



(51) International Patent Classification:

A61B 5/107 (2006.01) A61B 5/00 (2006.01)

(21) International Application Number:

PCT/EP2017/074952

(22) International Filing Date:

02 October 2017 (02.10.2017)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

1659563 04 October 2016 (04.10.2016) FR

(71) Applicant: L'OREAL [FR/FR]; 14 Rue Royale, 75008 PARIS (FR).

(72) Inventors: PIERRE, Julien; L'OREAL R&I Chevil-ly - 188, rue Paul Hochart BP553, 94152 CHEVILLY LA RUE (FR). FRANCOIS, Ghislain; L'OREAL R&I Chevil-ly - 188, rue Paul Hochart BP553, 94152 CHEVILLY LA

RUE (FR). FLAMENT, Frédéric; L'OREAL R&I Chevil-ly - 188, rue Paul Hochart BP553, 94152 CHEVILLY LA RUE (FR). COLOMB, Loïc; L'OREAL R&I Chevil-ly - 188, rue Paul Hochart BP553, 94152 CHEVILLY LA RUE (FR). BELHEDI, Amira; 44, rue de la Patience La Marsa Ouest, TUNIS (TN). KOUDORO, Serge; 16, rue des Cerisiers, 77210 SAMOREAU (FR). DECENCIERE, Etienne; MINES ParisTech 35, rue Saint Honoré, 77300 FONTAINEBLEAU (FR).

(74) Agent: CABINET NONY; 11 rue Saint-Georges, 75009 PARIS (FR).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ,

(54) Title: METHOD FOR CHARACTERIZING HUMAN SKIN RELIEF

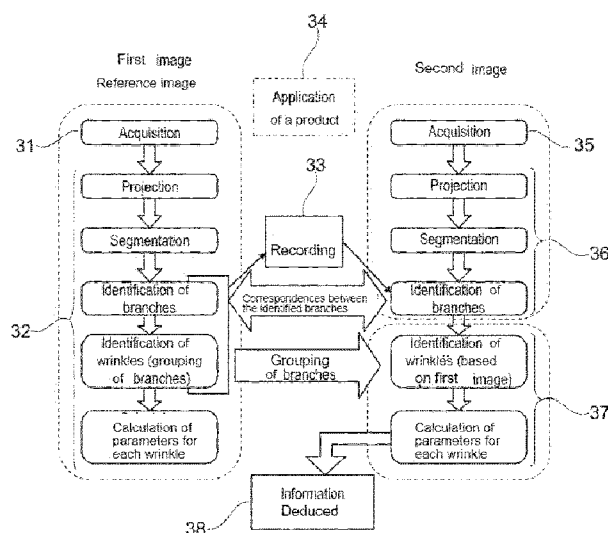


Fig. 12

(57) **Abstract:** The present invention relates to a method for characterizing human skin relief, notably signs relating to skin ageing, comprising the step of processing an acquisition of data representative of a person's skin relief at a given instant, in order to: - identify at least one characteristic object of this relief, - store at least one information element that can be used for individually recognizing the object or objects thus identified during the processing of a new acquisition carried out at a subsequent instant, and - allow the quantification of a change in at least one descriptor of this object or these objects, by comparison of the data between acquisitions.



OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA,
SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN,
TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

- (84) Designated States** (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

METHOD FOR CHARACTERIZING HUMAN SKIN RELIEF

The present invention relates to the observation and characterization of human skin relief, notably signs related to the ageing of the skin, with the aim, notably, of evaluating the efficacy of a cosmetic treatment.

5 The characterization of skin is essential for the evaluation of the efficacy of cosmetic products, notably in anti-ageing applications. In particular, the detailed and precise characterization of wrinkles is indispensable for the understanding of skin ageing, and for the clinical evaluation of the effects of anti-ageing care products, for the purpose of refining the offer of products to consumers, for example.

10 These products for reducing the visibility of wrinkles may have different mechanisms of action on skin relief, for example optical, biomechanical and/or biological effects. The action of such a product at the “*microscopic*” scale, on a given facial wrinkle, for example, such as a crow’s feet wrinkle, influences effects which can be seen at the “*mesoscopic*” scale, for example the eye contour, and at the “*macroscopic*” scale, for example at the scale of the whole face, as shown in Figure 1.

15 There are quantitative methods, known as “*global*” methods, relating to the measurement of wrinkles, which consist in measuring parameters, on the basis of the acquisition of an image of an area of the skin, over all the wrinkles in this area. These methods provide, notably, parameters of real or apparent linear or surface roughness, which reflect a general surface state of the skin, or overall smoothing, but cannot be used
20 to decode the mechanism of the action of a product or to describe the relief precisely, in terms of the number of wrinkles or their size, for example.

Other known methods consist in the analysis of histograms of the depths of skin relief, but are also subject to the limitations mentioned above in the description of wrinkles.

25 The method known as the “*cast shadows*” method consists in photographing impressions of wrinkles under lighting with a fixed angle of incidence. An image analysis is then performed in order to extract geometric parameters of the wrinkle shadows, related to the depth or the length of the wrinkles, for example. The objects can then be classified by length or depth, and the movements of populations of objects from one class to another
30 during cosmetic treatment are then evaluated.

However, this method cannot be used to measure the change in the geometric descriptors of each object from one measurement period to another. Nor can it be used to

provide an exhaustive description of the wrinkles or the effects of anti-ageing products, because parameters such as the width or volume of the wrinkles cannot be obtained. Furthermore, the positioning and repositioning of the impressions during acquisition, and of the regions of interest during the analysis phase, are particularly complicated.

5 There are methods known as "*object-based*" methods, consisting in detecting objects corresponding to wrinkles on the basis of a two-dimensional (2D) or three-dimensional (3D) image. The algorithms used are simple, using thresholding or the histogram of the image for example, resulting in the elimination of non-optimal objects. In the case of wrinkle observation, it is difficult, notably, to isolate a main wrinkle from the
10 secondary wrinkles surrounding it. Moreover, although detection is by object, no result is provided by object, and, in the case of wrinkles for example, only the means of the geometric parameters of the wrinkles are provided for a given area, making it impossible to analyse the changes in wrinkles precisely.

Patent application WO 2013/112974 discloses the use of a device having a
15 graduated scale to evaluate the seriousness of wrinkles, so that suitable treatment can be proposed, the degrees of the graduated scale depending on physical characteristics of the wrinkles such as their length and depth.

Patent application KR 2010-0093431 relates to a method for estimating a person's age by measuring the properties of his wrinkles, such as their length, their depth
20 or their width, using grey level images representing a set of wrinkles.

Patent application FR 2 984 108 describes a method for observing a biological tissue, consisting in acquiring a 3D image by multi-photon excitation for signals emitted by said tissue, and using image processing to determine a segmentation of said tissue into at least two regions. The aim of this method is, notably, to evaluate the effect of active
25 substances used in skin treatment.

Patent application EP 1 986 049 discloses the use of a lenticular network to cause different images, representing different aspects of keratinous substances, to appear in succession. The images can be used to identify at least one image corresponding to an actual degree or one desired by the consumer, the accepted image being intended to serve,
30 for example, as a target to be achieved at the end of a treatment, or to evaluate the efficacy of a treatment.

Patent application EP 1 297 781 describes a method for monitoring the effects of cosmetic treatment, executed by comparing photographs taken at different stages.

These methods cannot be used to characterize in a targeted and satisfactory way the relief elements, particularly the wrinkles, of one area of the body independently of the others, with the aim, notably, of studying the change, element by element, after the application of a care product.

Consequently there is a need to improve further the methods of characterizing human skin relief, for the purpose, notably, of facilitating the search for a suitable cosmetic treatment, and/or evaluating the efficacy of a cosmetic treatment.

The object of the invention is to meet this need, which is achieved, according to one aspect of the invention, by means of a method for characterizing human skin relief, notably signs relating to skin ageing, comprising the step of processing an acquisition of data representative of a person's skin relief at a given instant, in order to:

- identify at least one characteristic object of this relief,
- store at least one information element that can be used for individually recognizing the object or objects thus identified during the processing of a new acquisition carried out at a subsequent instant, and
- allow the quantification of a change in at least one descriptor of this object or these objects, by comparison of the data between acquisitions.

The characteristic object or objects of the skin relief identified during processing are, advantageously, wrinkles or fine wrinkles, notably crow's feet wrinkles.

The invention can be used to detect and isolate precisely each characteristic object of the skin relief in an acquisition. The method according to the invention provides a high level of precision, so that, for example, a complex network of wrinkles can be analysed into a main wrinkle and secondary wrinkles. Individual analysis of each wrinkle, wrinkle by wrinkle, is possible. The invention can be used to analyse the whole skin relief, including microreliefs such as wrinkles or fine wrinkles. The analysis of several wrinkles may be performed in parallel, wrinkle by wrinkle.

The invention can be used to measure human skin relief, notably wrinkles, according to numerous useful geometric criteria, such as length, width, depth, volume or curvature.

The invention can be used not only for classifying objects according to different geometric criteria, but also for indexing and monitoring objects, on an object by object basis, making it possible, notably, to provide exhaustive description and monitoring of the effects of cosmetic treatment over time.

5 The invention can be used to provide information for a better understanding of the general perception of consumers, since the effects of anti-ageing products can be described with the provision of targeted information at the scale of a single wrinkle or even a fine wrinkle.

10 The invention can be used to judge the effects of an anti-ageing product on a localized area of a person's skin, by comparing changes in the wrinkles by performing acquisitions before and after the application of the product, after a predetermined time interval, even between the night and the morning, for example, in the case of what is known as a "*night*" cream, or at different stages of the treatment, for example after three weeks, then one month, then three months, and so on.

15 A first acquisition is advantageously performed before the application of an anti-ageing product, a second acquisition being performed after the application of said product, at the end of a predetermined time interval, in order to evaluate the effect of the product. The first acquisition is considered to be the reference acquisition.

20 In a variant, or in combination, different acquisitions are performed for different states of the area to be characterized, notably for deformations caused by the face muscles, particularly after a contraction and relaxation of the zygomatic and/or eyebrow muscles when the person smiles and/or frowns. Thus the invention contributes to the knowledge and/or diagnosis of a person's skin. In fact, during a movement of the face, the features change, the wrinkles or fine wrinkles deepen and/or curve and appear in a
25 different way for each person. These modes of deformation of the face, not perceptible in a simple static image, can be perceived by means of the invention, and can be used, for example, to offer suitable treatment for the skin of the person being tested. In a variant, the deformation may be due not only to a muscle movement, but also to the presence of a device for compressing or stretching the skin, such as an adhesive strip or any other
30 element fixed to the skin and having this type of effect.

 The method according to the invention advantageously allows for the nature of the objects in order to detect them, notably their morphology, their depth, their alignment,

or their organization in networks. This enables the relevant objects to be found rapidly and effectively isolated from one another.

An acquisition system may be used to acquire data representative of the skin relief. The acquisition system may perform a 3D acquisition on the skin surface, carried out on impressions or directly on the skin, and executed by using, notably, a fringe projection method or stereophotogrammetry, in order to provide replicas of the skin relief. In a variant, the acquisition system is configured to take a 2D image of the desired area, for example a colour image or a grey level image.

Each acquisition advantageously produces a cloud of points, on the x, y and z coordinates in the case of 3D acquisition. This cloud of points may be recorded in a computer file, for example in the “*ply*” format (for “*polygon file format*”). The cloud of points may be accompanied by other data, such as one or more physical values associated with each point, for example the colour or brightness. A projection of the cloud of points is advantageously performed to provide a two-dimensional image, which is easier and quicker to analyse and display.

After the projection of the cloud of points, segmentation is advantageously applied to the image of the cloud of points in order to detect which points belong to the object or objects, for the purpose of identifying them. In the case of wrinkle observation, the points detected in this way form a mask of the wrinkle network. In this case, the cloud of points is, notably, representative of the hollows and protrusions forming a wrinkle on the surface of the face, enabling each wrinkle to be isolated.

In the present application, the term “*segmentation*” is used for “*image segmentation*”, an expression relating to the field of image processing and corresponding to the division of an image into different areas in order to separate the various visible components and identify them.

Each object defined in this way is preferably individualized and indexed, the corresponding points of the cloud of points being associated with the information, corresponding to a unique label, which enables the object to be individually recognized. The cloud of these labelled points enables the objects to be indexed.

The cloud of points can be analysed and it is possible to extract said at least one descriptor of the identified object or objects, for example the length, depth, width, curvature, tortuosity, or volume of the object. This may cause the objects to be classified

according to a given physical parameter, according to the length in the case of wrinkles for example, so that, notably, large wrinkles can be distinguished from medium or fine wrinkles.

In the case of wrinkles, objects may be treated as branches (elementary relief
5 objects), some branches being grouped together while others are not, to form the wrinkles. This grouping is advantageously based on a length criterion and an orientation criterion: if two branches can be grouped with a third, the choice between these two branches may be based on the greatest length of the grouping, that is to say either "*length of branch 1 + length of branch 3*" or "*length of branch 2 + length of branch 3*", and of the angle between
10 the two branches, for example a small angle between branch 1 or 2 and branch 3.

When a network of objects is identified on the basis of the cloud of points, measurements may be made on the basis of the network of objects as a whole, notably on the basis of the mask of the network of wrinkles in the case of wrinkles, for example the standard deviation of the depth of the points of the cloud relative to a reference plane, the
15 roughness of the surface described by the cloud of points, the number of points belonging to the mask of the wrinkles, the number of wrinkles, and the mean length of the wrinkles. The method according to the invention thus enables intra-object and inter-object measurements to be made.

In a preferred embodiment of the invention, the clouds of points of two
20 different acquisitions of the same area are compared, so as to extract measurements on the basis of these two acquisitions. To allow the effective comparison of the two clouds of points, the latter may be superimposed and spatially adjusted, resulting in an adjusted cloud of points for the second acquisition relative to the first acquisition, which is used for comparison.

25 Among a given set of transformations, for example translation, rotation, homothety or non-rigid transformation, it is possible to seek the transformation that allows the best approximation to a first cloud of points of a second cloud. Distance calculations between the clouds of points may then be performed, the distances being minimized when the two clouds are brought closer.

30 A correspondence may be established between the objects of the two acquisitions, in order to characterize the changes in the descriptor or descriptors of each object over time or in a different state.

A table called a “*contingency*” table may be drawn up to associate each object detected during the first acquisition with the number of pieces of information in common with each object detected in the new acquisition, for example the number of common pixels in the case of images. If this number is zero or small, the objects are considered to be different. Conversely, the maxima in the table advantageously indicate that a correspondence between two objects exists a priori. By using such a table it is possible to detect the association or dissociation of objects, or the appearance or disappearance of objects, between different acquisitions.

The following measurements may be used to characterize the changes in the cloud of points: the variation of the surface roughness, the absolute and relative variation of the number of points belonging to the network of objects, the variation of the number of objects or the proportion of objects in a given class, their position and orientation in the image, or the change in the mean length or any other geometric parameter of the objects, notably in the case of wrinkles.

The predetermined time interval between the different acquisitions may be at least a second, a minute, an hour, a day, a month or a year.

The method according to the invention may be executed by a computer system running a software package, using, notably, a graphical interface. The graphical interface may be configured to enable the clouds of points of the different acquisitions to be selected, to define the descriptors and measurements to be calculated, to validate visually the image quality of the network of objects and of each object detected, and/or to launch processing on one or more batches of acquisitions.

The invention is particularly suitable for detecting the various wrinkles in crow’s feet, which are characterized by being very numerous, very fine and concentrated in a small area. The invention can also be used to analyse lion wrinkles, forehead wrinkles, the wrinkles known as dehydration wrinkles, wrinkles on the lip contour, notably the nasal groove, wrinkles on the palm of the hand, or imperfections of the thighs, such as stretch marks. The invention is preferably used in non-dermatoglyphic areas, and is not intended to be used for the authentication of a person.

The acquisitions may be performed in laboratories, or on consumers at the point of sale, or by the evaluated persons themselves, using portable computing devices such as smartphones.

The information for individually recognizing the object or objects identified during the processing of an acquisition may be stored in a computer file, this file being recorded, notably, on a computer or a server, or on a removable digital medium, preferably belonging to the evaluated person, such as a USB ("*Universal Serial Bus*") stick, or the
5 internal memory card of a smartphone, or, in a variant, on an electronic chip inserted into the packaging of the product whose effects are to be evaluated. In a variant, the computer file containing this information is transmitted by electronic mail to the evaluated person, notably in the case where at least one acquisition is performed at a point of sale or in a laboratory. The descriptor or descriptors of the object or objects identified may be stored in
10 a similar way.

The method according to the invention may comprise a step of downloading the information for individually recognizing the object or objects identified during the processing of a first acquisition from the file where it has been stored, before the comparison with the data from a new acquisition. The descriptor or descriptors of the
15 object or objects identified may also be downloaded.

The data from the acquisitions may be processed locally or on a remote server.

The same acquisition system may be used to perform each acquisition. In a variant, different acquisition systems are used according to the acquisitions concerned; notably, a first acquisition system is used at a point of sale to perform the first acquisition,
20 and another acquisition system is used directly at the home of the evaluated person to perform the subsequent acquisition or acquisitions.

The product whose effects are to be evaluated by the present invention may be a product for topical application, such as an anti-ageing product, or a wrinkle filling device or product, or a make-up product intended to reduce skin imperfections. These products
25 may have an immediate or deferred action.

The invention also relates, according to another of its aspects, to a computer program product comprising code instructions which, when executed on a computer system, cause the computer system to process an acquisition of data representative of a person's skin relief at a given instant, in order to:

30 - identify at least one characteristic object of this relief,

store at least one information element that can be used for individually recognizing the object or objects thus identified during the processing of a new acquisition carried out at a subsequent instant, and

- allow the quantification of a change in at least one descriptor of this object or these objects, by comparison of the data between acquisitions.

The invention also relates, according to another of its aspects, to a system for characterizing human skin relief, notably signs related to skin ageing, comprising an acquisition system configured to perform acquisitions of data representative of the skin relief and a computer means configured to process an acquisition of data representative of a person's skin relief at a given instant, in order to:

- identify at least one characteristic object of this relief,
- store at least one information element that can be used for individually recognizing the object or objects thus identified during the processing of a new acquisition carried out at a subsequent instant, and
- allow the quantification of a change in at least one descriptor of this object or these objects, by comparison of the data between acquisitions.

The invention also relates, according to another of its aspects, to a method for establishing the effect of a product on human skin relief, notably an anti-ageing product, in which:

- at least one characteristic object of human skin relief is identified, by the characterization method according to the invention, on the basis of a first acquisition performed before the application of the product,
- a new acquisition is performed after the application of the product,
- a change in at least one descriptor of this object or these objects is quantified by a comparison of the data between the two acquisitions, and
- a piece of information representative of the effect of the product on the human skin relief is deduced at least from this change.

The aforementioned characteristics of the method of characterizing human skin relief also apply to the computer program product, to the characterization system and to the method of establishing the effect of a product.

The invention may be better understood from reading the following detailed description of nonlimiting exemplary embodiments thereof and from examining the appended drawing, in which:

- Figure 1, described above, illustrates the concept of microscopic, mesoscopic and macroscopic scales,
- Figure 2 shows the acquisition of data representative of a person's skin relief according to the invention,
- Figure 3 is a 3D image obtained from the acquisition of Figure 2;
- Figure 4 shows a cloud of points obtained from the image of Figure 3,
- Figure 5 shows the detection of the objects by segmentation applied to the cloud of points of Figure 4,
- Figure 6 shows the division into elementary objects obtained from Figure 5,
- Figure 7 illustrates the indexing of the objects detected in Figure 6,
- Figure 8 shows a cloud of points acquired at a different time,
- Figure 9 shows the superimposition of two clouds of points acquired at two different times,
- Figure 10 shows the superimposition of two clouds of points acquired at two different times and spatially adjusted,
- Figure 11 illustrates the comparison of the objects of two different acquisitions, and
- Figure 12 is a block diagram illustrating different steps of the execution of the method according to the invention.

An example of the acquisition of data representative of a person's skin relief according to the invention is shown in Figure 2. A very wrinkled area Z of the face is targeted, for example the crow's foot area, as seen in Figure 2(a). The acquisition may be performed directly "in vivo", as shown in Figure 2(b), or on the basis of an impression, as in Figure 2(c).

This acquisition provides a 3D image 10, shown in Figure 3.

This image 10 advantageously produces a cloud of points 11, seen in Figure 4. The cloud of points 11 may be accompanied by other data, such as one or more physical values associated with each point, for example the colour or brightness.

Figure 5 shows the result 12 of a segmentation applied to the cloud of points 11 with the aim of detecting which points in the cloud belong to the different objects (for example wrinkles or other relief elements), in order to identify them. The division into elementary objects, or branches, obtained from Figure 5 is shown in Figure 6. In the
5 described example of wrinkle observation, the hollows and protrusions of the image 10 of Figure 3 correspond to the wrinkles, and the points detected in this way form a mask of the wrinkle network, shown in Figure 6.

The cloud of points 11 is advantageously analysed in order to extract at least one descriptor of each wrinkle identified, for example the length, depth, width, curvature,
10 tortuosity, or volume of the wrinkle.

In a subsequent step shown in Figure 7, each wrinkle is individualized and indexed, the corresponding points of the cloud of points being associated with the information, corresponding to a unique label, which enables the wrinkle to be individually recognized. In the example considered, about twenty objects are identified and indexed, as
15 shown by way of example for the five objects 1, 2, 3, 4 and 5. These objects may or may not be associated with one another to form wrinkles.

A cloud of points 21 obtained from another acquisition in the same wrinkled area Z of the face is shown in Figure 8, this acquisition having been performed, for example, one month after the daily application of an anti-ageing product.

20 Figure 9 shows the superimposition of the clouds of points 11 and 21. The two 3D images are spatially adjusted, as shown in Figure 10, to form an adjusted cloud of points 23 relating to the second acquisition time. This cloud of points 23 is then projected, after which the resulting image is analysed by the method according to the invention, in order to extract the elementary objects or branches from it. These branches are compared
25 with those obtained for the first acquisition, to identify the correspondences between the branches of the first and second acquisitions.

In order to describe the changes in the objects identified during the first acquisition, the groupings of branches obtained in the first acquisition are specified for grouping the branches identified in the second acquisition. A branch identified on the first
30 acquisition may correspond to one or more branches on the second acquisition, or to no branch.

For example, wrinkle no. 14 corresponds to the grouping of branches no. 36 and no. 72 of a first acquisition. Branch no. 36 may be dissociated into two branches, no. 12 and no. 44, on the second acquisition, and branch no. 72 may have disappeared, so that no branch corresponds to it on the second acquisition. To determine the change in wrinkle
5 no. 14 in the first acquisition, the method according to the invention may specify that wrinkle no. 14 in the second acquisition corresponds to the group of branches no. 36 and no. 72 of the first acquisition, that is to say to branches no. 12 and no. 44.

The groupings of objects relating to two acquisitions from the same area Z are advantageously compared in order to extract measurements from these two acquisitions,
10 for example the variation of the surface roughness, the absolute and relative variation of the number of points belonging to the network of wrinkles, the variation of the number of wrinkles or the proportion of wrinkles in a given class, their position and orientation in the image, or the change in the mean length or any other characteristic geometric parameter of the wrinkles.

Figure 11 shows a comparison of the change, between the two segmentation
15 results 12 and 22, for each of the objects detected, object by object. A correspondence may be established between the objects of the two acquisitions, in order to characterize the changes in the descriptor or descriptors of each object over time, for example object 3 as shown in Figure 8.

20 Examples of the execution of the method for characterizing human skin relief according to the invention will now be described with reference to Figure 12.

In a step 31, an acquisition 10 of data representative of a person's skin relief is performed, as described above, in order to evaluate the effect of a product, notably an anti-ageing product, or to establish a diagnosis of the person's skin. This acquisition 10 may be
25 performed in a laboratory, or at a point of sale on the person evaluated, or by the person himself, at home, using a smartphone for example.

In a step 32, as described above, the acquisition 10 is processed, by projection and segmentation, to identify at least one object 1, 2, 3, 4, 5 characteristic of the skin relief, for example different branches grouped to form wrinkles, while at least one piece of
30 information is obtained for individually recognizing the object or objects 1, 2, 3, 4, 5 thus identified, and at least one descriptor of the object or objects identified is extracted.

This information is advantageously stored in a computer file, in a step 33. This file may be recorded on a computer or a server, or on a USB stick, or in the internal memory of the smartphone of the evaluated person, notably in the case where the acquisition is performed by this person. In a variant, the file is recorded on an electronic
5 chip inserted into the packaging of the product whose effects are to be evaluated. In yet another variant, the file is transmitted by electronic mail to the evaluated person, for example in the case where the acquisition is performed at a point of sale or in a laboratory.

In a step 34, the person starts to apply a product at least to the area to be evaluated, to his eye contour for example. This application may be one-off or repeated
10 daily, at night for example, or even twice daily, in the morning and at night, over a period varying from one day to several months.

In a variant, after the first acquisition has been performed for a particular state of the area to be characterized, for example when the person is not smiling and/or is not frowning, the person may change this state in step 34 by smiling or frowning. A device for
15 compressing or stretching the skin, such as an adhesive strip or any other element fixed to the skin and having this type of effect, may also be used. The aim of this is to cause deformations to be created by the face muscles in the area to be characterized, for example after a contraction and relaxation of the zygomatic and/or eyebrow muscles when the person smiles and/or frowns, or by using a suitable device.

A new acquisition is advantageously performed at a later time, in a step 35, for example one month after the initial application of the product, or following step 34 in the case of an observation of different states of the area to be characterized, or without application of a product but at a much later time, in order to judge the effects of ageing on the skin, after a year or more for example. This new acquisition may be performed in the
20 same place as the first acquisition 10, or in a different place. If the first acquisition has been performed in a laboratory or at a point of sale, the next acquisition may be performed at the home of the evaluated person, notably in the case where the effect of a product is evaluated. In the case of skin diagnosis by observation of different states of the area to be characterized, all the acquisitions may be performed at a point of sale, so that the consumer
25 can be directly advised about the most suitable products or devices for him.

In a step 36, this new acquisition is processed in a similar way to step 32, in order to identify at least one object 1, 2, 3, 4, 5 characteristic of the skin relief. Said at least

one piece of information for individually recognizing the identified object or objects 1, 2, 3, 4, 5, and the descriptor or descriptors of the identified object or objects, are preferably also stored in a computer file, as shown in Figure 9. This is because this information can be compared with that from a subsequent new acquisition.

5 Step 37 consists in comparing the data from the two acquisitions to quantify a change in the descriptor or descriptors of the identified object or objects. The computer means used for this purpose is advantageously configured to access the information recorded in step 33. As described above, in order to describe the changes in the objects identified during the first acquisition, the groupings of branches obtained in the first
10 acquisition are specified for grouping the branches identified in the second acquisition.

 In a step 38, a piece of information is deduced at least from this change, this information being representative of the effect of the product on the human skin relief and/or representative of the diagnosis of the person's skin according to the observation of different states of the area to be characterized.

15 The invention is not limited to the described examples.

 The invention may be used for designing customized products or products specific to a segment of the population, defined for example on the basis of sex, age, ethnicity, phototype, or a given skin characteristic such as the skin type, which may be, notably, dry, combination, or greasy.

20 It may enable the overall change in a person's skin relief to be quantified, by correlating the changes in the identified objects with a given factor, for example the person's age, his level of exposure to sunlight, a change of position, and/or on the basis of different areas of the body, notably areas of the face, such as the eye contour or the lip contour.

25 It may also contribute to a better understanding of the origin of the wrinkles.

 The invention may be used to characterize skin pores, or brown spots that may appear on the skin surface.

 The expression "*comprising a*" is to be understood as being synonymous with "*comprising at least one*".

30

CLAIMS

1 Method for characterizing human skin relief, notably signs relating to skin ageing, comprising the step of processing an acquisition (10) of data representative of a person's skin relief at a given instant, in order to:

5 - identify at least one characteristic object (1, 2, 3, 4, 5) of this relief,
 - store at least one piece of information that can be used for individually recognizing the object or objects (1, 2, 3, 4, 5) thus identified during the processing of a new acquisition carried out at a subsequent instant, and

10 - allow the quantification of a change in at least one descriptor of this object or these objects (1, 2, 3, 4, 5), by comparison of the data between acquisitions, an acquisition system being used to perform acquisitions of the data representative of the skin relief, using a 3D acquisition on the skin surface, carried out on impressions or directly on the skin.

15 2 Method for characterizing human skin relief, notably signs relating to skin ageing, comprising the step of processing an acquisition (10) of data representative of a person's skin relief at a given instant, in order to:

 - identify at least one characteristic object (1, 2, 3, 4, 5) of this relief,
 - store at least one piece of information that can be used for individually
20 recognizing the object or objects (1, 2, 3, 4, 5) thus identified during the processing of a new acquisition carried out at a subsequent instant, and

 - allow the quantification of a change in at least one descriptor of this object or these objects (1, 2, 3, 4, 5), by comparison of the data between acquisitions, each acquisition producing a cloud of points (11), and wherein a segmentation is applied to
25 this cloud of points (11) in order to detect which points belong to the object or objects (1, 2, 3, 4, 5), for the purpose of identifying them.

 3 Method for characterizing human skin relief, notably signs relating to skin ageing, comprising the step of processing an acquisition (10) of data representative of a person's skin relief at a given instant, in order to:

30 - identify at least one characteristic object (1, 2, 3, 4, 5) of this relief,

- store at least one piece of information that can be used for individually recognizing the object or objects (1, 2, 3, 4, 5) thus identified during the processing of a new acquisition carried out at a subsequent instant, and

- allow the quantification of a change in at least one descriptor of this object
5 or these objects (1, 2, 3, 4, 5), by comparison of the data between acquisitions, each acquisition producing a cloud of points (11), and wherein a segmentation is applied to this cloud of points (11) in order to detect which points belong to the object or objects (1, 2, 3, 4, 5), for the purpose of identifying them,
each object (1, 2, 3, 4, 5) being individualized and indexed, the corresponding points of the
10 cloud of points (11) being associated with the information which enables the object to be individually recognized.

4 Method according to any of the preceding claims, wherein the characteristic object or objects (1, 2, 3, 4, 5) of the skin relief identified during processing are wrinkles or fine wrinkles, notably crow's feet wrinkles.

15 5 Method according to any of the preceding claims, wherein a first acquisition (10) is performed before the application of an anti-ageing product, a new acquisition being performed after the application of said product, at the end of a predetermined time interval, in order to evaluate the effect of the product.

20 6 Method according to the preceding claim, wherein the product is a product for topical application, notably an anti-ageing product, or a wrinkle filling device or product, or a make-up product intended to reduce skin imperfections, these products having an immediate or deferred action.

25 7 Method according to any of the preceding claims, wherein different acquisitions are performed for different states of the area to be characterized, notably for deformations caused by a device for stretching or compressing the skin, for example an adhesive strip or any other element fixed to the skin and having this type of effect, or by the face muscles, particularly after a contraction and relaxation of the zygomatic and/or eyebrow muscles when the person smiles and/or frowns.

30 8 Method according to any of the preceding claims except claim 1, wherein an acquisition system is used to perform acquisitions of the data representative of the skin relief, using a 3D acquisition on the skin surface, carried out on impressions or directly on the skin.

9 Method according to claim 1 or the preceding claim, wherein the 3D acquisition on the skin surface is executed by using a fringe projection method or stereophotogrammetry.

5 10 Method according to any of the preceding claims except claims 2 and 3, wherein each acquisition produces a cloud of points (11), and wherein a segmentation is applied to this cloud of points (11) in order to detect which points belong to the object or objects (1, 2, 3, 4, 5), for the purpose of identifying them.

10 11 Method according to one of the two immediately preceding claims, wherein each object (1, 2, 3, 4, 5) is individualized and indexed, the corresponding points of the cloud of points (11) being associated with the information which enables the object to be individually recognized.

15 12 Method according to one of the two immediately preceding claims, wherein the cloud of points (11) is analysed and said at least one descriptor of the identified object or objects (1, 2, 3, 4, 5), notably the length, depth, width, curvature, tortuosity, or volume of the object, is extracted.

20 13 Method according to any of Claims 10 to 12, wherein, a network of objects being identified on the basis of the cloud of points (11), measurements are made on the basis of the network of objects as a whole, notably on the basis of the standard deviation of the depth of the points of the cloud of points (11) relative to a reference plane, the roughness of the surface described by the cloud of points, and, in the case of wrinkles, the number of points belonging to the mask of the wrinkles, the number of wrinkles, and the mean length of the wrinkles.

25 14 Method according to any of Claims 10 to 13, wherein the clouds of points (11, 23) of two different acquisitions of the same area (Z) are compared, so as to extract measurements on the basis of these two acquisitions.

15 Method according to any of the preceding claims, wherein a table is drawn up, associating each object detected during the first acquisition (10) with the number of pieces of information in common with each object detected in the new acquisition, notably the number of common pixels in the case of images.

30 16 Method according to any of the preceding claims, wherein the information for individually recognizing the object or objects identified during the processing of an

acquisition is stored in a computer file, this file being, notably, recorded on a removable digital medium, or transmitted by electronic mail to the evaluated person.

17 Method according to the preceding claim, comprising a step of downloading the information for individually recognizing the object or objects identified during the processing of a first acquisition (10) from the file where it has been stored, before the
5 comparison with the data from a new acquisition.

18 Method according to any of the preceding claims, executed by a software package which uses a graphical interface and which is, notably, configured so that the clouds of points of the different acquisitions can be selected, the descriptors and
10 measurements to be calculated can be defined, the image quality of the network of objects and of each object detected can be visually validated, and/or processing can be launched on one or more batches of acquisitions.

19 Computer program product comprising code instructions which, when executed on a computer system, cause the computer system to process an acquisition (10)
15 of data representative of a person's skin relief at a given instant, in order to:

- identify at least one characteristic object (1, 2, 3, 4, 5) of this relief,
- store at least one piece of information that can be used for individually recognizing the object or objects (1, 2, 3, 4, 5) thus identified during the processing of a new acquisition carried out at a subsequent instant, and
20 - allow the quantification of a change in at least one descriptor of this object or these objects (1, 2, 3, 4, 5), by comparison of the data between acquisitions,

an acquisition system being used to perform acquisitions of the data representative of the skin relief, using a 3D acquisition on the skin surface, carried out on impressions or directly on the skin.

25 20 System for characterizing human skin relief, notably signs related to skin ageing, comprising an acquisition system configured to perform acquisitions of data representative of the skin relief and a computer means configured to process an acquisition (10) of data representative of a person's skin relief at a given instant, in order to:

- identify at least one characteristic object (1, 2, 3, 4, 5) of this relief,
- 30 - store at least one piece of information that can be used for individually recognizing the object or objects (1, 2, 3, 4, 5) thus identified during the processing of a new acquisition carried out at a subsequent instant, and

- allow the quantification of a change in at least one descriptor of this object or these objects (1, 2, 3, 4, 5), by comparison of the data between acquisitions, an acquisition system being used to perform acquisitions of the data representative of the skin relief, using a 3D acquisition on the skin surface, carried out on impressions or
5 directly on the skin.

21 Method for establishing the effect of a product on human skin relief, notably an anti-ageing product, wherein:

- at least one characteristic object of human skin relief is identified, by the characterization method as defined in any of Claims 1 to 18, on the basis of a first
10 acquisition (10) performed before the application of the product,
 - a new acquisition is performed after the application of the product,
 - a change in at least one descriptor of this object or these objects is quantified by a comparison of the data between the two acquisitions, and
 - a piece of information representative of the effect of the product on the
15 human skin relief is deduced at least from this change.

Concept	Example	Scale
Body part	Face	"Macroscopic"
Area	Eye contour	"Mesoscopic"
Object	One of the crow's feet wrinkles	"Microscopic"

Fig. 1

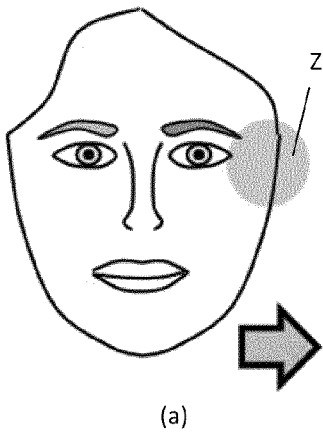
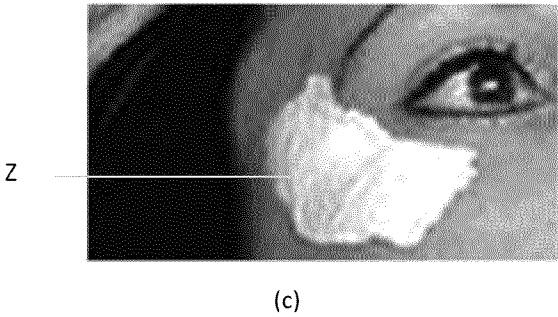
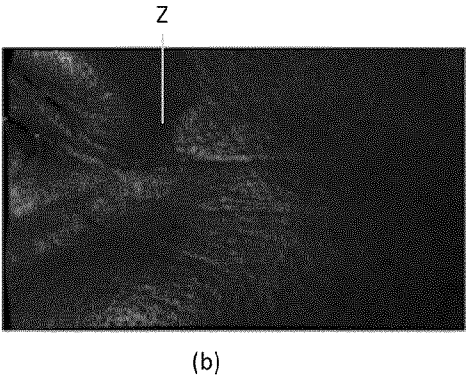


Fig. 2



2/5

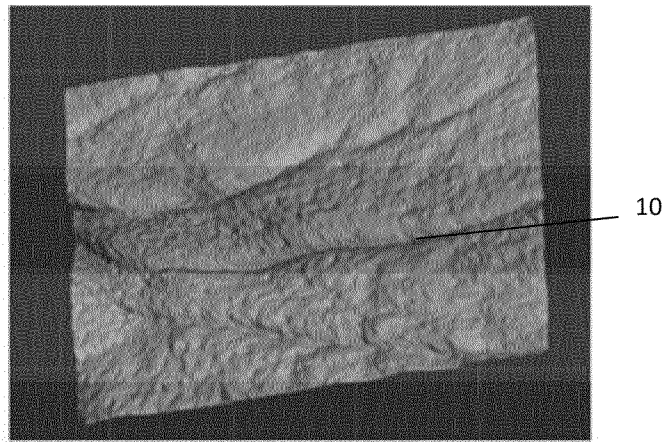


Fig. 3

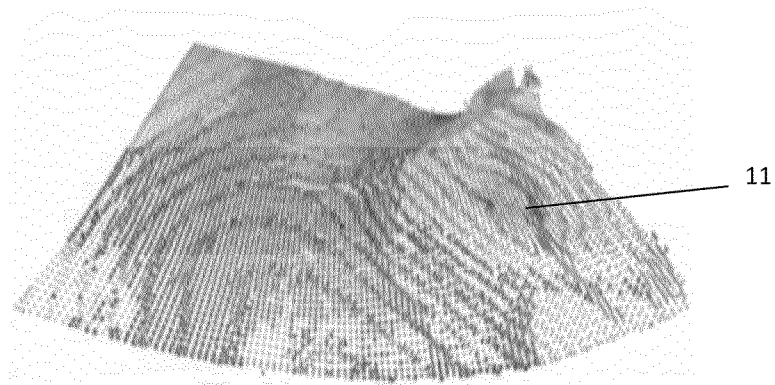


Fig. 4

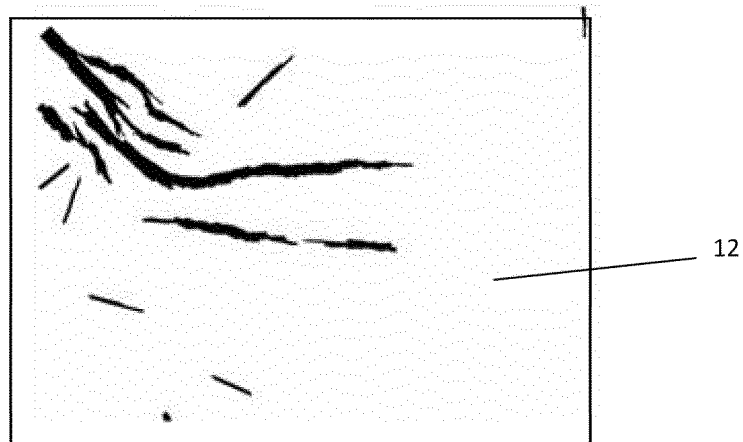


Fig. 5

3/5

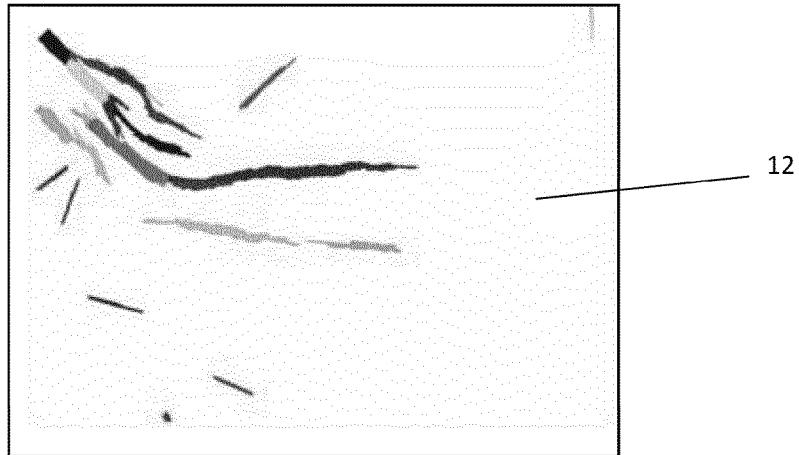


Fig. 6

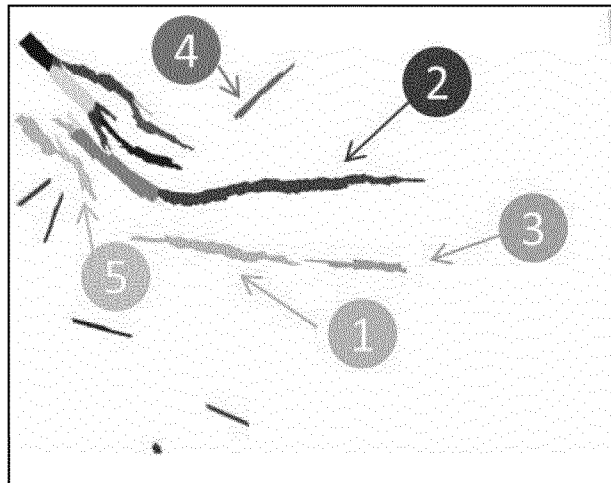


Fig. 7

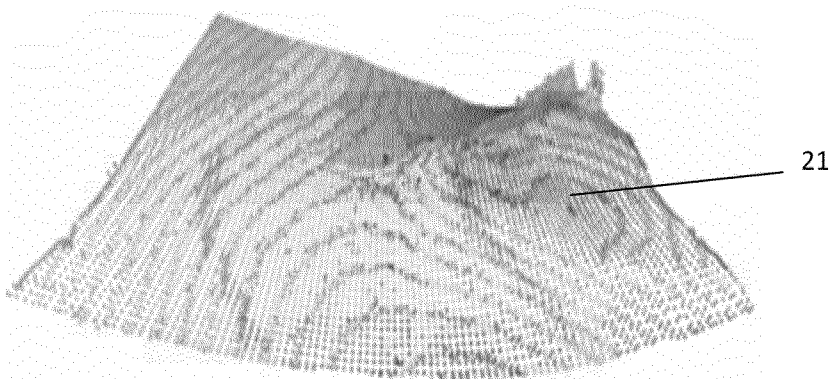


Fig. 8

4/5

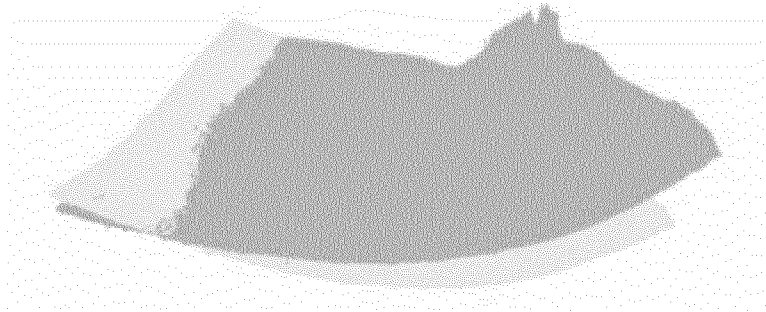


Fig. 9

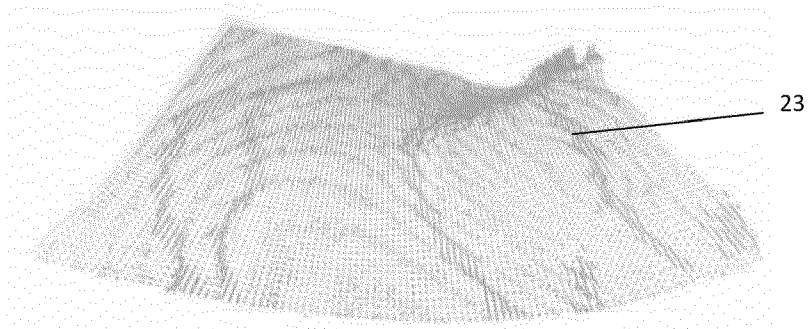


Fig. 10

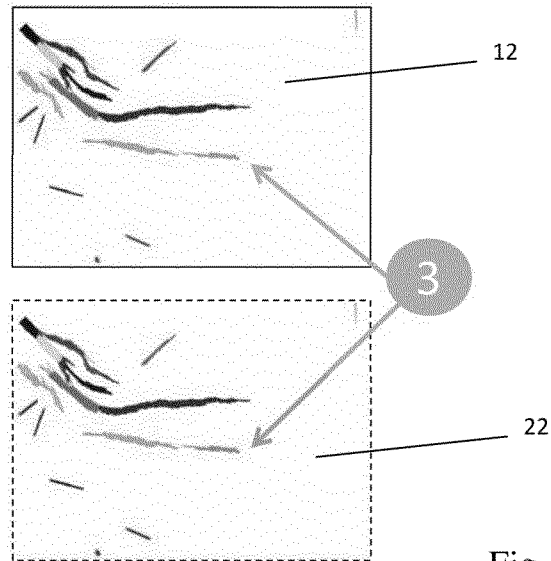


Fig. 11

5/5

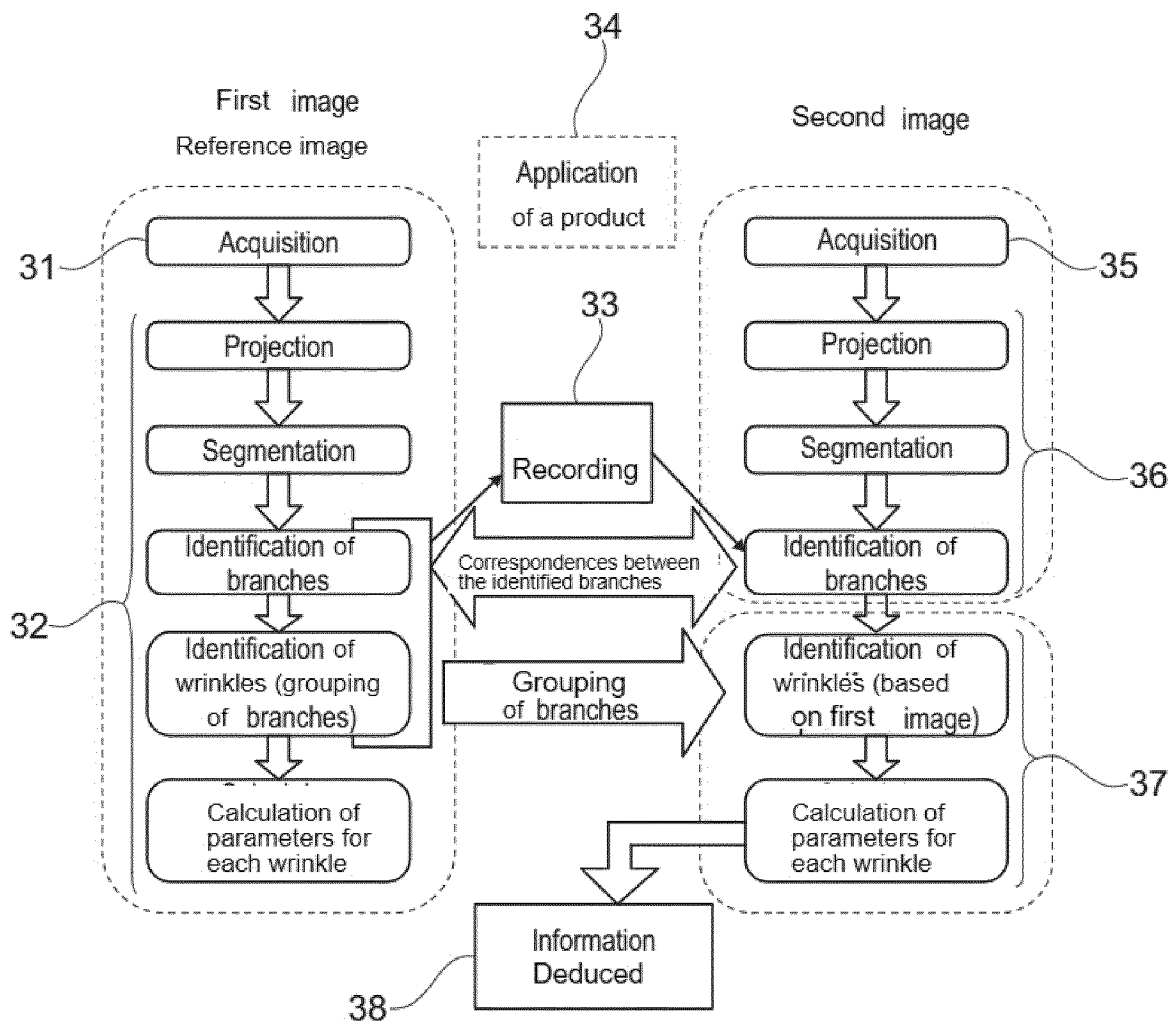


Fig. 12

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2017/074952

A. CLASSIFICATION OF SUBJECT MATTER
INV. A61B5/107 A61B5/00
ADD.

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)
A61B

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

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

EPO-Internal, WPI Data, COMPENDEX, EMBASE, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	EP 2 389 573 A2 (MYSKIN INC [US]) 30 November 2011 (2011-11-30) abstract paragraphs [0016] - [0060], [0201] - [0250], [0306] - [0308]; figures 1,5,6,15-17	1-21
Y	FR 2 984 108 A1 (OREAL [FR]) 21 June 2013 (2013-06-21) abstract page 5, line 3 - page 8, line 4; figures 3-6 page 9, line 1 - page 1, line 10 page 17, line 4 - page 26, line 4; figures 2-6; table 1 ----- -/--	1-21



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

4 December 2017

Date of mailing of the international search report

21/12/2017

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040,
Fax: (+31-70) 340-3016

Authorized officer

Juárez Colera, M

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2017/074952

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 3 017 755 A1 (SAMSUNG ELECTRONICS CO LTD [KR]) 11 May 2016 (2016-05-11) abstract paragraphs [0039] - [0051], [0093] - [0103], [0140] - [0142], [0282] - [0284]; figures 1-3,5 -----	1-21
A	WO 2010/111463 A1 (BRIGHTEX BIO PHOTONICS LLC [US]; CHHIBBER RAJESHWAR [US]; CHHIBBER ASH) 30 September 2010 (2010-09-30) abstract paragraphs [0035] - [0043]; figure 2 -----	1-21
A	WO 2015/019573 A1 (PANASONIC IP CORP AMERICA [US]) 12 February 2015 (2015-02-12) the whole document -----	1-21

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2017/074952

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 2389573	A2	30-11-2011	AU 2010214017 A1 18-08-2011
			AU 2015210414 A1 03-09-2015
			CA 2750266 A1 19-08-2010
			EP 2389573 A2 30-11-2011

FR 2984108	A1	21-06-2013	NONE

EP 3017755	A1	11-05-2016	CN 105574484 A 11-05-2016
			EP 3017755 A1 11-05-2016
			US 2016125228 A1 05-05-2016
			WO 2016072749 A1 12-05-2016

WO 2010111463	A1	30-09-2010	US 2010245823 A1 30-09-2010
			WO 2010111463 A1 30-09-2010

WO 2015019573	A1	12-02-2015	JP 2016112024 A 23-06-2016
			WO 2015019573 A1 12-02-2015
