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BEFORE THE PATENT TRIAL AND APPEAL BOARD

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Ex parte ALEXEY PANTELEEV, EVGENY MAKAROV,
SERGEY BOLOTOV, and YURY URALSKY

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Appeal 2018-006886
Application 14/166,627
Technology Center 2600

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Before ELENI MANTIS MERCADER, CATHERINE SHIANG, and
STEVEN M. AMUNDSON, *Administrative Patent Judges*.

AMUNDSON, *Administrative Patent Judge*.

DECISION ON APPEAL

Appellant[1] seeks our review under 35 U.S.C. § 134(a) from a rejection
of claims 1–20, i.e., all pending claims. Because the claims have been twice
rejected, we have jurisdiction under 35 U.S.C. §§ 6(b) and 134(a). *See*
Ex parte Lemoine, 46 USPQ2d 1420, 1423 (BPAI 1994) (precedential).

We reverse.

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[1] We use the word "Appellant" to refer to "applicant" as defined in
37 C.F.R. § 1.42 (2017). Appellant identifies the real party in interest as
Nvidia Corporation. Appeal Br. 3.

STATEMENT OF THE CASE

The Invention

According to the Specification, the invention concerns "computing indirect lighting" for computer graphics, in particular, "computing low-resolution indirect illumination using interpolation." Spec. ¶ 2, Abstract; *see id.* ¶¶ 9–11, 17–18. The Specification states that "[c]ertain algorithms compute indirect illumination coming from different directions for every pixel on the screen" but that doing so "is expensive." *Id.* ¶ 8. The Specification describes two steps to "improve performance." *Id.* First, "use sparse tracing" to compute indirect illumination only for selected pixels (called "sparse pixels" or "traced pixels"), e.g., "every fourth pixel on the screen." *Id.* Second, "for the remaining pixels" (called "untraced pixels"), interpolate indirect illumination, e.g., based on "pixel depth and normals." *Id.*

The Specification explains that "interpolating based on sparsely computed outgoing radiance fails to account for high-resolution surface detail when untraced pixels have normals that are significantly different from the normals of the traced pixels." Spec. ¶ 17. The Specification also explains that "accurate interpolation needs more information tha[n] sparsely computed outgoing radiance alone" provides and that "more information should be passed from the tracing step to the interpolation step." *Id.* ¶¶ 17–18. Hence, the invention interpolates using "directional incoming radiance" rather than "outgoing radiance." *Id.* ¶ 18.

Exemplary Claim

Independent claim 1 exemplifies the claims at issue and reads as follows:

1. A system for computing reduced-resolution indirect illumination using interpolated directional incoming radiance, comprising:

a cone tracing shader executable in a graphics processing unit to compute directional incoming radiance cones for sparse pixels and determine directional incoming radiance values of said sparse pixels by projecting said directional incoming radiance cones on a basis; and

an interpolation shader executable in said graphics processing unit to compute outgoing radiance values for untraced pixels that neighbor said sparse pixels by interpolating said directional incoming radiance values and projecting results of said interpolating onto normals of said untraced pixels.

Appeal Br. 19 (Claims App.).

The Prior Art Supporting the Rejections on Appeal

As evidence of unpatentability under 35 U.S.C. § 103, the Examiner relies on the following prior art:

Busch et al. ("Busch")   US 8,040,352 B2   Oct. 18, 2011
Cyril Crassin et al., *Interactive Indirect Illumination Using Voxel Cone Tracing*, 30 Proc. of Pacific Graphics 7 (2011) ("Crassin")

The Rejections on Appeal

Claims 1–4, 6–8, 10, 11, 13–17, 19, and 20 stand rejected under 35 U.S.C. § 112(a) for failing to comply with the written-description requirement. Non-Final Act. 3, 5–6; Ans. 2–3.

Claims 1–20 stand rejected under 35 U.S.C. § 103 as unpatentable over Crassin and Busch. Non-Final Act. 7–17; Ans. 3–12.

ANALYSIS

We have reviewed the rejections of claims 1–20 in light of Appellant's arguments that the Examiner erred. Based on the record before

us and for the reasons explained below, we disagree with the Examiner's determinations that (1) the Specification lacks support for every limitation in each independent claim and (2) the cited portions of Crassin and Busch teach or suggest computing outgoing radiance values for untraced pixels that neighbor sparse pixels "by interpolating said directional incoming radiance values and projecting results of said interpolating onto normals of said untraced pixels" as required by each independent claim. We provide the following to address and emphasize specific findings and arguments.

The § 112(a) Rejection of Claims
1–4, 6–8, 10, 11, 13–17, 19, and 20

Section 112(a) requires, among other things, that the specification "contain a written description of the invention." 35 U.S.C. § 112(a). The written-description requirement serves to "clearly allow persons of ordinary skill in the art to recognize that [the inventor] invented what is claimed." *Ariad Pharm., Inc. v. Eli Lilly & Co.*, 598 F.3d 1336, 1351 (Fed. Cir. 2010) (en banc) (alteration in original) (quoting *Vas-Cath, Inc. v. Mahurkar*, 935 F.2d 1555, 1563 (Fed. Cir. 1991)); *see Blue Calypso, LLC v. Groupon, Inc.*, 815 F.3d 1331, 1344 (Fed. Cir. 2016). "[T]he test for sufficiency is whether the disclosure of the application relied upon reasonably conveys to those skilled in the art that the inventor had possession of the claimed subject matter as of the filing date." *Ariad*, 598 F.3d at 1351; *Mentor Graphics Corp. v. EVE-USA, Inc.*, 851 F.3d 1275, 1296 (Fed. Cir. 2017). The "test requires an objective inquiry into the four corners of the specification from the perspective of a person of ordinary skill in the art." *Ariad*, 598 F.3d at 1351. The written-description requirement does not, however, "demand any particular form of disclosure" or require that "the

specification recite the claimed invention *in haec verba*." *Id.* at 1352. The analysis for disclosure sufficiency may consider "such descriptive means as words, structures, figures, diagrams, formulas, etc." *Lockwood v. Am. Airlines, Inc.*, 107 F.3d 1565, 1572 (Fed. Cir. 1997).

Here, independent claims 1, 8, and 15 each require determining directional incoming radiance values of sparse pixels "by projecting said directional incoming radiance cones on a basis." Appeal Br. 19–21 (Claims App.).

According to the Examiner, the Specification lacks support for the "determining by projecting" limitation in claims 1, 8, and 15. *See* Non-Final Act. 6; Ans. 12. The Examiner states that the Specification discloses "the step of determining directional incoming radiance values of sparse pixels, **followed by** the separate step of projecting said directional incoming radiance cones on a basis." Ans. 12. The Examiner explains that "separately performing the steps of determining and projecting . . . is very different than performing determining as a result of projecting." *Id.*

In response, Appellant explains that the Specification discloses "the step of computing directional incoming radiance ___cones___" rather than "the step of computing directional incoming radiance ___values___," as the Examiner states. Reply Br. 2 (citing Spec. ¶¶ 9–11). Appellant points out that the Specification describes an example where "[f]our directional incoming radiance cones 210, 220, 230, 240 are computed" and "projected on a basis of orthogonal axes α, β." *Id.* at 2–3 (quoting Spec. ¶ 30).

Based on the record before us, we determine that the Specification reasonably conveys to those skilled in the art that the inventors had possession of the claimed subject matter as of the filing date. As Appellant

points out, the Specification describes an example where "[f]our directional incoming radiance cones 210, 220, 230, 240 are computed" and "projected on a basis of orthogonal axes α, β." Spec. ¶ 30. In that example, a "geometry buffer" stores the "results of this cone tracing" as "projected directional incoming radiance values." *Id.* ¶¶ 31–32. Thus, the directional incoming radiance values result from projecting the directional incoming radiance cones on a basis as recited in claims 1, 8, and 15.

Because the Specification reasonably conveys to those skilled in the art that the inventors had possession of the claimed subject matter as of the filing date, we do not sustain the § 112(a) rejection of claims 1–4, 6–8, 10, 11, 13–17, 19, and 20.

The § 103 Rejection of Claims 1–20

INDEPENDENT CLAIMS 1, 8, AND 15

Claims 1, 8, and 15 each require computing outgoing radiance values for untraced pixels that neighbor sparse pixels "by interpolating said directional incoming radiance values and projecting results of said interpolating onto normals of said untraced pixels." Appeal Br. 19–21 (Claims App.). As noted above, the § 103 rejection of claims 1, 8, and 15 rests on Crassin and Busch. *See* Non-Final Act. 7–10, 14–15; Ans. 3–7, 10–11. More specifically, the Examiner cites Busch as teaching or suggesting the "computing by interpolating and projecting" limitation in claims 1, 8, and 15. *See* Non-Final Act. 8–10; Ans. 4–6.

Appellant argues that the Examiner erred in rejecting claims 1, 8, and 15 because the cited portions of Busch are "simply silent as to any interpolation of directional incoming radiance values of the traced pixels and any projection of the interpolation results onto normals of the untraced

pixels." Appeal Br. 9, 12, 16 (emphasis omitted); *see* Reply Br. 4–5. According to Appellant, the cited portions of Busch "merely teach that color values of untraced pixels are derived from depth values and light reflection angles of traced pixels" and "merely talk about increasing sampling frequency to ensure that an interpolation of untraced pixels does not smear out image qualities." Appeal Br. 9, 12, 15–16.

In response, the Examiner explains that "light reflection (i.e. incoming light, or radiance, being reflected off a surface)" in Busch "clearly reads on the incoming radiance of claim 1." Ans. 13. The Examiner also explains that "outgoing radiance" in Busch "is directly based on the incoming radiance" and "directly corresponds to the claimed outgoing radiance values for untraced pixels." *Id.* Further, the Examiner finds that "the interpolation and pixel shading being applied for generation of a missing pixel" in Busch "clearly reads on the claimed projection." *Id.* (citing Busch, 5:37–64).

Based on the record before us, we agree with Appellant that the Examiner has not adequately explained how the cited portions of Busch teach or suggest computing outgoing radiance values for untraced pixels that neighbor sparse pixels "by interpolating said directional incoming radiance values and projecting results of said interpolating onto normals of said untraced pixels" as required by claims 1, 8, and 15. Busch describes a two-dimensional "projection image" resulting from ray casting only for every n^{th} pixel in the "projection image." Busch, 2:4–5, 2:27–28, 5:14–16, 6:64–65; *see id.* at 1:11–25. Busch discloses interpolating values, e.g., "depth values or light reflection angles," for "pixels in the projection image for which no ray casting has been performed." *Id.* at 2:30–42, 3:32–36, 6:61–7:3.

Busch also discloses casting additional rays for certain areas of the "projection image" where "undersampling would cause a significant loss of image quality," such as "areas with high variations of the surface orientation." Busch, 5:20–35; *see id.* at 1:66–2:25, 5:45–53. The criteria for casting additional rays include "a difference between angles between viewing vectors and a surface normal of a pair of pixels in the projection image exceed[ing] a first predetermined threshold." *Id.* at 2:11–15; *see id.* at 5:37–64.

Based on the record before us, the Examiner has not adequately explained how Busch's disclosures about interpolating values and casting additional rays for certain areas of the "projection image" teach or suggest computing outgoing radiance values for untraced pixels that neighbor sparse pixels "by interpolating said directional incoming radiance values and projecting results of said interpolating onto normals of said untraced pixels" as required by claims 1, 8, and 15. Hence, we do not sustain the § 103 rejection of claims 1, 8, and 15.

DEPENDENT CLAIMS 2–7, 9–14, AND 16–20

Claims 2–7 depend directly from claim 1; claims 9–14 depend directly from claim 8; and claims 16–20 depend directly from claim 15. For the reasons discussed for claims 1, 8, and 15, we do not sustain the § 103 rejection of claims 2–7, 9–14, and 16–20.

Because the preceding determinations resolve the appeal with respect to claims 1–20, we need not address Appellant's other arguments regarding Examiner error. *See*, *e.g.*, *Beloit Corp. v. Valmet Oy*, 742 F.2d 1421, 1423 (Fed. Cir. 1984) (explaining that an administrative agency may render a decision based on "a single dispositive issue").

CONCLUSION

We reverse the Examiner's decision to reject claims 1–20.

In summary:

Claims Rejected	35 U.S.C §	Reference(s)/Basis	Affirmed	Reversed
1–4, 6–8, 10, 11, 13–17, 19, 20	112(a)	Written Description		1–4, 6–8, 10, 11, 13–17, 19, 20
1–20	103	Crassin, Busch		1–20
Overall Outcome				1–20

REVERSED