevé, et
des moyens de comparaison à une valeur seuil (35) qui sont adaptés pour comparer une valeur intégrée des distances calculées de façon incrémentielle pour les composantes, d'ordre hiérarchique croissant, des deux vecteurs transformés (f', g') par les moyens de calcul de distance (34) à une valeur seuil (S) définie à l'avance,
des moyens de contrôle qui sont adaptés pour contrôler le calcul de distance d'après un résultat obtenu par les moyens de comparaison à une valeur seuil (34), et
des moyens de sortie qui sont adaptés pour produire en sortie la valeur intégrée des distances calculées jusqu'aux dernières composantes des deux vecteurs caractéristiques transformés (f', g') en tant que similarité, les moyens de contrôle fonctionnant de telle sorte qu'un contrôle soit effectué de façon à tronquer le calcul de distance lorsque la valeur intégrée des distances calculées jusqu'à un certain ordre de composante est supérieure à la valeur seuil en résultat de la comparaison effectuée par les moyens de comparaison à une valeur

seuil (35), et que le calcul de distance entre les composantes d'ordres plus élevés suivants soit effectué lorsque la valeur intégrée des distances calculées jusqu'à un certain ordre de composante est inférieure à la valeur seuil, et les moyens de calcul de distance hiérarchique (34) fonctionnant de telle sorte que, dans une première étape, seul soit récupéré le vecteur partiel (g_1) de l'ordre de composante le plus élevé de la pluralité de vecteurs partiels (g_1, g_2) enregistrée dans les moyens d'enregistrement et que le calcul de distance soit effectué entre les composantes respectives constituant les vecteurs partiels (f_1, g_1) de l'ordre de composante le plus élevé, dans un ordre hiérarchique, composante par composante, et que, seulement lorsque la valeur intégrée des distances calculées entre toutes les composantes constituant les vecteurs partiels (f_1, g_1) de l'ordre de composante le plus élevé est inférieure à la valeur seuil (S), dans une deuxième étape, le vecteur partiel (g_2) de l'ordre de composante inférieur suivant de la pluralité de vecteurs partiels (g_1, g_2) du vecteur caractéristique préenregistré transformé (g') enregistrée dans les moyens d'enregistrement (33) soit récupéré et que le calcul de distance entre les composantes respectives constituant les vecteurs partiels (f_2, g_2) d'un ordre de composante inférieur soit effectué.

12. Programme pour permettre à un ordinateur d'exécuter un traitement de calcul de similitude pour déterminer une similitude entre deux vecteurs caractéristiques (f, g), un vecteur préenregistré (g) et un vecteur d'entrée (f), qui sont représentatifs d'un signal acoustique ou d'un signal vidéo, le programme comprenant :

une étape de transformation (S41, S52) dans laquelle une opération de transformation prédéterminée est mise en oeuvre sur les deux vecteurs caractéristiques (f, g),
une étape de division (S41, S52) dans laquelle les deux vecteurs caractéristiques transformés (f', g') sont divisés, composante par composante, en une pluralité de vecteurs partiels (f_1, g_1, f_2, g_2),
une étape d'enregistrement (S42, S43) dans laquelle la pluralité de vecteurs partiels (g_1, g_2) constituant le vecteur caractéristique préenregistré transformé (g') est enregistrée,
une étape de calcul de distance hiérarchique (S53, S54, S57, S58, S60, S63, S64) dans laquelle la distance entre les deux vecteurs caractéristiques (f', g') transformés à l'étape de transformation est calculée, dans un ordre prédéterminé sur la base de l'opération de transformation prédéterminée (S41, S52), le calcul de distance étant effectué entre les composantes respectives constituant les vecteurs partiels (f_1, g_1, f_2, g_2), dans un ordre hiérarchique, composante par composante, à partir du vecteur partiel (f_1, g_1) de l'ordre de composante le plus élevé,
une étape de comparaison à une valeur seuil (S55, S61) dans laquelle une valeur intégrée des distances calculées de façon incrémentielle pour les composantes (i), d'ordre hiérarchique croissant, des deux vecteurs caractéristiques transformés est comparée à une valeur seuil (S) définie à l'avance,
une étape de contrôle (S55, S56, S57, S58, S61, S62, S63, S64) dans laquelle le calcul de distance est contrôlé d'après un résultat de la comparaison à une valeur seuil obtenu à l'étape de comparaison à une valeur seuil (S55, S61), et
une étape de sortie (S65) dans laquelle la valeur intégrée des distances calculées jusqu'aux dernières composantes (i) des deux vecteurs caractéristiques transformés (f', g') est produite en sortie en tant que similarité,
le contrôle à l'étape de contrôle (S55, S56, S57, S58, S61, S62, S63, S64) étant effectué de façon que le calcul de distance soit tronqué lorsque la valeur intégrée des distances calculées jusqu'à un certain ordre de composante est supérieure ou égale à la valeur seuil (S), et de façon que le calcul de distance entre les composantes d'ordres plus élevés suivants soit effectué lorsque la valeur intégrée des distances calculées jusqu'à un certain ordre de composante est inférieure à la valeur seuil,
et le calcul de distance étant effectué de façon que, dans une première étape, seul soit récupéré le vecteur partiel (g_1) de l'ordre de composante le plus élevé de la pluralité de vecteurs partiels (g_1, g_2) enregistrée à l'étape d'enregistrement et que le calcul de distance soit effectué entre les composantes respectives constituant les vecteurs partiels (f_1, g_1) de l'ordre de composante le plus élevé, dans un ordre hiérarchique, composante par composante, et que, seulement lorsque la valeur intégrée des distances calculées entre toutes les composantes constituant les vecteurs partiels (f_1, g_1) de l'ordre de composante le plus élevé est inférieure à la valeur seuil, dans une deuxième étape, le vecteur partiel (g_2) de l'ordre de composante inférieur suivant de la pluralité de vecteurs partiels (g_1, g_2) du vecteur caractéristique préenregistré transformé (g') enregistrée à l'étape d'enregistrement (S42, S43) soit récupéré et que le calcul de distance entre les composantes respectives constituant les vecteurs partiels (f_2, g_2) de l'ordre de composante inférieur suivant soit effectué.

13. Support lisible par un ordinateur adapté pour qu'y soit enregistré un programme pour permettre à un ordinateur d'exécuter un traitement de calcul de similitude qui détermine une similitude entre deux vecteurs caractéristiques (f, g), un vecteur préenregistré (g) et un vecteur d'entrée (f), qui sont représentatifs d'un signal acoustique ou d'un signal vidéo, le programme comprenant :

une étape de transformation (S41, S52) dans laquelle une opération de transformation prédéterminée est mise en oeuvre sur les deux vecteurs caractéristiques (f, g),

une étape de division (S41) dans laquelle les deux vecteurs caractéristiques transformés (f', g') sont divisés, composante par composante, en une pluralité de vecteurs partiels (f_1, g_1, f_2, g_2),

une étape d'enregistrement (S42, S43) dans laquelle la pluralité de vecteurs partiels (g_1, g_2) constituant le vecteur caractéristique préenregistré transformé (g') est enregistrée,

une étape de calcul de distance hiérarchique (S53, S54, S57, S58, S60, S63, S64) dans laquelle le calcul de distance entre les deux vecteurs caractéristiques (f', g') transformés à l'étape de transformation est effectué, dans un ordre prédéterminé sur la base de l'opération de transformation prédéterminée (S41, S52), le calcul de distance étant effectué entre les composantes respectives constituant les vecteurs partiels (f_1, g_1, f_2, g_2), dans un ordre hiérarchique, composante par composante, à partir du vecteur partiel (f_1, g_1) de l'ordre de composante le plus élevé,

une étape de comparaison à une valeur seuil (S55, S61) dans laquelle une valeur intégrée des distances calculées de façon incrémentielle pour les composantes (i), d'ordre hiérarchique croissant, des deux vecteurs caractéristiques transformés (f', g') est comparée à une valeur seuil (S) définie à l'avance,

une étape de contrôle (S55, S56, S57, S58, S61, S62, S63, S64) dans laquelle le calcul de distance est contrôlé d'après un résultat de la comparaison à une valeur seuil obtenu à l'étape de comparaison à une valeur seuil (S55, S61), et

une étape de sortie (S65) dans laquelle la valeur intégrée des distances calculées jusqu'aux dernières composantes (i) des deux vecteurs caractéristiques transformés (f', g') est produite en sortie en tant que similarité,

le contrôle à l'étape de contrôle (S55, S56, S57, S58, S61, S62, S63, S64) étant effectué de façon que le calcul de distance soit tronqué lorsque la valeur intégrée des distances calculées jusqu'à un certain ordre de composante est supérieure ou égale à la valeur seuil (S), et de façon que le calcul de distance entre les composantes d'ordres plus élevés suivants soit effectué lorsque la valeur intégrée des distances calculées jusqu'à un certain ordre de composante est inférieure à la valeur seuil,

et le calcul de distance étant effectué de façon que, dans une première étape, seul soit récupéré le vecteur partiel (g_1) de l'ordre de composante le plus élevé de la pluralité de vecteurs partiels (g_1, g_2) enregistrée à l'étape d'enregistrement et que le calcul de distance soit effectué entre les composantes respectives constituant les vecteurs partiels (f_1, g_1) de l'ordre de composante le plus élevé, dans un ordre hiérarchique, composante par composante, et que, seulement lorsque la valeur intégrée des distances calculées entre toutes les composantes constituant les vecteurs partiels (f_1, g_1) de l'ordre de composante le plus élevé est inférieure à la valeur seuil (S), dans une deuxième étape, le vecteur partiel (g_2) de l'ordre de composante inférieur suivant de la pluralité de vecteurs partiels (g_1, g_2) du vecteur caractéristique préenregistré transformé (g') enregistrée à l'étape d'enregistrement (S42, S43) soit récupéré et que le calcul de distance entre les composantes respectives constituant les vecteurs partiels (f_2, g_2) de l'ordre de composante inférieur suivant soit effectué.

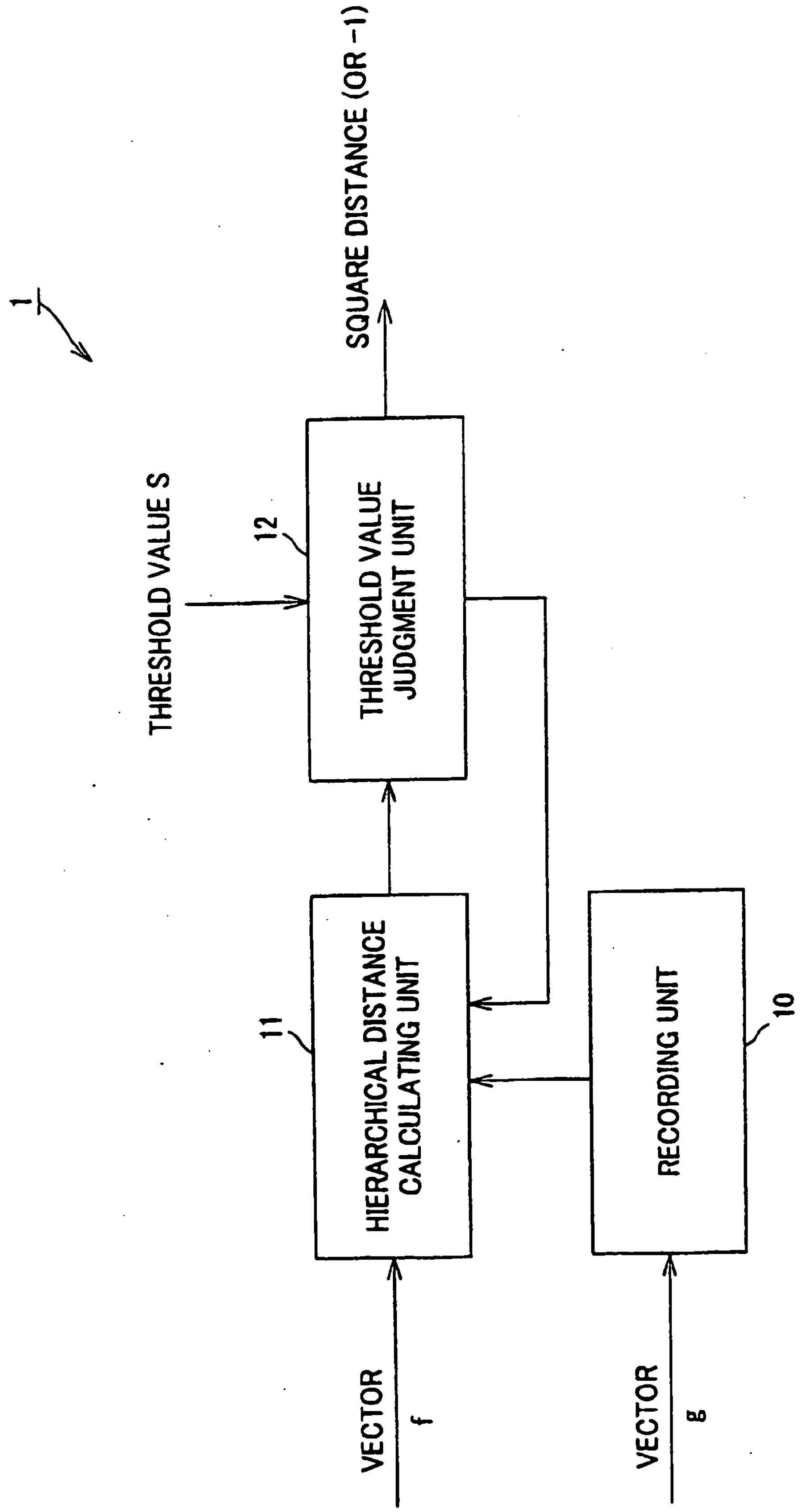

1
SQUARE DISTANCE (OR −1)
THRESHOLD VALUE S
12
THRESHOLD VALUE JUDGMENT UNIT
11
HIERARCHICAL DISTANCE CALCULATING UNIT
RECORDING UNIT
10
VECTOR f
VECTOR g

FIG. 1

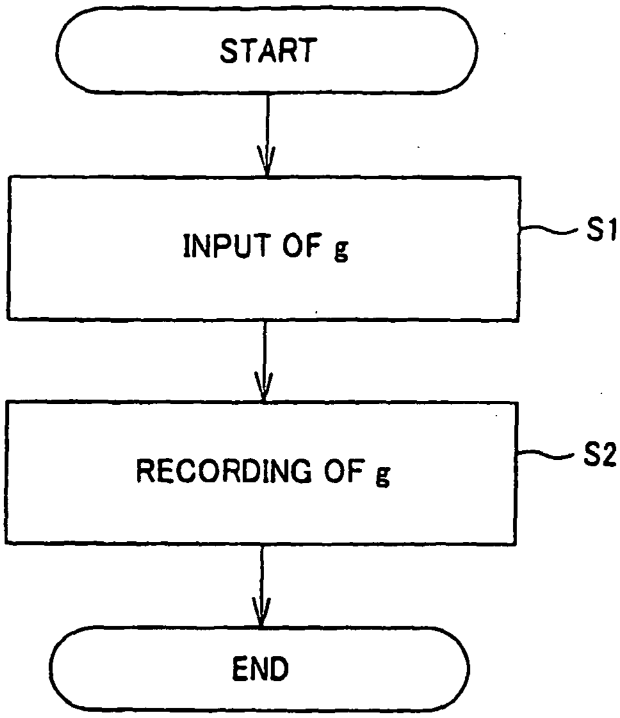


FIG.2

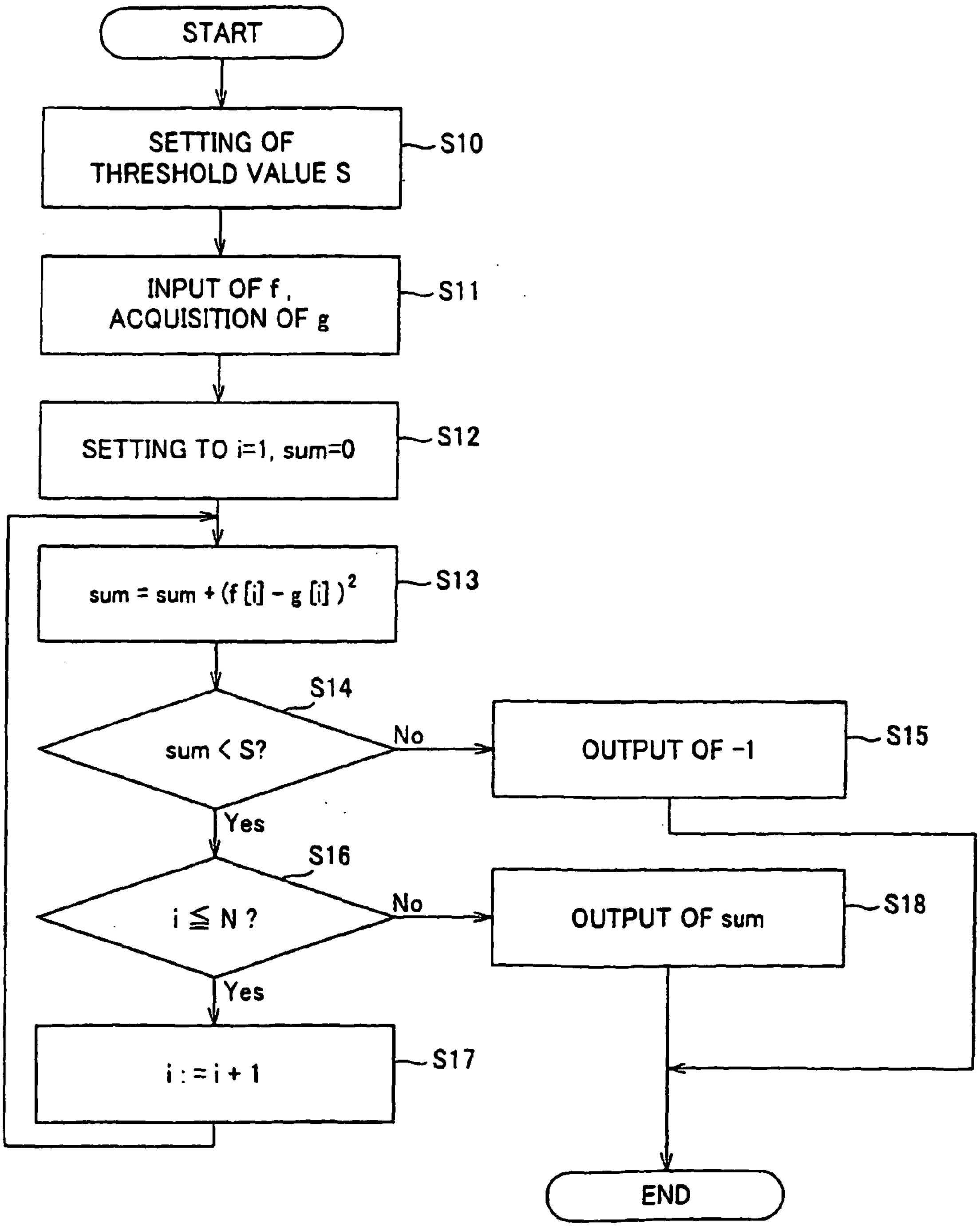

START
SETTING OF THRESHOLD VALUE S
S10
INPUT OF f, ACQUISITION OF g
S11
SETTING TO i=1, sum=0
S12
sum = sum + (f [i] - g [i])²
S13
S14
sum < S?
No
Yes
OUTPUT OF -1
S15
S16
i ≦ N ?
No
Yes
OUTPUT OF sum
S18
i : = i + 1
S17
END

FIG.3

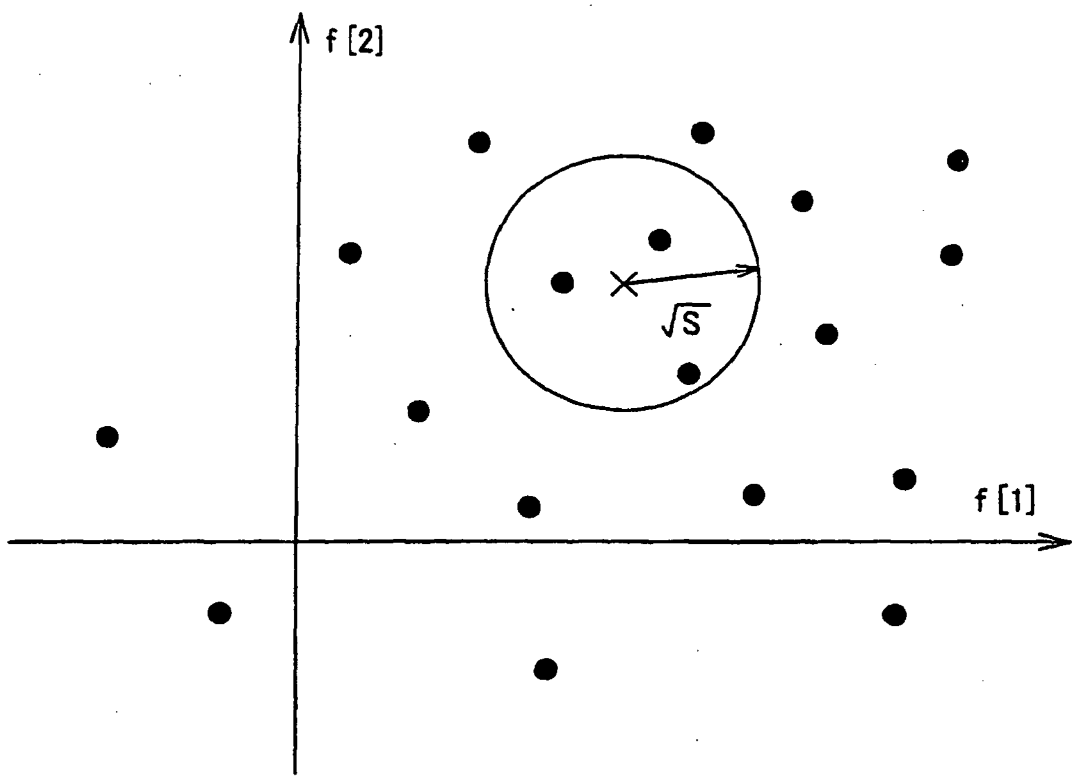


FIG.4

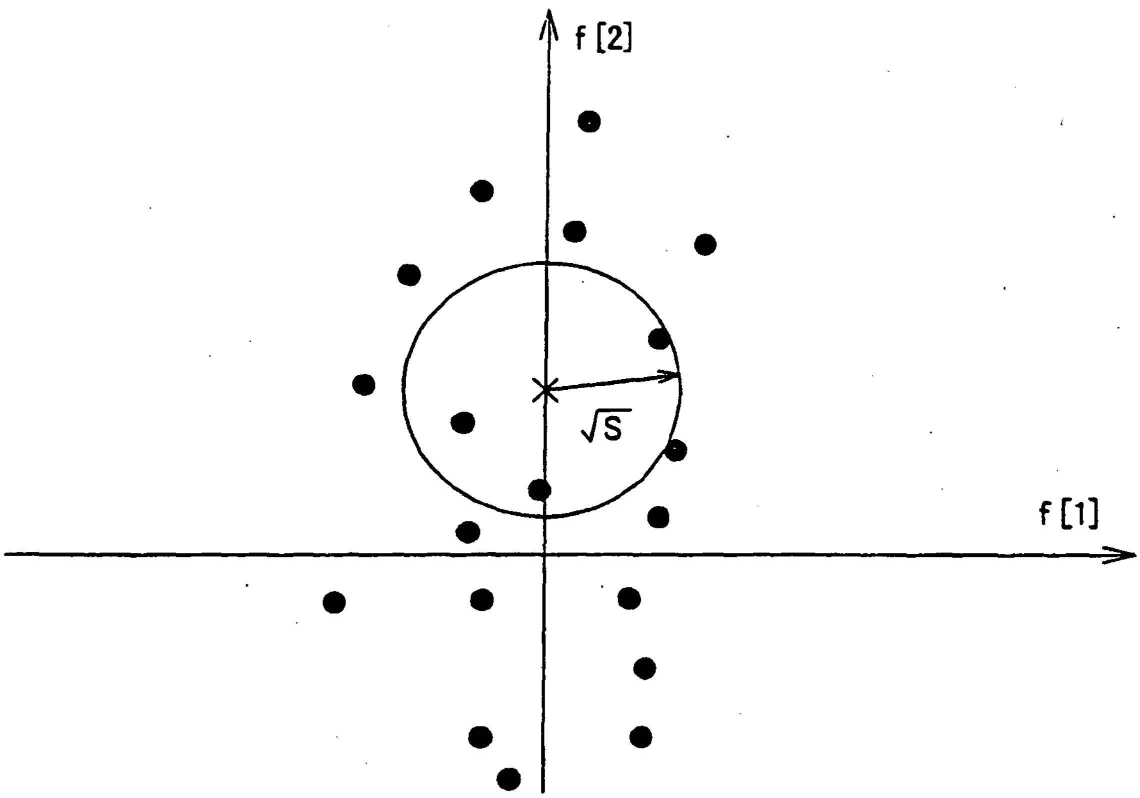


FIG.5

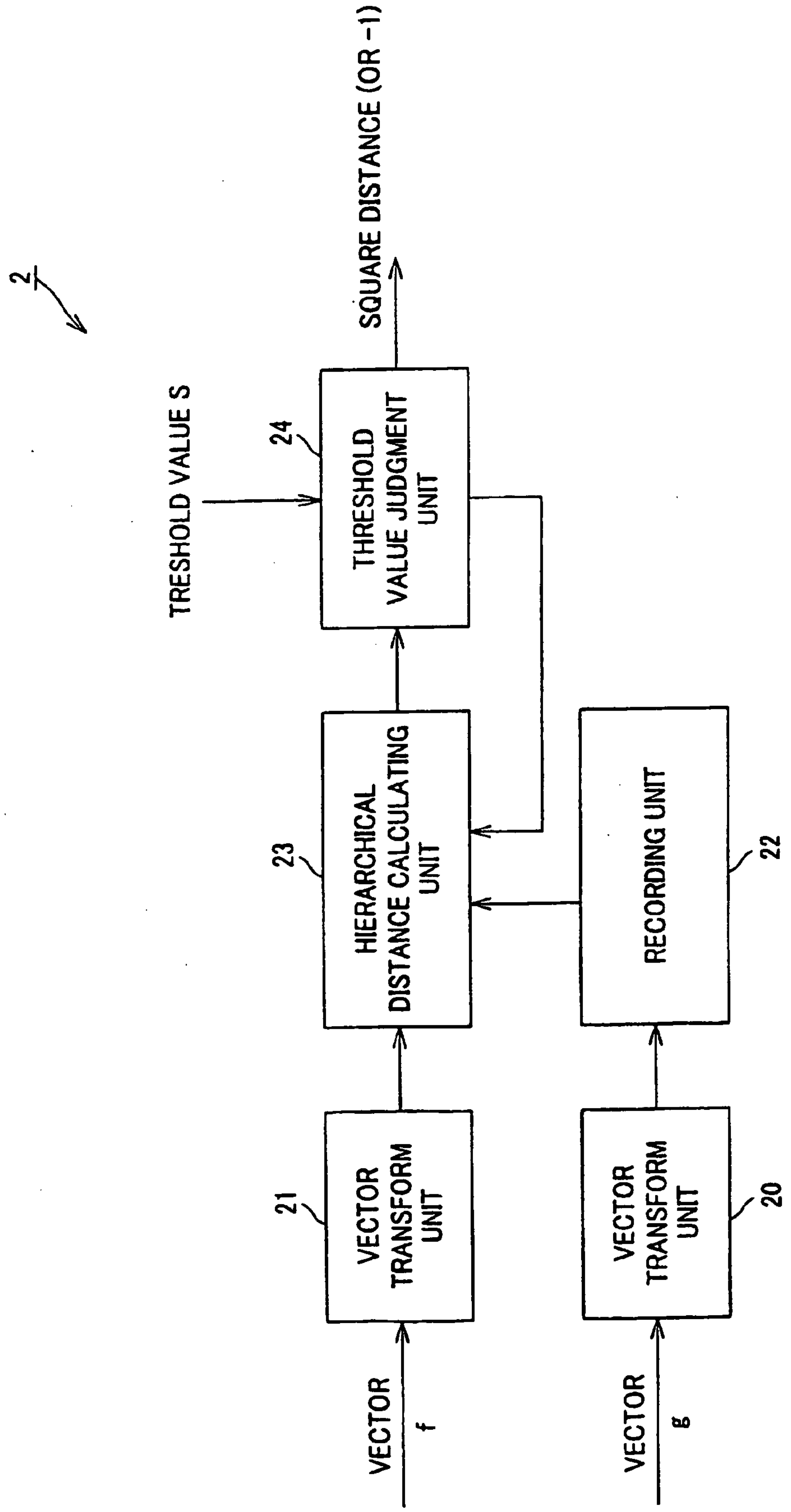

2
SQUARE DISTANCE (OR −1)
TRESHOLD VALUE S
24
THRESHOLD VALUE JUDGMENT UNIT
23
HIERARCHICAL DISTANCE CALCULATING UNIT
RECORDING UNIT
22
21
VECTOR TRANSFORM UNIT
VECTOR TRANSFORM UNIT
20
VECTOR f
VECTOR g

FIG.6

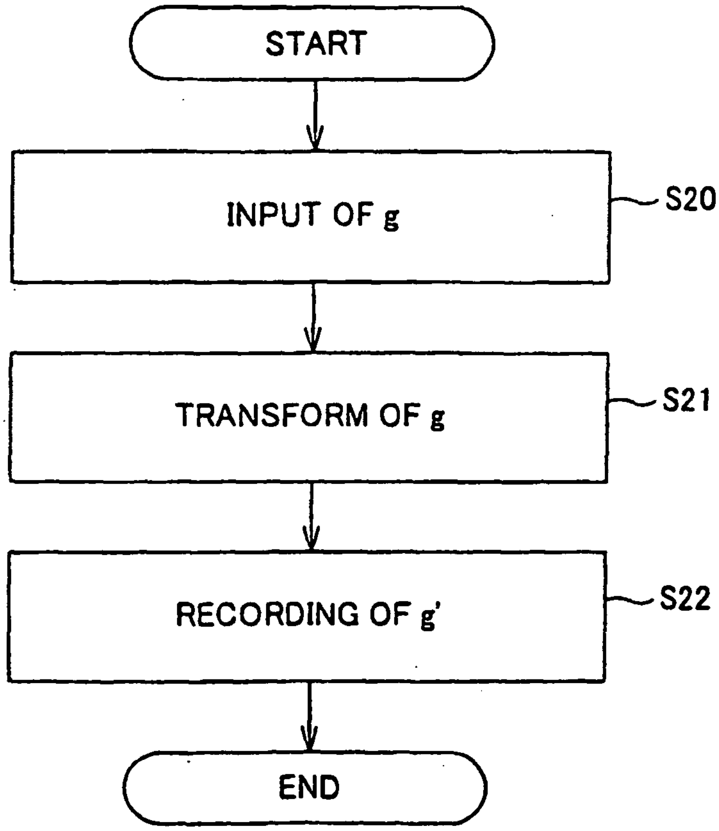


FIG.7

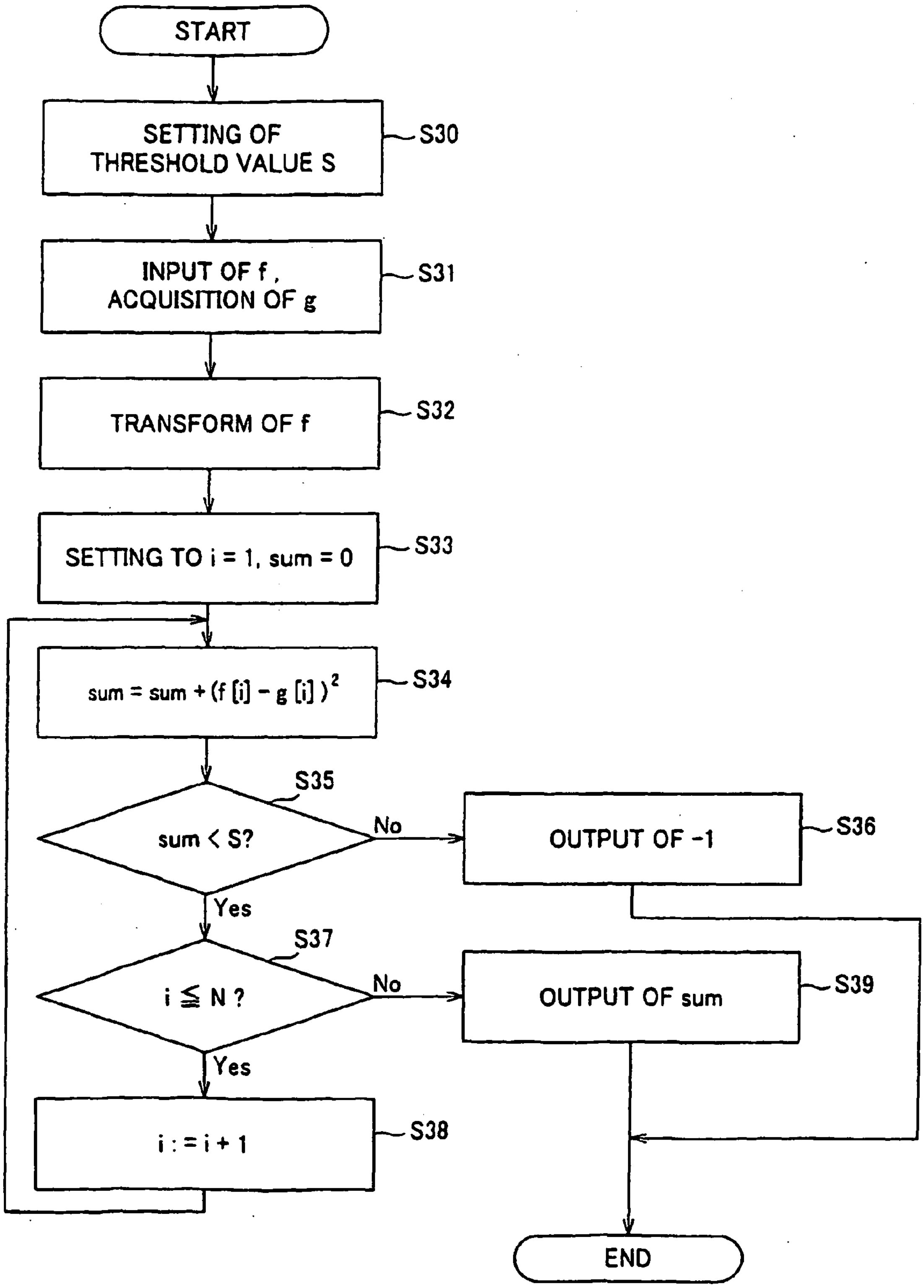

START
SETTING OF THRESHOLD VALUE S
S30
INPUT OF f, ACQUISITION OF g
S31
TRANSFORM OF f
S32
SETTING TO i = 1, sum = 0
S33
sum = sum + (f [i] - g [i])²
S34
S35
sum < S?
No
Yes
OUTPUT OF -1
S36
S37
i ≦ N ?
No
Yes
OUTPUT OF sum
S39
i : = i + 1
S38
END

FIG.8

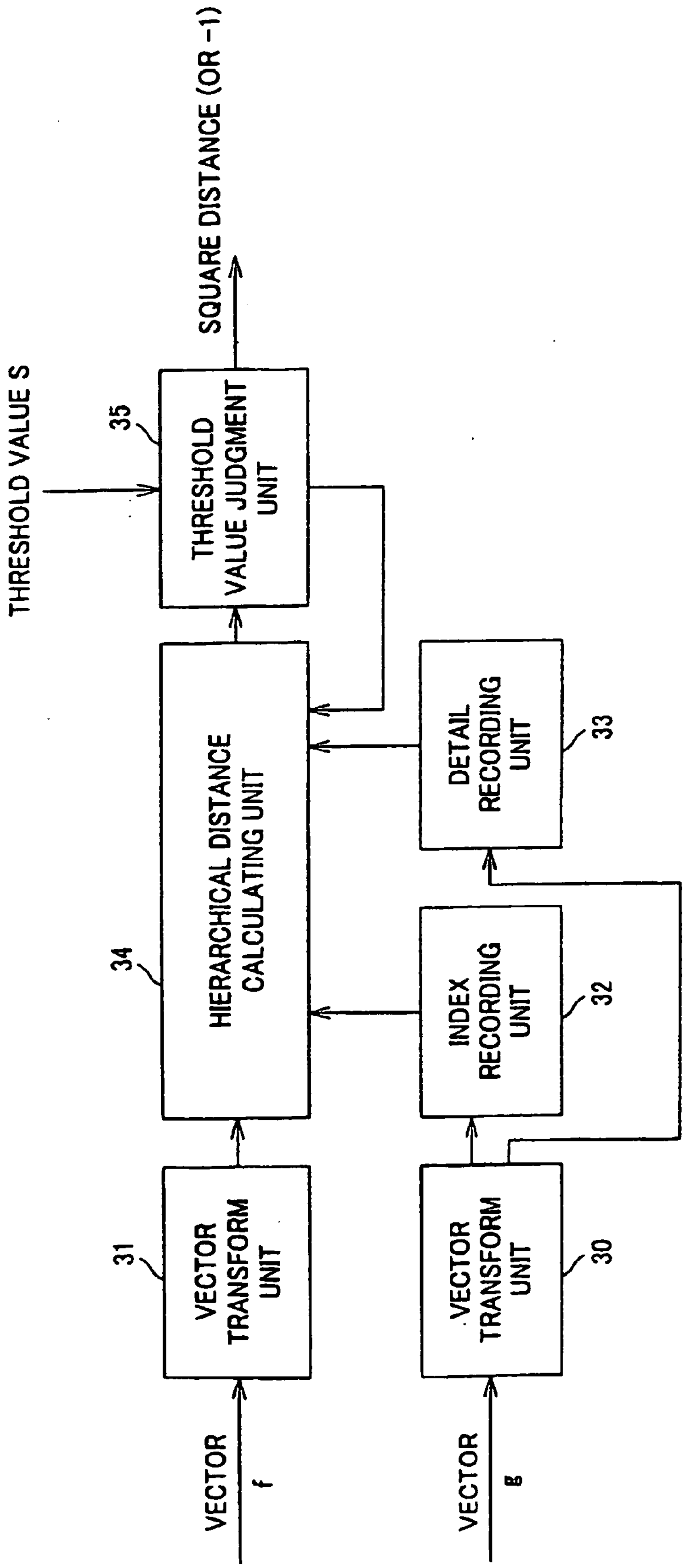

3
THRESHOLD VALUE S
35
THRESHOLD VALUE JUDGMENT UNIT
SQUARE DISTANCE (OR −1)
34
HIERARCHICAL DISTANCE CALCULATING UNIT
DETAIL RECORDING UNIT
33
INDEX RECORDING UNIT
32
31
VECTOR TRANSFORM UNIT
30
VECTOR TRANSFORM UNIT
VECTOR f
VECTOR g

FIG.9

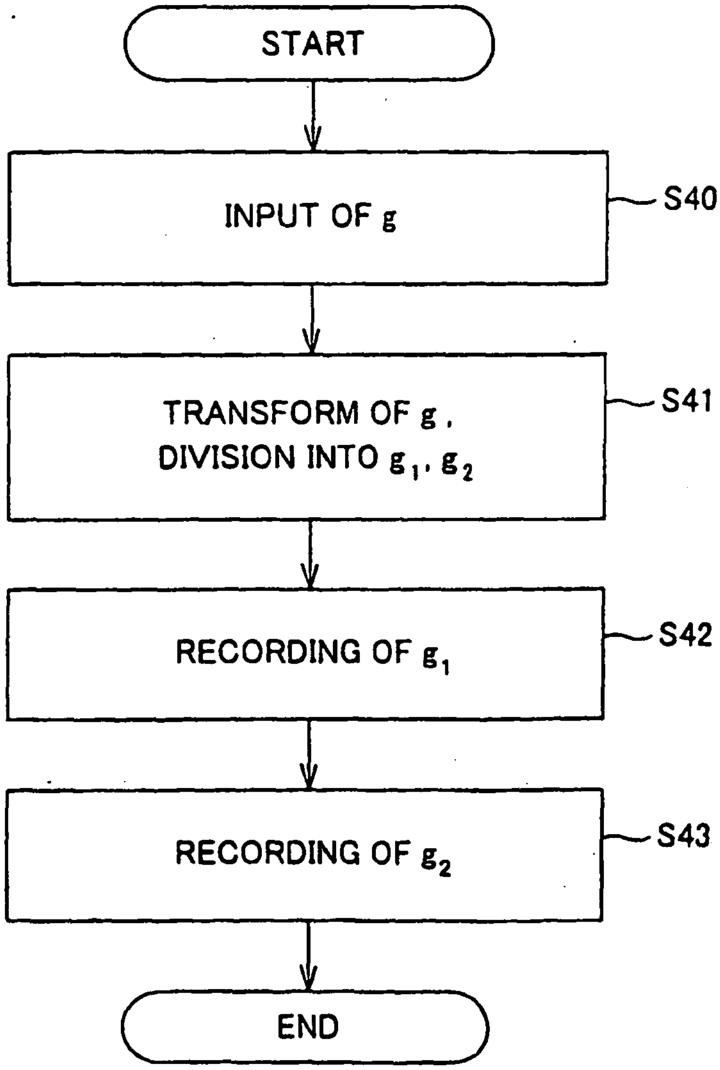

START
INPUT OF g
S40
TRANSFORM OF g ,
DIVISION INTO g1, g2
S41
RECORDING OF g1
S42
RECORDING OF g2
S43
END

FIG. 10

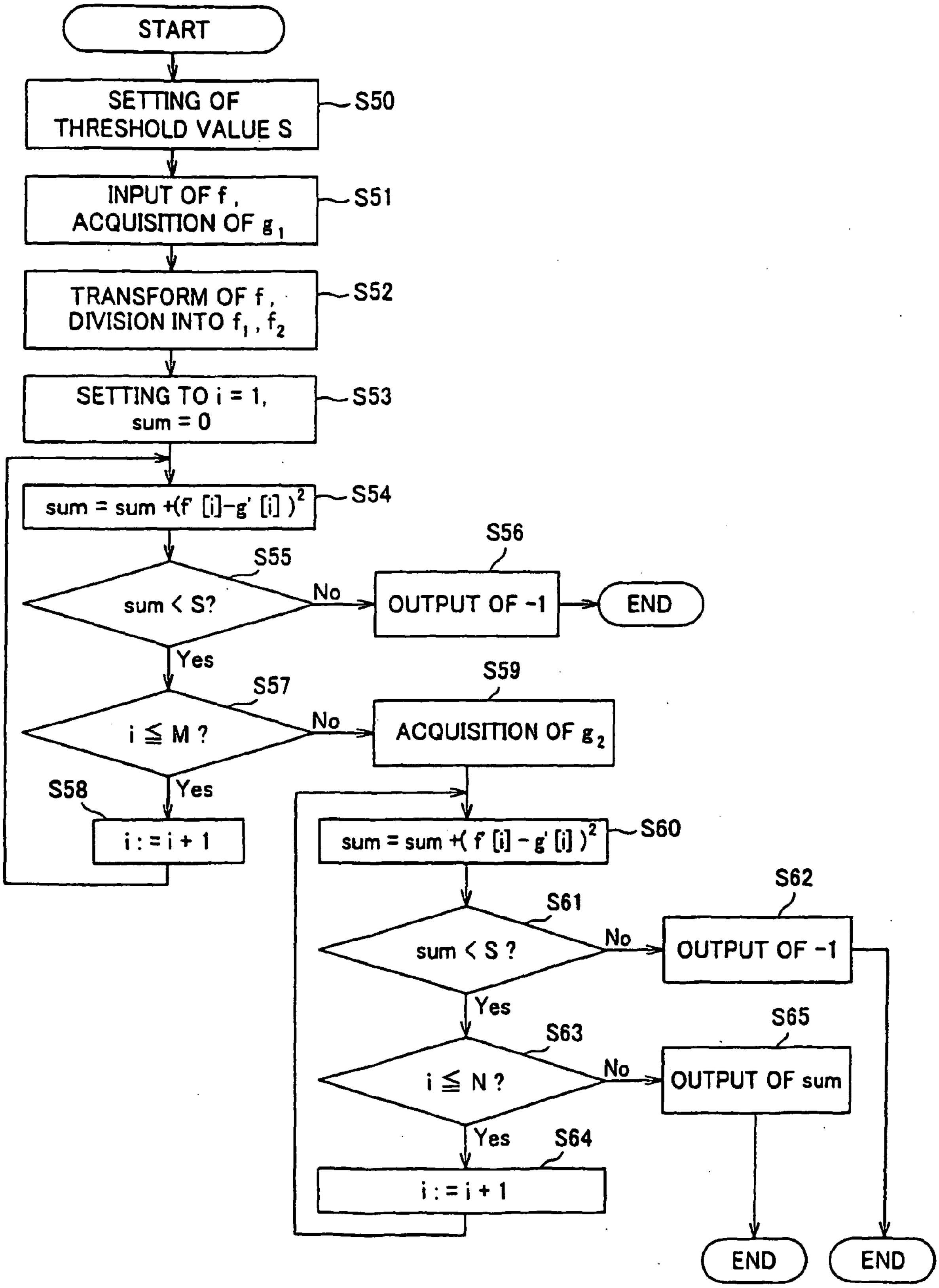

START
SETTING OF THRESHOLD VALUE S
S50
INPUT OF f, ACQUISITION OF g1
S51
TRANSFORM OF f, DIVISION INTO f1, f2
S52
SETTING TO i = 1, sum = 0
S53
sum = sum +(f' [i]−g' [i])2
S54
S55
sum < S?
No
S56
OUTPUT OF -1
END
Yes
S57
i ≦ M ?
No
S59
ACQUISITION OF g2
S58
Yes
i : = i + 1
sum = sum +(f' [i] − g' [i])2
S60
S61
sum < S ?
No
S62
OUTPUT OF -1
Yes
S63
i ≦ N ?
No
S65
OUTPUT OF sum
Yes
S64
i : = i + 1
END
END

FIG.11

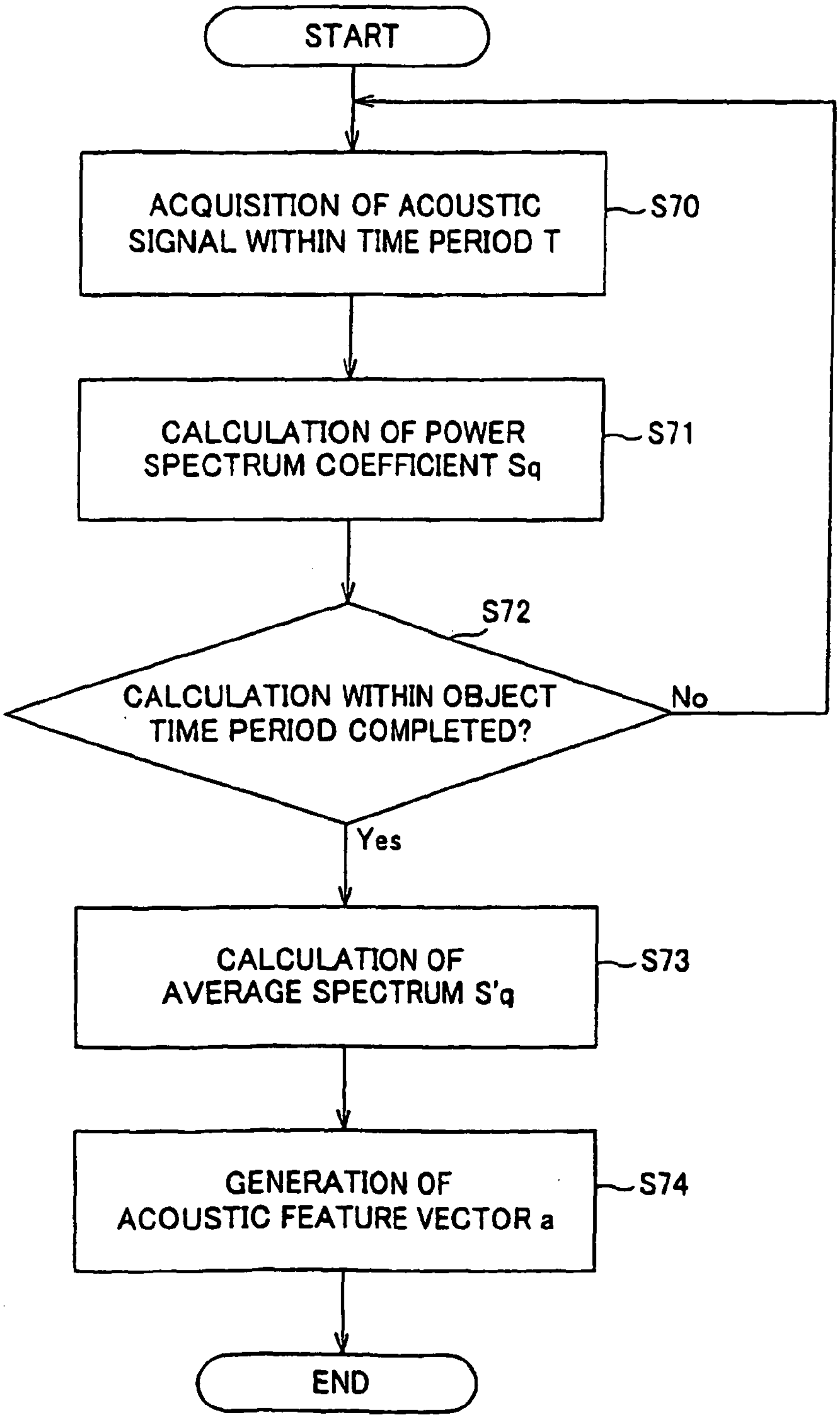

START
ACQUISITION OF ACOUSTIC SIGNAL WITHIN TIME PERIOD T
S70
CALCULATION OF POWER SPECTRUM COEFFICIENT Sq
S71
S72
CALCULATION WITHIN OBJECT TIME PERIOD COMPLETED?
No
Yes
CALCULATION OF AVERAGE SPECTRUM S'q
S73
GENERATION OF ACOUSTIC FEATURE VECTOR a
S74
END

FIG.12

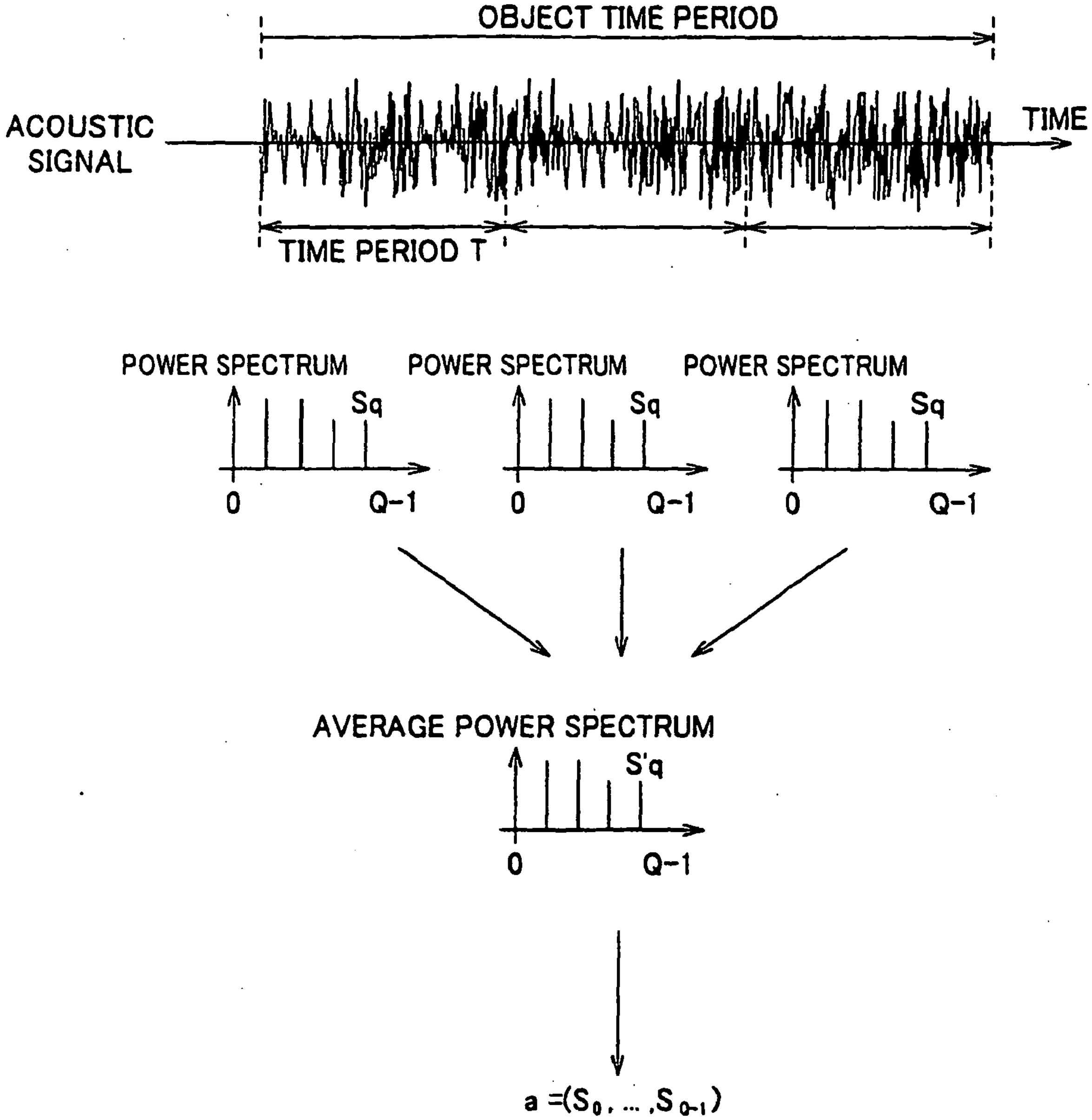

OBJECT TIME PERIOD
ACOUSTIC SIGNAL
TIME
TIME PERIOD T
POWER SPECTRUM
Sq
0
Q-1
POWER SPECTRUM
Sq
0
Q-1
POWER SPECTRUM
Sq
0
Q-1
AVERAGE POWER SPECTRUM
S'q
0
Q-1
a =(S0, ... ,SQ-1)

FIG.13

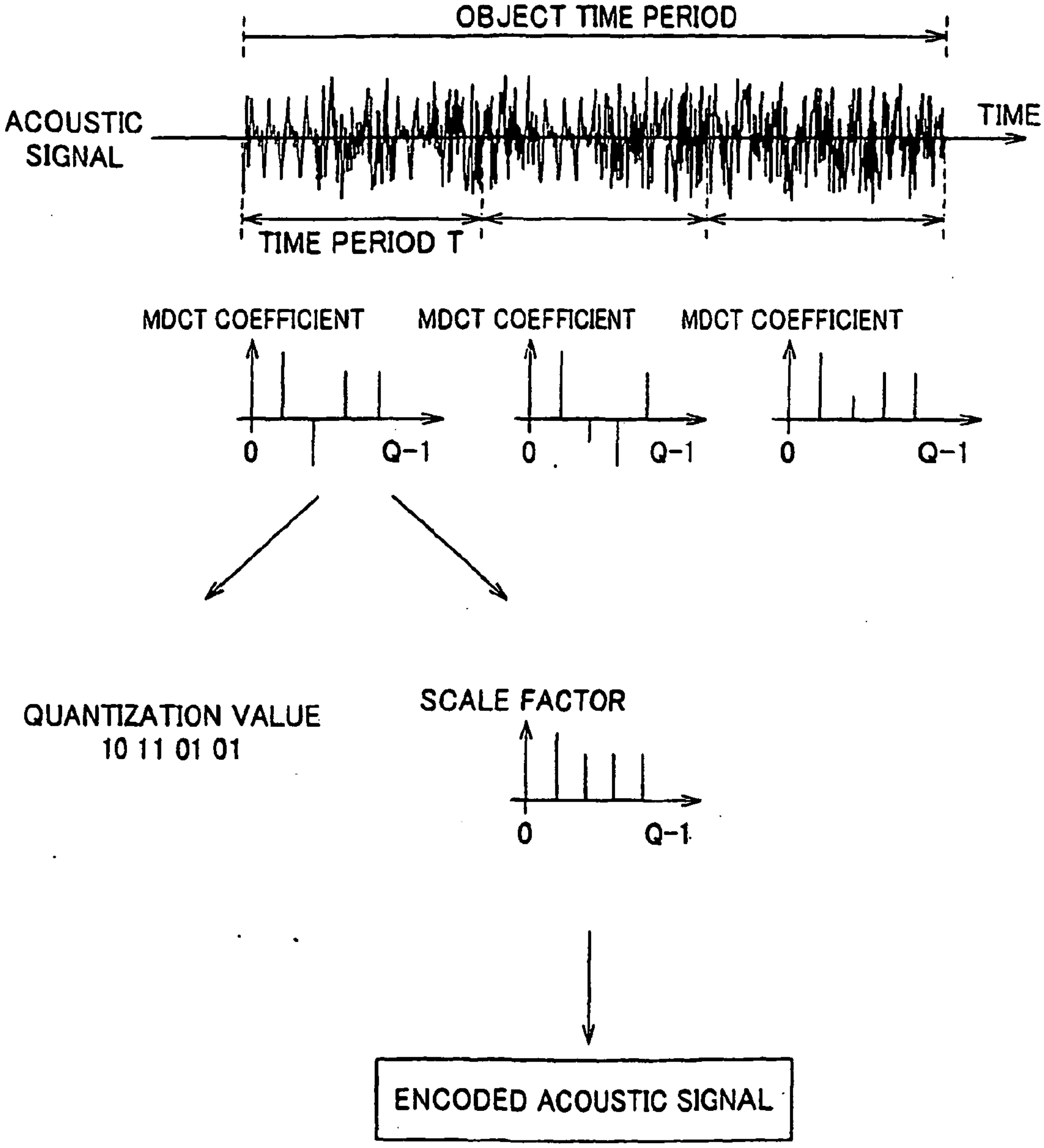

OBJECT TIME PERIOD
ACOUSTIC SIGNAL
TIME
TIME PERIOD T
MDCT COEFFICIENT
MDCT COEFFICIENT
MDCT COEFFICIENT
0
Q-1
0
Q-1
0
Q-1
QUANTIZATION VALUE
10 11 01 01
SCALE FACTOR
0
Q-1
ENCODED ACOUSTIC SIGNAL

FIG.14

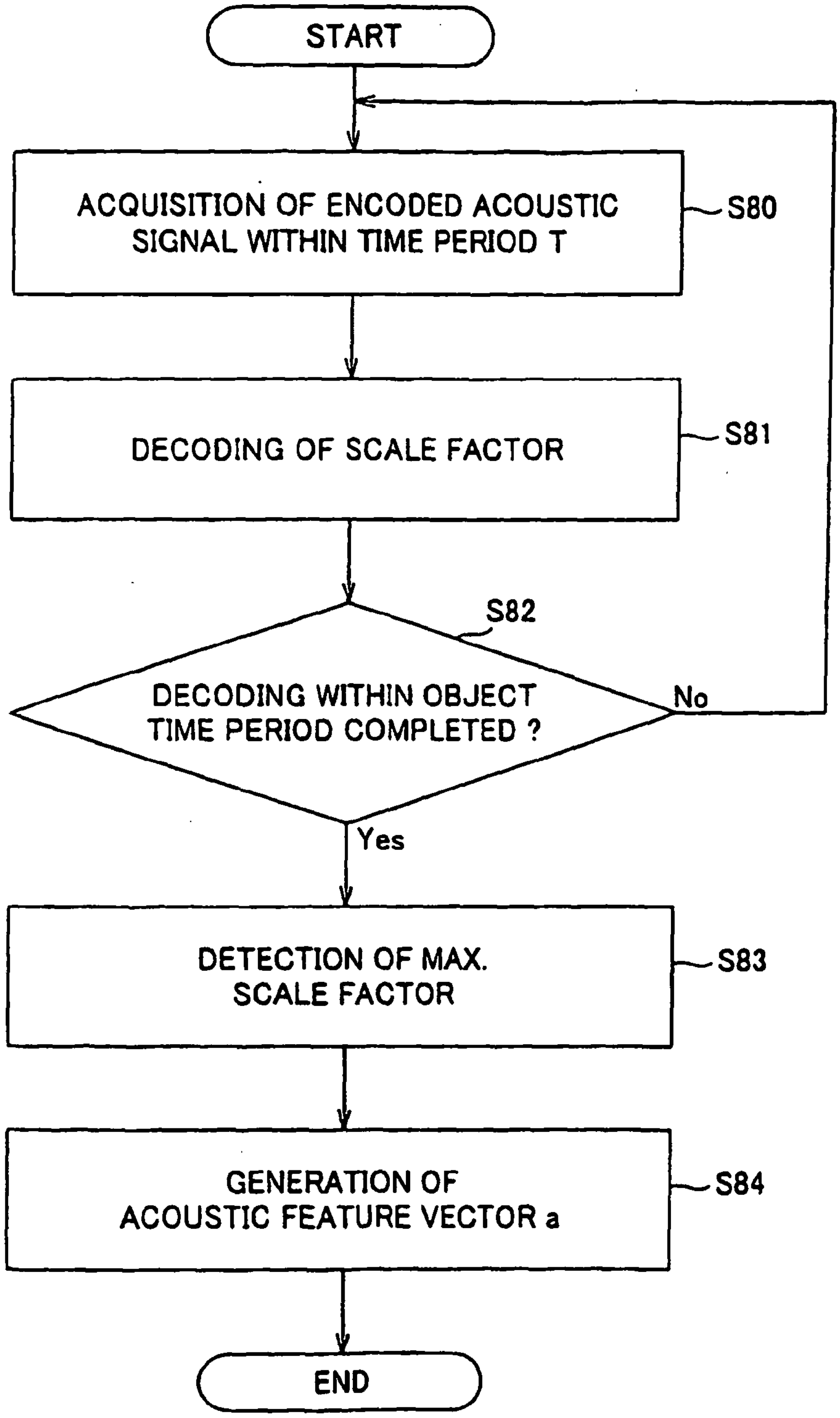

START
ACQUISITION OF ENCODED ACOUSTIC SIGNAL WITHIN TIME PERIOD T
S80
DECODING OF SCALE FACTOR
S81
S82
DECODING WITHIN OBJECT TIME PERIOD COMPLETED ?
No
Yes
DETECTION OF MAX. SCALE FACTOR
S83
GENERATION OF ACOUSTIC FEATURE VECTOR a
S84
END

FIG.15

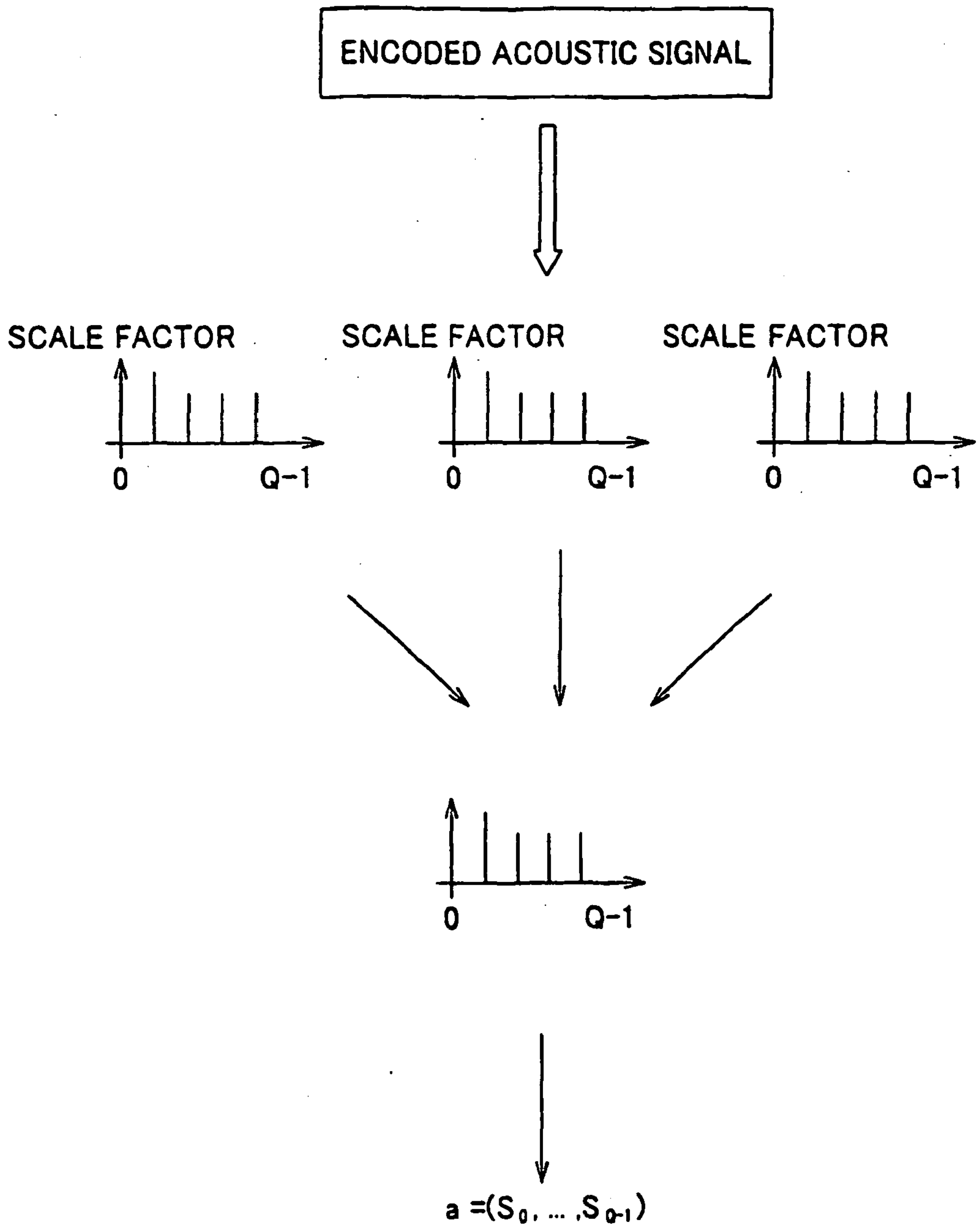

ENCODED ACOUSTIC SIGNAL
SCALE FACTOR
0
Q-1
SCALE FACTOR
0
Q-1
SCALE FACTOR
0
Q-1
0
Q-1
a =(S0, ... ,SQ-1)

FIG. 16

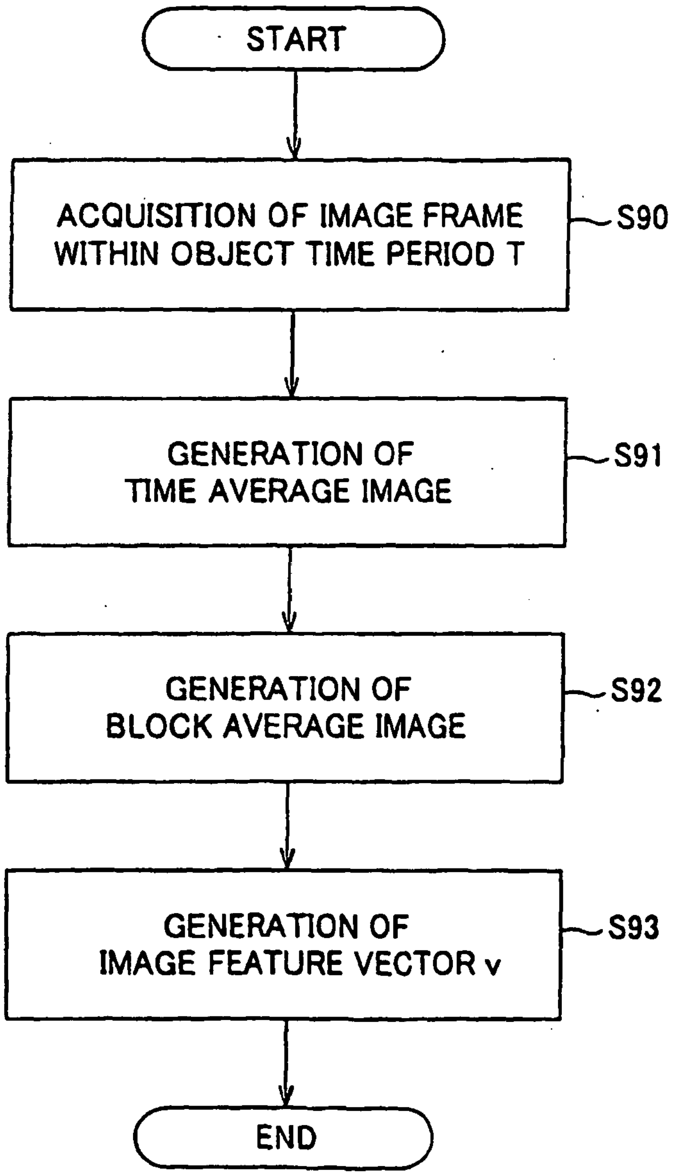

START
ACQUISITION OF IMAGE FRAME WITHIN OBJECT TIME PERIOD T
S90
GENERATION OF TIME AVERAGE IMAGE
S91
GENERATION OF BLOCK AVERAGE IMAGE
S92
GENERATION OF IMAGE FEATURE VECTOR v
S93
END

FIG.17

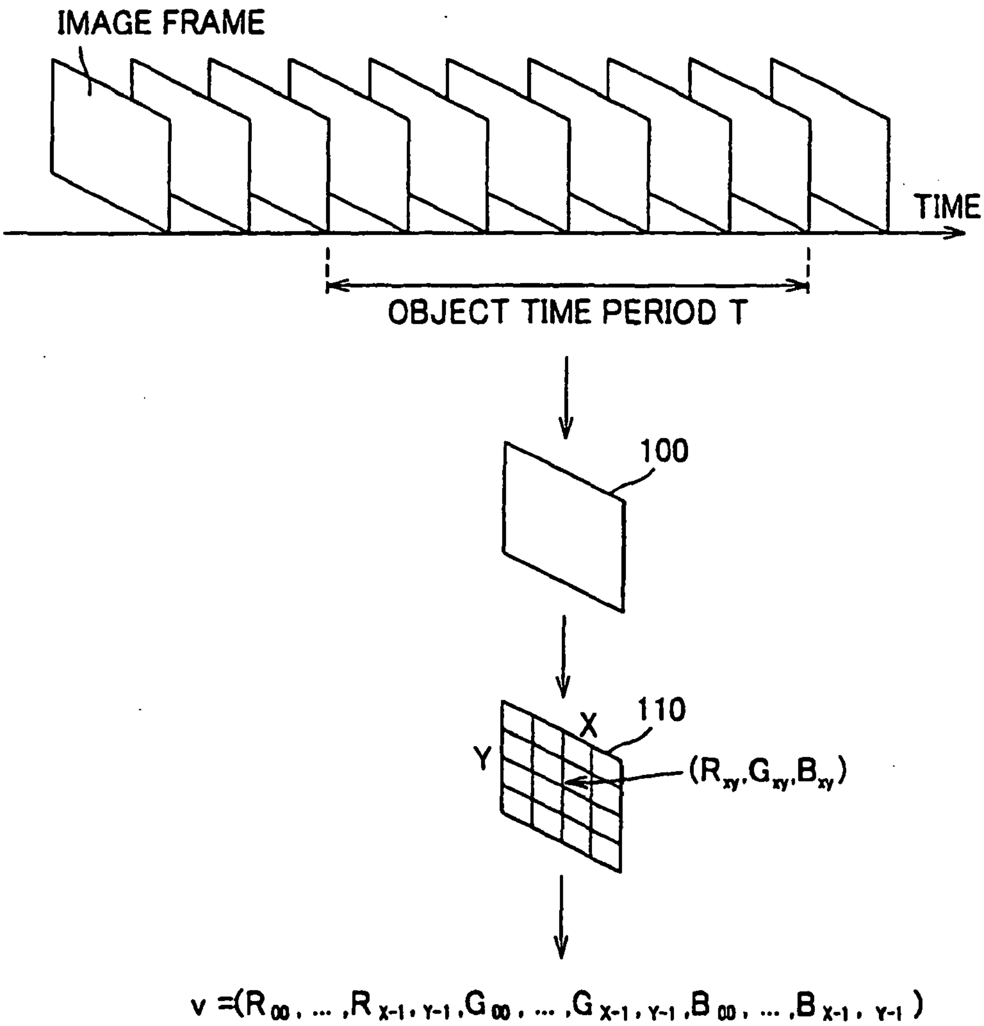


IMAGE FRAME
TIME
OBJECT TIME PERIOD T
100
110
X
Y
(Rxy,Gxy,Bxy)
v =(R00, ... ,RX-1, Y-1 ,G00, ... ,GX-1, Y-1 ,B00, ... ,BX-1, Y-1)

FIG.18

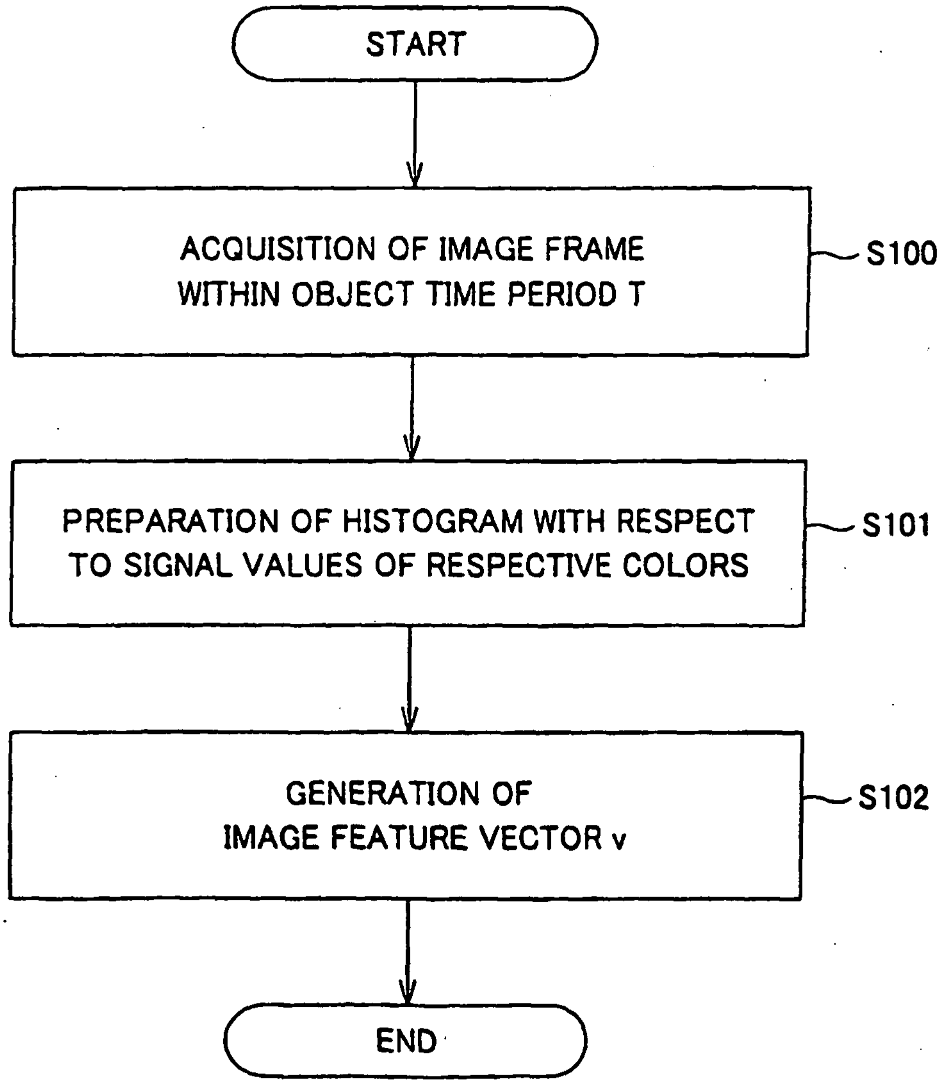

START
ACQUISITION OF IMAGE FRAME WITHIN OBJECT TIME PERIOD T
S100
PREPARATION OF HISTOGRAM WITH RESPECT TO SIGNAL VALUES OF RESPECTIVE COLORS
S101
GENERATION OF IMAGE FEATURE VECTOR v
S102
END

FIG.19

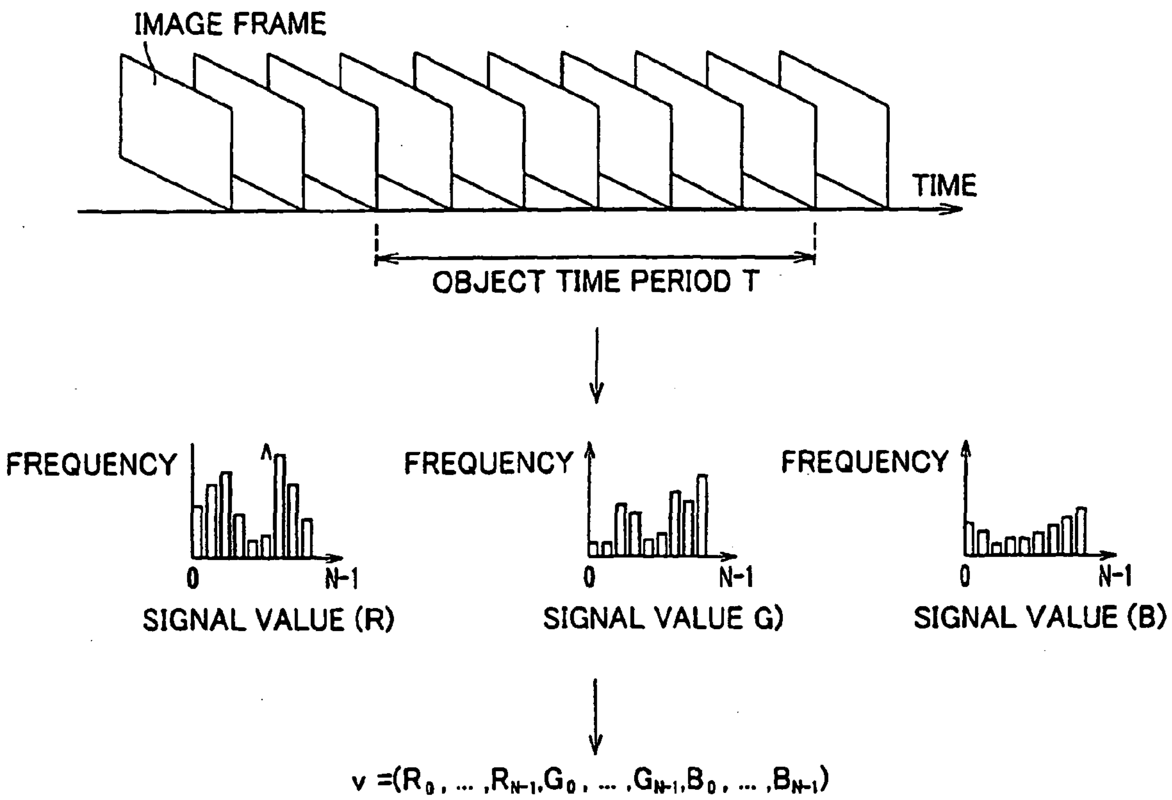


IMAGE FRAME
TIME
OBJECT TIME PERIOD T
FREQUENCY
0
N-1
SIGNAL VALUE (R)
FREQUENCY
0
N-1
SIGNAL VALUE G)
FREQUENCY
0
N-1
SIGNAL VALUE (B)
v =(R0, ... ,RN-1,G0, ... ,GN-1,B0, ... ,BN-1)

FIG.20

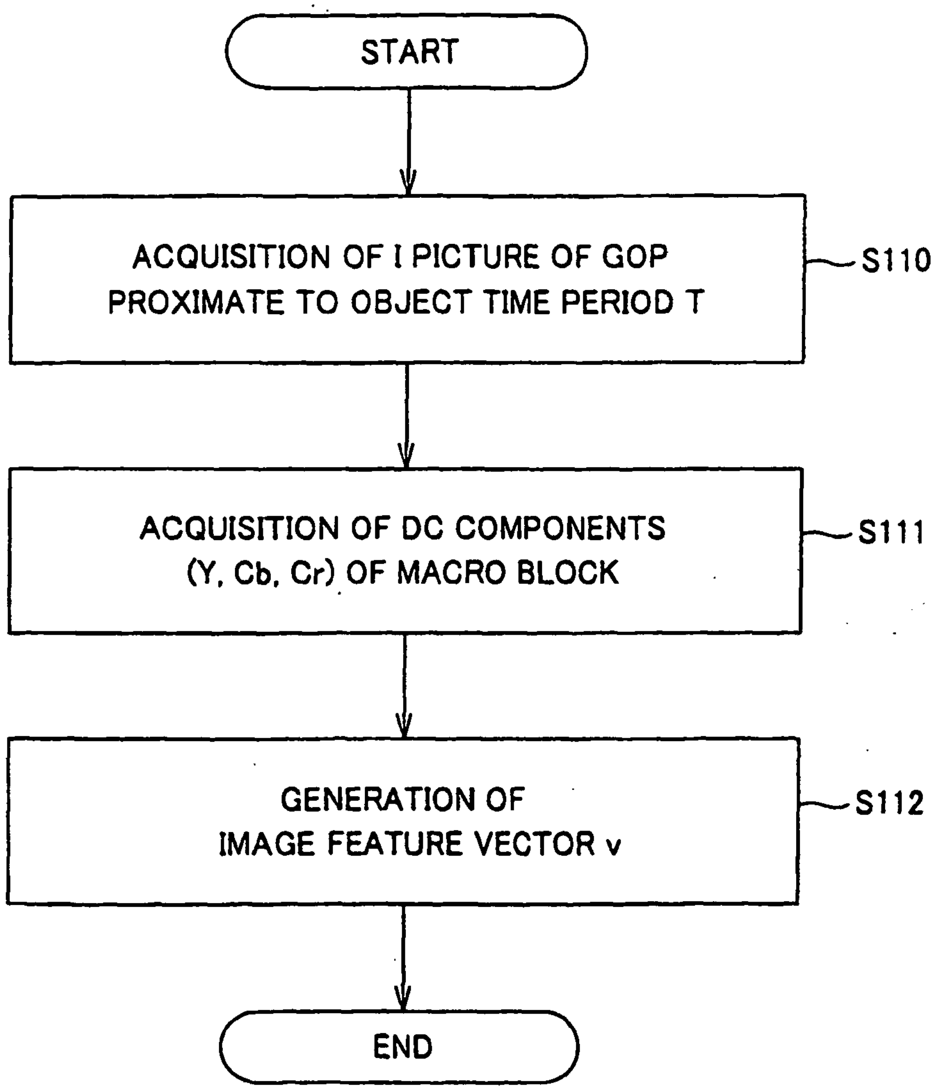
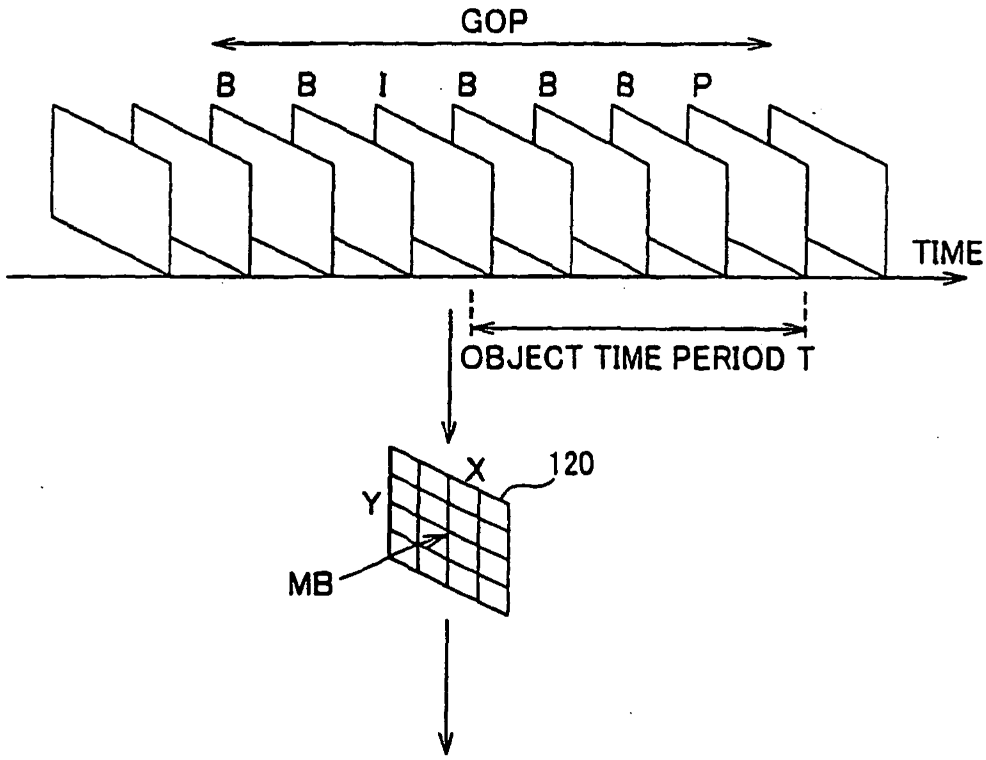

START
ACQUISITION OF I PICTURE OF GOP PROXIMATE TO OBJECT TIME PERIOD T
S110
ACQUISITION OF DC COMPONENTS (Y, Cb, Cr) OF MACRO BLOCK
S111
GENERATION OF IMAGE FEATURE VECTOR v
S112
END

FIG.21



$v = (Y_{00}, \ldots, Y_{X-1, Y-1}, Cb_{00}, \ldots, Cb_{X-1, Y-1}, Cr_{00}, \ldots, Cr_{X-1, Y-1})$

FIG.22

REFERENCES CITED IN THE DESCRIPTION

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- JP H08123460 B **[0006] [0008] [0010]**
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- **Shen, G. ; Liou. M. L.** An Efficient Codebook Post-Processing Technique and a Window-Based Fast-Search Algorithm for Image Vector Quantization. *IEEE Trans. on Circuits and systems for Video Technology,* 2000, vol. 10 (6), 990.997 **[0012]**