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BEFORE THE PATENT TRIAL AND APPEAL BOARD

Ex parte CUNEYT OZDAS, LUKE TILMAN PETERSON, STEVEN BLACKMON, and STEVEN JOHN CLOHSET

Appeal 2019-001703
Application 14/202,722
Technology Center 2600

Before CAROLYN D. THOMAS, BRADLEY W. BAUMEISTER, and JEREMY J. CURCURI, *Administrative Patent Judges*.

BAUMEISTER, *Administrative Patent Judge*.

DECISION ON APPEAL

Appellant appeals under 35 U.S.C. § 134(a) from the Examiner's final rejection of claims 1, 3–7, 9, 11–18, 23, and 34.[1] Appeal Br. 1. Claims 2, 8, 10, 19–22, 27, and 35–63 have been canceled. *Id.* Claims 24–26 and 28–33 are withdrawn from consideration pursuant to a restriction requirement. *Id.* We have jurisdiction under 35 U.S.C. § 6(b). The Board conducts a limited *de novo* review of the appealed rejections for error based upon the issues identified by Appellant, and in light of the arguments and evidence produced thereon. *Ex parte Frye*, 94 USPQ2d 1072, 1075 (BPAI 2010) (precedential).

We REVERSE.

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[1] Appellant identifies the real party in interest as Imagination Technologies Limited. Appeal Brief filed June 25, 2018 ("Appeal Br.") 1.

CLAIMED SUBJECT MATTER

Appellant describes the present invention as follows:

> Aspects relate to tracing rays in 3-D scenes that comprise objects that are defined by or with implicit geometry. In an example, a trapping element defines a portion of 3-D space in which implicit geometry exist. When a ray is found to intersect a trapping element, a trapping element procedure is executed. The trapping element procedure may comprise marching a ray through a 3-D volume and evaluating a function that defines the implicit geometry for each current 3-D position of the ray. An intersection detected with the implicit geometry may be found concurrently with intersections for the same ray with explicitly-defined geometry, and data describing these intersections may be stored with the ray and resolved.

Abstract.

Independent claim 1, reproduced below, illustrates the appealed claims:

> 1. A computer-implemented method of testing a ray for intersection with an implicit surface in a 3-D space of a computer graphics scene to be rendered, comprising:
>
> entering, by a processor, a surface of a shell bounding a 3-D volume in said 3-D space with a ray, the shell defining a maximum extent for implicitly-defined geometry within the shell;
>
> iteratively stepping, by a processor, a current 3-D position of the ray along its path through the 3-D volume defined by the shell;
>
> for each current 3-D position, by a processor
>
> projecting the current 3-D position of the ray to a current position on an explicitly defined 2-D surface in said 3-D space and bounded in the shell,
>
> producing data for the implicitly-defined geometry using the current position on the explicitly-defined 2-D surface in said 3-D space, and

> characterizing the ray as either hitting or missing the implicitly-defined geometry at the current 3-D position in said 3-D space, using the produced data; wherein the ray characterization is used in rendering of said scene on a visual display.

STATEMENT OF THE REJECTIONS

Claims 1, 3–6, 9, 11–13, 15–18, 23, and 34 stand rejected under 35 U.S.C. § 102(b) as anticipated by Porumbescu et al. (*Shell Maps*; AMC Transactions on Graphic (TOG). Vol. 24. No. 3 ACM, published 2005, hereinafter Porumbescu). Final Act. 2–13.[2]

Claims 1, 3–6, 9, 11–13, 15–18, 23, and 34 stand rejected alternatively under 35 U.S.C. § 103(a) as being unpatentable over Porumbescu and Hirche et al. (*Hardware Accelerated Per-Pixel Displacement Mapping*; Proceedings of Graphics interface published 2004, hereinafter Hirche). Final Act. 2–13.

Claims 7 and 14 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Porumbescu, Hirche, and Szirmay-Kalos & Tamas Umenhoffer (*Displacement Mapping on the GPU– State of the Art*; Computer Graphics Forum. Vol. 27. No. 6 published 2008, hereinafter Szirmay). Final Act. 13–14.

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[2] Rather than repeat the Examiner's positions and Appellant's arguments in their entirety, we refer to the above mentioned Appeal Brief, as well as the following documents for their respective details: the Final Action mailed January 24, 2018 ("Final Act."); the Examiner's Answer mailed October 19, 2018 ("Ans."); and the Reply Brief filed December 19, 2018 ("Reply Br.").

CONTENTIONS AND ANALYSIS

I.

Contentions

Appellant argues that the Examiner erred in rejecting the above-noted claims as anticipated by Porumbescu. Appeal Br. 5–10. Appellant first points out, *inter alia*, the difference, within the context of claim 1, between explicitly defined geometry and implicitly defined geometry. *Id.* 5–8. Appellant next argues that "Porumbescu is different than the subject matter as set forth in claim 1 in that Porumbescu is not directed to implicitly-defined surfaces[,] but rather to shell maps." *Id.* at 8; *see also id.* at 8–10 (supporting this argument).

In relation to the first point, Appellant argues,

> In the specification, explicitly-defined geometry is geometry that is defined by meshes of vertex data, such as meshes of triangles. The implicit geometry relates to the geometric surfaces defined by evaluating whatever programmatic or procedural refinement of the coarse geometry is indicated. When implicitly-defined geometry is used, the determination as to whether a ray intersects with the geometry is more complicated than a corresponding determination for explicitly-defined geometry.

Appeal Br. 6.

Appellant continues,

> The use of implicitly-defined geometry allows highly detailed geometry to be used in ray tracing, without using a large amount of storage space to define that geometry. The implicitly-defined geometry can be expressed as a hybrid of explicitly defined geometry and a programmatic refinement. This allows a relatively coarse geometry structure to express a more nuanced surface by allowing a programmatic or procedural refinement to the geometry surface.

Appeal Br. 6.

In relation to Appellant's second point, which regards the teachings of Porumbescu, Appellant argues,

> Porumbescu relates to the use of shell maps in which a bijective mapping[3] between a 3-D shell space and a 3-D texture space is generated so as to allow a 3-D volume in texture space to be mapped onto a surface. The arrangement of Porumbescu defines a shell between a base surface (on which the 3-D volume is to be mapped) and an offset surface having the same structure as the base surface and positioned above the surface. A correspondence between the 3-D space defined by the surfaces (shell space) and the 3-D space of the texture (texture space) is determined[,] which [correspondence determination] enables the 3-D volume in texture space to be mapped onto the base surface S. In this way, it is possible to texture a surface with a 3-D volume such as a series of columns or a representation of a rabbit[,] as illustrated in Figures 8 to 10.

Appeal Br. 8.

Appellant further points out that Porumbescu expressly explains,

> *Shell mapping does not supplant displacement mapping or other texturing techniques, but complements them. Displacement mapping modifies* a *surface by moving vertices along associated normal, whereas shell mapping adds 3D geometric detail to the shell map region* ***without modification of the original surface***.

Appeal Br. 9 (citing Porumbescu, section 5).

The Examiner finds Appellant's arguments to be unpersuasive because the Examiner finds (1) the claims do not recite "displacement

[3] In mathematics, "[a] function is bijective for two sets if every element of one set is paired with only one element of a second set, and each element of the second set is paired with only one element of the first set. This means that all elements are paired and paired once." https://brilliant.org/wiki/bijection-injection-and-surjection/#bijective.

mapping" and (2) the plain meaning of the claim term "implicitly-defined geometry" is not limited to the context of displacement mapping. Ans. 15–18. Based on a broader interpretation of implicitly defined geometry, the Examiner interprets Porumbescu's shell space as corresponding to the claimed shell space. Final Act. 2–3 (citing Porumbescu's Figure 7 and Appellant's Figure 6). The Examiner then interprets the claimed "explicitly-defined 2-D surface in the 3-D space" as corresponding to a surface of Porumbescu's texture space, and the Examiner interprets "an implicit surface in a 3-D space" as corresponding to the surface of Porumbescu's shell space. Final Act. 4.

Analysis

Even if we were to agree with the Examiner that the claimed "explicitly-defined 2-D surface" and "implicit surface" are not limited to the context of displacement mapping, the Examiner still has not established a prima facie showing of anticipation. Claim 1 requires that the two claimed surfaces exist within the same 3-D space. *See* claim 1 (reciting a method of testing a ray for intersection with an implicit surface in a 3-D space that comprises passing a ray through a shell defining a maximum extent for implicitly-defined geometry within the shell and then projecting a current 3-D position of the ray to a current position on an explicitly defined 2-D surface in said 3-D space).

In contrast, Porumbescu's shell space and textured space are not the same 3-dimensional space. As Porumbescu explains,

> Displacement mapping . . . explicitly models surface displacement by height fields. Smits *et al*. . . . describe methods to make displacement mapping reasonable for ray tracing. . . .

> We present a straightforward and powerful method for mapping three-dimensional regions containing textures or geometry into regions between surfaces and their offsets. *The mapping is bijective[,] which allows the use of applications that map shell-space points to texture space, and texture-space points to shell space*. This method allows many object types to be placed directly into texture space, greatly expanding the detail that can be created on surface models.

Porumbescu, section 2 (emphasis added).

Moreover, claim 1 recites, "projecting the current 3-D position of the ray to a current position on an *explicitly*-defined 2-D surface in said 3-D space," and then "producing data for the *implicitly*-defined geometry using the current position on the *explicitly*-defined 2-D surface." In contrast,

> Porumbescu discloses generating a bijective mapping between a 3-D shell space and a 3-D texture space to allow a 3-D volume in texture space to be mapped onto a surface S. A shell is defined between a base surface S and an offset surface S_0 having the same structure as the base surface and positioned above the base surface.

Reply Br. 2 (citing Porumbescu, p. 627; Fig. 2).

The Examiner does not sufficiently explain how Porumbescu allegedly teaches projecting the current position of a ray to an explicitly defined surface and then using the results to produce data for the implicitly defined geometry. Accordingly, we reverse the Examiner's anticipation rejection of claim 1, as well as claims 3–6, 9, 11–13, 15–18, 23, and 34, which either depend from claim 1 or otherwise include similar claim language as claim 1.

II.

Contentions

The Examiner additionally finds that even if Porumbescu is interpreted as being silent as to projecting the current 3-D position of a ray to a current position on an explicitly defined 2-D surface, "Hirche teaches that it [was] known to cast a ray into a 3D space to 'find out whether the ray intersects the displacement map . . . in a manner similar to Por[u]mbescu teaching entrance into the bounding prisms." Final Act. 5 (citing Hirche, section 3). The Examiner further finds,

> [i]n the same manner described by the claims, Hirche teaches the ray entering a shell and stepping a 3-D position along its path and projected onto the explicitly defined geometry on the base surface of the shell which defines the implicit geometry at that section to determine whether an intersection occurs with the implicit geometry in the shell.

Final Act. 6.

The Examiner determines that it would have been obvious to combine the teachings of Porumbescu and Hirche for the following reasons:

> Porumbescu teaches specifically that the method describe[d] is meant to "complement" displacement mapping (section 5) and that the base surface upon which the shell maps are generated can be any texture space containing "geometric objects, procedural volume textures, scalar fields (section 3) and that the illustrated use is in "applications utilizing geometry as generalized displacement maps" (section 1). Hirche as disclosed above then could have been combined with Por[u]mbescu to supply the specific projection technique as more clearly explained by Hirche in order to sample implicit geometry within the volume as defined by the claims. The results of such a combination would be predictable as it simply supplies an implementation

> technique for sampling within a volume containing implicit geometry.

Final Act. 7.

Appellant acknowledges that Appellant has not invented displacement mapping *per se*, but argues that the claims require more than mere displacement mapping. Appeal Br. 10–12. Appellant further argues,

> [t]he point of the Hirche paper is presenting an approach to displacement mapping that creates the appearance of a displaced surface on a per pixel basis, without requiring any insertion of vertices to retessellate the mesh. Hirche explicitly states that "The algorithm uses only pixel shaders and does not rely on adaptively adding geometry."

Appeal Br. 12. According to Appellant,

> Hirche does not disclose iteratively stepping, by a processor, a current 3-D position of the ray along its path through the 3-D volume defined by the shell; for each current 3-D position, by a processor
>
> > projecting the current 3-D position of the ray to a current position on an explicitly-defined 2-D surface in said 3-D space and bounded in the shell,
> >
> > producing data for the implicitly-defined geometry using the current position on the explicitly-defined 2-D surface in said 3-D space, and
> >
> > characterizing the ray as either hitting or missing the implicitly-defined geometry at the current 3-D position in said 3-D space, using the produced data.

Appeal Br. 11.

Analysis

Appellant's arguments are persuasive. The Examiner has not established that Hirche's process of iteratively stepping a current 3-D position of a ray along a path through the 3-D volume further includes the following requirements of claim 1:

> projecting the current 3-D position of the ray to a current position on an explicitly-defined 2-D surface in said 3-D space and bounded in the shell,
>
> producing data for the implicitly-defined geometry using the current position on the explicitly-defined 2-D surface in said 3-D space, and
>
> characterizing the ray as either hitting or missing the implicitly-defined geometry at the current 3-D position in said 3-D space, using the produced data.

And as explained in Section I of our Analysis, the Examiner has not demonstrated that this functionality is taught by Porumbescu either.

Accordingly, we reverse the Examiner's alternative, obviousness rejection of claims 1, 3–6, 9, 11–13, 15–18, 23, and 34, which all require this particular functionality.

III.

With respect to the remaining obviousness rejection of dependent claims 7 and 14, the Examiner does not rely upon Szirmay-Kalos to cure the deficiency of the anticipation and obviousness rejections explained above. Final Act. 13–14. Accordingly, we reverse the obviousness rejections of claims 7 and 14 for the reasons set forth above in relation to claim 1.

DECISION SUMMARY

In summary:

Claims Rejected	**35 U.S.C. §**	**Basis**	**Affirmed**	**Reversed**
1, 3–6, 9, 11–13, 15–18, 23, 34	102(b)	Porumbescu		1, 3–6, 9, 11–13, 15–18, 23, 34
1, 3–6, 9, 11–13, 15–18, 23, 34	103(a)	Porumbescu, Hirche		1, 3–6, 9, 11–13, 15–18, 23, 34
7, 14	103(a)	Porumbescu, Hirche, Szirmay-Kalos		7, 14
Overall Outcome				1, 3–7, 9, 11–13–18, 23, 34

REVERSED[4]

[4] Upon further prosecution, the Examiner may wish to consider whether the last limitation of claim 1, "wherein the ray characterization is used in rendering of said scene on a visual display," constitutes an affirmative method step of "rendering" that is sufficient to integrate the claim's recitations of abstract mathematical calculations and mental evaluations into a practical application, or whether the last limitation merely constitutes a recitation of an intended use of the other, affirmatively recited method steps. And if the Examiner determines that the last limitation merely constitutes an intended use of the recited method, the Examiner may wish further to consider whether claim 1 should be rejected under 35 U.S.C. § 101 for being directed to a judicial exception to patent-eligible subject matter without reciting significantly more.