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Datasheet for the decision of 19 May 2022

Case Number: T 1989/17 - 3.5.04

Application Number: 04723632.8

Publication Number: 1616303

IPC: G06T15/20

Language of the proceedings: EN

Title of invention:
EFFICIENT BUMP MAPPING USING HEIGHT MAPS

Applicant:
Imagination Technologies Limited

Headword:

Relevant legal provisions:
RPBA 2020 Art. 13(2)
EPC 1973 Art. 84, 56
EPC Art. 123(2)

Keyword:
Amendment after summons - exceptional circumstances (yes)
Claims - clarity - sole request (yes)
Amendments - sole request - added subject-matter (no)
Inventive step - sole request (yes)

Decisions cited:

Catchword:

Europäisches Patentamt
European Patent Office
Office européen des brevets

Beschwerdekammern

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Case Number: T 1989/17 - 3.5.04

D E C I S I O N
of Technical Board of Appeal 3.5.04
of 19 May 2022

Appellant: (Applicant)	Imagination Technologies Limited Home Park Estate Kings Langley, Hertfordshire WD4 8LZ (GB)
Representative:	Slingsby Partners LLP 1 Kingsway London WC2B 6AN (GB)
Decision under appeal:	**Decision of the Examining Division of the European Patent Office posted on 16 March 2017 refusing European patent application No. 04723632.8 pursuant to Article 97(2) EPC.**

Composition of the Board:

Chair	B. Willems
Members:	A. Seeger
	T. Karamanli

Summary of Facts and Submissions

I. The appeal is against the examining division's decision to refuse European patent application No. 04 723 632.8, published as international patent application WO 2004/095376 A2.

II. The prior-art documents cited in the decision under appeal included the following:

D1 Hast, A. et al: "*Reconstruction filters for bump mapping*", 10th International Conference in Central Europe on Computer Graphics, Visualization and Computer Vision, 4 to 8 February 2002, Plzen, Czech Republic, pages 9 to 12, XP002299248, ISSN: 1213-6972

D4 Farin, G.: "*Curves and surfaces for computer aided geometric design: a practical guide*", 1993, Academic Press, Boston, XP55320124, ISBN: 978-0-12-249052-1, pages 29 to 40 and 267 to 277

III. The decision under appeal was based on the finding that the subject-matter of the independent claims of the main request and the first and second auxiliary requests then on file did not involve an inventive step (Article 56 EPC) over the disclosure of document D1 combined with the common general knowledge of the person skilled in the art as exemplified by document D4.

IV. The applicant (appellant) filed notice of appeal. With the statement of grounds of appeal, the appellant maintained the main request and the first and second auxiliary requests on which the impugned decision was

based. It provided arguments to support its opinion that the claims of these requests met the requirements of Article 56 EPC.

V. A summons to oral proceedings and a communication under Article 15(1) of the Rules of Procedure of the Boards of Appeal in the 2020 version (RPBA 2020, see OJ EPO 2019, A63) were issued. In that communication, the board gave the following preliminary opinion.

(a) Claim 1 of all requests specified "*generating bump map data substantially in real time*" without clearly setting out the steps which ensured a substantially real-time generation of the bump map. Therefore, claim 1 of all requests did not meet the requirements of Article 84 EPC 1973. The same objection applied to the corresponding independent apparatus claim.

(b) The subject-matter of claims 1 and 5 of the main request and claims 1 and 4 of the first auxiliary request did not involve an inventive step within the meaning of Article 56 EPC 1973.

(c) The subject-matter of claim 1 of the second auxiliary request was not obvious over the disclosure of document D1 combined with the common general knowledge of the person skilled in the art exemplified by document D4. The board was also of the opinion that no other combination of prior-art documents would have rendered the subject-matter of claim 1 obvious. Hence, claim 1 of the second auxiliary request met the requirements of Article 56 EPC 1973. The same applied to the corresponding independent apparatus claim 5.

VI. By letter of reply dated 14 April 2022, the appellant filed amended claims according to a replacement main request and replacement first and second auxiliary requests. It submitted arguments to support its opinion that the replacement requests should be admitted into the appeal proceedings and that the claims of all requests met the requirements of Articles 56 and 84 EPC 1973.

VII. On 19 May 2022, oral proceedings took place before the the board.

During the oral proceedings, the appellant filed claims according to a "Replacement Second Auxiliary Request" and a third auxiliary request.

The appellant made the third auxiliary request its sole request and withdrew all other requests on file.

The appellant's final request was that the decision under appeal be set aside and that a European patent be granted on the basis of the claims of the sole request filed as the third auxiliary request at the oral proceedings of 19 May 2022.

At the end of the oral proceedings, the chair announced the board's decision.

VIII. The claims of the sole request read as follows:

"1. A method for generating bump map data for use in a 3-dimensional computer graphics system comprising the steps of:

receiving data defining an area to which a texture is to be applied, the data comprising a requested sample position of the texture;

receiving texture data to apply to the area, the data including surface height data;

performing a filtering step on samples of the texture data to generate filtered samples;

deriving surface tangent vectors from the filtered samples; and

deriving a bump map surface normal from the surface tangent vectors characterised in that the filtering step includes the steps of: using bi-quadratic B-splines to model a height surface from the surface height data; and, for the requested sample position of the texture, fetching a 3x3 set of height values (100) for the surface height data comprising four partially overlapping 2x2 grids of values, and filtering the four 2x2 grids of values at respective bilinear units (65, 66, 67, 68) to generate the filtered samples, the bilinear units (65, 66, 67, 68) being red, green, blue and alpha bilinear units configured to calculate a respective red, green, blue and alpha colour channel, the bilinear units using a set of blending factors so that the bilinear unit that filters the top-left 2x2 grid of values uses blending factors ($Ublend_0$, $Vblend_0$), the bilinear unit that filters the top-right 2x2 grid of values uses blending factors ($Ublend_1$, $Vblend_0$), the bilinear unit that filters the bottom-left 2x2 grid of values uses the blending factors ($Ublend_0$, $Vblend_1$) and the bilinear unit that filters the bottom-right 2x2 grid of values uses the blending factors ($Ublend_1$, $Vblend_1$), where $Ublend_0 = 1/2 +$

Ublend/2; $Ublend_1$ = Ublend/2; $Vblend_0$ = 1/2 + Vblend/2; $Vblend_1$ = Vblend/2 and Ublend and Vblend are linear blending factors.

2. Apparatus for generating bump map data for use in a 3-dimensional computer graphics system comprising:

means for receiving data defining an area to which a texture is to be applied that comprises a requested sample position (50) of the texture;

means (151) for receiving texture data to apply to the area, the data including height data;

a blend factor unit (153) for computing a set of blending factors;

means (65, 66, 67, 68) for performing a filtering step on samples of the texture data using the blending factors to generate filtered samples;

means (155) for deriving surface tangent vectors from the filtered samples; and

means (156) for deriving a bump map surface normal from the surface tangent vectors, and characterised in that the filtering means comprises: a means to use bi-quadratic B-splines to model height surfaces from the surface height data; a texture fetch unit (151) configured to fetch, for the requested sample position of the texture, a 3x3 set of height values for the height surface comprising four partially overlapping 2x2 grids of values; and a red, green, blue and alpha bilinear unit (65, 66, 67, 68) for calculating a red, green, blue and alpha colour channel respectively, each bilinear unit being configured to filter a respective

2x2 grid of values using the blending factors to generate the filtered samples, the bilinear units (65, 66, 67, 68) being configured so the bilinear unit that filters the top-left 2x2 grid of values uses blending factors ($Ublend_0$, $Vblend_0$), the bilinear unit that filters the top-right 2x2 grid of values uses blending factors ($Ublend_1$, $Vblend_0$), the bilinear unit that filters the bottom-left 2x2 grid of values uses the blending factors ($Ublend_0$, $Vblend_1$) and the bilinear unit that filters the bottom-right 2x2 grid of values uses the blending factors ($Ublend_1$, $Vblend_1$), where $Ublend_0 = 1/2 + Ublend/2$; $Ublend_1 = Ublend/2$; $Vblend_0 = 1/2 + Vblend/2$; $Vblend_1 = Vblend/2$ and Ublend and Vblend are linear blending factors."

IX. In the decision under appeal, concerning the second auxiliary request then on file, the examining division held as follows.

The region of the curve was calculated with the standard approach of using the equivalent Bézier representation of the quadratic B-spline, where the Bézier points were derived as the mid-points of the connecting line segments between the control points and were obtained by simple averaging, as acknowledged in the description on page 6, lines 15 to 23.

The calculation of blending factors was inherent in de Casteljau's algorithm, as acknowledged on page 7 of the description and known from the prior art - see, for example, document D4, page 269, first two sentences.

The claimed conversion of the blending factors was mathematically equivalent to the above-mentioned standard approach. Using a mathematically equivalent

calculation did not involve an inventive step (see decision under appeal, points 4.1 and 5 b)).

Reasons for the Decision

1. The appeal is admissible.

2. Sole request - admittance (Article 13(2) RPBA 2020)

2.1 In the case in hand, the summons to oral proceedings was notified after the date on which RPBA 2020 entered into force, i.e. 1 January 2020 (Article 24(1) RPBA 2020). In accordance with Article 25(1) and (3) RPBA 2020, therefore, Article 13(2) RPBA 2020 applies to the question of whether to admit the appellant's sole request. That request was filed after notification of the summons to oral proceedings and thus constitutes an amendment within the meaning of Article 13(2) RPBA 2020.

2.2 The board considers the sole request to be a response to the objections under Article 84 EPC 1973 raised for the first time in the board's communication under Article 15(1) RPBA 2020 and during the oral proceedings. The board thus considers that, here, the circumstances leading to the amendment are exceptional. Therefore, the board exercised its discretion under Article 13(2) RPBA 2020 and decided to admit the sole request into the appeal proceedings.

3. Sole request - added subject-matter (Article 123(2) EPC)

3.1 Claim 1 is based on claims 1 and 3 as originally filed.

3.2 Claim 2 is based on claims 6 and 8 as originally filed.

3.3 The further amendments to claims 1 and 2 are based on the following passages of the description:
- page 5, lines 22 to 25
- page 12, last paragraph, to page 13, penultimate paragraph

3.4 Therefore, claims 1 and 2 of the sole request do not contain subject-matter which extends beyond the content of the application as filed. Claims 1 and 2 thus meet the requirements of Article 123(2) EPC.

4. Sole request - clarity (Article 84 EPC 1973)

4.1 In comparison with the second auxiliary request on which the decision under appeal was based, the expression "*substantially in real time*" in the independent claims was deleted. The objection of lack of clarity raised by the board in its communication under Article 15(1) RPBA 2020 (see point V.(a) above) was thereby overcome.

4.2 All dependent claims were deleted, thereby resolving the objections of lack of clarity raised against these claims by the board during the oral proceedings.

4.3 Therefore, claims 1 and 2 of the sole request are clear (Article 84 EPC 1973).

5. Sole request - inventive step (Article 56 EPC 1973)

5.1 Document D1 discloses, applying the wording of claim 1, a method for generating bump map data for use in a 3-dimensional computer graphics system (see page 1, left column, lines 1 to 7) comprising the steps of:

- receiving data defining an area to which a texture is to be applied, the data comprising a requested sample position of the texture (see page 3, left column, lines 7 to 9: "*A torus is bump mapped*")

- receiving texture data to apply to the area, the data including surface height data (see page 1, left column, lines 1 to 7)

- performing a filtering step on samples of the texture data to generate filtered samples (see page 2: left column, last paragraph; right column, equations (3) and (4); right column, first to third paragraphs)

- deriving surface tangent vectors from the filtered samples (see page 2, right column, equations (5) and (6))

- deriving a bump map surface normal from the surface tangent vectors (see page 1, right column, equation (1), lines 5 to 11)

5.2 Furthermore, document D1 discloses that the filtering step includes the step of using a suitable family of spline curves to model a height surface from the surface height data (see page 2, right column, lines 1 to 4 and 14 to 18). One such family of spline curves disclosed in document D1 comprises cubic B-splines (see page 3, left column, first paragraph: "*Cubic B-splines*" and section 3.1). Since these cubic B-splines are applied in both u and v dimension (see page 2, equation (4) and the subsequent paragraph), they act as bi-cubic B-splines.

5.3 It is common ground (see decision under appeal: page 8, point 4.1, first and second paragraphs, in combination with page 7, second paragraph; and statement of grounds of appeal: page 9, fourth paragraph, in combination with page 7, second paragraph) that the subject-matter of claim 1 differs from the disclosure of document D1 in that the filtering step of claim 1 includes the following distinguishing features:

(a) using bi-quadratic B-splines to model a height surface from the surface height data

(b) for the requested sample position of the texture, fetching a 3x3 set of height values for the surface height data comprising four partially overlapping 2x2 grids of values

(c) filtering the four 2x2 grids of values at respective bilinear units to generate the filtered samples, the bilinear units being red, green, blue and alpha bilinear units configured to calculate a respective red, green, blue and alpha colour channel

(d) the bilinear units using a set of blending factors so that the bilinear unit that filters the top-left 2x2 grid of values uses blending factors ($Ublend_0$, $Vblend_0$), the bilinear unit that filters the top-right 2x2 grid of values uses blending factors ($Ublend_1$, $Vblend_0$), the bilinear unit that filters the bottom-left 2x2 grid of values uses the blending factors ($Ublend_0$, $Vblend_1$) and the bilinear unit that filters the bottom-right 2x2 grid of values uses the blending factors ($Ublend_1$, $Vblend_1$), where $Ublend_0 = 1/2 + Ublend/2$; $Ublend_1 = Ublend/2$; $Vblend_0 = 1/2 + Vblend/2$; $Vblend_1 =$

Vblend/2 and Ublend and Vblend are linear blending factors.

5.4 Using bi-quadratic B-splines instead of bi-cubic B-splines (see distinguishing feature a) in point 5.3 above) has the technical effect of simplifying a calculation of the spline, because fewer polynomial coefficients are to be determined.

The distinguishing feature b) in point 5.3 above together with the feature of "*filtering the four 2x2 grids of values at respective bilinear units to generate the filtered samples*" has the technical effect of simplifying the calculation of bi-quadratic B-splines through the application of successive bilinear interpolations between sub-sets of control points in the form of de Casteljau's algorithm.

The feature "*the bilinear units being red, green, blue and alpha bilinear units configured to calculate a respective red, green, blue and alpha colour channel*" allows for a hardware-efficient implementation through the reuse of available hardware units within a graphics processing unit (see description as originally filed: page 3, line 19, to page 5, line 26 and Figures 4a and 4b).

The technical effect of feature d) in point 5.3 above is that the results of a bilinear interpolation between B-spline control points using the modified sets of blending factors become identical to the results of bilinear interpolation between Bézier control points using the blending factors Ublend and Vblend (see decision under appeal: page 9, first paragraph and page 10, section 5 b); and statement of grounds of appeal: page 10, third and fourth paragraphs). Thus, a

conversion from B-spline control points to Bézier control points can be avoided while achieving the same filtering.

5.5 A necessary condition imposed on the filtered surface height data is that the data must have at least C1 continuity or, in other words, a continuous first derivative. This guarantees the existence of defined surface tangents and a surface normal can thus be calculated at all positions of the height map (see description as originally filed, page 8, lines 3 to 5).

5.6 In view of the above, the objective technical problem could be formulated as reducing the complexity of filtering using B-splines while maintaining at least C1 continuity in the modelled height surface and implementing this filtering in a hardware-efficient manner.

5.7 The board finds that the person skilled in the art, faced with this objective technical problem, would not have come across any hint or suggestion in the available prior art so as to arrive at distinguishing feature d) of point 5.3 above.

For example, in Figures 16.1, 16.2, 16.3 and 16.4 of document D4, the set of Bézier data points $b_{i,j}$ indicates the range of u and v values for which bilinear interpolation in de Casteljau's algorithm is to be performed according to equation 16.5. No data point is used that is outside this range of u and v values. Hence, there is no indication to the person skilled in the art that averaging operations needed to convert bi-quadratic B-spline control points to Bézier points (see description page 6, lines 15 to 23) can be avoided.

5.8 The examining division held that the results of a bilinear interpolation between B-spline control points using the modified sets of blending factors were identical to the results of bilinear interpolation between Bézier control points using the blending factors Ublend and Vblend. The examining division concluded that using a mathematically equivalent calculation did not involve an inventive step (see point IX. above).

However, the board finds that distinguishing feature d) of point 5.3 above provides a specific technical effect of avoiding a conversion from B-spline points to Bézier points through alteration of the blending factors. This amounts to a simplification of the computing workflow facilitated by using bilinear interpolation units as available in a common graphics processing unit with non-standard interpolation factors.

5.9 Therefore, the board is of the opinion that the subject-matter of claim 1 according to the sole request is not obvious over the disclosure of document D1 combined with the common general knowledge of the person skilled in the art exemplified by document D4.

5.10 The board is also of the opinion that no other combination of prior-art documents would render the subject-matter of claim 1 obvious.

5.11 In view of the above, the board finds that claim 1 of the sole request meets the requirements of Article 56 EPC 1973. The same applies to the corresponding independent apparatus claim 2.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the examining division with the order to grant a European patent on the basis of claims 1 and 2 of the sole request filed as third auxiliary request at the oral proceedings of 19 May 2022 and a description to be adapted thereto.

The Registrar: The Chair:

N. Michaleczek B. Willems

Decision electronically authenticated