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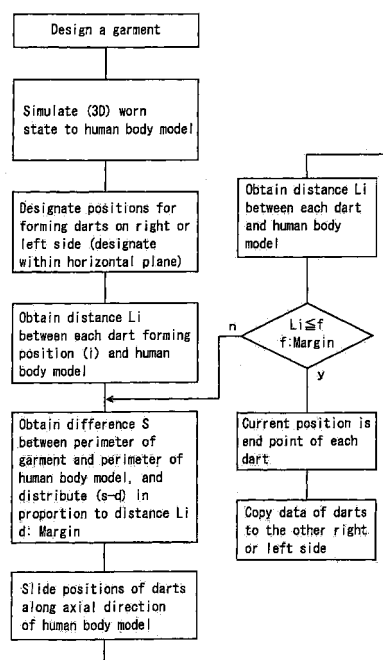
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(54) **DART DESIGNING METHOD, DESIGNING DEVICE, AND DESIGNING PROGRAM**

(57) Positions where darts (45, 46, 51 to 55, 70 to 76) are to be formed are designated from a monitor (6), and the distance between a garment and a human body model (42) at each of the positions and the difference between the perimeter of the garment and that of the human body model (42) are obtained. According to the distances between respective garments and human body models (42), the differences between the perimeters of the garments and the human body models (42) are distributed to the respective darts (45, 46, 51 to 55, 70 to 76), and a point, on the extended line of a dart (45, 46, 51 to 55, 70 to 76), where the distance between the garment and the human body model (42), is equal to or shorter than a predetermined value is set as an end point of the dart (45, 46, 51 to 55, 70 to 76). The darts (45, 46, 51 to 55, 70 to 76) can be designed nearly automatically.

FIG. 2



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Description

[0001] The present invention relates to an automation of designing darts.

[0002] Darts are used in garments such as skirts and suits. The darts are designed by dressing a dress form, or a human body model, in a pattern paper, or toile, and eliminating or cutting the section remaining with respect to the dress form. Dressing a dress form in a pattern paper and correcting the pattern paper is called "toiles check," which requires a lot of skill. Therefore, the darts are designed manually by a skilled worker. The paragraphs [0071] to [0073] in Patent Document 1: JP1996-325821A describe designing darts, in which a garment is grabbed on a designing device to estimate the amount of darts. Patent Document 1, however, does not describe how the darts are designed.

[0003] Patent Document 1: JP1996-325821A

[0004] An object of the present invention is to automate the designing of darts.

[0005] The present invention is a dart designing method for designing a garment by three-dimensionally simulating a worn state of the garment on a human body model and displaying an image obtained by the simulation, on a color monitor, the dart designing method comprising:

a generation step of generating, on the garment, a plurality of positions where darts are to be formed;
 a distance calculation step of obtaining a distance between the garment and the human body model in each of the positions where the darts are to be formed;
 a perimeter calculation step of obtaining a difference between a perimeter of the garment and a perimeter of the human body model, along the plurality of positions where the darts are to be formed;
 a width determination step of determining a width of each of the darts, such that the width of each of the darts increases as the distance between the garment and the human body model increases in each of the positions where the darts are to be formed, and that the width of each of the darts increases as the perimeter difference increases; and
 a length determination step of determining a length of each of the darts, such that each of the darts is extended along an axial direction of the human body model, and that a point, on an extended line of each of the darts, where the distance between the garment and the human body model is equal to or shorter than a predetermined value, is set as an end point of each of the darts,
 the dart designing method being characterized in that
 the designing unit designs the darts in the garment, such that each of the positions generated in the generation step has the width determined in the width determination step, and that the point obtained in the length determination step is set as the end point.

[0006] The present invention is also a dart designing device, having a simulation unit for three-dimensionally simulating a worn state of a garment on a human body model, a color monitor for displaying an image obtained by the simulation, and a designing unit for designing the garment, the dart designing device comprising:

generation means for generating, on the garment, a plurality of positions where darts are to be formed;
 distance calculation means for obtaining a distance between the garment and the human body model in each of the positions where the darts are to be formed;
 perimeter calculation means for obtaining a difference between a perimeter of the garment and a perimeter of the human body model, along the plurality of positions where the darts are to be formed;
 width determination means for determining a width of each of the darts, such that the width of each of the darts increases as the distance between the garment and the human body model increases in each of the positions where the darts are to be formed, and that the width of each of the darts increases as the perimeter difference increases; and
 length determination means for determining a length of each of the darts, such that each of the darts is extended along an axial direction of the human body model, and that a point, on an extended line of each of the darts, where the distance between the garment and the human body model is equal to or shorter than a predetermined value, is set as an end point of each of the darts,
 the dart designing device being characterized in that the designing unit designs the darts in the garment, such that each of the positions generated by the generation means has the width determined by the width determination means, and that the point obtained by the length determination means is set as the end point.

[0007] Moreover, the present invention is a dart designing program for, as a dart design device, a computer system, which has a simulation unit for three-dimensionally simulating a worn state of a garment on a human body model, a color monitor for displaying an image obtained by the simulation, and a designing unit for designing the garment, to function as:

generation means for generating, on the garment, a plurality of positions where darts are to be formed;

distance calculation means for obtaining a distance between the garment and the human body model in each of the positions where the darts are to be formed;

perimeter calculation means for obtaining a difference between a perimeter of the garment and a perimeter of the human body model, along the plurality of positions where the darts are to be formed;

width determination means for determining a width of each of the darts, such that the width of each of the darts increases as the distance between the garment and the human body model increases in each of the positions where the darts are to be formed, and that the width of each of the darts increases as the perimeter difference increases;

length determination means for determining a length of each of the darts, such that each of the darts is extended along an axial direction of the human body model, and that a point, on an extended line of each of the darts, where the distance between the garment and the human body model is equal to or shorter than a predetermined value, is set as an end point of each of the darts; and

means for using the designing unit to design the darts in the garment, such that each of the positions generated by the generation means has the width determined by the width determination means, and that the point obtained by the length determination means is set as the end point.

[0008] In the present invention, when, for example, an operator inputs the positions where the darts are to be formed, the distance between the garment and the human body model in each of the positions where the darts are to be formed is automatically obtained. The difference between the perimeter of the garment and the perimeter of the human body model is obtained, and this difference in perimeter is distributed to each dart in accordance with the distance between each of the positions where the darts are to be formed and the human body model, to obtain the width of each dart. Each of the darts is extended to a point where the garment almost comes into contact with the human body model, or a point where the distance between the garment and the human body model is equal to or shorter than the predetermined value, and then this point is set as the end point of the dart. In this manner, the width and length of each dart can be designed automatically. The width of each dart is defined such that the garment naturally comes into contact with the human body model, and the length of each dart is defined such that it ends at a point where the garment naturally comes into contact with the human body model. Consequently, the darts can be designed so that the garment fits a human body.

[0009] In this specification, the description of the designing method applies directly to the designing device and the designing program, and the description of the designing device applies directly to the designing method and the designing program. The garment may be made of not only a cloth but also a knitted fabric.

The positions where the darts are to be formed are designated manually, for example. However, the positions where the darts are to be formed may be determined automatically based on an experimental rule where the number of darts is designated and stored in a database or the like.

[0010] When dressing a human body in a garment, a certain amount of margin, or space, is necessary. Therefore, when dealing with the distance between the garment and a human body model, the distance therebetween may be calculated and the distance of a required space may be subtracted from the obtained distance. In this case, the garment adheres tightly to the human body model when the distance is 0. However, the result that is obtained by subtracting the distance of a required space from the calculational distance between the garment and the human body model beforehand may be taken as the distance. In this case, there is an adequate space between the garment and the human body model when the distance is 0. The same is true with the calculation of the difference between the perimeter of the garment and the perimeter of the human body model. In other words, the difference in perimeter may be obtained, and thereafter the distance of a required margin may be subtracted therefrom. In this case, the garment adheres tightly to the human body model when the difference in perimeter is 0. Alternatively, the difference in perimeter may be obtained to provide a required margin beforehand, in which case there is an adequate space between the garment and the human body model when the difference in perimeter is 0.

[0011] It is preferred that the length determination step obtain the distance between the garment and the human body model in a plurality of positions on the extended line of each of the darts, and determine the width of each of the darts along the extended line such that the width of each of the darts increases as the obtained distance increases.

In this manner, when the distance between the human body model and the garment decreases linearly, linear darts are obtained. When the distance between the human body model and the garment changes nonlinearly, rounded darts are obtained. Because the width of each dart changes in each part of the dart in accordance with the distance between the garment and the human body model, darts that allow the garment to fit the human body well can be obtained.

[0012] More preferably, the positions where the darts are to be formed, the width of each of the darts, and the length of each of the darts are determined with respect to one of the right and left sides of the garment, and the thus-obtained positions where the darts are to be formed, the width and the length are copied symmetrically onto the other one of the right and left sides of the garment.

Since the actual human body is substantially symmetrical, designing the darts with respect to one of the right and left sides of the body and symmetrically copying the darts onto the other one of the right and left sides can reduce the data throughout in designing the darts, by approximately 1/2. If the darts are designed for each of the right and left sides from

the beginning, the positions where the darts are to be formed, the width or length of each dart might not become symmetrical. The reason that the positions where the darts are to be formed are symmetrical is mostly because the positions where the darts are to be formed are not input appropriately. The reason that the width or length of each dart is not symmetrical is mostly because the garment is not put on the human body model symmetrically during the simulation of the worn state of the garment, and consequently the distance between the garment and the human body model becomes asymmetric. Therefore, copying the design of the darts for the right or left side is likely to produce good design results.

[0013]

Fig. 1 is a block diagram of a design method according to an embodiment;
 Fig. 2 is a diagram showing a dart design algorithm according to the embodiment;
 Fig. 3 is a diagram showing the lengths (depths) of darts, wherein Fig. 3A is a side view showing the lengths of the darts, and Fig. 3B a front view showing the lengths of the darts;
 Fig. 4 is a diagram showing a space between a human body model and each part;
 Fig. 5 is a diagram showing an example where the widths of the darts change roundly;
 Fig. 6 is a diagram showing an example where the widths of the darts change linearly;
 Fig. 7 is a diagram showing an example of copying a design of the darts of the right or left side onto the other;
 Fig. 8 is a diagram showing a state in which the human body model is dressed in a pattern paper for a skirt, wherein the right-hand side of the diagram shows a cross section of the waist of the human body model and the pattern;
 Fig. 9 is a diagram showing a state in which the human body model is dressed in the pattern paper for a skirt, wherein the right-hand side of the diagram shows a cross section of the hip of the human body model and the pattern;
 Fig. 10 is a diagram showing a worn state of the pattern paper in which the darts are created according to the embodiment;
 Fig. 11 is a diagram showing the pattern obtained before and after the darts are created;
 Fig. 12 is a diagram showing various darts created in the embodiment; and
 Fig. 13 is a diagram showing how the width of each dart is calculated from the height of the bust, according to the present embodiment.

[0014] The best mode for implementing the present invention is described next.

[Embodiment]

[0015] Figs. 1 to 13 show a design of a garment having darts, according to the embodiment. Designing device 2 is configured by a computer system. Reference numeral 4 is a bus, 6 a color monitor, 8 a mouse, 10 a keyboard, and 12 a color printer. In place of the mouse 8, a trackball, joystick, stylus and the like may be used. Reference numeral 14 is a LAN interface, 16 a removable memory, such as a CD-ROM or USB memory, and 18 a scanner for reading a design image.

[0016] Reference numeral 20 is a general-purpose memory for storing data other than the image, programs and files. Reference numeral 22 is an image memory for storing image data. The designing device 2 has a CPU and graphic unit, not shown, and realizes a parts joining unit 24 to design editing unit 39 by using the CPU and graphic unit, as well as the memory 20, image memory 22, and a design program stored in the memory 20.

[0017] The parts joining unit 24 joins together parts such as the sleeves, collar, front body, rear body, pockets, wrists of a garment, to configure a shape of the garment, and stores pattern data of the garment. A 3D simulator 26 dresses a human body stored in a human body model storage 30, in the virtual garment generated by the parts joining unit 24, and three-dimensionally simulate the dressing result. As a result, three-dimensional data expressing the state in which the human body model is dressed in the virtual garment can be obtained. An aligning unit 28 aligns the center of the garment (the point B in Fig. 4) with the center of the human body model (the point A in Fig. 4) with respect to a horizontal direction. The human body model storage 30 stores the three-dimensional data of the human body model. The human body model may be any general model that does not correspond to an individual human or may be based on an actual measured value of a human shape.

[0018] A darts arranging unit 32 arranges darts on the garment. A plurality of the darts are arranged within, for example, one horizontal plane, such as around the waist. A space processor 34 obtains the perimeter of the garment from the pattern data along a line in which the darts are arranged, and then obtains the difference between the perimeter of the garment and the perimeter of the human body model. When the garment is thick, the inner perimeter of the garment is obtained. A certain amount of margin is required in order to have the human body dressed in the garment. Margins d, f are considered as parameters, where d is a margin of the perimeter, whereas f is a margin of the distance between an inner surface of the garment and the front surface of the human body model. The space processor 34 distributes, to each of the darts, the result obtained by subtracting the margin d from the difference S between the perimeter of the

garment and the perimeter of the human body model (S - d). Note that, in this garment, a seam section between the front body and the rear body is double-stitched as with the darts. Although this double stitching is not normally referred to as a dart, the detail of this process is the same as that on a dart. Therefore, this process is included in the darts in this specification. The position of the seam section between the front body and the rear body does not have to be designated. The space processor 34 obtains the distance between the inner surface of the garment and the human body model from the 3D simulation result, and the result obtained by subtracting the margin d from the difference S in perimeter is distributed to each dart so as to be proportional to this distance. This distributed value is set as the width of each dart.

[0019] The space processor 34 further extends the darts along an axial direction of the human body model, which is, in the case of a skirt, a direction from the waist to the hip, and, in the case of a blouse or a jacket, directions from the waist to both the chest and the hip. Then, in accordance with the distance between the garment and the human body model, the width of each dart is determined based on a plurality of points on an extended line. For example, the width of each dart that is obtained at the position of the waist is changed in proportion to the distance between the human body model and the garment on the extended line. At this moment, the difference in perimeter does not need to be obtained on the extended line of the dart. On the other hand, the difference between the perimeter of the garment and the perimeter of the human body model and the distance between the human body model and the garment may be obtained at each point on the extended line of the dart, and the difference in perimeter may be distributed to each dart. The space processor 34 further measures a gap between the garment and the human body model on the extended line of the dart, and sets an end point of the dart when the gap is equal to or lower than the margin f. The symbol "f" here is, for example, a constant common in the darts.

[0020] A dart shape creating unit 36 determines the shape of each dart by using a starting point of the dart obtained by the darts arranging unit 32, the width of the dart and the end point of the dart, which are obtained by the space processor 34. In this manner, an isosceles triangular or curved dart shape is determined. Arranging the darts, processing the space (the width and length of each dart), and determining the dart shape may be performed on one of the right and left sides of the garment, and a copy unit 38 copies these data onto the other one of the right and left sides of the garment symmetrically. Once the design of the darts is determined as described above, the design editing unit 39 changes the design data of the garment and adds the darts to the design data.

[0021] The design of the darts is described with reference to Figs. 2 to 7. The garment is designed, and a state in which the human body model is dressed in the garment is simulated three-dimensionally. For example, reference numeral 40 in Fig. 3 is a pattern of the garment, which is pattern data or a pattern paper. The pattern of the garment means pattern data in terms of data processing. Reference numeral 42 represents the human body model. Fig. 3A shows a side view of the worn state, and Fig. 3B shows a front view thereof. The positions (base points) of the darts are expressed by black circles •. The darts are extended from these positions, in the directions of the arrows. The points where the garment nearly comes into contact with the human body model are set as the end points of the darts. Therefore, the pattern 40 fits the human body model 42 at the end points of the darts.

[0022] The width of each of the darts is determined as illustrated in Figs. 4 to 6. The index "i" hereinafter represents the number of each dart. The symbol "Li" represents the distance between the inner perimeter and the front surface of the human body model. Since the human body model and the garment are supposedly symmetrical, the distance between the garment and the human body model is the same between two symmetrical darts. In addition, the center of the human body model is taken as A, and the center of the garment is taken as B. When these centers are not aligned in the horizontal direction, a problem is considered to be present in dressing simulation, and the positions of the centers are aligned in the horizontal direction. The lower side of Fig. 4 shows the front surface, and the upper side shows the rear surface.

[0023] The perimeter of the human body model can be found out at the position of the waist or the like, and the inner perimeter of the garment is also obtained from the pattern data or 3D simulation data. The margin d that is required for putting the garment is subtracted from the difference in perimeter, and thus obtained result is distributed to the darts. For example, suppose that the difference in perimeter is S, the distance between the garment and the human body model is Li, the margin required in the perimeters is d, and the margin required in the distance between the human body model and the garment is f. The width Wi of ith dart is:

$$W_i = (S - d) \times (L_i - f) / \sum_i (L_i - f)$$

[0024] Next, the darts are extended long the axial direction of the human body model, which is, in the case of Fig. 3, from the waist to the hip, to obtain how the distance Li changes at the plurality of positions in the middle. This state is shown in Figs. 5 and 6, wherein the dashed line on slightly the inside of the pattern 40 indicates a space corresponding to a margin. By changing the width of the dart in accordance with the obtained Li, the curved dart shown in Fig. 5 or the linear dart shown in Fig. 6 can be obtained.

[0025] These processes may be executed on half of the plurality of symmetrical darts, and the arrangement and shapes of these darts may be copied to the other half. Such a condition is shown in Fig. 7, wherein, for example, three dart forming positions P1 to P3 are designated on one of the right and left sides of the pattern 40, and the distances L1 to L3 between the human body model and the pattern 40 and 1/2 of the difference S in perimeter (S/2) are obtained. Dart forming positions P1' to P3' are obtained on the other one of the right and left sides, and the widths L1 to L3 of the darts may be made symmetrical.

[0026] Figs. 8 to 11 show examples of the designs of the darts. Fig. 8 shows the human body model and the pattern paper surrounding the human body model (before forming the darts), wherein the right-hand side of the diagram shows a horizontal cross section of the waist part of the human body model (thin line) and the pattern (thick line). Fig. 9 shows a cross section of the hip part of the human body model and the pattern paper. For example, on the display showing the cross section of the human body model and the pattern surrounding the human body model, as shown in the upper right in Fig. 8, the positions where the darts are to be formed are designated on the right or left side, by using the mouse. Instead of designating the positions of the darts on the cross sectional display, the positions of the darts may be designated by, for example, slowly rotating the human body model and the pattern on a side view, front view or rear view of the human body model and the pattern paper. However, the positions of the darts can be input more accurately by using the cross section.

[0027] The positions of the darts may be input around one complete circle of the garment, but it is only necessary to input the positions of the darts only on the right or left side. Since a certain level of experimental rule is required for providing the positions of the darts, for example, only the number of darts may be input and then the darts may be arranged around, for example, the waist part in accordance with the experimental rule. Since the pattern is normally divided into two sections, the front section and the rear section, when automatically arranging the darts, a seam allowance needs to be marked on the border between the front section and the rear section of the pattern, and the darts are provided on this border as well. Darts other than the darts on the border are arranged in appropriate positions in the front section and the rear section in accordance with the experimental rule.

[0028] Fig. 10 shows a worn state of the pattern paper in which the darts are formed according to the embodiment. The right-hand side of the diagram shows a cross-section of the waist position of the pattern paper and the human body model. In Fig. 10, the lines running downward on the pattern paper from the waist represent the darts.

[0029] Fig. 11 shows the pattern obtained before the darts are created, as well as the pattern obtained after the darts are created, wherein the front side (the right-hand side of the diagram) and rear side (left-hand side) of a skirt are shown. Reference numerals 51 to 55, 51' to 55' represent normal darts, which are arranged symmetrically. Reference numeral 56, 56' represent darts where the front side and the rear side are stitched together.

[0030] The darts can be applied not only to skirts but also to any type of garment including jackets, one-piece suits, women's dresses, children's clothes and men's clothes. The types of skirts are arbitrary. In the example of parts 60 to 66 shown in Fig. 12, the part 60 is a front body, the part 61 a rear body, and the part 62 is a right or left side front body. The part 64 is a front right or left side of a skirt, and the part 66 is a part that is sewn with the upper side of the half body 64 of the skirt. Reference numerals 70 to 76 represent darts. The darts 70, 71 and 73 thin down at the upper and lower sides thereof, from the waist position. Therefore, the darts are extended from the waist position shown by the horizontal lines, to the upper and lower sides, in order to determine the shapes of the darts. The dart 72 is a dart for three-dimensionally expanding the part 62 at the chest section. The parts 66 and 64 are stitched together at the darts 74 and 76 so that the upper end of the dart 74 is overlapped with the lower end of the dart 76.

[0031] Fig. 13 shows how to determine the shape of a dart like the dart 72 for accomplishing the three-dimensional expansion. Since the position of a bust top is already known, a distance r from this position to an end of the right or left side of the garment is obtained. With the dart 72, the garment bulges at the bust top as the center. The greater the cutting edge angle θ , which is formed by the dart 72, is, the greater the height h. The height by which the garment bulges is expressed by a letter "h," and the cutting edge angle θ of the dart is expressed in the radian unit. Suppose that the garment forms a circular cone in the circumference of the bust top. The distance between the top of the circular cone and the circumference is r, the height is h, and the perimeter of the bottom surface of the circular cone is $r \times (2\pi - \theta)$. Therefore, a radius R of the bottom surface of the circular cone is $R = r(1 - \theta/2\pi)$, which becomes, based on the Pythagorean theorem,

$$h = (r^2 - R^2)^{1/2} = r(\theta/\pi)^{1/2}(1 - \theta/4\pi)^{1/2} \cong r(\theta/\pi)^{1/2}(1 - \theta/(8\pi)).$$

In this manner, θ is obtained from h and r, whereby the width of the dart is defined. The rest are similar to the embodiment illustrated in Figs. 1 to 11, and the dart 72 is, for example, symmetrical.

[0032] The following effects are achieved in the embodiment.

- (1) The darts can be designed automatically by inputting the positions where the darts are to be formed.
 (2) The width and length of each dart can be obtained automatically such that the garment fits the human body model.
 (3) The end points of the darts are positioned such that the garment nearly fits the human body model.
 (4) Since the distance between the garment and the human body model is obtained based on the points on the
 5 extended lines of the darts, the garment fits the human body model at not only the starting points or end points of
 the darts but also the positions in the middle.

[0033] In the embodiment, certain positions on the garment that correspond to certain positions on the human body
 10 model are obtained in the 3D simulation, and the perimeter itself of the garment is obtained from the pattern data along
 the obtained positions. In addition, the distance between the garment and the human body model is obtained in the 3D
 simulation. However, the perimeter of a deformed garment may be obtained by the 3D simulation.

[0034]

2	Designing device
15 4	Bus
6	Color monitor
8	Mouse
10	Keyboard
12	Color printer
20 14	LAN interface
16	Removable memory
18	Scanner
20	Memory
22	Image memory
25 24	Parts joining unit
26	3D simulator
28	Aligning unit
30	Human body model storage
32	Dart arranging unit
30 34	Space processor
36	Dart shape creating unit
38	Copy unit
39	Design editing unit
40	Pattern
35 42	Human body model
45, 46	Dart
51 to 55	Dart
56, 56'	Stitching position
60 to 66	Part
40 70 to 76	Dart
D1 to D3	Depth of dart
L1 to L3	Space
P1 to P2	Dart position
P3	Stitching position
45 A	Center of human body model
B	Center of pattern

Claims

- 50 1. A dart designing method for designing a garment by three-dimensionally simulating a worn state of the garment on
 a human body model (42) and displaying an image obtained by the simulation, on a color monitor (6),
 the dart designing method comprising:

55 a generation step of generating, on the garment, a plurality of positions where darts (45, 46, 51 to 55, 70 to 76)
 are to be formed;
 a distance calculation step of obtaining a distance between the garment and the human body model (42) in
 each of the positions where the darts (45, 46, 51 to 55, 70 to 76) are to be formed;

a perimeter calculation step of obtaining a difference between a perimeter of the garment and a perimeter of the human body model (42), along the plurality of positions where the darts (45, 46, 51 to 55, 70 to 76) are to be formed;

a width determination step of determining a width of each of the darts (45, 46, 51 to 55, 70 to 76), such that the width of each of the darts (45, 46, 51 to 55, 70 to 76) increases as the distance between the garment and the human body model (42) increases in each of the positions where the darts (45, 46, 51 to 55, 70 to 76) are to be formed, and that the width of each of the darts (45, 46, 51 to 55, 70 to 76) increases as the perimeter difference increases; and

a length determination step of determining a length of each of the darts (45, 46, 51 to 55, 70 to 76), such that each of the darts (45, 46, 51 to 55, 70 to 76) is extended along an axial direction of the human body model (42), and that a point, on an extended line of each of the darts (45, 46, 51 to 55, 70 to 76), where the distance between the garment and the human body model (42) is equal to or shorter than a predetermined value, is set as an end point of each of the darts (45, 46, 51 to 55, 70 to 76),

the dart designing method being **characterized in that**

the designing unit designs the darts (45, 46, 51 to 55, 70 to 76) in the garment, such that each of the positions generated in the generation step has the width determined in the width determination step, and that the point obtained in the length determination step is set as the end point.

2. The dart designing method according to claim 1, **characterized in that** the length determination step obtains the distance between the garment and the human body model (42) in a plurality of positions on the extended line of each of the darts (45, 46, 51 to 55, 70 to 76), and determines the width of each of the darts (45, 46, 51 to 55, 70 to 76) along the extended line such that the width of each of the darts (45, 46, 51 to 55, 70 to 76) increases as the obtained distance increases.

3. The dart designing method according to claim 1 or 2, **characterized in that** the positions where the darts (45, 46, 51 to 55, 70 to 76) are to be formed, the width of each of the darts (45, 46, 51 to 55, 70 to 76), and the length of each of the darts (45, 46, 51 to 55, 70 to 76) are determined with respect to one of the right and left sides of the garment, and the thus-obtained positions where the darts (45, 46, 51 to 55, 70 to 76) are to be formed, the width and the length are copied symmetrically onto the other one of the right and left sides of the garment.

4. A dart designing device (2), having a simulation unit for three-dimensionally simulating a worn state of a garment on a human body model (42), a color monitor (6) for displaying an image obtained by the simulation, and a designing unit for designing the garment,
the dart designing device (2) comprising:

generation means for generating, on the garment, a plurality of positions where darts (45, 46, 51 to 55, 70 to 76) are to be formed;

distance calculation means for obtaining a distance between the garment and the human body model (42) in each of the positions where the darts (45, 46, 51 to 55, 70 to 76) are to be formed;

perimeter calculation means for obtaining a difference between a perimeter of the garment and a perimeter of the human body model (42), along the plurality of positions where the darts (45, 46, 51 to 55, 70 to 76) are to be formed;

width determination means for determining a width of each of the darts (45, 46, 51 to 55, 70 to 76), such that the width of each of the darts (45, 46, 51 to 55, 70 to 76) increases as the distance between the garment and the human body model (42) increases in each of the positions where the darts (45, 46, 51 to 55, 70 to 76) are to be formed, and that the width of each of the darts (45, 46, 51 to 55, 70 to 76) increases as the perimeter difference increases; and

length determination means for determining a length of each of the darts (45, 46, 51 to 55, 70 to 76), such that each of the darts (45, 46, 51 to 55, 70 to 76) is extended along an axial direction of the human body model (42), and that a point, on an extended line of each of the darts (45, 46, 51 to 55, 70 to 76), where the distance between the garment and the human body model (42) is equal to or shorter than a predetermined value, is set as an end point of each of the darts (45, 46, 51 to 55, 70 to 76),

the dart designing device (2) being **characterized in that** the designing unit designs the darts (45, 46, 51 to 55, 70 to 76) in the garment, such that each of the positions generated by the generation means has the width determined by the width determination means, and that the point obtained by the length determination means is set as the end point.

5. The dart designing device (2) according to claim 4, **characterized in that** the length determination means obtains

the distance between the garment and the human body model (42) in a plurality of positions on the extended line of each of the darts (45, 46, 51 to 55, 70 to 76), and determines the width of each of the darts (45, 46, 51 to 55, 70 to 76) along the extended line such that the width of each of the darts (45, 46, 51 to 55, 70 to 76) increases as the obtained distance increases.

5 6. The dart designing device (2) according to claim 4 or 5, **characterized in that** the positions where the darts (45, 46, 51 to 55, 70 to 76) are to be formed, the width of each of the darts (45, 46, 51 to 55, 70 to 76), and the length of each of the darts (45, 46, 51 to 55, 70 to 76) are determined with respect to one of the right and left sides of the garment, and the thus-obtained positions where the darts (45, 46, 51 to 55, 70 to 76) are to be formed, the width and the length are copied symmetrically onto the other one of the right and left sides of the garment.

10 7. A dart designing program, **characterized in** causing, as a dart design device, a computer system, which has a simulation unit for three-dimensionally simulating a worn state of a garment on a human body model (42), a color monitor (6) for displaying an image obtained by the simulation, and a designing unit for designing the garment, to function as:

generation means for generating, on the garment, a plurality of positions where darts (45, 46, 51 to 55, 70 to 76) are to be formed;

20 distance calculation means for obtaining a distance between the garment and the human body model (42) in each of the positions where the darts (45, 46, 51 to 55, 70 to 76) are to be formed;

perimeter calculation means for obtaining a difference between a perimeter of the garment and a perimeter of the human body model (42), along the plurality of positions where the darts (45, 46, 51 to 55, 70 to 76) are to be formed;

25 width determination means for determining a width of each of the darts (45, 46, 51 to 55, 70 to 76), such that the width of each of the darts (45, 46, 51 to 55, 70 to 76) increases as the distance between the garment and the human body model (42) increases in each of the positions where the darts (45, 46, 51 to 55, 70 to 76) are to be formed, and that the width of each of the darts (45, 46, 51 to 55, 70 to 76) increases as the perimeter difference increases;

30 length determination means for determining a length of each of the darts (45, 46, 51 to 55, 70 to 76), such that each of the darts (45, 46, 51 to 55, 70 to 76) is extended along an axial direction of the human body model (42), and that a point, on an extended line of each of the darts (45, 46, 51 to 55, 70 to 76), where the distance between the garment and the human body model (42) is equal to or shorter than a predetermined value, is set as an end point of each of the darts (45, 46, 51 to 55, 70 to 76); and

35 means for using the designing unit to design the darts (45, 46, 51 to 55, 70 to 76) in the garment, such that each of the positions generated by the generation means has the width determined by the width determination means, and that the point obtained by the length determination means is set as the end point.

40 8. The dart designing program according to claim 7, **characterized in that** the length determination means obtains the distance between the garment and the human body model (42) in a plurality of positions on the extended line of each of the darts (45, 46, 51 to 55, 70 to 76), and determines the width of each of the darts (45, 46, 51 to 55, 70 to 76) along the extended line such that the width of each of the darts (45, 46, 51 to 55, 70 to 76) increases as the obtained distance increases.

45 9. The dart designing program according to claim 7 or 8, **characterized in** causing the computer system to function as means for determining the positions where the darts (45, 46, 51 to 55, 70 to 76) are to be formed, the width of each of the darts (45, 46, 51 to 55, 70 to 76), and the length of each of the darts with respect to one of the right and left sides of the garment, and symmetrically copying the thus-obtained positions where the darts (45, 46, 51 to 55, 70 to 76) are to be formed, the width and the length, onto the other one of the right and left sides of the garment.

FIG. 1

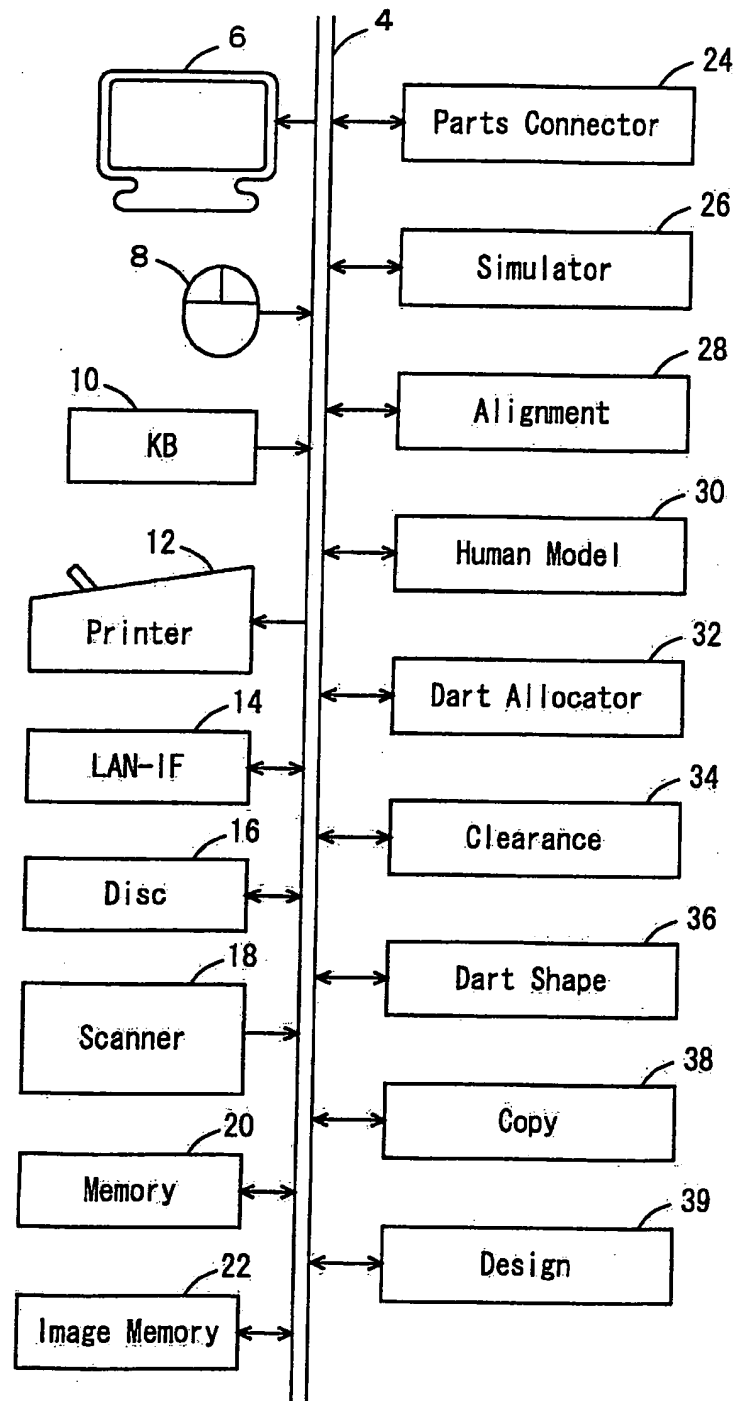


FIG. 2

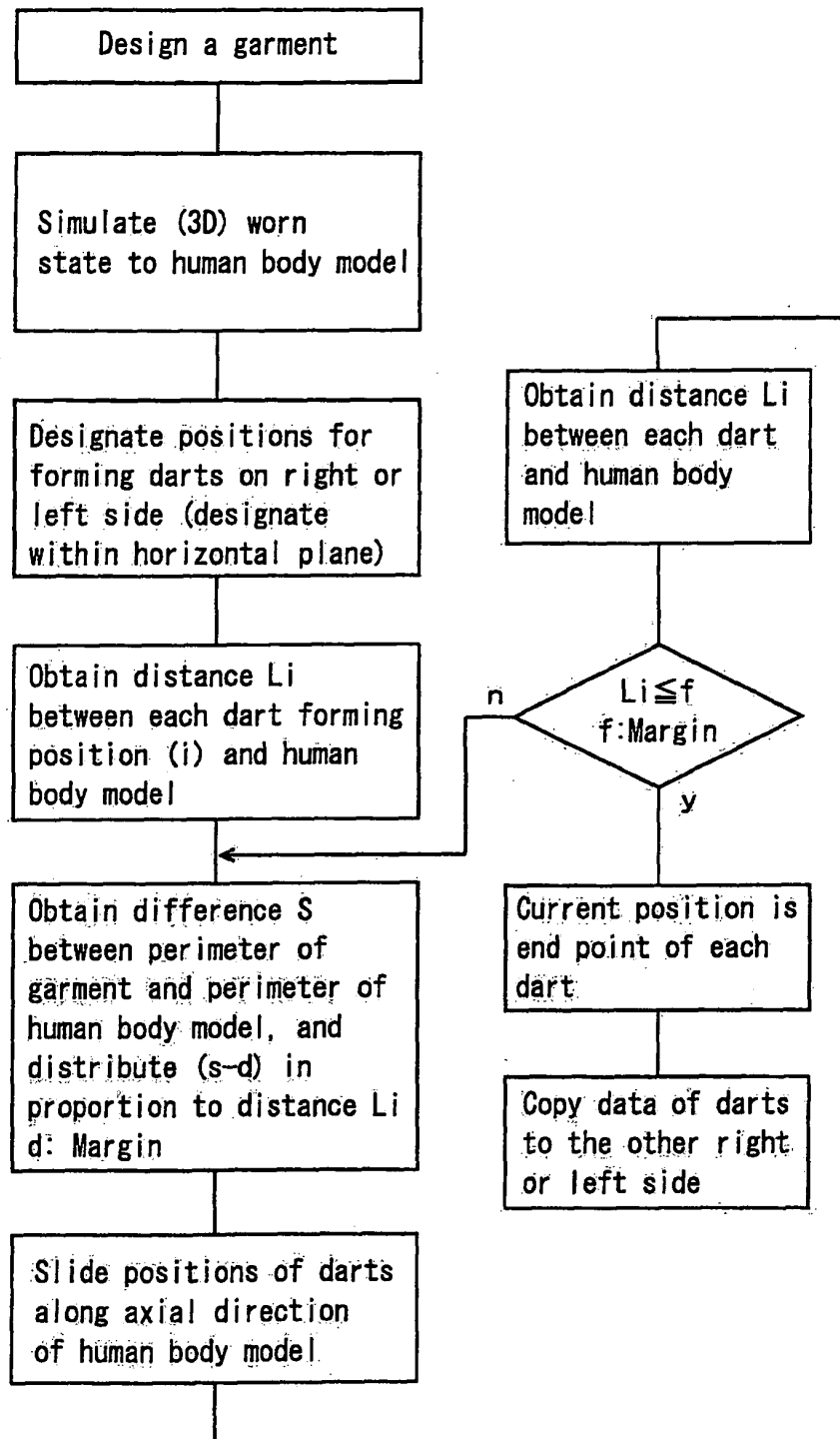


FIG. 3

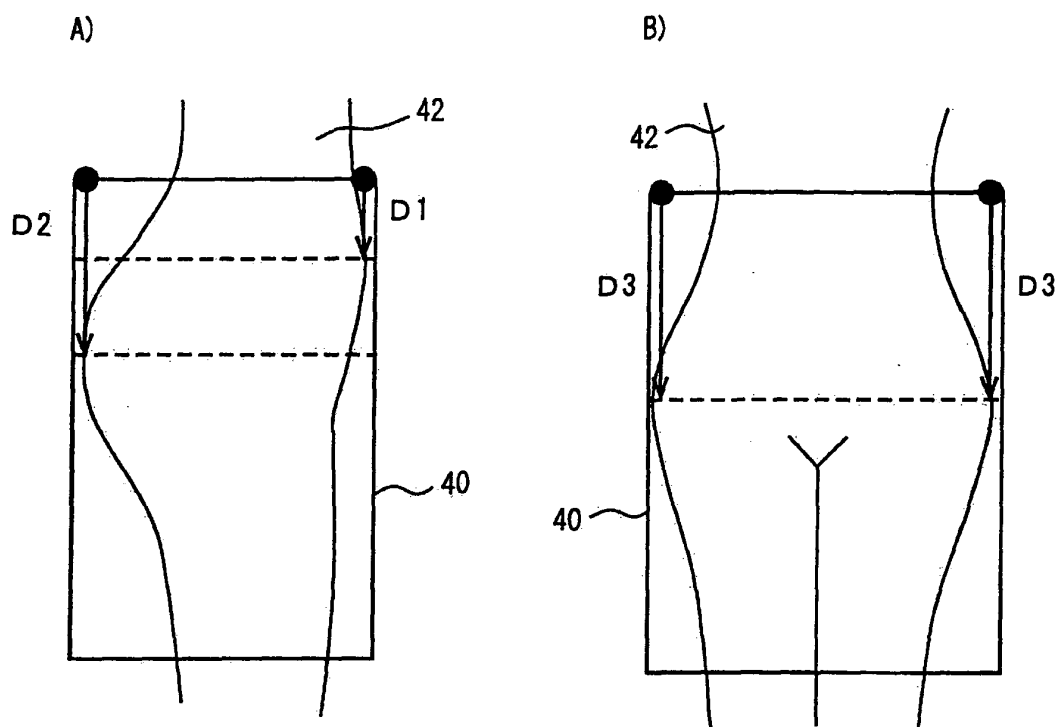


FIG. 4

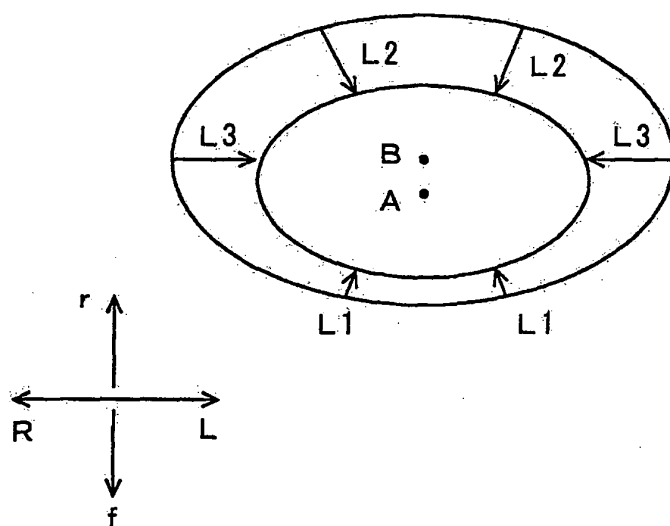


FIG. 5

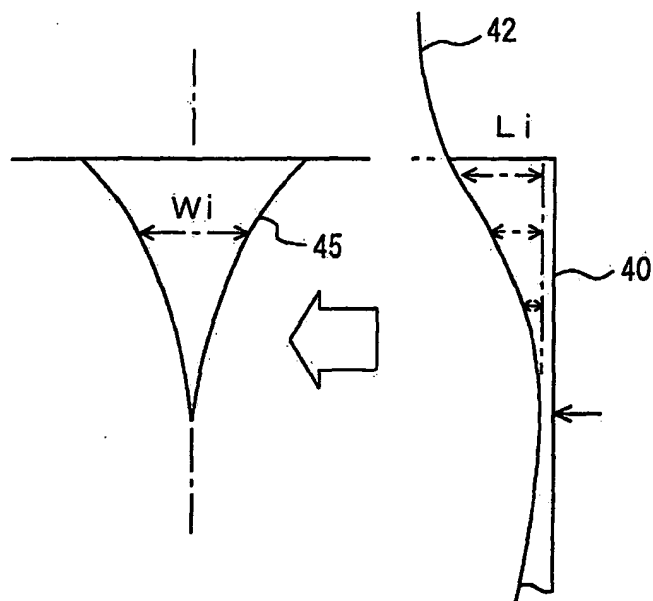


FIG. 6

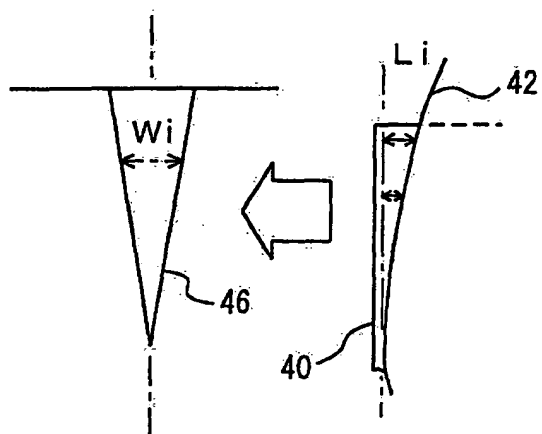


FIG. 7

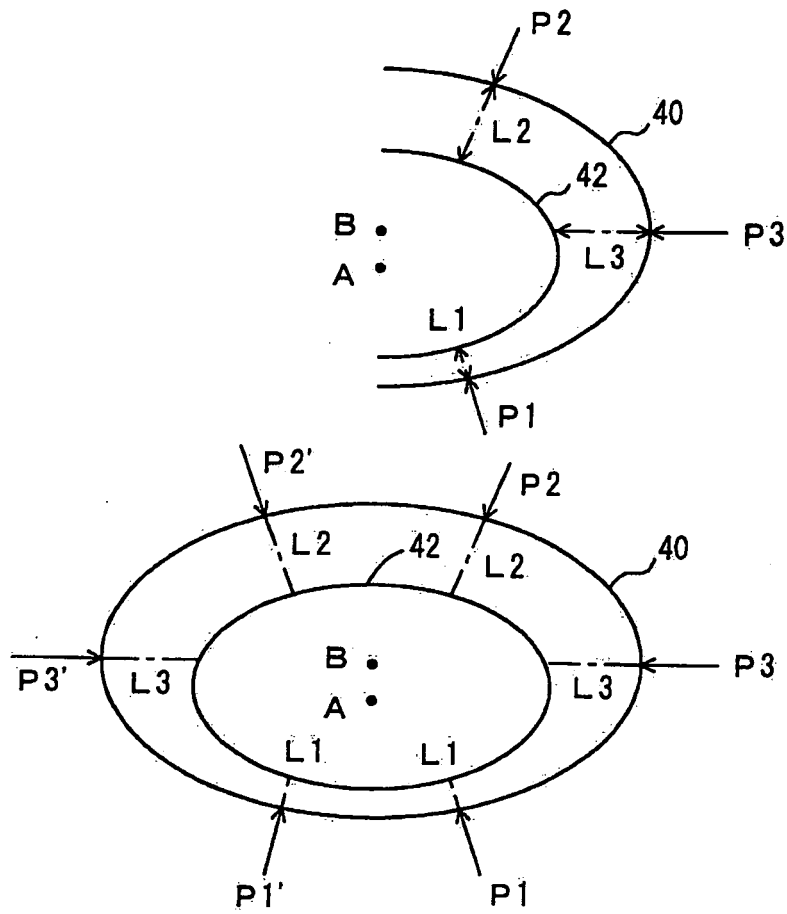


FIG. 8

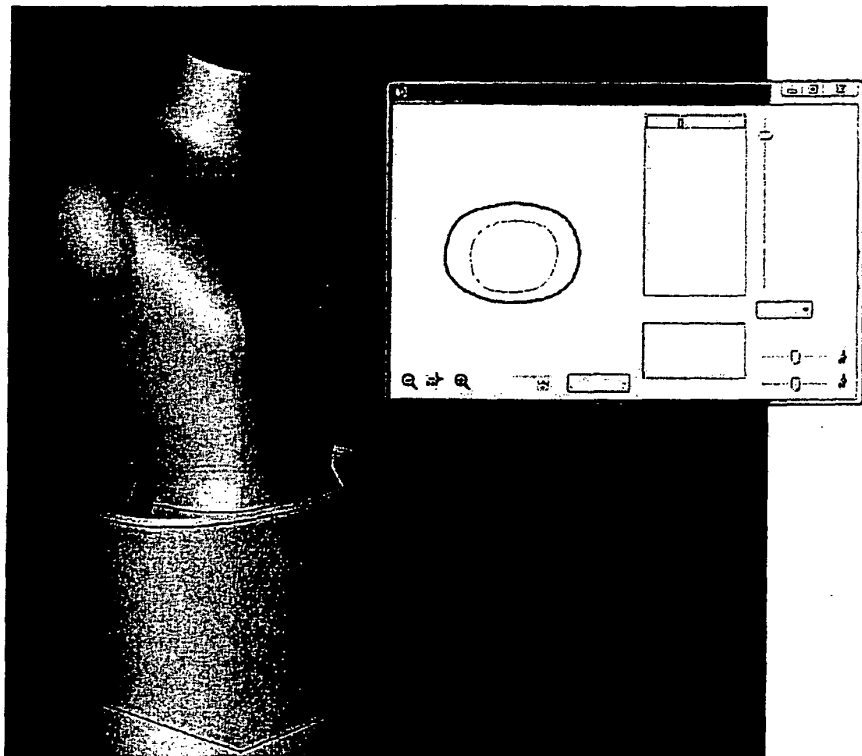


FIG. 9

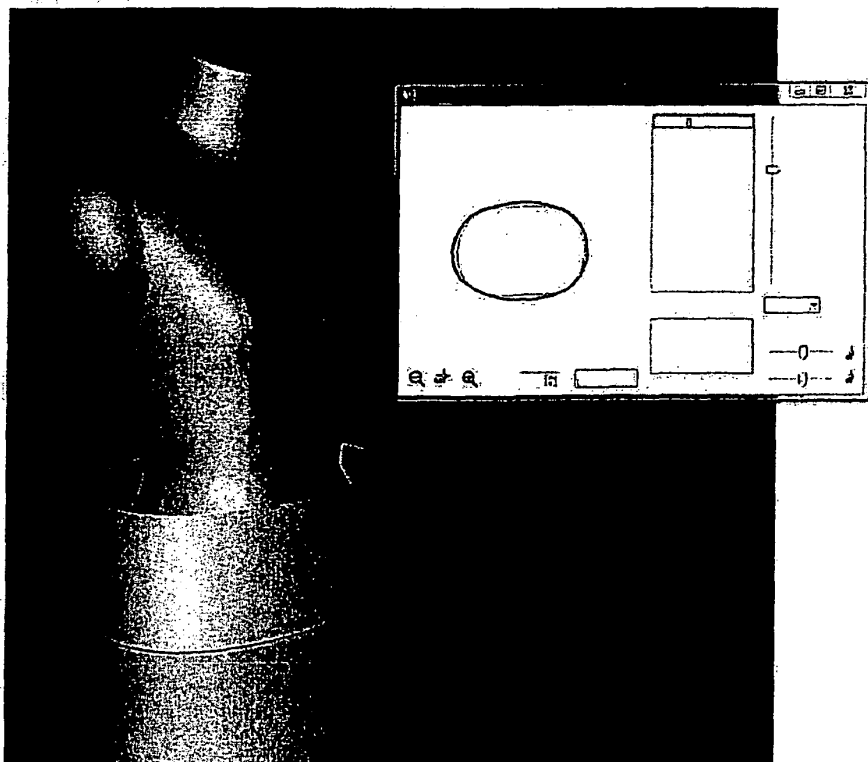


FIG. 10

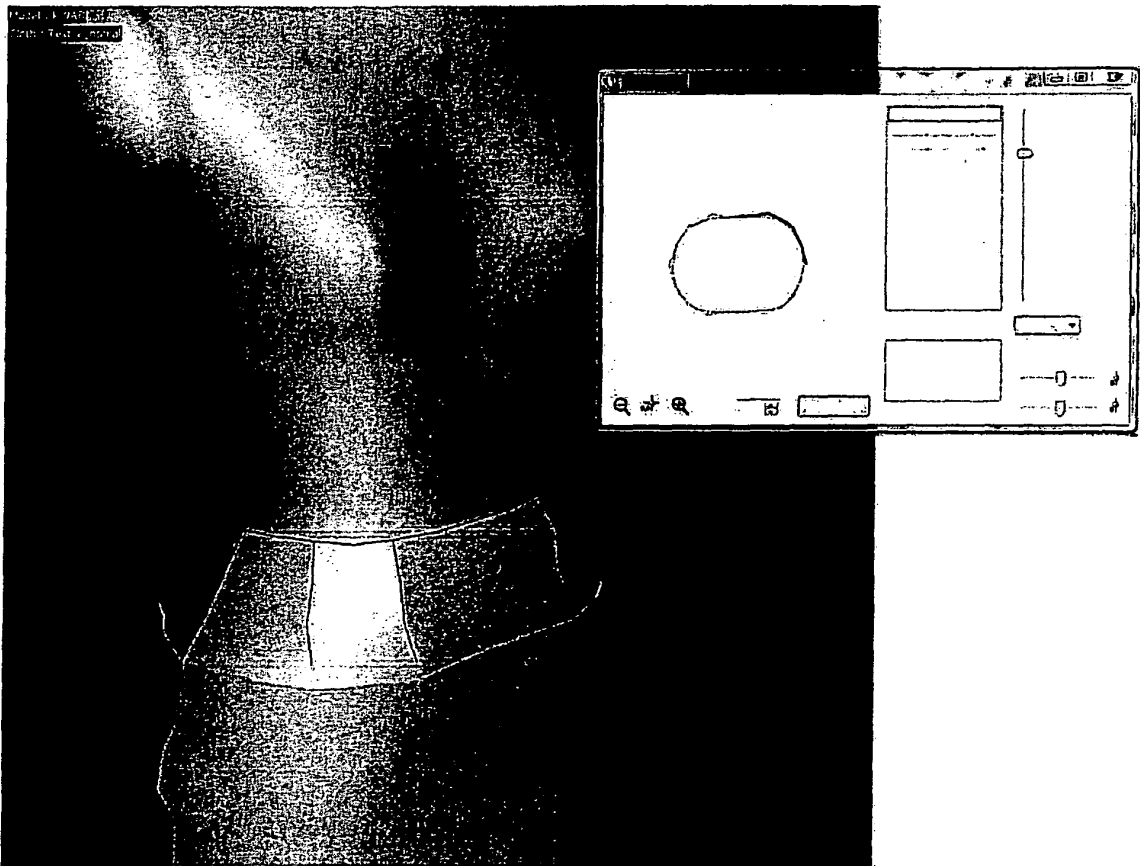


FIG. 11

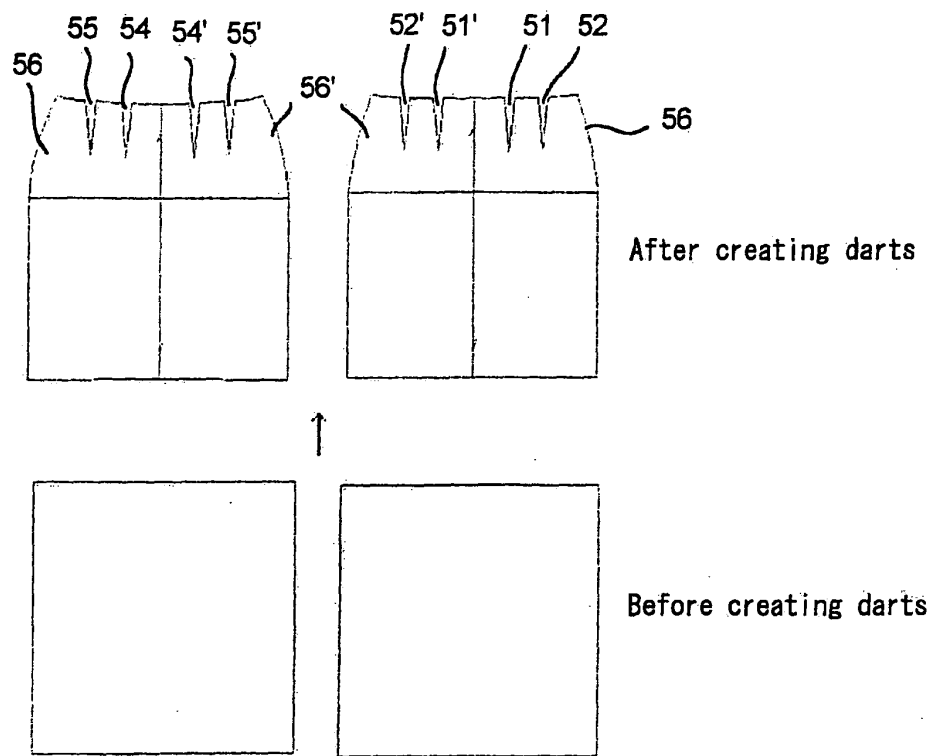


FIG. 12

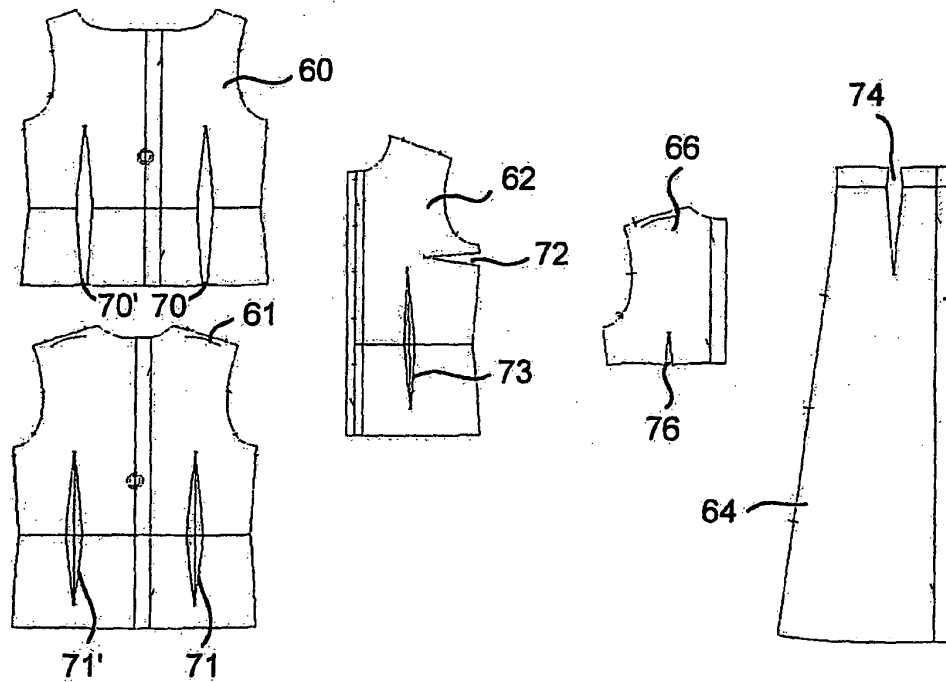
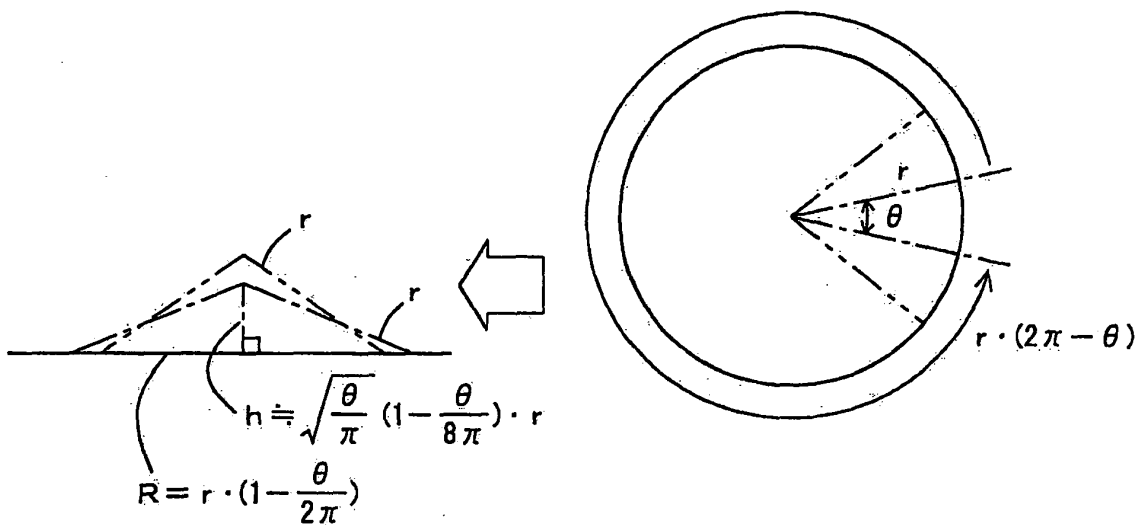


FIG. 13



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2009/064107

A. CLASSIFICATION OF SUBJECT MATTER

A41H43/00 (2006.01) i, G06F17/50 (2006.01) i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

A41H43/00, G06F17/50

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2009
Kokai Jitsuyo Shinan Koho	1971-2009	Toroku Jitsuyo Shinan Koho	1994-2009

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 8-325821 A (Toyobo Co., Ltd.), 10 December 1996 (10.12.1996), paragraphs [0070] to [0072] (Family: none)	1-9
A	WO 2007/071880 A1 (LECTRA), 28 June 2007 (28.06.2007), entire text; all drawings & JP 2009-520292 A & US 2009/0099683 A & EP 1973435 A & FR 2894783 A & FR 2894783 A1	1-9



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See patent family annex.

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Date of the actual completion of the international search
29 October, 2009 (29.10.09)Date of mailing of the international search report
10 November, 2009 (10.11.09)Name and mailing address of the ISA/
Japanese Patent Office

Authorized officer

Facsimile No.

Telephone No.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2009/064107

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 3-503911 A (Minnesota Mining & Manufacturing Co.), 29 August 1991 (29.08.1991), entire text; all drawings & US 4926344 A & US 4916634 A & US 4916624 A & EP 417103 A & WO 1989/008409 A1 & AU 3218089 A & BR 8907318 A	1-9
A	JP 2008-163525 A (Shima Seiki Mfg., Ltd.), 17 July 2008 (17.07.2008), entire text; all drawings & KR 10-2008-0063070 A & CN 101209134 A	1-9

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 8325821 A [0002] [0003]