



Submission in opposition proceedings made following summons to attend oral proceedings

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Opponent/representative's reference

W 454

The information given below is pertaining to the following patent in opposition proceedings:

Patent No.

EP2442720

Application No.

EP10727345.0

Documents attached:

	Description of document	Original file name	Assigned file name
1	Facts and arguments	Response.pdf	OPPO.pdf

Evidence filed subsequently:

E14	Patent document	US4640620 (A1) original file name: E14_US4640620A-1.pdf attached as: Published-Evidence-1.pdf
E15	Patent document	US5381236 (A) original file name: E15_US5381236A.pdf attached as: Published-Evidence-2.pdf
E16	Patent document	US2007103460 (A1) original file name: E16_US2007103460A1.pdf attached as: Published-Evidence-3.pdf
E17	Patent document	US2009087050 (A1) original file name: E17_US2009087050A1.pdf attached as: Published-Evidence-4.pdf

E18	Patent document	US2007081718 (A1) original file name: E18_US2007081718A1.pdf attached as: Published-Evidence-5.pdf
E19	Patent document	US20060001739 (A1) original file name: E19_US20060001739A1.pdf attached as: Published-Evidence-6.pdf

Signatures

Place: **München**
 Date: **18 September 2018**
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PR 1787

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In response to the Summons to Oral Proceedings dated April 26, 2018

I. Requests

1. The Opponent requests to revoke the patent.
2. Auxiliary, Oral Proceedings are requested.

II. Grounds

1. **Lack of Enablement Disclosure**

1.1 The Opponent is still of the opinion that the patent in suit does not disclose means to enable a person skilled in the art to carry out the feature

1.6 means for varying (151) the position of the focus plane of the pattern on the object while maintaining a fixed spatial relation of the scanner and the object.

First, it should be noted that the passage of document D2/E1b to which the Opposition Division refers in section 3.1.6 is in itself meaningless. In fact, it is stated in lines 1 to 4 on page 4 of D2/E1b: "It does not mean that the scan must be provided with a fixed spatial relation of the scanner and the object, but merely that the focus plane can be varied (scanned) with a fixed spatial relation of the scanner and the object". Thus, it seems to be indicated by the patent in suit that "no fixed spatial relation is necessary, but a fixed spatial relation". Apparently, this is a contradiction.

An explanation that might help to resolve this contradiction seems to be given in lines 18 to 34 on page 10 of D2/E1b, to which the Division further refers: a fixed spatial relation can be assumed, if the "3D surface acquisition time [is] small enough to reduce the impact of relative movement between probe and teeth, e.g. reduce effect of shaking". This implies that the focus plane is varied with a frequency that is much higher than the frequencies of relative movements like shaking such that the focus plane variation does not "see" the shaking.

1.2 Hence, from the description a skilled person learns that a fixed spatial relation can only be assumed if 3D surface acquisition and focus plane variation are fast enough, i.e. if the time scales of focus plane variation and image generation are small in comparison to the time scales of inevitable movements of a handheld scanner. Differently speaking, the description enables a skilled person to carry out the invention for handheld scanners only, if a specific type of focus plane variation and image acquisition is used.

However, what is claimed is a generic scanner, a generic varying of the focus plane, and a generic image acquisition.

Here, the Opponent wants to remind the Opposition Division that a skilled person must be enabled by the description to carry out the invention over the entire range of the claimed subject-matter. In the present case enablement disclosure is only provided for a subset of this entire claimed subject-matter.

A skilled person does not learn from the description how to vary the focus plane "while maintaining a fixed spatial relation of the scanner and the object", if a handheld scanner is used that is not configured to carry out high-speed variation of the focus plane and high speed image acquisition.

Hence, it is not a question of “missing essential features” to include conditions as indicated between lines 18 to 34 on page 10 of D2/E1b in the claims. In contrast, as the subject-matter of claim 1 can only be carried out within the limits indicated therein, and as claim 1 also covers subject-matter outside of these limits, a restriction is necessary due to the requirements of Art. 83 EPC. Otherwise, it is not possible to carry out the claimed subject-matter in the entire claimed range.

1.3 Since an according limitation has not been presented in any of the Auxiliary Requests filed by the Patent Proprietor, not only the claims as granted, but also the claims of the Auxiliary Requests do not fulfill the requirements of Art. 83 EPC.

2. Inadmissible Extension

2.1 The Opponent shares the view of the Opposition Division that claims 7 and 13 as granted are inadmissibly extended over the original application documents.

Regarding claim 13 nothing to the opposite is declared by the Patent Proprietor. Regarding claim 7 the Patent Proprietor refers to lines 7 to 16 on page 13 of D2/E1b, and alleges that therein “external pattern generators” would be disclosed. However, this is not the case, the passage cited by the Patent Proprietor does refer neither explicitly nor implicitly to such “external pattern generators”.

2.2 Claim 1 of Request K, i.e. of Auxiliary Request 8, combines the features of claims 1 and 21 as granted and adds the clause “configured for enhancing specular reflections. Support for this amendment is indicated to be given in lines 14 to 18 on page 28 of D2/E1b.

However, in this passage of D2/E1b a specific arrangement of a combination of means for polarizing and means for changing the polarization state is indicated. In particular, a “quarter wave plate with an orientation of 45 degrees of its fast axis to the linear polarization direction” is arranged behind the means for polarizing (see also D2/E1b, p. 49, l. 15 to p. 50, l. 2). Since it is further indicated in line 14 on page 28 of D2/E1b that “[t]his may be utilized to enhance specular reflections [...]”, a skilled person understands that the enhancement of specular reflections occurs only for the aforementioned specific alignment of a quarter wave plate.

Since claim 1 of Request K does not comprise these indications it must be considered an intermediate generalization. Claim 1 of Request K is therefore inadmissibly extended, and must not be admitted into the proceedings.

3. Clarity

3.1 Requests F, G, and H, i.e. Auxiliary Requests 1 to 3, are directed to several independent claims in the same category. According to Rule 86 EPC requests filed during opposition proceedings have to comply with Rule 43(2) EPC. Since the independent claims of Requests F, G, or H are neither interrelated products, nor alternative solutions to a particular problem, nor referring to different uses of a product, the requirements of Rule 43(2) EPC are not satisfied. Requests F, G, and H must therefore not be admitted into the proceedings.

3.2 Claim 1 of Requests F, G, and I introduces the feature that “the resolution of the measured 3D geometry is lower than the resolution of the camera”.

However, only the camera is part of the claimed scanner, while the measured 3D geometry is external to the claimed scanner. The 3D geometry to be measured is used to define the features of the camera. Since the 3D geometry to be measured can have any kind of resolution and is not definable by the claimed scanner, a skilled person is unable to determine which resolution shall be used for the claimed camera.

In addition, the term “resolution of 3D geometry” is unclear by itself. It is not clear whether the resolution of the three-dimensional shape obtainable by the scanner is meant, or a feature of the 3D geometry itself like the presence of textures.

Finally, “the” resolution of the 3D geometry lack antecedent basis.

Requests F, G, and I must therefore not be admitted into the proceedings.

3.3 Claim 2 of Requests F and G as well as claim 1 of Request J share the lack of clarity discussed above in section 3.2. Moreover, these claims newly introduce the expression “groups of sensor elements”. Claim 1 as granted referred to “an array of sensor elements” and “a plurality of groups of image pixels”.

It is not clear whether the newly introduced “groups of sensor elements” refer to a part of the already present “sensor elements”, to one of the “plurality of groups of image pixels”, or to both since “sensor elements” and “image pixels” are the same.

Further, it is also not clear whether in “the resolution being determined [...]” reference is made to “the resolution of the measured 3D geometry” or “the resolution of the camera”.

In addition, it is indicated in the claim that the resolution being “determined” by the size of the groups of sensor elements. It is not clear how one should deduce only from the size of a group of sensor elements the resolution of the 3D geometry. In fact, the obtainable resolution of the 3D geometry will depend on the distribution of changes in the illumination and correlation patterns. As illustrated e.g. in Fig. 16 of the patent in suit a two-pixel resolution in the x- and y-direction is obtainable by having a pattern with a two-pixel pitch in each of these directions.

However, such a pitch cannot be deduced simply by referring to a “size of a group”. A group of four pixels can assume many forms, e.g. four pixels in a row or a block of 2x2 pixels. Thus the same size can lead to different resolutions in the same direction. A skilled person can therefore not deduce from the claim how the resolution of the 3D geometry is determined by the size of the group of pixels.

Due to this introduction of unclear terminology Requests F, G, and J must not be admitted to the proceedings.

3.4 In claim 4 of Request F, claim 2 of Request H, and claim 1 of Request E the feature has been added to the claims as granted that “the motion sensors are used as a remote control for visualizing the acquired scan, where the remote control rotates the view” (underlines added). In this feature “the view” has no antecedent basis. Alone for that reason the claim is unclear. Moreover, it is completely undefined what kind of view is referred to. Is it the view of the scanned object? Or is it a view on a different object displayed in the user interface?

Hence, also in claim 4 of Request F, claim 2 of Request H, and claim 1 of Request E unclear terminology has been introduced. Also for this reason these requests must not be admitted into the proceedings.

3.5 The expression “configured to enhance specular reflections” in claim 1 of Request K is unclear. The respective clause indicates only a result to be achieved without giving sufficient teachings how to do so. In particular, it is not guaranteed that by simply providing “a retardation plate and a linearly polarizing element, located in the optical path” specular reflections will be enhanced. In contrast, the precise arrangement of optical components illustrated in Fig. 1 of D2/E1b seems to be necessary to achieve the claimed result.

Further, it is not clear which “specular reflections” shall be enhanced.

Hence, Request K must not be admitted into the proceedings as being unclear.

4. Novelty and Inventive Step

A. Main Request

The Opponent shares the opinion of the Opposition Division that the claims as granted are not novel over documents D4/E3 and D6/E5. Moreover, the Opponent is still of the opinion that also documents D3/E2 and D5/E4 anticipate the subject-matter of claim 1 as granted.

The Opponent is further of the opinion that the arguments of the Patent Proprietor regarding patentability of claim 1 as granted cannot be considered convincing.

Document D3/E2

4.1 In section 3.3.3 of the preliminary opinion it is indicated that “applying a Laplacian filter operator to enhance certain frequencies in the images as disclosed by D3 would not be understood by the skilled person as ‘evaluating a correlation measure’”. Hence, the feature of claim 1 referring to “means for evaluating” (feature 1.8) is considered to be not disclosed. The Patent Proprietor does not add anything to this statement.

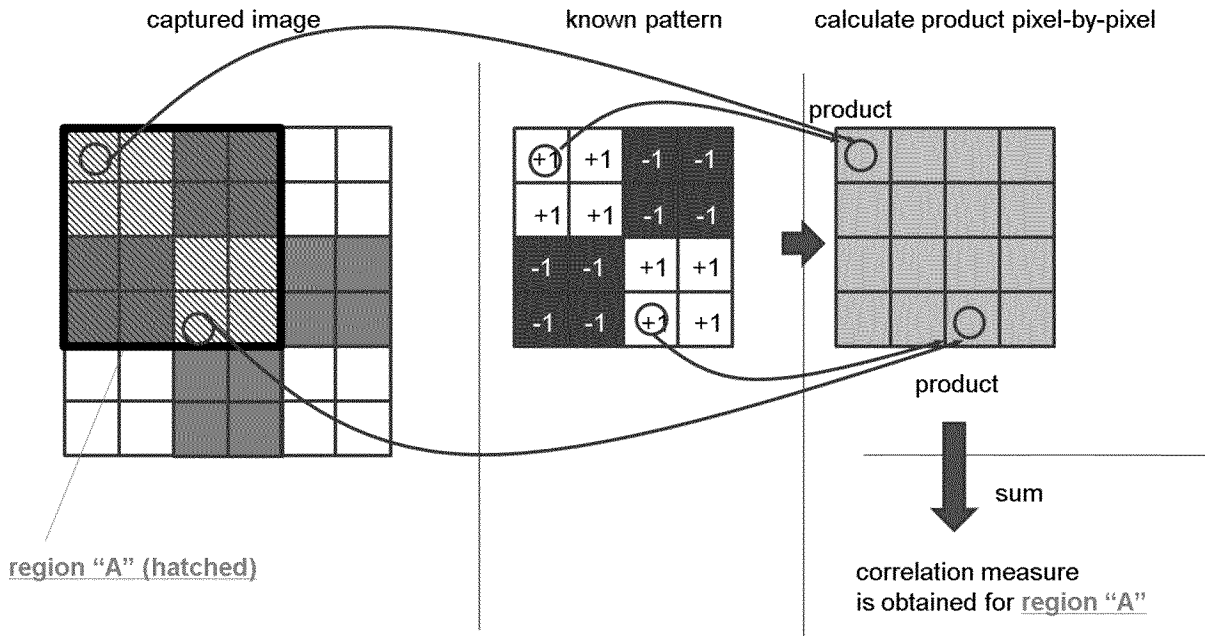
From the brief statement cited above it seems that the Opposition Division questions whether applying a Laplacian to enhance frequencies of a pattern can be identified with looking for a correlation. In this regard Applicant wants to stress that the enhancement of frequencies of document D3/E2 is the same as measuring “a light oscillation amplitude” which is identified in paragraph 39 of D1/E1 with forming a correlation measure.

What is done in the patent in suit when a correlation measure is formed is that pieces of a varying signal are multiplied with pieces of a varying reference function and that the resultant products are summed (see e.g. D1/E1, par. 73, 81, 106). In a continuous variant the signal function and the reference function are multiplied and the product is integrated (see e.g. par. 90). The resultant of this so called “dot product” is then used as measure for the correlation between signal and reference function.

Since the reference function itself is strongly varying, e.g. changing its value from “-1” to “+1” every time step or for each pixel, any dot product with the reference function enhances high frequency components in the signal: for a slowly varying signal a low correlation measure has to be expected, while for a strongly varying signal a high correlation measure will be obtainable. Of course, high correlation will only be obtained, when the frequency of the signal matches the frequency of the reference signal.

This is illustrated in the below figure. In region A an illumination pattern shown as checkerboard is captured. This region A of the captured image is correlated with a known pattern correspond-

ing to the illumination pattern by multiplying the respective pixel values with the values of the correlation pattern. The resulting products are then summed in order to obtain the correlation measure for region A.



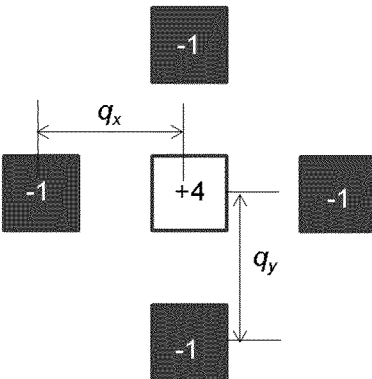
Nothing else is done in document D3/E2. First, it should be noted that the aim of D3/E2 is to match the parameters of an illumination pattern with the parameters of a Laplacian such as to provide a "focus measure function $g(x,y)$ " (see D3/E2, abstract; p. 32, last full paragraph; p. 35, last paragraph before section 3.1; p. 38, eq. (20)), i.e. a function that allows assigning a single focus measure to each pixel value in the two dimensional image plane.

To this end, in section 3.1 of D3/E2 the illumination pattern is modeled in equations (1) to (3). Although looking little appealing, these equations describe nothing else than a pattern as also used in the "spatial correlation" of the patent in suit (see e.g. Figs. 2 of D3/E2, showing the resulting checkerboard patterns for the optimal choice of parameters). In a similar manner, in section 3.4 the image sensing capabilities of the used CCDs are parametrized.

Finally, in section 3.5 of D3/E2 the Laplacian focus operator is introduced. It should be noted that in the spatial representation indicated in equation (16) the Laplacian consists basically of delta-functions. From this a skilled person understands that the Laplacian is intended to act on the signal by an integral. Further, it is clear to a skilled person that the Laplacian constitutes a

strongly varying reference or weighting function. The parts of this function that are not zero are determined by the parameters q_x and q_y of the Laplacian.

A translation of the mathematical representation of the Laplacian given in equation (16) of D3/E2 into a geometric representation that corresponds to the above illustration for the patent in suit looks like this:

$$\begin{aligned}
 l(x, y) &= l(x, y; q_x, q_y) \\
 &= 4\delta(x) \cdot \delta(y) - [\delta(x) \cdot \delta(y - q_y) + \delta(x) \cdot \delta(y + q_y) \\
 &\quad + \delta(x - q_x) \cdot \delta(y) + \delta(x + q_x) \cdot \delta(y)] \\
 &= 2 \left[\delta(x) - \Pi \left(\frac{1}{2q_x} x \right) \right] \cdot \delta(y) + 2 \left[\delta(y) - \Pi \left(\frac{1}{2q_y} y \right) \right] \cdot \delta(x).
 \end{aligned} \tag{16}$$


The first term gives a central value of “+4”, while the other terms give values of “-1” that are spaced from the central value by q_x and q_y .

Application of the Laplacian onto the image of the illuminated object in the CCD is discussed in section 3.6 of D3/E2. Here, equation (18) parametrizes the light pattern directed to the illuminated object, by “i” the initial intensity, “o” the optical transfer function, and “h” the defocus function. This means that the convolution of i, o, and h indicated in equation (18) constitutes the intensity distribution on the object.

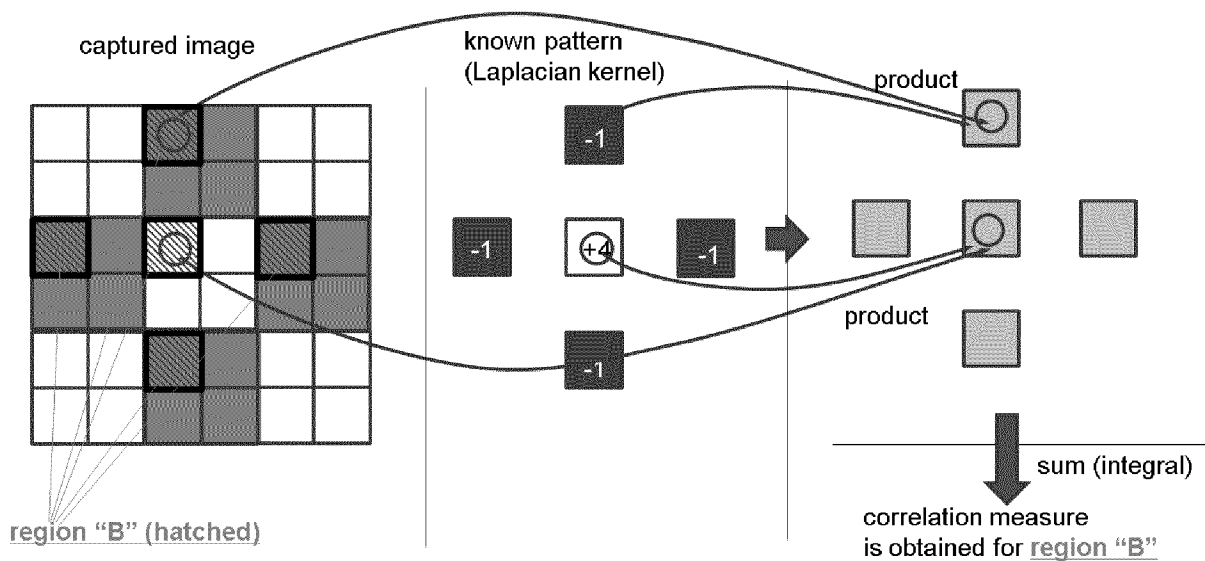
Since the light reflected from the object travels through the same optics back to the CCD the functions “o” and “h” appear twice in equation (19). In addition, the camera functions s_c and s_g appear that parameterize the input efficiency of the CCD. Equation (19) is therefore just an expression for the image detected by the CCD.

This image is then evaluated by convoluting it with the Laplacian, i.e. by multiplying the image signal with the weighting function of equation (16) and by integrating over the product. As is well known the convolution of two functions $f(t)$ and $g(t)$ is given by:

$$h(x) = \int_{-\infty}^{\infty} f(t)g(\tau - t)dt$$

The “final focus measure function $g(x,y)$ ” is therefore nothing else than e.g. the integral of paragraph 90 or a continuous version of the sum of paragraph 106 of D1/E1. According to the last full paragraph of D3/E2 this focus measure is determined at “a set of focus measure values at each image point (x,y) ”.

This can be illustrated similarly as done above for the patent in suit:



In region B an illumination pattern shown as checkerboard is captured. This region B of the captured image is correlated with the known pattern of the Laplacian that corresponds via q_x and q_y to the illumination pattern. The respective pixel values are multiplied with the values of the correlation pattern (multiplication part of the convolution). The resulting products are then integrated, i.e. summed, in order to obtain the correlation measure for region B.

D3/E2 discloses therefore “means for evaluating a correlation measure at each focus plane position between at least one image pixel and a weight function”.

Considering the form of the Laplacian indicated in equation (16) and the form of the pattern indicated in equations (2) together with the condition for optimal correlation measurement indicated in equations (43) and (44) it is also apparent that “the weight function is determined based on information of the configuration of the spatial pattern”.

In fact, as indicated in equations (43) and (44) of D3/E2 the image parameters b_x , b_y that define the grid of the illumination pattern and the Laplacian parameters q_x , q_y that determine the spacing between neighboring elements of the discrete Laplacian kernel have the same size. This means that a deviation of the grid shape in the projected pattern will be recognized by applying the Laplacian in the sense of a correlation between the spacing parameters q_x , q_y and the grid parameters b_x , b_y .

The Opponent is therefore still of the opinion that D3/E2 discloses feature 1.8 of claim 1 as granted.

4.2 Regarding feature 1.6, directed to the variation of the focus plane instead of varying the position of a stage, the Opponent is still of the opinion that this feature is implied by lines 5 and 6 of page 32 of D3/E2. These lines refer in general terms to a “depth (shape) from focus” apparatus, with which one can measure a 3D shape of objects using focus movement. A person skilled in the art understands therefore directly and unambiguously that instead of displacing the sample on the stage as taught at the beginning of section 2 of D3/E2 also the focal length, i.e. the focus plane, could be varied.

At least a skilled person would consider a variation of the focus plane instead of shifting the object stage to be an obvious solution to the problem of how to provide an alternative manner of changing the optical path length between image sensor and imaged object, in particular since this solution is already referred to in D3/E2. Further, this solution is known to a skilled person also from: D4/E3, par. 32 or 50; D6/E5, abstract, col. 1, l. 9 to 10, col. 4, l. 26 to 28; D10/E9, par. 84; and D11/E10, par. 66.

Hence, the subject-matter of claim 1 as granted is at least not based on an inventive step over D3/E2.

Document D4/E3

4.3 The Patent Proprietor considers feature 1.8 of claim 1 as granted to be not disclosed by D4/E3, since “only a correlation signal, i.e. a plurality of values corresponding to a set of pixels, not a correlation measure, i.e. a single value for a set of pixels” would be obtained in D4/E3.

Here, it should be noted that nowhere in claim 1 as granted it is defined what a “correlation measure” should be. According to paragraph 39 of the patent in suit a correlation measure is “a measure of the degree of correlation”. This does not imply that the correlation measure of claim 1 as granted must be understood as “a single value for a set of pixels” as alleged by the Patent Proprietor.

It must therefore strongly be emphasized that the interpretation of “correlation measure” as presented by the Patent Proprietor seems to be an attempt to narrow the claimed subject-matter unduly in view of the cited prior art. Also, the Opponent is of the opinion that the various techniques for determining shape from focus disclosed in the presented prior art are all based on obtaining some kind of “correlation measure”.

Hence, even if D4/E3 would only disclose a correlation signal, this would be sufficient to anticipate claim 1 as granted, which requires only a quantity that indicates a degree of correlation.

4.4 However, document D4/E3 discloses also a single correlation value according to the Patent Proprietor’s understanding of “correlation measure”.

The lengthy discussion of the allegedly distinguishing feature 1.8 on pages 5 to 9 of the submission of the Patent Proprietor of 28.06.2018 focuses mainly at the so-called “spatial correlation” disclosed in paragraphs 99 to 112 of D1/E1. “Temporal correlation” as disclosed in paragraphs 66 to 86 is only briefly mentioned as not being disclosed by any of the cited prior art documents. However, it has been indicated on pages 17, 27 and 28 of the opposition that document D4/E3 discloses on “optical correlation”, which is presented in paragraphs 87 to 98 of the patent in suit as a specific kind of “temporal correlation” that leads to a single valued correlation measure.

In fact, in the parallel optical focal point tomography device of D4/E3 (it should be noted that D4/E3 is not simply a conventional optical coherence tomography, OCT, apparatus as alleged by the Patent Proprietor in the beginning of page 5 of the submission of 28.06.2018, see D4/E3, par. 57 to 59) an illumination pattern reflected from an object is correlated with the pattern of a grid provided in the optical path between object and imaging device (see D4/E3, Fig., grid 12). The illumination pattern is generated by moving a grid that has the same pattern (see D4/E3, par. 17 and 18).

Speaking in the words of paragraph 91 of the patent in suit, the reflected illumination pattern gathered in one pixel “j” of sensor 13 is “ S_j [,] the time-varying light intensity of light returned from the scanned object” and the relative movement of the two grids of D4/E3 provides a transfer function that equals “ T_j [,] the time-varying transmission [...] imaged onto the j’th light sensing element”.

The light intensity obtained by pixel “j” of sensor 13 of D4/E3 is the integral between time “t” and time “t+ δt ” (with “ δt ” the image pickup time) over the product of these signals S_j and T_j (see D4/E3, par. 20 and 49). Hence, also for D4/E3 the intensity obtained in a single pixel j is

$$I_j = K \int_t^{t+\delta t} T_j(t') S_j(t') dt',$$

i.e. exactly the same as the intensity indicated in paragraph 90 of the patent in suit for “optical correlation”.

Document D4/E3 discloses therefore all features of claim 1 as granted.

In this regard reference is also made to document US 4 640 620 (E14) that also discloses how to obtain an optical correlation (see E14, col. 2, l. 10 to col. 3, l. 2). Hence, optical correlations as the ones described in paragraph 90 of the patent in suit are well known to a person skilled in the art, and could be implemented easily in any known scanners, since no additional processor for calculating the correlation is necessary.

Document D5/E4

4.5 Regarding document D5/E4 it should be noted that the confocal microscope disclosed therein is used to obtain a correlation measure for a single pixel by correlating the focus of the incoming light related to this pixel with the aperture of the microscope. It is therefore not true that the Opponent identifies the correlation measure and the image pixel both with the intensity data obtained by the detector. What is correlated is the light belonging to one pixel and the aperture. The result of this correlation is then detected by the detector.

Here, it should be noted that this kind of correlation is the reduction of the correlation scheme explained in paragraph 174 of the patent in suit to a single pixel situation. Instead of correlating a multi-pixel pattern of dark and bright areas with the same pattern, a single bright spot is correlated with a single opening of an aperture.

In particular, on an object a spot corresponding to a single pixel is illuminated and the reflection of the illumination light is focused by a lens system. Depending on the distance of the spot from the microscope the location of the focus of the reflected light differs. Only if this focus coincides with the opening of the aperture an image forms (i.e. high correlation) otherwise no light can pass (i.e. low correlation).

Claim 1 as granted explicitly includes the possibility of forming the correlation between a single pixel and a weight function. For the “Optical Correlation” described in paragraph 174 of the patent in suit this seems to be nothing else than the function of a confocal microscope as disclosed in D5/E4. Accordingly, this document does also disclose feature 1.8.

Further, although document D5/E4 refers in paragraph 21 to an avalanche photo diode, it should be noted that this is only an example for the camera used in D5/E4 (see D5/E4, par. 21: “[...] a detector 32, such as an avalanche photo diode [...]”). A skilled person understands therefore that also any other camera might be used, such as e.g. a CCD that comprises “an array of sensor elements”. Such a configuration is disclosed for confocal microscopes e.g. in D13/E12, p. 454, Fig. 19.18.

The subject-matter of claim 1 as granted can therefore at least not be considered to be based on an inventive step.

Document D6/E5

4.6 Also with respect to document D6/E5 the Patent Proprietor alleges that a single value for a correlation need to be determined in order to obtain the “correlation measure” of feature 1.8.

However, already the “PRODUCT” signal of Fig. 5 of D6/E5 can be considered as a “measure of the degree of correlation” as defined in paragraph 39 of the patent in suit. In fact, this signal can be analyzed to determine the in-focus positions of the pixels that contribute to it as is requested in feature 1.9 of claim 1 as granted. For example, this can be done by making the discrete decision for in focus or out of focus referred to as optional determination in lines 57 to 59 of D6/E5.

Again, it must be emphasized that there is no reason to interpret the claimed “correlation measure” to refer only to a specific single value as is done by the Patent Proprietor.

Hence, document D6/E5 discloses evaluation of a correlation measure as defined in paragraph 39 of D1/E1.

4.7 But even if one would follow the Patent Proprietor’s narrow interpretation that only a single value can be considered as “correlation measure” as claimed, document D6/E5 discloses all features of claim 1 as granted.

First, it should be noted that for the pixel group used to generate the “PRODUCT” signal of Fig. 5 by correlation with the “REFERENCE” signal, the low pass filter gives a signal with a well-defined maximum. This maximum constitutes e.g. a single value for a correlation measure of this pixel group with the reference signal.

As is well known to a person skilled in the art taking a windowed average, i.e. an average on a subset of k neighboring elements out of a total of n elements, is the simplest kind of low pass filter. D6/E5 discloses therefore to form a product of a group of pixel values with a reference pattern and to sum over the single products to obtain a respective correlation measure.

An alternative correlation value is disclosed in lines 3 to 8 of column 5 of D6/E5, where the ratio $(V_p - V_m) / (V_p + V_m)$ is used as correlation measure, since this function “is only a maximum in regions where sharp focus exists”, i.e. for a group of pixels that obtain in focus image signals the thus defined, single valued correlation measure will be larger than for a group of pixels obtaining only out of focus image signals.

Hence, also the ratio of column 5 of D6/E5 can be used as correlation measure that allows determining in-focus positions of a single pixel (i.e. the middle pixel) or of a group of pixels.

Document D6/E5 discloses therefore the subject-matter of claim 1 as granted.

Document US 5 381 236 (E15)

4.8 Beside the documents cited above also document E15 is pertinent to the novelty of claim 1 as granted. Document E15 has to be admitted into the proceedings, since it is *prima facie* relevant.

As can be seen from Fig. 2 of E15, E15 discloses a scanner for determining the 3D geometry of an object (see e.g. E15, col. 1, l. 5 to 9), comprising a camera (E15, Fig. 2, CCD 1), means for generating patterned light (E15, Fig. 2, lamp 5 together with spatial filter 7), means for transmitting the patterned light to the object (E15, Fig. 2, lens system 2), and means for transmitting reflected light from the object to the camera (E15, Fig. 2, lens system 2). In the camera images are taken by a plurality of pixels (see e.g. E15, col. 4, l. 35 to 38 and col. 5, l. 60 to 67). E15 discloses therefore features 1.1 to 1.5 and 1.7 of claim 1 as granted.

The position of the lens by which light is transmitted onto the object is varied in order to vary the focus plane position of the light (E15, col 3, l. 24 to 26 and 46 to 51). Thus, also feature 1.6 is disclosed.

Document E15 is concerned with temporal correlation as discussed in paragraph 73 of the patent in suit. The correlation measure M is the normalized difference between the intensities of a single pixel in two consecutive frames: $M = |i_1 - i_2| / I$ (see E15, col. 5, l. 43 to col. 6, l. 11). This corresponds to the formula indicated for temporal correlation in paragraph 73 of the patent in suit for $n=2$, $f_1=1/I$, and $f_2=-1/I$. E15 discloses therefore also feature 1.8.

As indicated between line 36 of column 6 to line 31 of column 7 of E15 by using these technique for all focus plane positions the 3D real world coordinates of the object can be obtained from the in-focus positions of all pixels (see also E15, col. 1, l. 46 to 51). Hence, also features 1.9 and 1.10 are disclosed by E15.

It is therefore *prima facie* apparent that document E15 discloses all features of claim 1 (and claim 24) as granted.

4.9 As is apparent from the discussion of prior art above all correlation methods discussed in the patent in suit had been well known at the priority date of the patent in suit. Spatial correlation, in which a group of pixels is multiplied and summed with a reference pattern, is known from D3/E2 and D6/E5. Temporal correlation, in which a time series of intensities of a single pixel is multiplied and summed with a reference pattern, is known from E15. Optical correlation, in which a pattern is used twice in order to multiply illumination light with reflected light and wherein this product is integrated by the corresponding pixel, is known from D4/E3 and E14.

Hence, the overall disclosure of the patent in suit is only a summary of well-known techniques that does not go beyond what has been known by a skilled person at the priority date of the patent in suit. The patent in suit contains therefore no inventive subject-matter at all.

B. Auxiliary Requests

Request F

4.10 Claim 1 of Request F (Auxiliary Request 1) includes the additional feature that

the resolution of the measured 3D geometry is lower than the resolution of the camera.

This feature cannot be considered limiting. The resolution of the measured 3D geometry is not part of the claimed scanner. That the resolution of the camera of the claimed scanner is higher than the resolution of the measured 3D geometry can be easily obtained by using one of the scanners of documents D3/E2 to D6/E5 to scan an object with low resolution, i.e. with nearly no textures. Hence, each of the devices of documents D3/E2 to D6/E5 is capable to satisfy the above feature.

Should the above feature be understood such that the resolution of the object obtainable by the scanner shall be limited, the Opponent refers to the description of Fig. 2b on page 43 of D3/E2, where it is indicated that the illumination pattern of Fig. 2b has a cell size that is four times the size of a pixel of the used sensor, i.e. 2x2 pixels form an illumination pattern cell. Since the size of the illumination cell determines the obtainable resolution, D3/E2 discloses that the camera has a higher resolution than the resolution that can be obtained for the scanned object.

Hence, claim 1 of Request F is anticipated by or at least obvious from document D3/E2.

Further, from Fig. 5 of D6/E5 it is clear that the camera disclosed therein has a resolution corresponding to one period of the reference signal. Since the product signal is filtered by a low pass, a group of pixels contributes to a single correlation measure. The resolution obtainable for the 3D shape of the scanned object is therefore lower than the resolution of the camera.

Accordingly, also D6/E5 discloses all features of claim 1 of Request F.

In addition, checkerboard patterns as the one described in D3/E2 might be used in any of the scanners of D4/E3 and D6/E5. Since the specific type of illumination pattern, and the relation of illumination pattern to pixel pattern lies within the discretion of a skilled person, the subject-matter of claim 1 of Request F is also obvious, if one considers D4/E3 or D6/E5 as closest prior art.

It should also be noted that adaption of the resolution of the camera to the resolution of the obtainable 3D geometry is commonly known in the field of dental 3D scanners. This is for example illustrated by US 2007/0103460 A1 (E16) where it is indicated in paragraph 37 that for obtaining a three-dimensional model of a tooth from capturing the tooth (see E16, par. 35 and 42) the three dimensional resolution might be adapted according to the speed of image acquisition. Further, paragraph 43 of E16 teaches that only a subset of the available pixels is used for establishing the 3D geometry, i.e. that “the resolution of the measured 3D geometry is lower than the resolution of the camera”.

4.11 Claim 2 of Request F refines the additional limitation of claim 1 of Request F by indicating that “the resolution being determined by the size of the groups of sensor elements”. Also, it is indicated that the illumination pattern is static.

As discussed above, for document D6/E5 the low pass filter over the multiplication of image signal and reference function determines the resolution in dependence of the image pixels involved in taking the image signal. For example in Fig. 5 four pixels are involved leading to a spatial resolution of four times the camera resolution. The obtainable resolution is therefore “determined by the size of the groups of sensor elements” that were used, as required by the additional feature of claim 2 of Request F.

Further, the illumination pattern used in D6/E5 is static (see D6/E5, col. 2, l. 22 to 27).

Similarly as for claim 1 of Request F it must be considered trivial for a skilled person to adapt the desired resolution to his needs. As indicated above, document E16 teaches a skilled person to use a lower resolution, if the speed of image acquisition shall be increased (see E16, par. 37). To do this in one of the documents cited before by combining a plurality of pixels to a group

of pixels (or super-pixel) cannot be considered inventive, but is merely a design option a skilled person has.

Also claim 2 of Request F is therefore not new over D6/E5.

4.12 Claim 3 of Request F corresponds to claim 3 of Request A submitted by the Patent Proprietor on November 17, 2017, which was discussed in section 3.4.3 of the Preliminary Opinion.

Regarding the allegation of the Patent Proprietor that document D10/E9 does not disclose the additional features of claim 3 of Request F, the Opponent refers to paragraph 88 of D10/E9. There, it is indicated that the tilt sensor is used to “determine a profile of the object” together with an accelerometer. It is therefore directly and unambiguously clear to a skilled person that the images processed to produce the 3D map according to paragraph 12 of D10/E9 are the images the relative angle of which are determined according to paragraph 13 of D10/E9.

Further, reference is made to US 2009/0087050 A1 (E17). E17 discloses a handheld scanner for scanning teeth (see E17, par. 1, Fig. 2), in which motion sensors for determining the motion of the scanner are integrated (see E17, par. 42). According to paragraphs 12 and 13 the detected movements are used to align the different images obtained by the scanner in different positions. E17 discloses therefore *prima facie* the additional features of claim 3 of request F. In addition, how to align a series of consecutive frames is disclosed in US 2007/0081718 A1 (E18, see e.g. abstract, par. 20, 84, 231, 235, and 244), or in E16 (see E16, par. 44 to 46). Also from these documents, all lying in the same field as documents D3/E2 to D6/E5 and E15, a skilled person would be able to obtain the additional features of claim 3 of Request F in an obvious manner.

The subject-matter of claim 3 of Request F is therefore obvious in view of documents D10/E9 or E16 to E18.

4.13 Claim 4 of Request F corresponds to claim 4 of Request A submitted by the Patent Proprietor on November 17, 2017, which was discussed in section 3.4.4 of the Preliminary Opinion.

Regarding the subject-matter of claim 4 of Request F it is referred to column 18, line 50 to 53 of D12/E11. From this passage a skilled person learns that views on an acquired scan can be rotated by a mouse. From column 19, lines 40 to 48 the skilled person learns that instead of a mouse a gyroscopic pointing device might be used instead of a mouse.

In order to solve the problem of how to interact with the system in a hygienic manner, a skilled person would therefore take into account the above passages of D12/E11 to provide the

handheld scanner of e.g. D4/E3 or D5/E4 with a gyroscopic pointing device that allows *inter alia* rotation of a view of the scanned object.

Similarly, since the tracking system disclosed in paragraph 86 of D14/E13 explicitly also refers to visual guiding, a skilled person would consider it obvious to use such a tracking system to rotate a view of the scanned object in order to be guided to the desired position.

Hence, also the subject-matter of claim 4 of Request F is obvious from the cited prior art.

Requests G to J, D, and E

4.14 Requests G to J, D, and E (Auxiliary Requests 2 to 7) contain only subsets of the claims of Request F. The above applies therefore respectively to these requests.

4.15 In Requests I and J the Patent Proprietor has filed dependent claims corresponding to claims 2 to 4 as granted. The objections to these claims as brought forward in the Opposition apply still to these claims.

In particular, it should be noted again that taking a low pass filter on series of data as disclosed in D6/E5 corresponds to taking a windowed average, i.e. an average on a subset of k neighboring elements out of a total of n elements. D6/E5 discloses therefore to form a product of a group of pixel values with a reference pattern and to sum over the single products to obtain a respective correlation measure, i.e. it discloses a dot product as defined in paragraph 106 of the patent in suit, where the group size n determines the filter power: the higher n , the higher the filter power will be.

Document D6/E5 discloses therefore exactly the same kind of dot product as discussed in the patent in suit.

The same is true for D3/E2, where the convolution of the Laplacian with the sensor signal is the continuous analog to the sum of paragraph 106 (see also above, section 4.1).

Dependent claim 4 of Requests I or J can therefore not establish novelty over the cited prior art.

Request K

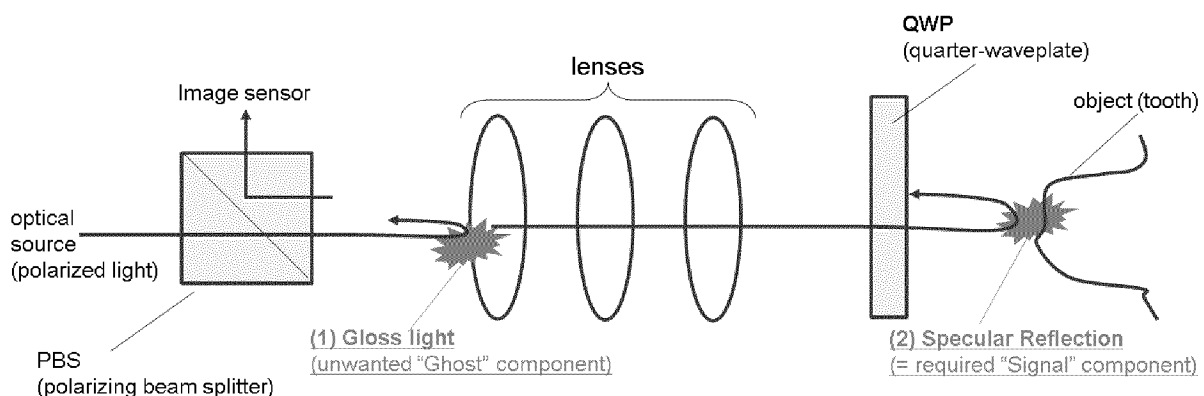
4.16 Request K (Auxiliary Request 8) introduces a retardation plate and a linearly polarizing element that are “configured for enhancing specular reflections”.

The figure of document D4/E3 disclose an arrangement of a polarizing beam splitter 5 and a quarter wave plate 11 that correspond exactly to the arrangement of the linearly polarizing element 140 and the retardation plate 160 illustrated in Fig. 1 of the patent in suit.

The physical effects of these systems will therefore be the same: linearly polarized light is changed to circularly polarized light in the quarter wave plate, is specularly reflected as circularly polarized light, further shifted by the quarter wave plate, and received as linearly polarized light at the polarizing beam splitter.

The Patent Proprietor alleges that document D4/E3 teaches in paragraph 42 that this leads to a reduction of specular reflections, while according to the patent in suit to would lead to an enhancement.

However, the Patent Proprietor does not cite paragraph 42 of D4/E3 precisely. In fact, D4/E3 refers to “gloss”, which is partly back-reflected “illumination of the object”, but not illumination light reflected from the object. As is well known to a person skilled in the art “gloss” refers to the back reflection from the lenses of the system. The arrangement of the polarizers and $\lambda/4$ -plate in D4/E3 reduces the gloss therefore by transmitting the specular reflections of the object, while suppressing the specular reflections of the lens system, since lens system and object are arranged on different sides of the $\lambda/4$ -plate. This situation is illustrated in the following figure:



Gloss light is specularly reflected. Since it does not travel through the $\lambda/4$ -plate it will not be able to pass the polarizing beam splitter (which must be considered as a beam splitter having crossed polarizers on its sides) towards the image sensor. On the other hand, the light reflected from the object travels twice through the $\lambda/4$ -plate and can pass through the polarizing beam splitter. Thus, an arrangement as disclosed in D4/E3 enhances specular reflections as claimed by reducing the gloss component.

In this regard, also the disclosure of US 2006/0001739 A1 (E19) should be noticed. E19 refers to devices for obtaining a 3D geometry of an object by varying the focus planes of illumination

light (see E19, par. 9 and 10), and discloses in paragraph 170 an arrangement of polarizers and a $\lambda/4$ -plate as claimed. It is further indicated in paragraph 170 that gloss is reduced, while the reflection from the object is enhanced, thus giving further support that document D4/E3 also discloses an arrangement of optical components “configured for enhancing specular reflections” as claimed in Request K.

Further, it should be noted that also document D5/E4 seems to disclose in paragraph 21 an arrangement of polarizers and quarter wave plates that corresponds to the one of Fig. 1 of D1/E1. Hence, also D5/E4 discloses an arrangement that is configured to enhance specular reflections, if this is possible with the arrangement of the patent in suit.

Here, it should be noted that a skilled person would easily combine documents D4/E3 and D5/E4 in this regard - as seems to be also indicated in section 3.4.2 of the preliminary opinion, since both documents refer to depth from focus measurements and since the elements arranged along the optical path of the device of both documents are almost identical. Further, document D4/E3 explicitly mentions confocal microscopes in its paragraph 22.

Claim 1 of Request A

4.17 Although the Patent Proprietor does at the moment no claim corresponding to claim 1 of Request A the Opponent wants to point out that - as also stated by the Opposition Division in section 3.4.1 of the Preliminary Opinion - document D4/E3 clearly discloses as single lens, but not a lens assembly as alleged by the Patent Proprietor (see e.g. D4/E3, par. 32, 50, claim 16, and lens 7 of the figure). Therefore, should the Patent Proprietor reintroduce claim 1 of Request A also this claim would not be novel over the cited prior art.

5. Summary

The patent in suit has to be revoked. The claims as granted lack enablement disclosure, are inadmissibly extended, and lack novelty.

The claims of the Auxiliary Requests are either inadmissibly extended, unclear, lack enablement disclosure, lack novelty, or lack inventive step.

// R. Wunderlich //
R. Wunderlich
Patentanwalt

Enclosures
Documents E14 to E19