

【Invention Title】

DEVICE AND METHOD FOR ANALYZING AND EVALUATING DANCE
MOTION

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【TECHNICAL FIELD】

[1] The present disclosure relates to a device and a method for analyzing and evaluating a dance motion, and more particularly, relates to a device and a method for analyzing and evaluating a dance motion utilizing a mobile.

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【BACKGROUND ART】

[2] The Hallyu craze is spreading around the world, and Hallyu contents such as Korean dramas, Korean movies, Korean music, and Korean fashion are becoming the envy of people around the world, regardless of age or
15 gender.

[3] In particular, Korean music is at the center of the Hallyu craze, and in the age of Internet development, Korean music is established as a genre of entertainment for the younger generation by easily singing along to songs and following rhythms anytime, anywhere, across borders.

20 [4] With the emergence of young boy and girl groups in Korean music, dances that visually stimulate the fan base as well as lyrics are so popular that contests are held in various places to replicate them.

[5] In relation to this, the cover dance, which dances to the songs of K-pop stars, is a new Hallyu product with great potential for generating profits.

[6] Nevertheless, until recently, development of a device for recognizing and coaching dance motion is not satisfactory, and most expensive equipment and complex and large-scale facilities should be installed. In addition, since
5 the equipment is mobilized, the software used is expensive, and the operation speed is slow, and therefore there is a limit in deriving the results of motion in real time.

[7] Republic of Korea Patent Registration No. 10-1936692 (January 03,
10 2019) discloses a device that trains a user's dance motion, compares the reference motion with the user's motion, and derives the difference. However, the device is far from a device able to be used by a user because various hardware should be accompanied and heavy software such as converting 3D motion to 2D is operated.

15 [8] As in the above disclosure, most of the equipment focusing on feedback through analysis of dance movements or motion analysis focuses on motion accuracy analysis, and thus it is difficult for general consumers who follow the cover dance of K-pop stars to use it and the barrier to access is very high.

[9] After all, there is a need for an easy-to use device, which analyzing and
20 evaluating dance motion at an affordable price to the user.

【DETAILED DESCRIPTION OF THE INVENTION】

【TECHINICAL PROBLEM】

[10] It is an object of the present disclosure to provide a dance motion analysis evaluation device and method capable of easily shooting and analyzing a captured image in real time.

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【TECHNICAL SOLUTION】

[11] A device for analyzing and evaluating a dance motion mounted on a mobile according to an embodiment of the present disclosure includes a photographing unit that takes a test dance image, an object generating unit
10 that generates a test object pattern including a joint and a link by using a test object in the test dance image, and an evaluating unit that compares the test object pattern and a sample object pattern and evaluates the test dance image by comparing a joint angle of the test object pattern and a joint angle of the sample object pattern.

15 [12] In addition, the device for analyzing and evaluating the dance motion may further include a storage unit that stores a sample dance image for evaluating the test dance image and stores a sample object pattern including the joints and links of the object in the sample dance image.

[13] Here, the object generating unit may include an object extraction
20 module that extracts an object to be analyzed and evaluated from the test dance image and a pattern generation module generates a test object pattern from the extracted object.

[14] Here, the object extraction module may simultaneously extract two or more objects, and the pattern generation module may simultaneously extract two or more test object patterns.

[15] Here, the evaluating unit may include a time scheduler that matches a
5 frame of the test dance image with a frame of the sample dance image, an angle calculation module that matches the joints in the test object pattern and the sample object pattern and calculates an angle of the joint in each object pattern, a comparison module that compares the joint angle in the test object pattern with the joint angle in the sample object pattern, and a score calculation
10 module that calculates a score depending on whether the joint angles match or not.

[16] Here, the angle calculation module and the comparison module may calculate and compare the angle of the joint using an artificial intelligence algorithm.

15 [17] The device for analyzing and evaluating the dance motion may further include an output unit that synthesizes the test dance image and the test object pattern and to output it through a screen of the mobile device.

[18] A method of analyzing and evaluating a dance motion performed by a device for analyzing and evaluating the dance motion includes extracting a test
20 object from a test dance image, generating a test object pattern including a joint and a link by using the test object, comparing a joint angle of the test object pattern and a joint angle of the sample object pattern, and calculating a score using a compared value.

[19] Here, the comparing of the angles includes matching the test object pattern joint and the sample object pattern joint for each frame of the image and outputting a value compared for each joint by synthesizing the test object pattern and the test dance image.

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【 ADVANTAGEOUS EFFECTS OF THE INVENTION】

[20] The device and method for analyzing and evaluating dance motion according to an embodiment of the present disclosure may photograph, analyze, and evaluate a user's dance motion only with a mobile device.

10 [21] In addition, it is possible to perform quick calculations during analysis and evaluation of dance motions, and thus it is possible to analyze and evaluate the user's dance motions in real time after motion analysis.

【 DESCRIPTION OF THE DRAWINGS】

15 [22] FIG. 1 is a functional block diagram of a device for analyzing and evaluating a dance motion according to an embodiment of the present disclosure.

[23] FIG. 2 is a detailed block diagram of an object generating unit according to an embodiment of the present disclosure.

20 [24] FIG. 3 is an actual photograph of a test object pattern implemented by a pattern generation module according to an embodiment of the present disclosure.

[25] FIG. 4 is a detailed block diagram of an evaluating unit according to an embodiment of the present disclosure.

[26] FIG. 5 is a diagram illustrating an actual implementation of an angle calculation module according to an embodiment of the present disclosure.

5 [27] FIG. 6 is a diagram illustrating an angle comparison of a comparison module according to an embodiment of the present disclosure.

[28] FIG. 7 is a simulation photograph of a device for analyzing and evaluating a dance motion according to an embodiment of the present disclosure.

10 [29] FIG. 8 is an exemplary screen output through an output unit according to an embodiment of the present disclosure.

[30] FIG. 9 is a flowchart of a method of analyzing a dance motion according to an embodiment of the present disclosure.

15 **【 BEST MODE】**

[31] Specific structural or functional descriptions of the embodiments according to the concept of the present disclosure disclosed herein are only exemplified for the purpose of explaining the embodiments according to the concept of the present disclosure, and the embodiments according to the
20 concept of the present disclosure may be implemented in various forms and may not be limited to the embodiments described herein.

[32] Since the embodiments according to the concept of the present disclosure may have various changes and may have various forms, the embodiments will be illustrated in the drawings and described in detail herein. However, this is not intended to limit the embodiments according to the concept of the present disclosure to specific disclosed forms, and includes all changes, equivalents, or substitutes included in the spirit and scope of the present disclosure.

[33] Terms such as first or second may be used to describe various elements, but the elements should not be limited by the terms. The above terms are used only for the purpose of distinguishing one component from another, for example without departing from the scope of the inventive concept, a first component may be termed a second component and similarly a second component may also be termed a first component.

[34] When a component is referred to as being "connected" or "connected to" another component, it will be understood that the one component may be directly connected or connected to another component, but other components may exist in between. On the other hand, when a component is referred to as being "directly connected" or "directly connected" to another element, it should be understood that the other element does not exist in between. Other expressions describing the relationship between the elements, such as "between" and "immediately between" or "neighboring to" and "directly adjacent to" should be interpreted similarly.

[35] The terms used herein are used only to describe specific embodiments, and are not intended to limit the present disclosure. The singular expression includes the plural expression unless the context clearly dictates otherwise. In this specification, it should be understood that terms such as "comprise" or "have" are intended to designate that a feature, number, step, operation, component, part, or combination thereof described herein exists, but this does not preclude the possibility of addition or existence of one or more other features or numbers, steps, operations, components, parts, or combinations thereof.

[36] Unless defined otherwise, all terms used herein, including technical and scientific terms, have the same meaning as commonly understood by one of ordinary skill in the art to which this disclosure belongs. Terms such as those defined in a commonly used dictionary should be interpreted as having a meaning consistent with the meaning in the context of the related art, and unless explicitly defined herein, it should not be construed in an ideal or overly formal sense.

[37] Hereinafter, embodiments of the present disclosure will be described in detail with reference to the accompanying drawings. However, the scope of the disclosure is not limited or confined by the embodiments. Like reference numerals in each figure indicate like elements.

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[39] FIG. 1 is a functional block diagram of a device for analyzing and evaluating a dance motion according to an embodiment of the present disclosure.

[40] As shown in FIG. 1, a device for analyzing and evaluating a dance motion according to an embodiment of the present disclosure which is a device for analyzing and evaluating a dance motion mounted on a mobile device, includes a photographing unit 100 that takes a test dance image, an object generating unit 200 that generates a test object pattern including a joint and a link by using a test object in the test dance image and an evaluating unit 300 that compares the test object pattern and a sample object pattern and evaluates the test dance image by comparing a joint angle of the test object pattern and a joint angle of the sample object pattern.

[41] In addition, the device for analyzing and evaluating the dance motion according to an embodiment of the present disclosure includes a storage unit 400 that stores a sample dance image for evaluating the test dance image and stores a sample object pattern including the joints and links of the object in the sample dance image and an output unit 500 that outputs an analysis result.

[42] The mobile on which the device for analyzing and evaluating the dance motion according to an embodiment of the present disclosure is mounted may be a known predetermined electronic device, for example, may include at least one of a smart phone, a tablet PC, a head mounted display (HMD) device, a smart watch, a laptop computer, a desktop computer, a digital television, a set-top box, a navigation device, an artificial intelligence speaker, a handheld

game console, a personal digital assistant (PDA), an electronic blackboard, an electronic billboard, a consumer electronic and/or electronic devices capable of inputting other codes or outputting data visually/auditively.

[43] The device for analyzing and evaluating the dance motion according to
5 an embodiment of the present disclosure may not require complex equipment and may be implemented by a mobile device as in the above example.

[44] Hereinafter, for convenience of description, as a mobile device, the description of the device of the present disclosure will be mainly focused on a smart phone.

10 [45] The photographing unit 100 includes an image photographing device including a camera installed on one surface of a smart phone or the like. The photographing unit 100 captures a user's dance motion and generates a test dance image.

[46] The object generating unit 200 extracts a test object that is an object to
15 be analyzed or evaluated from the photographed test dance image, and generates a test object pattern expressed by the test object as a joint and a link.

[47] FIG. 2 is a detailed block diagram of an object generating unit according to an embodiment of the present disclosure.

20 [48] As shown in FIG. 2, the object generating unit 200 according to an embodiment of the present disclosure includes an object extraction module 210 that extracts an object to be analyzed and evaluated from the test dance

image and a pattern generation module 220 that generate a test object pattern from the extracted object.

[49] The object extraction module 210 separates a background screen and the object through an edge extraction technique and extracts the object. The
5 object extraction module 210 extracts a test object by utilizing various previously disclosed object extraction techniques, and therefore a detailed description thereof will be omitted.

[50] The object extraction module 210 may extract an object within an area set by a user from one frame included in the test dance image and may extract
10 two or more objects at the same time, and thus may perform processing to test the dance images of one or more users.

[51] Furthermore, through the object extraction module 210, the extracted object of the test dance image may be adjusted or transformed for each section, and another background screen may be synthesized or replaced with
15 the object through a chroma key technique.

[52] The pattern generation module 220 generates a test object pattern from the object extracted through the object extraction module 210. The object pattern described throughout the specification of the present disclosure may be a model including joints and links, or a simplified avatar.

20 [53] FIG. 3 is an actual photograph of a test object pattern implemented by a pattern generation module according to an embodiment of the present disclosure.

[54] As shown in FIG. 3, the test object pattern implemented by the pattern generation module 220 of the device of analyzing and evaluating the dance motion according to the embodiment of the present disclosure includes a total of 17 joints and links connecting each joint.

5 [55] In particular, each joint may be configured to match joints of the human body, ends of links such as hands and feet, and eyes, mouth, and ears, but is not necessarily limited thereto.

[56] In addition, the pattern generation module 220 may configure the joint in various ways depending on types of dance (hip-hop, swing dance, poppin
10 dance, etc.). In a case of poppin dance, which uses a lot of joints, additional joints may be formed on wrists and knuckles, and in a case of a dance that mainly has waves and soft movements, such as swing dance, additional joints may be formed on a spine in a cent of the body.

[57] The pattern generation module 220 may form a test object pattern using
15 a test object extracted from the test dance image that is a target of analysis and evaluation of dance motion and may form a sample object pattern using the sample object extracted from the sample dance image stored in the storage unit 400 to be described later.

[58] The evaluating unit 300 evaluates the test dance image by comparing
20 joint angles of the test object pattern and the sample object pattern.

[59] FIG. 4 is a detailed block diagram of an evaluating unit according to an embodiment of the present disclosure.

[60] As shown in FIG. 4, the evaluating unit 300 includes a time scheduler 310 that matches a frame of the test dance image with a frame of the sample dance image, an angle calculation module 320 that matches the joints in the test object pattern and the sample object pattern and calculates an angle of the joint in each object pattern, a comparison module 330 that compares the joint angle in the test object pattern with the joint angle in the sample object pattern, and a score calculation module 340 that calculates a score depending on whether the joint angles match or not.

[61] The time scheduler 310 matches the frame of the test dance image with the frame of the sample dance image to specify a frame of a sample dance image to be compared with each frame of the test dance image. In general, depending on how many images are recorded per second, processing speed of recording or playing the video varies for each device. A video shot with a smartphone supports 30 frames per second (60 fps) by default, and although it may vary depending on the setting, most may support 30 frames or more.

[62] It is desirable to record a video of a sports game or dance that involves fast movement at 60 fps so that it may be recorded and played back clearly without afterimage.

[63] When the frame of the test dance image and the frame of the sample dance image match at 30 fps, the time scheduler 310 may match the frames between the images with time, and when the frame of the test dance image and the frame of the sample dance image per second do not match each other, they are matched through a method such as matching frames overlapping

each other. In particular, the time scheduler 310 forms a wide range of matching frames between the two images (test dance image vs. sample dance image) depending on difficulty of the dance and a skill level of a user, or delays the sample dance image frame to match the test dance image. This may be one way of adjusting the difficulty so that a beginner level user who takes a dance motion while watching a sample dance image may follow it.

[64] The angle calculation module 320 matches the joints of the test object pattern and the sample object pattern with each other and calculates the angle of the joint.

10 [65] FIG. 5 is a diagram illustrating an actual implementation of an angle calculation module according to an embodiment of the present disclosure.

[66] As shown in FIG. 5, the test object pattern generated in one frame is expressed as 12 joints excluding the joint of the face. A separate identifier is assigned to each joint, and the movement of each joint is tracked in the image.

15 In FIG. 5, joints 1 to 6 are the right side of the test object, and the other joints 7 to 12 are the left side of the test object. An angle formed by joint 5, a knee joint among the right joints, is α , and an angle formed by joint 8, a knee joint among the left joints, is β , and an angle formed by joint 9, a left waist, is γ .

[67] The angle calculation module 320 calculates an angle for each joint as described with reference to FIG. 5. In particular, for joints where three links intersect, such as joint 3, joint 10, joint 4, and joint 9, two joint angles may be derived and may or may not be included in the calculated angle for each joint

depending on the difficulty of the dance, the type of dance, and the skill level of the user.

[68] In addition, the angle calculation module 320 may perform calculations using an artificial intelligence-based algorithm. That is, when motion video is
5 taken using a smartphone camera, the angle and motion trajectory of the body are tracked and the position of a dance line is converted into vector data, and then the vector data may be stored in a data structure and learned to calculate the angle of the joint.

[69] The comparison module 330 compares the joint angle in the test object
10 pattern with the joint angle in the sample object pattern.

[70] FIG. 6 is a diagram illustrating an angle comparison of a comparison module according to an embodiment of the present disclosure.

[71] As shown in FIG. 6, the comparison module 330 compares the angle of the joint 5 of the test object pattern shown in FIG. 5 with the angle of the joint
15 5' of the sample object pattern as an example.

[72] The angle calculation module 320 calculated the angle of the joint 5 as $\angle 456 = \alpha$. The angle of the joint 5' of the sample object pattern was calculated as $\angle 4'5'6' = \alpha'$. The comparison module 330 matches the 5-6 links of the test object pattern with the 5'-6' links of the sample object pattern, and calculates
20 $\alpha - \alpha'$. The calculated value ($\alpha - \alpha'$) is stored as an angle comparison value of joint 5 of a specific frame. That is, the angle calculation module 320 matches one

link regardless of the direction in which the link is directed and calculates only the difference value of the angle to generate an angle comparison value.

[73] A series of joint angle comparison values as shown in FIG. 6 is calculated eight times per frame, from joint 2 to joint 5 and from joint 8 to joint 11.

[74] The comparison module 330 may store information about past data and process new data by using a Convolution Neural Network (CNN), which is an artificial intelligence-based algorithm. For example, the comparison module 330 may generate an angle comparison value in consideration of an angle caused by rotation in a depth direction using a CNN algorithm. In detecting the movement of the object pattern that is photographed by a camera and rotates or moves in forward and backward directions on a two-dimensional plane recognized as the object pattern, it is possible to calculate an exact angle comparison value by using the CNN algorithm. That is, information on depth values may be obtained using an artificial intelligence-based CNN algorithm, and thus accurately calculate and draw an angle comparison value.

[75] FIG. 7 is a simulation photograph of a device for analyzing and evaluating a dance motion according to an embodiment of the present disclosure.

[76] FIG. 8 is an exemplary screen output through an output unit according to an embodiment of the present disclosure.

[77] As shown in FIG. 7, the comparison module 330 compares a sample dance image located at an upper left and a test dance image located at an upper right through an object pattern. As a result of comparison, a joint with a moderate error may be displayed with a bright circle as shown in the image at
5 a bottom right, and a joint with a large error may be displayed with a relatively dark circle.

[78] The score calculation module 340 calculates a user's dance score by synthesizing a comparison value of each frame/joint angle of the test object pattern in the test dance image in the comparison module 330 as described
10 above. Various methods for calculating the user's dance score may be considered. The score calculation module 340 is also capable of calculating a score based on a user's setting, such as classification by depending on dance proficiency and weighting depending on differences in the degree of movement for each body part.

15 [79] The device for analyzing and evaluating the dance motion according to an embodiment of the present disclosure may include a storage unit 400 that stores a sample dance image for evaluating the test dance image and stores the sample object pattern including the joints and links of objects in the sample dance image and the output unit 500 for synthesizing the test dance image
20 and the test object pattern and outputting it through a mobile screen.

[80] The storage unit 400 may store various information for dance motion analysis and evaluation, and may include, for example, at least one of a main memory device and an auxiliary memory device. The main memory device

may be implemented using a semiconductor storage medium such as ROM and/or RAM. The ROM may include, for example, a conventional ROM, an EPROM, an EEPROM, and/or a MASK-ROM. The RAM may include, for example, DRAM and/or SRAM. The auxiliary storage device may be

5 implemented using at least one storage medium capable of permanently or semi-permanently storing data, such as memory devices, secure digital (SD) cards, solid state drives (SSDs), hard disk drives (HDDs), magnetic drums, compact discs (CDs), and DVDs or an optical recording medium such as a laser disk, a magnetic tape, a magneto-optical disk, and/or a floppy disk.

10 [81] The output unit 500 may output the test object and the test object pattern which are synthesized and matched as shown in FIG. 3, or may output the test object and the test object pattern which are separated, as shown in FIG. 8, at the same time. In addition, through the output unit 500, the device for analyzing and evaluating the dance motion according to an embodiment of

15 the present disclosure may simultaneously output the sample object and the test object, display the joint in which the error occurs in the test object, and may playback and output start and stop, comparison of postures in the measurement area, a calculated score, and play at the desired speed, using a touchable user interface.

20 [82] The device for analyzing and evaluating the dance motion according to an embodiment of the present disclosure has been described in detail above. Hereinafter, another aspect of the present disclosure, a method of analyzing a dance motion will be described.

[83] A description of the repetitive configurations with the previous embodiment will be omitted.

[84] FIG. 9 is a flowchart of a method of analyzing a dance motion according to an embodiment of the present disclosure.

5 [85] As shown in FIG. 9, a method of analyzing a dance motion according to an embodiment of the present disclosure includes extracting a test object from a test dance image in S100, generating a test object pattern including a joint and a link by using the test object in S200, comparing a joint angle of the test object pattern and a joint angle of the sample object pattern in S300, and
10 calculating a score using a compared value in S400.

[86] The extracting of the test object from the test dance image in S100 includes extracting only the test object from an image with a background through an edge extraction technique. There may be one test object in the image, but a plurality of test objects may also be extracted at the same time.

15 [87] The generating of the test object pattern including the joint and the link by using the test object in S200 includes simplifying the object to analyze the dance motion of the object to the angle of the joint, thereby increasing the calculation speed, and generating the test object including the joints and links to enable a large number of calculations.

20 [88] The comparing of the joint angle of the test object pattern and the joint angle of the sample object pattern in S300 includes, as shown in FIG. 6, matching and comparing the angle of the sample object pattern joint stored in

the storage unit and the angle of the test object pattern joint stored in the storage unit for each frame and joint.

[89] In addition, the comparing of the angles in S300 includes matching the test object pattern joint and the sample object pattern joint for each frame of the image, and outputting the compared value for each joint by synthesizing the test object pattern and the test dance image.

[90] The calculating of the score using the compared value in S400 includes scoring the comparison value of the test object pattern and the sample object pattern for each joint in consideration of weight and difficulty. A method for calculating the score may be considered in many different ways.

[91] According to the device and method for analyzing and evaluating the dance motion as described above, it is possible to imitate the motion of cover dance using the mobile device used in daily life, quantify and receive the corresponding feedback, and easily practice and learn the desired dance motion without the assistance of a dance coach.

[92] Although the present disclosure has been described with reference to the embodiment shown in the drawings, which is merely exemplary, those skilled in the art will understand that various modifications and equivalent other embodiments are possible therefrom. For example, the described techniques are performed in an order different from the described method, and/or the described components of the system, structure, apparatus, and/or circuit, are combined or coupled in a different form than the described method, or other components or substituted by equivalents may achieve an appropriate result.

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Accordingly, the technical protection scope of the present disclosure should be determined by the technical spirit of the appended claims.

CLAIMS

1. A device for analyzing and evaluating a dance motion mounted on a mobile, the device comprising:
- 5 a photographing unit configured to take a test dance image;
- an object generating unit configured to generate a test object pattern including a joint and a link by using a test object in the test dance image; and
- an evaluating unit configured to compare the test object pattern and a sample object pattern and to evaluate the test dance image by comparing a
- 10 joint angle of the test object pattern and a joint angle of the sample object pattern.
2. The device of claim 1, further comprising:
- a storage unit configured to store a sample dance image for evaluating
- 15 the test dance image and to store a sample object pattern including the joints and links of the object in the sample dance image.
3. The device of claim 1, wherein the object generating unit includes:
- 20 an object extraction module configured to extract an object to be analyzed and evaluated from the test dance image; and
- a pattern generation module configured to generate a test object pattern from the extracted object.

4. The device of claim 3, wherein the object extraction module simultaneously extracts two or more objects, and the pattern generation module simultaneously extracts two or more test object patterns.

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5. The device of claim 1, wherein the evaluating unit includes:
a time scheduler configured to match a frame of the test dance image with a frame of the sample dance image;
an angle calculation module configured to match the joints in the test
10 object pattern and the sample object pattern and to calculate an angle of the joint in each object pattern;
a comparison module configured to compare the joint angle in the test object pattern with the joint angle in the sample object pattern; and
a score calculation module configured to calculate a score depending
15 on whether the joint angles match or not.

6. The device of claim 5, wherein the angle calculation module and the comparison module calculate and compare the angle of the joint using an artificial intelligence algorithm.

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7. The device of claim 1, further comprising:
an output unit configured to synthesize the test dance image and the test object pattern and to output it through a screen of the mobile device.

8. A method of analyzing and evaluating a dance motion performed by a device for analyzing and evaluating the dance motion, the method comprising:

- 5 (a) extracting a test object from a test dance image;
- (b) generating a test object pattern including a joint and a link by using the test object;
- (c) comparing a joint angle of the test object pattern and a joint angle of the sample object pattern; and
- 10 (d) calculating a score using a compared value.

9. The method of claim 8, wherein the (c) includes:
matching the test object pattern joint and the sample object pattern joint for each frame of the image.

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10. The method of claim 9, wherein the (c) includes:
outputting a value compared for each joint by synthesizing the test object pattern and the test dance image.