

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

SAMSUNG ELECTRONICS CO., LTD.; AND
SAMSUNG ELECTRONICS AMERICA, INC.
Petitioners

v.

IMAGE PROCESSING TECHNOLOGIES, LLC
Patent Owner

IPR2017-01190
Patent 6,717,518 B1

Before JONI Y. CHANG, MIRIAM L. QUINN, and
SHEILA F. McSHANE, *Administrative Patent Judges*.

McSHANE, *Administrative Patent Judge*.

FINAL WRITTEN DECISION
Inter Partes Review
35 U.S.C. § 318(a) and 37 C.F.R. § 42.73

I. INTRODUCTION

We have jurisdiction to hear this *inter partes* review under 35 U.S.C. § 6. This Final Written Decision is issued pursuant to 35 U.S.C. § 318(a) and 37 C.F.R. § 42.73. For the reasons discussed herein, we determine that Petitioner has shown, by a preponderance of the evidence, that claim 39 (“the challenged claim”) of U.S. Patent No. 6,717,518 B1 (Ex. 1001, “the ’518 patent”) is unpatentable.

A. Procedural Background

Samsung Electronics Co., Ltd. and Samsung Electronics America, Inc. (“Petitioner”) filed a Petition requesting *inter partes* review of claim 39 of the ’518 patent pursuant to 35 U.S.C. §§ 311–319. Paper 2 (“Pet.”). Petitioner also filed the supporting Declaration of Dr. John C. Hart (“Hart Declaration”). (Ex. 1002). Image Processing Technologies, LLC (“Patent Owner”) filed a Preliminary Response to the Petition. Paper 6 (“Prelim. Resp.”). Pursuant to 35 U.S.C. § 314(a), on October 3, 2017, we instituted *inter partes* review on the following grounds:

- whether claim 39 would have been obvious under 35 U.S.C. § 103(a) in view of Eriksson¹ and Stringa²;
- whether claim 39 would have been obvious under 35 U.S.C. § 103(a) in view of Ando³ and Suenaga⁴.

¹ Martin Eriksson, *Eye-Tracking for Detection of Driver Fatigue*, Proceedings of November 1997 IEEE Conference on Intelligent Transportation Systems, 314–319. (Ex. 1005).

² Luigi Stringa, *Eyes Recognition for Face Recognition*, Applied Artificial Intelligence—An International Journal, Vol. 7, No. 1, 1993, 365–382. (Ex. 1006).

³ U.S. Patent No. 5,008,946 (issued April 16, 1991) (Ex. 1009).

⁴ U.S. Patent No. 5,805,720 (issued September 8, 1998) (Ex. 1007).

See Paper 11 (“Inst. Dec.” or “Dec.”). Subsequent to institution, Patent Owner filed a Patent Owner Response (Paper 15, “PO Resp.”). Petitioner filed a Reply (Paper 19, “Pet. Reply”) to the Patent Owner Response.

On April 24, 2018, the Supreme Court held that a final written decision in an *inter partes* review must decide the patentability of all claims challenged in the petition. *SAS Inst., Inc. v. Iancu*, 138 S. Ct. 1348, 1359–60 (2018) (“SAS”). Pursuant to SAS, on May 3, 2018, we instituted *inter partes* review on the following additional ground:

whether claim 39 would have been obvious under 35 U.S.C.

§ 103(a) in view of Ando and Stringa.

See Paper 24; see also *PGS Geophysical AS v. Iancu*, 891 F.3d 1354, 1360–61 (Fed. Cir. 2018) (reading “the SAS opinion as interpreting the statute to require a simple yes-or-no institution choice respecting a petition, embracing all challenges included in the petition”); *Guidance on the Impact of SAS on AIA Trial Proceedings* (April 26, 2018) (available at <https://www.uspto.gov/patents-application-process/patent-trial-and-appealboard/trials/guidance-impact-sas-aia-trial>) (“[I]f the PTAB institutes a trial, the PTAB will institute on all challenges raised in the petition.”). The parties were requested to advise the Board if they wished to change the case schedule or submit further briefing in light of the institution of the Ando and Stringa ground. Paper 24, 1. The parties did not request additional briefing, nor was there a request for a change to the schedule. Paper 25, 3.

An oral hearing was held on June 29, 2018. A transcript of the hearing is included in the record. Paper 31 (“Tr.”).

B. Related Proceedings

The parties indicate that a related matter is: *Image Processing Technologies LLC v. Samsung Elecs. Co.*, No. 2:16-cv-00505-JRG (E.D. Tex.) (“the district court action”). Pet. 1, Paper 4, 1. The parties also indicate that *inter partes* review petitions have been filed for other patents asserted in the district court action. Pet. 1–2; Paper 4, 1.

C. The ’518 Patent

The ’518 patent is entitled “Method And Apparatus For Detection Of Drowsiness,” and was filed as PCT application No. PCT/EP99/00300 on January 15, 1999, and issued on April 6, 2004. Ex. 1001, [22], [45], [54], [86]. The ’518 patent claims priority to application FR 98 00378, dated January 15, 1998 and application PCT/EP98/05383, dated August 25, 1998. *Id.* at [30]. The application entered the U.S. national stage as application No. 09/600,390, meeting the requirements under 35 U.S.C. § 371 on February 9, 2001. *Id.* at [21], [86].

The ’518 patent is directed to applying a generic image processing system in order to detect a person’s drowsiness. Ex. 1001, 2:1–5, 2:32–40. In order to accomplish that, the driver’s blink rate is detected using a video camera in a car. *Id.* at 6:28–57. The system first detects a driver entering the vehicle, by use of pixels “moving in a lateral direction away from the driver’s door.” *Id.* at 25:24–39. A driver’s head is detected by identifying pixels with selected characteristics, with the pixels loaded in histograms as depicted in Figure 24, reproduced below. *Id.* at 5:64–65, 26:46–49.

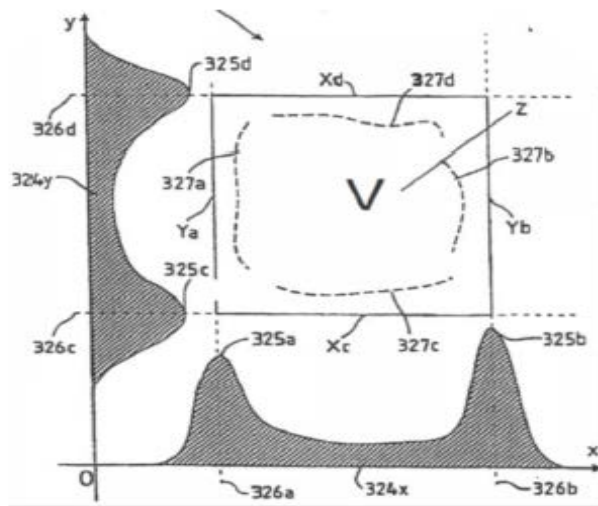


Figure 24, above, illustrates the detection of the edges of a head using histograms. Ex. 1001, 5:64–65. The head edges are detected by looking for peaks in the histogram. *Id.* at 26:49–65. The system then masks portions of an image, and continues to analyze only the unmasked portions. *Id.* at 26:66–27:10; see also *id.* at Fig. 25. The system then uses an anthropomorphic model to set sub-areas for further analysis. *Id.* at 27:31–38. Figure 26, reproduced below, shows the derivation of a sub-area. See *id.* at 27:31–38.

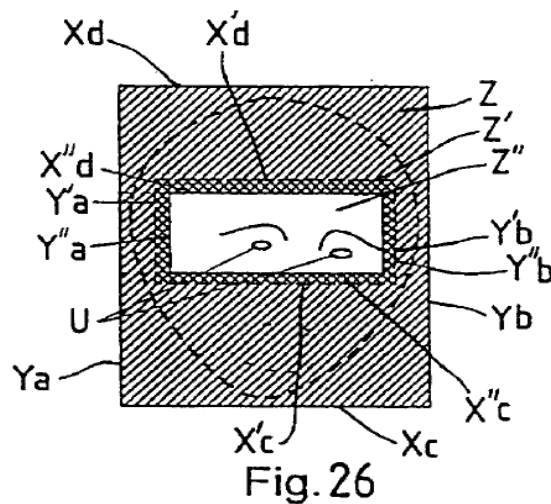
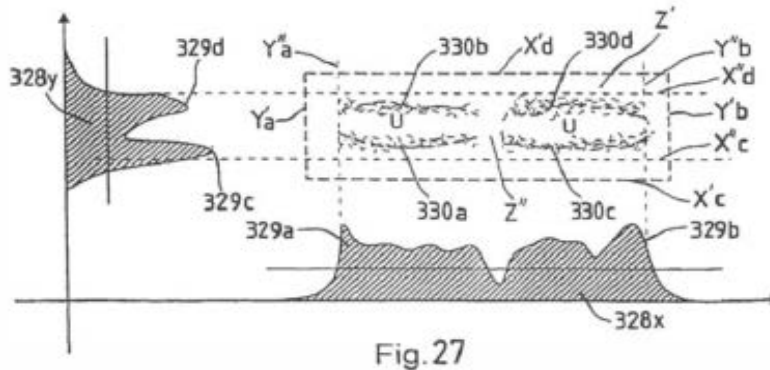


Figure 26, above, depicts masking outside the eyes. Ex. 1001, 6:1–2. The '518 patent includes a variety of methods to identify blinking, including use of histograms to determine whether eyes are open or closed, as depicted in Figure 27, reproduced below. *Id.* at 27:52–28:14.



The system checks for eye movement by methods including analyzing the pixels within area Z' depicted above in Figure 27. Ex. 1001, 27:52–55. The peaks of the histogram shown in Figure 27, above, are used to determine whether an eye is open or closed. *Id.* at 28:32–29:10. Characteristics of features in a search box, such as, such as “a moving eyelid, a pupil, iris or cornea, a shape corresponding to an eye, a shadow corresponding to an eye, or any other indicia indicative of an eye,” may also be analyzed. *Id.* at 30:56–59.

Claim 39, with added formatting and paragraph annotations, is reproduced below.

39. A process of detecting a feature of an eye, the process comprising the steps of:
- [a] acquiring an image of the face of the person, the image comprising pixels corresponding to the feature to be detected;
 - [b] identifying a characteristic of the face other than the feature to be detected;

[c] identifying a portion of the image of the face comprising the feature to be detected using an anthropomorphic model based on the location of the identified facial characteristic;

[d] selecting pixels of the portion of the image having characteristics corresponding to the feature to be detected;

[e] forming at least one histogram of the selected pixels;

[f] and analyzing the at least one histogram over time to identify characteristics of the feature to be detected;

[g] said feature being the iris, pupil or cornea.

Ex. 1001, 36:60–38:4.

II. ANALYSIS

A. The Parties’ Post-Institution Arguments

In our Decision on Institution, we concluded that the arguments and evidence advanced by Petitioner demonstrated a reasonable likelihood that claim 39 of the ’518 patent would have been unpatentable under 35 U.S.C. § 103 over Eriksson and Stringa and over Ando and Suenaga. Dec. 7–26. We now determine whether Petitioner has established by a preponderance of the evidence that claim 39 is unpatentable. We previously instructed Patent Owner that “any arguments for patentability not raised and fully briefed in the [Patent Owner Response] will be deemed waived.” Paper 12, 3; *see also* 37 C.F.R. § 42.23(a) (“Any material fact not specifically denied may be considered admitted.”); *In re Nuvasive, Inc.*, 842 F.3d 1376, 1379–82 (Fed. Cir. 2016) (holding Patent Owner waived an argument addressed in Preliminary Response by not raising the same argument in the Patent Owner Response). Additionally, the Board’s Trial Practice Guide states that the Patent Owner Response “should identify all the involved claims that are believed to be patentable and state the basis for that belief.” Office Patent Trial Practice Guide, 77 Fed. Reg. 48,756, 48,766 (Aug. 14, 2012).

With a complete record before us, we note that we have reviewed arguments and evidence advanced by Petitioner to support its unpatentability contentions where Patent Owner chose not to address certain limitations in its Patent Owner Response. In this regard, the record contains persuasive arguments and evidence presented by Petitioner regarding the manner in which the asserted prior art teaches corresponding limitations of claim 39. Based on the preponderance of the evidence before us, we conclude that the prior art identified by Petitioner teaches or suggests all of the limitations of the reviewed claim.

B. Claim Construction

In an *inter partes* review, the Board interprets claim terms in an unexpired patent according to the broadest reasonable construction in light of the specification of the patent in which they appear. 37 C.F.R. § 42.100(b); *Cuozzo Speed Techs., LLC v. Lee*, 136 S. Ct. 2131, 2144–46 (2016) (upholding the use of the broadest reasonable interpretation approach). Under that standard, and absent any special definitions, we give claim terms their ordinary and customary meaning, as they would be understood by one of ordinary skill in the art at the time of the invention. *In re Translogic Tech., Inc.*, 504 F.3d 1249, 1257 (Fed. Cir. 2007).

“selecting pixels of the portion of the image having characteristics corresponding to the feature to be detected; forming at least one histogram of the selected pixels” (element 39[d], [e])

Patent Owner asserts that the construction of claim element 39[d] is dispositive of the challenge to claim 39, and the claim language requires *“selecting and forming a histogram of pixels that have characteristics corresponding to the feature to be detected, not merely selecting all the*

pixels in a particular area and forming a histogram of all the pixels in, for example, a rectangular area.” PO Resp. 34.

Patent Owner refers to the discussion in the Decision on Institution related to this claim element, and argues that some portions of the '518 patent are contrary to the Board's view of the claim construction in the Decision on Institution, and instead support Patent Owner's proposed construction. PO Resp. 34. Patent Owner refers to Figure 27, with associated disclosure, asserting that “histograms that are formed only of ‘pixels with the selected criteria corresponding to the driver's eyelids, preferably DP=1 with vertical movement.”” *Id.* at 35 (citing Ex. 1001, 28:15–18, 28:8–10). Patent Owner also refers to other portions of the '518 patent specification, alleging that “[t]he claim interpretation proposed . . . follows naturally from and is supported by the teachings of the remainder of the patent specification, which teach selecting particular pixels with characteristics of a feature such as luminance or movement and then forming histograms of only those selected pixels.” *Id.* at 39–41 (citing Ex. 1001, Ex. 1001, 30:61–64, Figs. 32, 36).

Patent Owner contends that the language of the claim, including elements 39[c], [d], and [e], requires “identification of an image portion that includes the feature to be detected, followed by selection of pixels within that image portion that have characteristics that correspond to the feature, followed by formation of a histogram of those selected pixels.” PO Resp. 36. Patent Owner argues its proposed construction is in view of claim element 39[c], which uses the term “comprising” to indicate a portion of the image that includes more than just the feature to be detected, and contrasts this with element 39[d], which does not use that term. *Id.* at 37.

Patent Owner refers to other portions of the '518 patent alleged to provide guidance and “reinforce[] the understanding that selecting pixels having characteristics corresponding to a feature means choosing only those pixels that have the characteristics of that particular feature.” PO Resp. 37. In support, Patent Owner refers to other claims of the '518 patent, such as claim 4, which recites “selecting pixels of the image having characteristics corresponding to the facial characteristic,” and its dependent claim 5, which recites that the “facial characteristic” is the “nostril” and “the step of selecting pixels of the image having characteristics corresponding to the facial characteristic” is selecting pixels with “low luminance levels.” *Id.* at 37–38 (citing Ex. 1001, 33:10–31). Other independent/dependent claim sets 12 and 13; 17 and 18; and 22 and 23 are also referred to as examples that recite selecting pixels that are moving (while blinking) in order to identify an eye. *Id.* at 38.

Petitioner disputes Patent Owner’s proposed limited construction because it would limit element 39[d] to “selecting pixels of a portion of the image having characteristics corresponding to the feature to be selected’ [that] precludes selection of pixels that are not of the feature itself.” Pet. Reply 6 (quoting Inst. Dec. 16).⁵ Petitioner asserts that claim terms should be given their broadest reasonable interpretation and should be interpreted according to their ordinary and customary meaning. *Id.* at 3–4. Petitioner argues that Patent Owner’s arguments ignore the use of “comprising” in the preamble, which signals that the entire claim is presumptively open-ended.

⁵ Petitioner also refers to, and disputes, Patent Owner’s allegation that element 39[e] “cannot include ‘forming a histogram of all pixels in . . . a rectangular area’ but must include ‘only iris, pupil, or cornea pixels.’” Pet. Reply 6 (citing PO Resp. 34, 37).

Id. at 6. Petitioner alleges that the term “having” is an open-ended term, and nothing in the specification precludes elements 39[d] and 39[e] from selecting and forming a histogram of all pixels in a specific area (“portion”) identified in element 39[c]. *Id.* at 7.

Petitioner asserts that the '518 patent discloses histograms that depict pixels other than those for the feature at issue. Pet. Reply 8 (citing Ex. 1001, Figs. 27, 32, 33, 34, and 36). Petitioner refers to annotated Figures 27, 32, 33, 34, and 36, reproduced below.

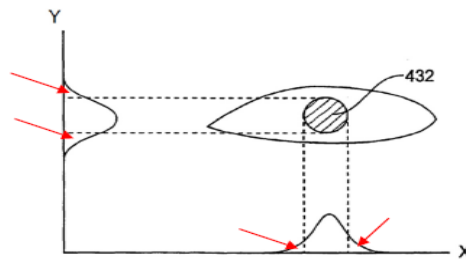


FIG. 36

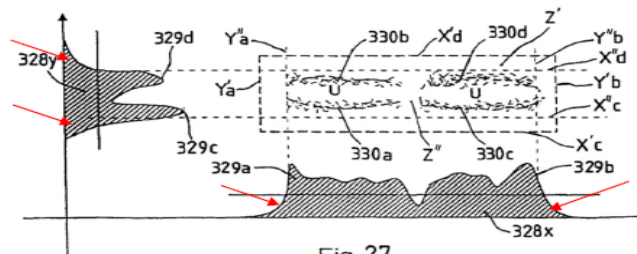


Fig.27

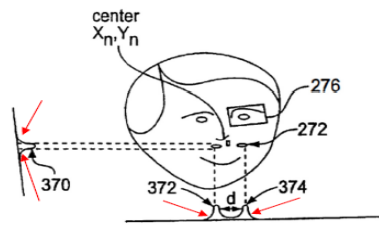


FIG. 32

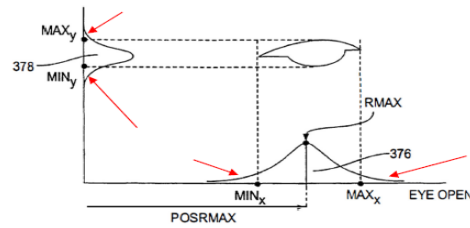


FIG. 33

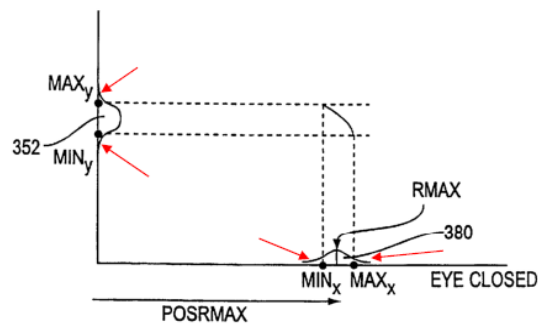


FIG. 34

Petitioner refers to annotated Figure 36 as an example and asserts that it “shows two histograms of a pupil, and the histograms both include pixels that are not pupil pixels (annotated in red).” Pet. Reply 10. Petitioner also refers to other examples in the Specification where it alleges that all pixels in an area are used for forming a histogram. *Id.* (citing Ex. 1001, 18:58–19:25).

Although we agree with Petitioner that the term “comprising” in the preamble signals the entire claim is presumptively open ended and could extend to the consideration of additional steps of a claimed process, the

individual step element 39[d] stands on its own. Element 36[d] requires “selecting pixels of the portion of the image having characteristics corresponding to the feature.” Transitional phrases, such as “having,” are interpreted in light of the specification to determine whether open or closed language is intended. *Lampi Corp. v. American Power Prods. Inc.*, 228 F.3d 1365, 1376 (Fed. Cir. 2000) (citing Manual of Patent Examining Procedure § 2111.03 (7th ed. rev. 2000)).

Turning to the specification, it describes the formation of Figure 36 as follows:

Controller 42 sets the histogram formation units to detect the desired criteria. For example, FIG. 36 shows a sample histogram of a pupil 432, in which the linear combination units and validation units are set to detect pixels with very low luminance levels and high gloss that are characteristic of a pupil.

Ex. 1001, 30:59–64.

The pixels selected for the formation of the histogram in Figure 36 to detect the pupil, the feature of interest, are those having certain luminance and gloss levels that “are characteristic” of a pupil. Figure 36 depicts that, as described, the histogram includes pixels that are selected based on certain characteristics (like luminance levels) corresponding to the feature, but the histogram also includes pixels that are not those of the feature (pupil 432) itself. Thus, the specification discloses histograms that are formed of selected pixels having certain characteristics, however, the selected pixels with those characteristics may not end up being part of the feature itself. Therefore, the selected pixels are not restricted to those of the feature.

We have reviewed the other claims that Patent Owner refers us to (PO Resp. 37–39), and do not find that these claims serve to differentiate the

interpretation of element 39[d] on the issue of whether the selection of pixels having characteristics corresponding to the feature should be restricted to pixels that are of the feature itself.

Therefore, we do not adopt Patent Owner’s proposed construction of element 39[d] because it is too limited. The claim only requires the selection of pixels of the portion of the image having characteristics corresponding to the feature and then using the selected pixels to form the histogram.

Accordingly, we determine that the term “selecting pixels of the portion of the image having characteristics corresponding to the feature to be detected” requires that, as claimed, the selected pixels of the portion of the image have characteristics corresponding to the feature be selected, and this does not preclude selection of other pixels that have characteristics corresponding to the feature, that are not pixels of the feature itself. We also determine that we need not further construe the term to resolve the issues before us.

“histogram”

Patent Owner proposes that the term “histogram” be construed as “*a statistical representation of the frequency of occurrence with which values of a parameter fall within a series of intervals.*” PO Resp. 28. Patent Owner asserts that this construction is consistent with the ordinary and customary meaning of the term. *Id.* Petitioner does not dispute Patent Owner’s proposed construction. Tr. 34:20–24.

We adopt Patent Owner’s proposed construction of the term “histogram.”

“characteristic of the face”/“facial characteristic”

Patent Owner also proposes claim construction for the terms “characteristic of the face”/“facial characteristic.” PO Resp. 33–34. Patent Owner asserts that construing these terms would be relevant to the disputed issues for Suenaga and Eriksson. *Id.* at 32. We do not reach Petitioner’s additional challenge under Suenaga, and Patent Owner does not present any arguments for Eriksson related to these terms. *See id.*, 45–52. Accordingly, we determine that it is not necessary to provide an express interpretation of these terms.

Other Terms

We determine that it is not necessary to provide an express interpretation of any other term of the claims. *Vivid Techs., Inc. v. Am. Sci. & Eng’g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999) (“[O]nly those terms need be construed that are in controversy, and only to the extent necessary to resolve the controversy.”).

C. Level of Ordinary Skill in the Art

Petitioner’s expert, Dr. Hart, testifies that a person of ordinary skill at the time of the ’518 patent invention would have had

either (1) a Master’s Degree in Electrical Engineering or Computer Science or the equivalent plus at least a year of experience in the field of image processing, image recognition, machine vision, or a related field or (2) a Bachelor’s Degree in Electrical Engineering or Computer Science or the equivalent plus at least three years of experience in the field of image processing, image recognition, machine vision, or a related field. Additional education could substitute for work experience and vice versa.

Ex. 1002 ¶ 44 (*see also* Pet. 4).

Patent Owner does not provide proposed qualifications for one of ordinary skill in the art. *See* PO Resp. 1–75.

We adopt and apply the assessment of the level of ordinary skill in the art articulated by Petitioner to our obviousness analysis in this proceeding. In addition, we note that the art of record in this proceeding—namely, Eriksson, Stringa, Ando, and Suenaga—is indicative of the level of ordinary skill in the art. *See Okajima v. Bourdeau*, 261 F.3d 1350, 1355 (Fed. Cir. 2001).

D. Obviousness of Claim 39 over Eriksson and Stringa

Petitioner contends that claim 39 is obvious over Eriksson and Stringa. Pet. 26–41. To support its contentions, Petitioner provides evidence and explanations as to how the prior art teaches each claim limitation. *Id.* Petitioner also relies upon the Hart Declaration (Ex. 1002) to support its positions. Patent Owner counters that the prior art does not render claim 39 obvious because the prior art fails to teach or suggest some limitations of the claim and a person of skill in the art would not have combined Eriksson and Stringa in the manner proposed. PO Resp. 45–57.

Based on the evidence in this entire trial record, we are persuaded by Petitioner’s explanations and evidence in support of the obviousness grounds asserted under Eriksson and Stringa for claim 39. We begin our discussion with a brief summary of the prior art, and then address the evidence, analysis, and arguments presented by the parties.

1. Eriksson (Ex. 1005)

Eriksson is directed to “a system that locates and tracks the eyes of a driver” for the “purpose of . . . detect[ing] driver fatigue.” Ex. 1005, 314.⁶ Eriksson uses a small camera to “monitor the face of the driver and look for eye movements which indicate that the driver is no longer in condition to drive.” *Id.* Eriksson uses four steps for detection: (1) localization of the face; (2) computation of the vertical location of the eyes; (3) computation of the exact location of the eyes; and (4) estimation of the iris position. *Id.* at 315. In the first step, localization of the face, Eriksson uses a “symmetry histogram,” shown in Figure 1 below. *Id.*

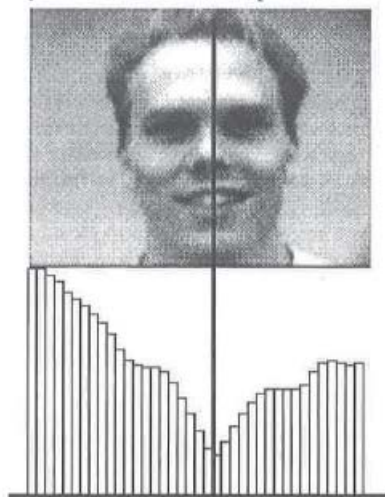


Figure 1. The symmetry histogram.

Figure 1, above, depicts computed symmetry values that form the symmetry histogram used to determine the center of a face. Ex. 1005, 315–316. In the second step of Eriksson, the vertical location of the eyes is determined using an edge detection algorithm to form the histogram depicted in Figure 2. *Id.* at 316.

⁶ The references used herein refer to the page numbers used in the original publication.



Figure 2. The original image, the edges and the histogram of projected edges.

Figure 2, above, depicts an original image, edges detected, and a histogram of the detected edges. Ex. 1005, 316. The peaks formed are considered in the third step of the process that computes the exact location of the eyes. *Id.* The eyes are located by searching for “intensity-valleys” in the image and also using “general constraints, such [as] that both eyes must be located ‘fairly close’ to the center of the face.” *Id.* Finally, the position of the iris is found by the use of an “eye-template” shown in Figure 3. *Id.*

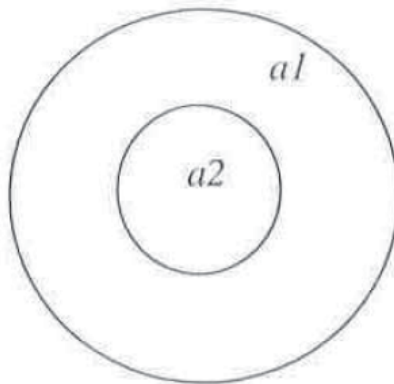
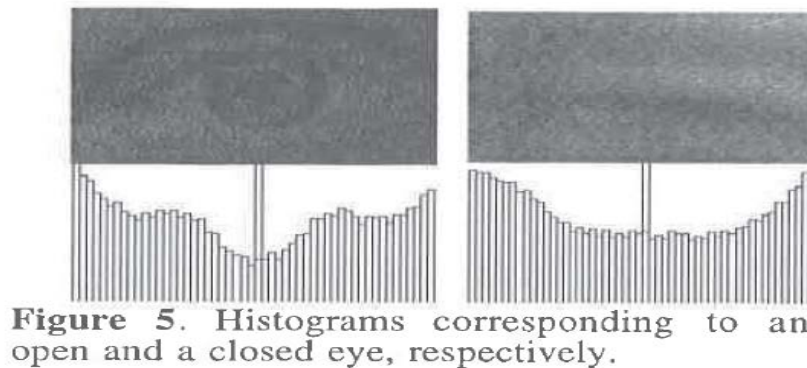


Figure 3. The eye-template.

Figure 3, above, depicts the eye-template that is laid over the image to find the position of the iris. Ex. 1005, 316. The template determines that there is a good match if there are “many dark pixels in the area inside the inner circle, and many bright pixels in the area between the two circles.” *Id.* at 316–317. Upon a match, “the inner circle is centered on the iris and the

outside circle covers the sclera.” *Id.* at 317. Eriksson generates a horizontal histogram across the pupil. *Id.* at 318. Figure 5, reproduced below, depicts horizontal histograms for open and closed eyes. *Id.* at 318.



The histograms depicted above in Figure 5 are used to determine whether an eye is open or closed. Ex. 1005, 318. Measurement of blink rates over time can be used to detect drowsy drivers. *Id.*

2. Stringa (Ex. 1006)

Stringa is directed to an image processing normalization algorithm for face recognition. Ex. 1006, 365. Stringa locates the position of eyes “based on the exploitation of (a priori) anthropometric information combined with the analysis of suitable grey-level distributions, allowing direct localization of both eyes.” *Id.* at 369. Stringa discusses the “grammar” of facial structure, where the “human face presents a reasonable symmetry,” with “knowledge of the relative position of the main facial features.” *Id.*

Stringa’s “guidelines can be derived from anthropometric data corresponding to an average face and refined through the analysis of real faces.” *Id.* An algorithm detects a line that connects the eyes, side limits of the face, and the nose axis, in order to estimate “the expectation zones of the two eyes.” *Id.* at 376. Stringa searches for the pupil based upon an analysis

of horizontal grey-level distribution. *Id.* at 377. Figure 9, reproduced below, depicts the expectation zone for the eyes. *Id.*

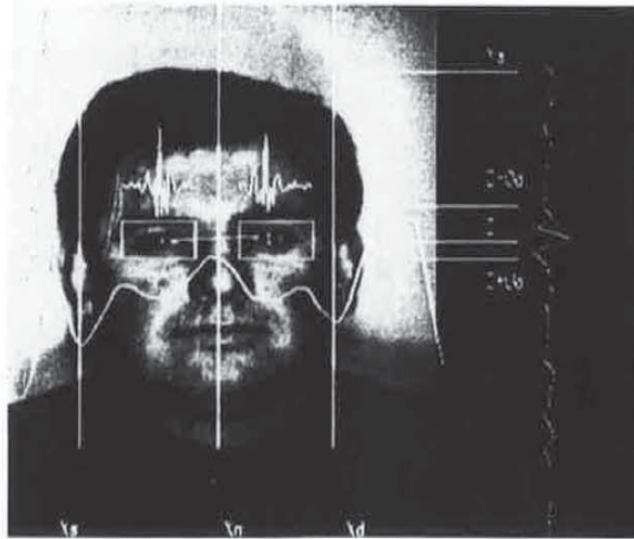


FIGURE 9. The rectangular regions located between the face limits and the nose axis indicate the expectation zones of the two eyes.

Figure 9, above, depicts the computed expectation zone for two eyes. *Ex.* 1006, 377. Stringa uses an analysis of a horizontal grey-area distribution, and then uses a second derivation for pupil identification as depicted in Figure 10. *Id.* at 377–378.

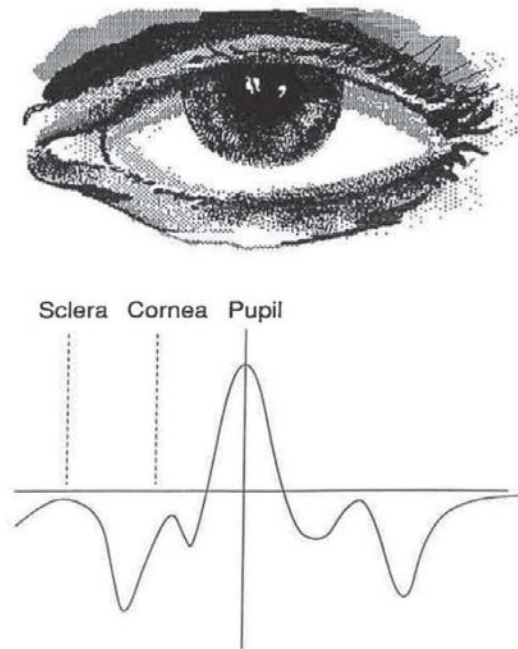


FIGURE 10. A typical plot of the second derivative used to localize the eye pupils: note the peak in the middle, corresponding to the pupil's position.

Figure 10, above, depicts a plot of a second derivation of eye data used to locate pupil location. Ex. 1006, 378. Figure 10 shows a peak corresponding to the eye's pupil, with two adjacent peaks of lesser intensity indicating the discontinuity represented by the cornea. *Id.*

3. Analysis

A patent claim is unpatentable under 35 U.S.C. § 103(a) if the differences between the claimed subject matter and the prior art are such that the subject matter, as a whole, would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 406 (2007). The question of obviousness is resolved on the basis of underlying factual determinations including (1) the scope and content of the prior art; (2) any differences between the claimed subject matter and the prior art;

(3) the level of ordinary skill in the art; and (4) objective evidence of nonobviousness.⁷ *Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966).

Petitioner alleges, and we agree, that Eriksson teaches a process of detecting a features of an eye by acquiring an image of a person’s face comprised of pixels.⁸ Pet. 29–30 (citing Ex. 1005, 314–316; Ex. 1002 ¶¶ 85–87). Petitioner contends, and we agree, that Eriksson teaches the step of “identifying a character of the face other than the feature to be detected” recited as element 39[b], its teaching of the identification of the edges of the face and the vertical location of the eyes. *Id.* at 31–32 (citing Ex. 1005 at 315–316; Ex. 1002 ¶¶ 89–92).

Petitioner asserts, and we agree, that Stringa teaches element 39[c] by its use of the eye-connecting line, the face sides, and the nose axis for identification of the expectation zone for eyes. Pet. 34–35 (citing Ex. 1006, 370, 376–379, Ex. 1002 ¶ 98). Stringa characterizes its approach as the use of an anthropomorphic model: “an algorithm is used based on the exploitation of (a priori) anthropometric information combined with the analysis of suitable grey-level distributions, allowing direct localization of the eyes.” *Id.* at 35 (citing Ex. 1006, 369).

Petitioner contends, and we agree, that Eriksson teaches the step of pixel selection of the feature by selecting pixels from a portion of the image identified using the symmetry histogram and the gradient histogram

⁷ Patent Owner does not argue on the record that there are objective indicia of nonobviousness.

⁸ The Decision on Institution considered Eriksson’s teachings for the all the elements of claim 39, except for element 39[c]. Dec. 13–14. Here, we similarly consider the prior art, and in light of the determination that the evidence is sufficient to demonstrate the teachings of claim 39, as discussed below, we need not reach other of Petitioner alternative assertions.

(element 39[d]). Pet. 36. For instance, Eriksson teaches selection of pixels from the portion of the image identified using the symmetry histogram, where it searches for areas within the portion of the symmetry histogram that have “intensity valleys” using a “raster-scan algorithm” and information from the gradient histogram. *Id.* (citing Ex. 1002 ¶ 100; Ex. 1005, 316). We agree with Petitioner’s argument that by searching for “intensity-valleys,” Eriksson uses the fact that pupils are generally darker and in an area more shadowed than the rest of the face. *Id.*; *see also* Ex. 1002 ¶ 101; Ex. 2003, 156:13–157:4. Thus, Eriksson selects pixels based on whether they have the corresponding characteristic (darker) to the feature to be detected, i.e. the pupils. *Id.*

Petitioner alleges, and we agree, that Eriksson teaches element 39[e] of “forming . . . a histogram of the selected pixels,” with analysis over time, to identify the characteristic of the feature, i.e. the pupil. Pet. 37–39 (citing Ex. 1002 ¶¶ 102, 103, 106, 108). Petitioner relies on Figure 5 of Eriksson’s teaching of the histogram formed. *Id.* at 37. Petitioner also alleges, and we agree, that Eriksson discloses analysis of the histogram and identification of, at least, a “pupil,” for the teaching of elements 39[f] and [g]. *Id.* at 38–40 (citing Ex. 1005, 318; 1002 ¶¶ 106, 110).

We agree with Petitioner that the combination of Eriksson and Stringa teaches every limitation of claim 39 and credit Dr. Hart’s supporting testimony, (Ex. 1002 ¶¶ 83, 85–87, 89–92, 98–99, 100–101, 103–104, 106–108), as it is consistent with the prior art disclosures.

Petitioner asserts that a person of ordinary skill in the art would have been motivated to combine Eriksson and Stringa because both references are directed to similar systems that operate in a similar manner. Pet. 26.

Petitioner alleges that Stringa was cited by, and partially incorporated into, Eriksson, and therefore one of ordinary skill in the art would have known “that Stringa was a relevant and helpful reference in the field of facial recognition.” *Id.* at 28 (citing Ex. 1005, 315; Ex. 1002 ¶ 82). Petitioner contends that Stringa’s more extensive use of anthropomorphic models based on multiple facial features would have allowed Eriksson to achieve more precise localization of the pupil. *Id.* at 27. (See Ex. 1006 at 366 (“the eyes localization algorithm . . . proves very sensible, allowing very precise positing of both pupils for each facial image include in the data base”), 369, 369, 370, 372, 376–79, 381; Ex. 1002 ¶ 80). Petitioner also asserts that a person of ordinary skill would have expected the combination of the references to yield predictable results, that is, these references disclose applying known anthropomorphic models in similar systems, and, in the combination, the elements would have retained their original properties and functions. *Id.* at 27–28 (citing Ex. 1002 ¶ 81). We credit the supporting testimony of Dr. Hart (Ex. 1002 ¶¶ 79–82), and determine that Petitioner has demonstrated a sufficient rationale for the combination of Eriksson and Stringa. *See KSR*, 550 U.S. at 417 (noting that “if a technique has been used to improve one device, and a person of ordinary skill in the art would recognize that it would improve similar devices in the same way, using the technique is obvious unless its actual application is beyond his or her skill”).

Having considered the complete record now before us, we determine that Petitioner has provided sufficient evidentiary support that the combination of Eriksson and Stringa teach each and every limitation of claim 39, and also has provided sufficient rationale for combining the teachings of Eriksson and Stringa.

Patent Owner disputes the teachings of the asserted prior art relating to histograms and the selection of pixels. Patent Owner also disputes whether a person of ordinary skill in the art would have combined Eriksson and Stringa in the manner proposed. We address these issues in turn.

a. Histogram

Patent Owner argues that Eriksson does not teach or suggest forming or analyzing a histogram. PO Resp. 45–48. Patent Owner contends that Eriksson does not disclose a histogram because (i) the reference relies on “match values” to determine whether the eye is open or closed and that is not a histogram; and (ii) “even if Figure 5, a graph of intensity values for a line of pixels, is used in the manner asserted[], it is not a histogram.” *Id.* at 45.

(i) Match Values

Patent Owner asserts that Eriksson does not teach a histogram because it uses “match values” for each frame to determine if an eye is open or closed. PO Resp. 45 (citing Ex. 2003, 138:13–139:14). Patent Owner argues that, in Eriksson, a “match value” is calculated using the intensity value of three pixels along a line, and “[c]alculating a match value based on the difference in intensity values among three pixels is not a histogram.” *Id.* at 45–46 (citing Ex. 1005, 318). Patent Owner additionally argues that although Dr. Hart asserts that the curve in Figure 5 is used to determine pupil center and radius, it is apparent that an eye template is used. *Id.* at 46. Patent Owner asserts that Figure 5 is “merely illustrative” to show there is reasoning behind using three match intensity values to calculate a match value. *Id.*

In Reply, Petitioner argues that Eriksson describes using the match function to analyze the Figure 5 histogram, and not in place of a histogram. Pet. Reply 17–18. Petitioner persuasively argues that Eriksson explains that “[the method] needs a robust way to determine if the eyes are open or closed, so we developed a method that **looks at the horizontal histogram** across the pupil,” and states that “[w]e **use** the characteristic curve generated by plotting the image-intensities along the line going through the pupil from left to right, **as shown in Figure 5.**” *Id.* (citing Ex. 1005, 317–318). Petitioner refers to Figure 5, which is captioned “Histograms corresponding to an open and a closed eye, respectively,” and Eriksson’s description of how the curve is used to determine whether an eye is open or closed. *Id.* at 18 (citing Ex. 1005, 318, Fig. 5). Petitioner refers to Dr. Hart’s explanation that the parameters of the matching function are set using the histogram of Figure 5. *Id.* (citing Ex. 2003, 139:15–141:4).

Based on our review of the evidence, we agree with Petitioner that Eriksson teachings support that a match value is used for the analysis of Eriksson’s Figure 5. Accordingly, we are not persuaded by Patent Owner’s argument that Figure 5 is not a histogram on this basis.

(ii) Characterization of Figure 5

Patent Owner also contends that “[e]ven if Figure 5 is used by Eriksson in some manner, it is not a histogram.” PO Resp. 47. Patent Owner argues that, although Eriksson refers to Figure 5 as a “histogram,” it is instead “a plot of intensity values ‘along the line going through the pupil from left to right.’” *Id.* (citing Ex. 1005, 318). Patent Owner refers to the testimony of Dr. Hart, arguing that (i) the frequency of occurrence of intensity values is not counted or represented by the plot in Figure 5; (ii) the

depicted “plot of intensity values is neither an intensity histogram nor a projection histogram;” and (iii) “[t]he plot is of nothing other than intensity values for a single line of pixels and does not incorporate intensity information from other neighboring lines. *Id.* at 47–48 (citing Ex. 2003, 141:8–21, 144:9–15, 145:7–146:12).

Petitioner refers to Eriksson, an IEEE peer reviewed article, and its Figure 5, which is described as a “horizontal histogram.” Pet. Reply 12 (citing Ex. 1005, 318). Petitioner argues that Patent Owner relies upon attorney argument only in support of its assertion that Figure 5 is not a histogram. *Id.*

Petitioner contends that Eriksson’s Figure 5 depicts a histogram, relying on Dr. Hart’s explanation that Eriksson’s histograms represent the frequency with which units of radiometric energy, such as luminance or intensity, fall within a series of intervals, with each of the intervals being a location on a portion of an x-axis. Pet. Reply 17 (citing Ex. 2003, 143:14–144:23). Petitioner alleges that Eriksson builds on the teachings of Stringa, and uses the same terminology to describe the same data construct for histograms. *Id.* at 16–17 (citing Ex. 1005, 315 (“One interesting application for face recognition was developed by Stringa [12] We use a similar approach”), 317–318). Petitioner argues that Stringa’s teachings of the formation of vertical histograms apply equally to Eriksson’s horizontal histogram. *Id.* at 14–16 (citing Ex. 1005, 315; Ex. 1006, 370–371, Fig. 3). Petitioner asserts that Stringa teaches forming horizontal grey level distribution (histogram) of pixels along the x-axis in the expectation zone, where at each position along the x-axis, the histogram counts the number of

pixels in the corresponding vertical line that exceed a certain intensity threshold. *Id.* at 14–16 (citing Ex. 1006, 370–372, 377–378).

The evidence of record supports that an ordinarily skilled artisan reading Eriksson would have understood Eriksson to teach forming a horizontal histogram. Figure 5 of Eriksson is captioned “histograms,” and is described as a “horizontal histogram.” Ex. 1005, 318. Stringa, which is referred to in Eriksson for its “similar approach”—provides support that the histograms as characterized refer to plots formed by a process that counts the number of pixels at the corresponding line that exceed a certain intensity threshold and plots them.⁹ Ex. 1005, 315–316; Ex. 1006, 370–372, 377–378). We have reviewed the testimony of Dr. Hart, and it suggests that he was interpreting the plot in Figure 5 in different ways—but nonetheless, Dr. Hart clearly testifies that Eriksson’s Figure 5 presents a histogram. *See* Ex. 2003, 141–148. Patent Owner provides no expert testimony in rebuttal.

Weighing the evidence, we determine that it is sufficient to support that Eriksson teaches forming a “histogram” under the construction adopted here.

b. Prior Art Teaching of a Histogram “of the Selected Pixels”

Patent Owner argues that Eriksson in combination with Stringa does not teach or suggest forming a histogram of the selected pixels having characteristics of the iris, pupil, or cornea. PO Resp. 48. Patent Owner also argues that the prior art does not disclose “a histogram that is formed from

⁹ Stringa presents a section entitled “Eye Localization: Detailed Description” with a subsection entitled “Preliminaries” that states that a detailed description of an eye localization algorithm is provided in that section, and introduces “some general notions that will be used throughout.” Ex. 1006, 370.

all the pixels in a particular area, without first selecting pixels in that area that have characteristics of the feature to be detected, as is required.” *Id.* at 49. According to Patent Owner, Eriksson’s teachings are insufficient because they use a matching function of intensity values, they include all intensity values along a line, and they do not find any eye part. *Id.* at 49–50.

We do not find Patent Owner’s arguments to be persuasive. To the extent that Patent Owner’s arguments are directed the use of a matching function, we have addressed that issue above. *See* Pet. 37. To the extent that Patent Owner’s arguments are directed to Eriksson’s characterization of Figure 5 as a histogram, we also have addressed them above. To the extent that Patent Owner’s arguments are addressed to the selection of pixels for forming a histogram, the claim construction we have adopted does not preclude the selection of pixels that are not of the feature itself. More specifically, the claim construction does not preclude the selection of pixels that are not of the feature itself, as long as the pixels have characteristics corresponding to the feature. And, as addressed above, we find that Petitioner has provided sufficient evidence that Eriksson teaches that the selected pixels have characteristics, which is that they are darker, corresponding to the characteristics of the feature of the pupil to be detected.

c. Rationale for Combination

Patent Owner argues that a person of ordinary skill in the art would not have combined Eriksson and Stringa because “[t]here were many algorithms and approaches available to detect and analyze faces, some of which were considered better than histograms.” PO Resp. 52–53. Patent Owner alleges that Eriksson states that many methods had been proposed for localizing facial features. *Id.* at 52–53. Patent Owner contends that a person

of ordinary skill in the art would not have combined the references because such an artisan would have applied the symmetry approach of Eriksson, rather than using Stringa's more complex method for localizing facial features. *Id.* at 53. Patent Owner contrasts Eriksson's symmetry approach with Stringa's approach. *Id.* at 54–57. According to Patent Owner, Eriksson's simpler approach would have been preferable because of its faster speed of processing. *Id.* at 57.

We are not persuaded by Patent Owner's arguments based on the allegation that the prior art would not have been combined in the manner asserted based on Eriksson's alleged advantages to Stringa of a less complex process and faster speed of processing for face localizing. As discussed above, Dr. Hart testified that Stringa offers advantages by its use of anthropomorphic models based on multiple facial features that would have allowed Eriksson to achieve more precise localization of the pupil. *See Ex. 1002 ¶ 80.* There is no expert testimony presented by Patent Owner concerning how a person of ordinary skill in the art would have compared and weighed the advantages of the combination relative to the alleged complexity differences. We credit Dr. Hart's testimony that one of skill in the art would have sought to make the combination. *See Ex. 1002 ¶¶ 79–82.* And, even though, as Patent Owner argues, there may have been other algorithms and approaches available to detect and analyze faces, this alone does not take away from the demonstrated motivation for the combination of the prior art.

d. Conclusion

For the reasons discussed above, Petitioner has shown by a preponderance of the evidence that claim 39 of the '518 patent is unpatentable as obvious over the combination of Eriksson and Stringa.

Having found claim 39 unpatentable over the combination of Eriksson and Stringa, we do not reach Petitioner's additional challenges to this claim.

III. CONSTITUTIONALITY ISSUE

Patent Owner objects to the constitutionality of this *inter partes* review. PO Resp. 5 (citing *Oil States Energy Services, LLC v. Greene's Energy Group, LLC*, No. 16-712 (U.S. Nov. 23, 2016, cert. granted June 12, 2017)). However, on April 24, 2018, the U.S. Supreme Court held that "inter partes review does not violate Article III or the Seventh Amendment" of the Constitution. *Oil States Energy Servcs., LLC v. Greene's Energy Grp., LLC*, 138 S. Ct.1365 (2018). Therefore, Patent Owner's argument is moot.

IV. MOTION TO SEAL

Petitioner filed a motion to seal the redacted portions of Exhibit 1021. Paper 32 ("the Motion"). The Motion includes a request to enter the Board's default protective order. *See id.* at 2. The Motion is unopposed.

We have reviewed the proposed redactions, as well as the explanation of the confidential nature of the redacted materials of Exhibit 1021 provided in the motion. We grant the Motion and the associated request to enter the Board's default Protective Order, which is applied to the conduct of the proceeding. *See Practice Guide, App'x B (Default Protective Order)*. We also order the expungement of Paper 7 (a previously filed Motion to Seal), which has been withdrawn.

V. CONCLUSION

Petitioner has demonstrated by a preponderance of the evidence that Claim 39 is unpatentable as obvious over Eriksson and Stringa.

VI. ORDER

Accordingly, it is:

ORDERED that claim 39 of the '518 patent has been shown to be unpatentable;

ORDERED that Petitioner's Motion to Seal (Paper 32) is *granted*;

FURTHER ORDERED that the request to enter the Board's default protective order is *granted*;

FURTHER ORDERED that Paper 7 shall be *expunged*; and

FURTHER ORDERED that, because this is a Final Written Decision, parties to the proceeding seeking judicial review of the decision must comply with the notice and service requirements of 37 C.F.R. § 90.2.

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