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Paper 43
Entered: August 6, 2017

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

APPLE INC. and FITBIT, INC.,
Petitioner,

v.

VALENCELL, INC.,
Patent Owner.

Case IPR2017-00319
Patent 8,923,941 B2[1]

Before BRIAN J. McNAMARA, JAMES B. ARPIN, and SHEILA F. McSHANE, *Administrative Patent Judges*.

ARPIN, *Administrative Patent Judge*.

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

[1] Case IPR2017-01555 has been joined with this proceeding.

I. INTRODUCTION

Apple Inc. ("Petitioner") filed a Petition requesting *inter partes* review of claims 1–13 ("the challenged claims") of U.S. Patent No. 8,923,941 B2 (Ex. 1001, "the '941 patent") under 35 U.S.C. §§ 311–319. Paper 2 ("Pet."). Valencell, Inc. ("Patent Owner") filed a Preliminary Response. Paper 6 ("Prelim. Resp."). We instituted the instant *inter partes* review as to claims 1, 2, and 6–13. Paper 10 ("Inst. Dec."). Petitioner filed a Request for Rehearing (Paper 13) of our Decision on Institution with respect to our denial of institution of Petitioner's challenges to claim 3, and we entered a decision (Paper 15) denying Petitioner's Request for Rehearing. Fitbit, Inc. (also "Petitioner") filed a corresponding Petition (IPR2017-01555, Paper 2), accompanied by a Motion for Joinder (IPR2017-01555, Paper 3), challenging claims 1, 2, and 6–13 of the '941 patent, and we granted the Motion for Joinder and instituted review of the challenged claims (IPR2017-01555, Paper 9) based on the corresponding Petition.

Subsequent to institution, Patent Owner filed a Patent Owner Response (Paper 22 ("PO Resp.")), and Petitioner filed a Reply (Paper 27 ("Reply")). A transcript of the oral hearing held on February 27, 2018, has been entered into the record as Paper 34 ("Tr.").[2]

On April 24, 2018, the U.S. Supreme Court held that a decision to institute under 35 U.S.C. § 314 may not institute on fewer than all of the claims challenged in the Petition. *SAS Inst., Inc. v. Iancu*, 138 S. Ct. 1348, 1354 (2018). In view of the Court's decision, we issued an Order (Paper 39)

[2] This was a consolidated hearing with the following related case: Case IPR2017-00321. *See* Tr. 3:2–5.

modifying our Decision on Institution to institute on all of the challenged claims and on all of the grounds asserted in the Petition. In particular, the additional grounds upon which we instituted review are: (1) claim 3 as obvious over the combined teachings of Luo and Craw (Ground 1) or over Mault, Al-Ali, and Lee (Ground 7); and (2) claims 4 and 5 as obvious over the combined teachings of Luo, Craw, and Wolf (Ground 2) or over Mault, Al-Ali, and Behar (Ground 8).[3] Paper 39, 4; *see infra* Sections I.D. and I.E. Chief Administrative Patent Judge Ruschke granted a good cause extension of the one-year period for issuing a final written decision in this case (Paper 37), and the panel extended the deadline to issue a final written decision until August 6, 2018 (Paper 38). Pursuant to our authorization (Paper 39, 5–6), Petitioner filed additional briefing regarding the newly-instituted grounds and associated claims, (Paper 40 ("Add'l Br.")), and Patent Owner filed a response to Petitioner's additional briefing (Paper 41 ("Add'l Resp.")).

Although Patent Owner filed objections to evidence submitted with the Petition (Paper 14) and Petitioner filed objections to evidence submitted with Patent Owner's Preliminary Response (Paper 12) and to evidence submitted with the Patent Owner Response (Paper 23), neither party filed a Motion to Exclude. Consequently, these objections are deemed waived. 37 C.F.R. § 42.64(c) ("A motion to exclude evidence must be filed to preserve any objection."). Petitioner also filed a list of alleged

[3] Petitioner Fitbit did not request joinder with respect to claims 3–5, and our institution of review based on Petitioner Fitbit's Petition concerned claims 1, 2, and 6–13 of the '941 patent, but we granted Petitioner Fitbit's request to join as a party. *See* IPR2017-01555, Paper 9, 1. This Decision addressing the status of each challenged claim in this proceeding applies to all parties.

misrepresentations of fact and inconsistent statements made by Patent Owner in its Preliminary Response. Paper 9. We considered these listed items in preparation of our Decision on Institution (*see* Inst. Dec. 24 n.7), and Petitioner does not raise the listed, alleged misrepresentations of fact and inconsistent statements in its post-institution filings. Consequently, Petitioner also does not preserve these objections, and we do not consider them further here.

This Final Written Decision is entered pursuant to 35 U.S.C. § 318(a). For the reasons that follow, we determine that Petitioner has demonstrated by a preponderance of the evidence that claims 1, 2, and 6–13 of the '941 patent are unpatentable, but that Petitioner fails to demonstrate by a preponderance of the evidence that claims 3–5 of the '941 patent are unpatentable.

A. Related Proceedings

According to the parties, the '941 patent is involved in the following civil actions: *Valencell, Inc. v. Apple Inc.*, Case No. 5-16-cv-00010 (E.D.N.C. 2016); *Valencell, Inc. v. Bragi Store, LLC et al.*, Case No. 5-16-cv-00895 (E.D.N.C. 2016); and *Valencell, Inc. v. Fitbit, Inc.*, Case No. 5-16-cv-00002 (E.D.N.C. 2016). Pet. 52; Paper 5, 1. Further, the '941 patent is involved in a related petition for *inter partes* review, Case IPR2017-00321, filed by Petitioner on the same day as the instant Petition. We also instituted review of a related Petition by Fitbit, Inc. with the same grounds, and granted a Motion for Joinder of that case with Case IPR2017-00321. IPR2017-01556, Paper 9. The Board issued a Final Written Decision, finding all challenged claims unpatentable and denying a Motion to Amend in Case IPR2017-00321. IPR2017-00321, Paper 44, 76.

B. The '941 Patent

The '941 patent is entitled "Methods and Apparatus for Generating Data Output Containing Physiological and Motion-Related Information," and was filed February 19, 2014, and issued December 30, 2014. Ex. 1001, (22), (45), (54). The '941 patent is a continuation of U.S. Patent Application No. 12/691,388, filed January 21, 2010, now issued as U.S. Patent No. 8,700,111 B2 (*id*. at (63)), and claims priority to four provisional patent applications: U.S. Provisional Patent Application Nos. 61/208,567, filed February 25, 2009; 61/208,574, filed February 25, 2009; 61/212,444, filed April 13, 2009; and 61/274,191, filed August 14, 2009 (*id*. at (60)). For purposes of this Decision, we accept February 25, 2009, as the earliest effective filing date of the '941 patent. *See* Pet. 9.

The '941 patent relates generally to physiological monitoring apparatus. Ex. 1001, 1:21–23. Figure 5 of the '941 patent depicts an exemplary embodiment and is reproduced below.

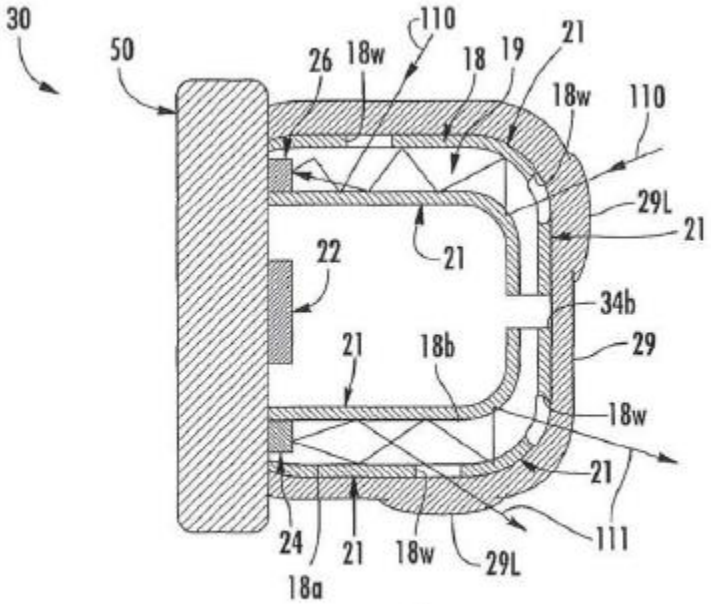


FIG. 5

Figure 5 depicts a side section view of light-guiding earbud 30 for a headset. In particular, earbud 30 includes light guiding cover 18 that serves the function of a housing. *Id*. at 16:16–19. Cover 18 includes a plurality of windows 18w formed in cladding material 21 on outer surface 18a of cover 18. *Id*. at 16:19–21. Light 111 emitted from light emitter 24 passes through windows 18w and into the wearer's body, and scattered light 110 returning from the wearer's body passes into light guiding cover 18 through windows 18w and is directed to light detector 26. *Id*. at 16:21–24. In other embodiments, earbud housing and cover 18 may be separate components, for example, as shown in Figures 3 and 4, which depicts cover 18 surrounding housing 16. *Id*. at 14:6–10. In addition, cover 18 of Figure 5 is surrounded by layer 29 of light transmissive material. *Id*. at 16:30–31. One or more lenses 29L are formed in layer 29 and are in optical communication with respective windows 18w in cover 18, and lenses 29L are configured to collect returning, scattered light 110 and to direct scattered light 110 into light guiding region 19 and to light detector 26. *Id*. at 16:31–41. An earbud, such as earbud 30, may integrate a sensor module containing a plurality of sensor elements for measuring physiological information and at least one noise source for measuring noise information and may include a microprocessor that is in electrical communication with the sensor module or modules. *Id*. at 3:46–55, 4:21–25.

In the apparatus described in the '941 patent, photoplethysmography ("PPG") signals may be pre-conditioned by the microprocessor to reduce motion artifacts and signal noise. *Id*. at 4:11–17, 4:25–32, 30:44–48; *see id*. at 32:1–15, 3:47–55. In particular, the physiological information may be filtered to remove signal noise by using various, known signal processing

techniques. *See id*. at 3:56–67. Thus, the '941 patent discloses apparatus for removing motion-related noise artifacts, such as subject footstep noise. *See id.* at 3:65–4:5; 31:18–19.

C. Illustrative Claim

Claim 1 is the sole, challenged independent claim of the '941 patent. Each of claims 2–13 depends directly or indirectly from claim 1. Claim 1 is illustrative and is reproduced below, with disputed limitations emphasized.

> 1. A method of generating data output containing physiological and motion-related information, the method comprising:
>
> sensing physical activity and physiological information from a subject via a single monitoring device attached to the subject, wherein the monitoring device comprises at least one motion sensor for sensing the physical activity and *at least one photoplethysmography (PPG) sensor* for sensing the physiological information; and
>
> *processing signals from the at least one motion sensor and signals from at least one PPG sensor via a processor of the monitoring device into a serial data output of physiological information* and motion-related information, wherein the serial data output is configured *such that a plurality of subject physiological parameters comprising subject heart rate and subject respiration rate can be extracted from the physiological information* and such that a plurality of subject physical activity parameters can be extracted from the motion-related information.

Id. at 30:35–54 (emphases added).

D. Applied References and Declaration

Petitioner relies on the following references and declaration in support of its asserted grounds of unpatentability.

Exhibit	References and Declaration
1003	Declaration of Dr. Majid Sarrafzadeh
1004	Curriculum Vitae of Dr. Majid Sarrafzadeh
1009	Japanese Patent Application Publication No. 2005/040261 A to Numaga *et al*., published February 17, 2005
1010	Certified English-language translation of Numaga[4] ("Numaga")
1016	U.S. Patent Application Publication No. 2009/0105556 A1 to Fricke *et al*., filed September 29, 2008, published April 23, 2009 ("Fricke")
1025	Hyonyoung Han *et al*., *Development of a wearable health monitoring device with motion artifact reduced algorithm*, International Conference on Control, Automation and Systems, IEEE (2007) ("Han")
1031	U.S. Patent Application Publication No. 2005/0059870 A1 to Aceti, published March 17, 2005
1032	G. Comtois & Y. Mendelson, *A Comparative Evaluation of Adaptive Noise Cancellation Algorithms for Minimizing Motion Artifacts in a Forehead-Mounted Wearable Pulse Oximeter*, IEEE (2007) ("Comtois")
1042	U.S. Patent Application Publication No. 2007/0197881 A1 to Wolf *et al*., published August 23, 2007 ("Wolf")
1055	U.S. Patent Application Publication No. 2008/0200774 A1 to Luo, filed February 16, 2007; published August 21, 2008
1056	U.S. Patent Application Publication No. 2008/0133699 A1 to Craw *et al*., filed October 4, 2007, published June 5, 2008 ("Craw")
1057	U.S. Patent No. 6,513,532 B2 to Mault *et al*., issued February 4, 2003 ("Mault")
1058	U.S. Patent Application Publication No. 2003/0181798 A1 to Al-Ali, published September 25, 2003 ("Al-Ali")
1061	International Patent Application Publication No. WO 2006/009830 to Behar *et al*., published January 26, 2006 ("Behar")
1064	U.S. Patent No. 6,996,427 to Ali *et al*., issued February 7, 2006 ("Ali")

[4] Citations to Numaga are to this English-language translation.

Pet. vii–x.

As noted above, the '941 patent issued claiming benefit from U.S. provisional patent applications having filing dates as early as February 25, 2009. Ex. 1001, (60). Each of the applied references has an effective filing date prior to February 25, 2009. *See* Pet. 8–9.

E. Asserted Grounds of Unpatentability

Petitioner asserted the following grounds of unpatentability:

References	**Basis**	**Challenged Claim(s)**
Luo and Craw	35 U.S.C. § 103(a)	1–3, 9, and 11–13
Luo, Craw, and Wolf	35 U.S.C. § 103(a)	4 and 5
Luo, Craw, and Fricke	35 U.S.C. § 103(a)	6 and 8
Luo, Craw, Fricke, and Comtois	35 U.S.C. § 103(a)	7
Luo, Craw, and Aceti	35 U.S.C. § 103(a)	10
Mault and Al-Ali	35 U.S.C. § 103(a)	1, 2, 9, 11, and 12
Mault, Al-Ali, and Lee	35 U.S.C. § 103(a)	3
Mault, Al-Ali, and Behar	35 U.S.C. § 103(a)	4 and 5
Mault, Al-Ali, and Han	35 U.S.C. § 103(a)	6–8
Mault, Al-Ali, and Numaga	35 U.S.C. § 103(a)	10
Mault, Al-Ali, and Ali	35 U.S.C. § 103(a)	13

Pet. 8–9. We instituted *inter partes* review of all of the challenged claims and on all of these asserted grounds. Paper 39, 6; *see supra* Section I.A.

II. DISCUSSION

A. Claim Interpretation

In an *inter partes* review, claim terms in an unexpired patent are given their broadest reasonable construction in light of the specification of the patent in which they appear. 37 C.F.R. § 42.100(b). Under the broadest

reasonable interpretation standard, claim terms are given their ordinary and customary meaning, as they would have been understood by one of ordinary skill in the art in the context of the entire disclosure. *See In re Translogic Tech., Inc.*, 504 F.3d 1249, 1257 (Fed. Cir. 2007). Any special definition for a claim term must be set forth with reasonable clarity, deliberateness, and precision. *See In re Paulsen*, 30 F.3d 1475, 1480 (Fed. Cir. 1994).

1. "physiological information" (Claims 1–13)

Petitioner argues that the Specification of the '941 patent provides an express definition of the term "physiological." Pet. 13–14. In particular, the Specification states that:

> The term "physiological" refers *to matter or energy of or from the body of a creature* (e.g., humans, animals, etc.). In embodiments of the present invention, the term "physiological" is intended to be used broadly, covering both physical and psychological matter and energy of or from the body of a creature. However, in some cases, the term "psychological" is called-out separately to emphasize aspects of physiology that are more closely tied to conscious or subconscious brain activity rather than the activity of other organs, tissues, or cells.

Ex. 1001, 10:9–18 (emphasis added). Therefore, Petitioner argues that the broadest reasonable interpretation of the term "physiological information" is "information about physical and/or psychological matter and energy of or from the body of a creature." Pet. 14; *see* Ex. 1003 ¶ 61.

Patent Owner did not address construction of this term in its Patent Owner Response. *See* PO Resp. 7–9. Thus, Patent Owner waived challenges to Petitioner's construction of this term. *See* Paper 11, 3 ("The patent owner is cautioned that any arguments for patentability not raised in the response will be deemed waived.").

On this record, we are persuaded that Petitioner's proposed construction of the term "physiological information" as "information about physical and/or psychological matter and energy of or from the body of a creature" is the broadest reasonable interpretation of that term.

2. "application-specific interface (API)" (Claim 3)

Petitioner argues that the term "application-specific interface (API)" of claim 3 should be construed as "application *programming* interface" and "to include at least an application interface that specifies how some software components should interact with each other." Pet. 14–15. Petitioner explains that the claim term refers to the term "application programming interface" and, as such, is characterized by "broad applicability to different applications—and not 'application specific' as such." *Id*. at 14. In particular, Petitioner argues that the recitation in claim 3 of an "application-specific interface (API)" contains a typographical error. *Id*.; Add'l Br. 1–3. Further, Petitioner argues that this typographical error also appears in the Specification of the '941 patent, which describes an "application-specific interface (API)." Pet. 14 (citing Ex. 1001, 26:15–19); *see* Add'l Br. 1 ("the specification contained a typographical error"; citing Ex. 1003 ¶ 62). Petitioner argues that "[application programming interface] was a well-known term in common usage at the time of the alleged invention. By contrast, 'application-specific interface' did not have a common meaning in the art." Pet. 14 (citing Ex. 1003 ¶ 62); *see* Add'l Br. 2–3. Thus, because API was a well-known abbreviation, Petitioner concludes that "application-*specific* interface" in the claim and the Specification should have been "application *programming* interface," so that the recitations would have been consistent with the known abbreviation. Pet. 14. Patent Owner does

not propose a construction for this term in this case, but only opposes Petitioner's proposed construction. Add'l Resp. 1–5.

We are unpersuaded by Petitioner's proposed construction of this term as the broadest reasonable interpretation for at least three reasons. First, because the term appears in the identical form, namely, "application-specific interface (API)," in both claim 3 and in the Specification, the evidence argued does not provide sufficient support that this term contains a typographical error. The similarity of the abbreviation "API" selected by the patentee to a well-known abbreviation may be no more than a coincidence. We find nothing persuasive in the intrinsic evidence to demonstrate a typographical error. Further, even assuming that Petitioner is correct and that this term contains a typographical error, on this record, we cannot be certain whether the error is in the words of the term (i.e., "application *programming* interface," rather than "application-*specific* interface") or the letters of the abbreviation (i.e., "A*S*I," rather than "A*P*I"). The specific error is essential to Petitioner's proposed claim construction and, on this record, even were we to determine that an error is likely, we could not say with any certainty what that error is.

Second, when construing a claim term under the broadest reasonable interpretation standard, we begin with the words of the term as it appears in the claims and, if the ordinary and customary meaning is not plain, we look to the specification to discern the meaning of the term. *In re Morris*, 127 F.3d 1048, 1054 (Fed. Cir. 1997); *see Trivascular, Inc. v. Samuels*, 812 F.3d 1056, 1062 (Fed. Cir. 2016) ("While the broadest reasonable interpretation standard is broad, it does not give the Board an unfettered license to interpret

the words in a claim without regard for the full claim language and the written description."; internal citations omitted).

We also may look to the prosecution history to try to discern a claim term's meaning. We note here that the prosecution history consistently uses the term "application-specific interface (API)." Ex. 1002, 47–48, 55, 95, 132, 157. Thus, we also find no evidence of a typographical error in the prosecution history. We note, however, that because prosecution history represents an ongoing negotiation between the Office and the inventor, it may lack the clarity of the specification and, thus, may be less useful for claim construction purposes. *Trading Techs. Int'l, Inc. v. eSpeed, Inc.*, 595 F.3d 1340, 1352 (Fed. Cir. 2010) (citing *Netcraft Corp. v. eBay, Inc.*, 549 F.3d 1394, 1401 (Fed. Cir. 2008)).

"A patent's specification, together with its prosecution history, constitutes intrinsic evidence to which the [the Board] gives priority when it construes claims." *Knowles Elecs. LLC v. Cirrus Logic, Inc.*, 883 F.3d 1358, 1361 (Fed. Cir. 2018). When the intrinsic evidence is not definitive, we consult extrinsic evidence to construe the claims. *Knowles*, 883 F.3d at 1363; *see Teva Pharm. USA, Inc. v. Sandoz, Inc.*, 135 S. Ct. 831, 840 (2015) ("In some cases, however, the district court will need to look beyond the patent's intrinsic evidence and to consult extrinsic evidence in order to understand, for example, the background science or the meaning of a term in the relevant art during the relevant time period."). As Petitioner notes, "[t]he Board said that when the intrinsic evidence is clear, there is no need to look to extrinsic evidence. (DI, 10-11.)" Add'l Br. 4. Petitioner, however, would have us assume a particular typographical error in the term "application-specific interface (API)" and then favor extrinsic evidence, over the

consistent intrinsic evidence, to construe the term as rewritten by Petitioner. We decline to presume error in the claim language and then to rely on extrinsic evidence *over intrinsic evidence* as to the claim term's meaning.

Petitioner relies upon the testimony of its declarant, Dr. Sarrafzadeh, and Patent Owner's declarant's, Dr. Pollonini's, deposition testimony to support its contention that the term contains a typographical error. Pet. 14 (citing Ex. 1003 ¶ 62 (Dr. Sarrafzadeh's declaration)); Add'l Br. 3–4 (citing Ex. 1069, 127:13–24, 126:6–16, 128:4–12 (Dr. Pollonini's deposition)); *see* Tr. 18:19–26; *but see* Add'l Resp. 3–4 (citing Ex. 1069, 64:23–65:3, 128:9–11); Tr. 34:4–25.[5] We find no evidentiary support for either declarant's testimony and, thus, we afford less weight to unsupported opinion testimony when considering the construction of this disputed term. *See* 37 C.F.R. § 42.65(a) ("Expert testimony that does not disclose the underlying facts or data on which the opinion is based is entitled to little or no weight."). Consequently, although we consider the declarants' testimony, we do not find that the unsupported declarant testimony outweighs the intrinsic evidence present in this record.

Third, we decline to adopt Petitioner's proposed construction for the term "application-specific interface (API)" because we find that construction is inconsistent with the explanation of the meaning of the term in the

[5] Despite any suggestion that we expressly construed the term in the Decision on Institution, we did not. We noted the Specification's description of an "application-specific interface (API)" and rejected Petitioner's proposed construction, but we did not provide our own construction of that term. Inst. Dec. 8–12; *see* Add'l Br. 2 n.3 ("While the Board did not provide an explicit construction, the decision that [Petitioner's] proposed construction was incorrect was a claim construction determination.").

Specification of the '941 patent. In particular, Petitioner argues that "[application programming interfaces] are thus characterized *by their broad applicability to different applications—and not "application specific" as such*." Pet. 14 (emphasis added, citing Ex. 1003 ¶ 62). Therefore, Petitioner argues that "'application-specific interface (API)' should be [construed] *broadly* to include at least an application interface that specifies how some software components should interact with each other." *Id*. at 14–15 (citing Ex. 1003 ¶ 63).

Nevertheless, the Specification of the '941 patent states that:

> The multiplexed data outputs **604** may be a serial data string of activity and physiological information **700** (FIG. **18**) parsed out specifically such that an *application-specific interface* (API) can utilize the data as required for *a particular application*. The applications may use this data to generate high-level assessments, such as overall fitness or overall health. Furthermore, the individual data elements of the data string can be used to facilitate better assessments of other individual data elements of the data string.

Ex. 1001, 26:15–23 (emphasis added). Thus, contrary to Petitioner's arguments, the Specification explains that the "application-specific interface (API)" is directed to a "particular application," rather than *broadly* to different applications.

Petitioner further argues that:

> While the specification gave a use case, it did not *define* the term any more clearly. Again, the intrinsic evidence indicates that an API is "utilize[d]" for a particular application, not that the API itself is "directed to" a particular application. Apple did not choose extrinsic evidence over the intrinsic evidence, as alleged. ([Inst. Dec.] 11.) Apple consulted extrinsic evidence because the intrinsic evidence was just as ambiguous – indeed, verbatim – as the claim language in question. (Pet., 14.) Thus, the use of

> extrinsic evidence (Dr. Sarrafzadeh's declaration) was appropriate, and should not be discredited.

Add'l Br. 4. Petitioner did not raise this argument in its Petition and fails to provide evidence to support this proposition in either the Petition or its additional briefing. Pet. 14; Add'l Br. 4. Nevertheless, as noted above, Petitioner states that "[application programming interfaces] are thus characterized *by their broad applicability to different applications—and not 'application specific' as such*." Pet. 14 (emphasis added). Consequently, in its Petition, Petitioner argues that application programming interfaces have broad "applicability" or utility to different applications, while its new argument attempts to distinguish between whether an application programming interface may be *utilized* for a particular application and whether it has *broad applicability* to a different applications. Pet. 14; Add'l Br. 4. We find this new argument is not consistent with Petitioner's earlier arguments nor with the disclosure of the '941 patent.[6] *See* Ex. 1001, 26:15–19 ("such that an application-specific interface (API) can utilize the data as required for a particular application"). We are not persuaded by Petitioner's new argument.

In the related case, Case IPR2017-00321, also directed to the '941 patent, Patent Owner filed a Motion to Amend (IPR2017-00321, Paper 24), in which Patent Owner proposed substitute claims including the term "application-specific interface (API)." IPR2017-00321, Paper 44, 58–62. After considering the parties' arguments and the cited evidence in that case,

[6] Although we have considered Petitioner's new argument, Petitioner did not request authorization to raise a new argument. Paper 39, 6 ("The parties may not raise new arguments or submit new evidence without our authorization.").

especially the Specification of the '941 patent and the ordinary meaning of the word "interface" in this field,[7] in the context of the substitute claims, we construed the term "application-specific interface (API)" to mean "an interface which enables a particular application to utilize data obtained from hardware, such as the at least one motion sensor and the at least one PPG sensor." *Id*. at 62. Although the Final Written Decision in Case IPR2017-00321, including this claim construction, was mailed on June 5, 2018, after Petitioner filed its Additional Briefing in this case, Petitioner did not seek authorization to supplement its briefing to address any potential implications of this construction on this proceeding. *See* Add'l Br. 2 n.3. Patent Owner also did not seek to apply the construction of the term "application specific interface (API)" from Case IPR2017-00321 in this case. *See* Add'l Resp. 1–5 (response filed June 6, 2018). Thus, neither party seeks to rely here on the construction of the disputed term that we applied to the substitute claims in Case IPR2017-00321.

Consequently, we decline to accept Petitioner's overly broad construction of the term "application-specific interface (API)." Because Petitioner's assertions challenging claim 3 are based on the rejected construction of this term, and the evidentiary support relied upon is predicated upon the same, we are not persuaded that Petitioner has shown by a preponderance of the evidence that claim 3 is rendered obvious over Luo

[7] A relevant definition of "interface" is "[s]oftware that enables a program to work with the user (the user interface, which can be a command-line interface, menu-driven interface, or a graphical user interface), with another program such as the operating system, or with the computer's hardware." MICROSOFT COMPUTER DICTIONARY, 279–80 (5th ed. 2002) (Ex. 3003).

and Craw (Pet. 27) or over Mault, Al-Ali, and Lee (*id*. at. 55–59).[8] We do not address this claim further in this Decision.

3. "the application" (Claims 4 and 5)

In the Petition, Petitioner argues that the term "the application" in claim 4 contains a typographical error. Pet. 15. In particular, Petitioner argues that, because claim 4 depends from claim 1 and because "*an* application" does not appear in claim 1, the term "*the* application" in claim 4 lacks antecedent basis. *Id*. Petitioner alleges that, in view of this lack of antecedent basis, one of two possible errors exists in claim 4. First, Petitioner suggests that the dependency of claim 4 is incorrect and that, because claim 3 recites "an application," "claim 4 should have depended on claim 3." *Id*.; Add'l Br. 5–6. Second, Petitioner argues that, alternatively and for purposes of this Petition only, the term "*the* application" should be read as "*an* application." Pet. 15.

Petitioner argues that "for purposes of this petition only, Petitioner construes the term 'the application' to mean 'an application,' where under

[8] Petitioner argues that "[h]ad claim 3 been instituted, as the *SAS* decision now tells us it should have been, then discovery would have shown that Apple's original analysis was correct." Add'l Br. 2. Even though initial institution did not include claim 3, Petitioner's deposition of Patent Owner's declarant addressed issues related to the disputed claim term of claim 3 and Petitioner introduced argument based on that deposition testimony into the record. *Id*. at 2–3 (citing Ex. 1069, 126:6–16, 127:13–24, 128:4–12); *see* Ex. 1072, 6:12–7:13. Additionally, absent action by Patent Owner, Petitioner was not entitled to additional discovery, and Petitioner did not request additional discovery in view of Patent Owner's response to Petitioner's additional briefing or in view of our Final Written Decision in Case IPR2017-00321. *See* Paper 39, 6 n.1.

[broadest reasonable interpretation], the application can be any application, including but not limited to an application accessible through an application programming interface." *Id*. (citing Ex. 1003 ¶ 64). Petitioner's challenge to claims 4 and 5 in the Petition are based on this construction of claim 4, from which claim 5 depends. *See id*. at 29–32, 59–61. In its additional briefing, however, Petitioner argues that "[t]he '941 file history indicates that claim 4 should depend on claim 3, which recites 'an application,' and thus claim 4 appears to contain a typographical error. (Pet., 15; Ex. 1003, ¶64.)" Add'l Br. 5–6 ("These facts indicate that patent claim 4's dependence on claim 1 is a typographical error and that patent claim 4 should depend on patent claim 3, which recites 'an application.'"). Thus, Petitioner has changed its argument between the Petition and the additional briefing. Further, Petitioner relies on its application of the cited references to support its challenge to claims 4 and 5 under either claim construction theory. *Id*. at 7.

Patent Owner agrees with Petitioner's interpretation in the additional briefing that claims 4 and 5 should properly depend from claim 3. Add'l Resp. 5–6. However, Patent Owner contends that "Section 112 is not proper subject matter for an *inter partes* review. [Inst. Dec] 13 (citing 35 U.S.C. § 311(b)); *see also Cuozzo Speed Techs., LLC v. Lee*, 136 S. Ct. 2131, 2142 (2016) (canceling a patent claim for indefiniteness under §112 in inter partes review would be impermissible "shenanigans")." Add'l Resp. 5. Patent Owner concludes that "the Board should either (1) decline to address a Section 112 issue or (2) construe claim 4 to depend from claim 3. In either

case, the Board should find that Petitioner has failed to meet its burden to demonstrate unpatentability with respect to claims 4 and 5."[9] *Id*. at 7.

The U.S. Court of Appeals for the Federal Circuit has addressed the question "whether a district court can act to correct an error in a patent by interpretation of the patent where no certificate of correction has been issued." *Novo Indus., L.P. v. Micro Molds Corp.*, 350 F.3d 1348, 1354 (Fed. Cir. 2003). The Federal Circuit held that "a district court can do so only if (1) the correction is not subject to reasonable debate based on consideration of the claim language and the specification and (2) the prosecution history does not suggest a different interpretation of the claims." *Id*. Although we agree that the recitation of the term "the application" in claim 4 lacks antecedent basis in claim 1, we declined to speculate as to the intended meaning of the term. Inst. Dec. 13. Although Petitioner and Patent Owner now seem to agree on the nature of the error in claims 4 and 5 (Add'l Br. 5–7; Add'l Resp. 5–6), we find that the nature of the error in claims 4 and 5 is subject to reasonable debate in view of the language of claims 1 and 3–5 and/or that the prosecution history does not demonstrate a single interpretation of the claims. Pet. 15 (describing two possible errors in claim 4); Add'l Br. 6 ("But, in the applicant's August 26, 2015 office action response, original claim 5's dependency *appears to have been inadvertently changed* from original claim 4 (patent claim 3) to claim 1." (emphasis added)). Therefore, to the extent that the Board has the authority to correct

[9] If we accept the parties' current arguments that claims 4 and 5 properly depend from claim 3, rather than claim 1, Petitioner's challenges to those claims must fail for the same reasons that its challenges to claim 3 must fail. *See supra* Section II.A.2.

errors such as this (*see* Add'l Resp. 6), we decline to choose one possible correction of the error in claims 4 and 5 over the other on this record. *See* 37 C.F.R. § 1.322(a)(3) ("If the request relates to a patent involved in . . . [a] trial before the Patent Trial and Appeal Board, the request must comply with the requirements of this section and be accompanied by a motion under . . . § 42.20 of this title.").

Further, as Patent Owner notes, the lack of antecedent basis is an issue arising under 35 U.S.C. § 112. Improper dependency also is an error arising under 35 U.S.C. § 112. As Congress instructed us and the U.S. Supreme Court has reminded us, Section 112 is not proper subject matter for an *inter partes* review. *See* 35 U.S.C. § 311(b); *Cuozzo*, 136 S. Ct. at 2142.

Unless the language *or* dependency of claims 4 and 5 is properly corrected, their meaning remains uncertain. If the scope and meaning of the claims cannot be determined without speculation, the differences between the challenged claims and the prior art cannot be ascertained. *See BlackBerry Corp. v. MobileMedia Ideas, LLC*, Case IPR2013-00036, slip op. at 19–20 (PTAB Mar. 7, 2014) (Paper 65) (citing *In re Steele*, 305 F.2d 859, 862–63 (CCPA 1962) and reasoning that "the prior art grounds of unpatentability must fall, pro forma, because they are based on speculative assumption as to the meaning of the claims"). In other words, "[w]ithout ascertaining the proper claim scope, we cannot conduct a necessary factual inquiry for determining obviousness—ascertaining differences between the claimed subject matter and the prior art." *Id*. at 20 (citing *Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966)).

Because Petitioner's assertions challenging claim 4 and claim 5, which depends from claim 4, are based on its construction of this term, we

are not persuaded that Petitioner has shown by a preponderance of the evidence that claims 4 and 5 are rendered obvious over Luo, Craw, and Wolf (*id*. at 29–32) or over Mault, Al-Ali, and Behar (*id*. at. 59–61). We do not address these claims further in this Decision.

4. "PPG sensor" (Claim 1)

Patent Owner, but not Petitioner, proposes a construction for the term "PPG sensor" in this case. PO Resp. 8–9. Patent Owner also proposed and we adopted a construction of this term in the related case, Case IPR2017-00321, challenging different claims of the same patent. In particular, Patent Owner proposed to construe the term "PPG sensor" to mean "an optically obtained plethysmogram that results from blood flow modulations caused by the subject's heartbeat." IPR2017-00321, Paper 6, 16 (citing IPR2017-00321, Ex. 2005, 1). Patent Owner modifies its proposed construction of this term to refer to an "optical sensor," specifically, and Patent Owner proposes that we construe this term to mean "an optical sensor which obtains a plethysmogram that results from blood flow modulations caused by the subject's heartbeat." PO Resp. 8–9. Because Patent Owner proposes a construction of this term *in this case* and that proposed construction is unopposed, because we adopted this modified construction in the related case, because both this case and Case IPR2017-00321 relate to challenges to claims of the '941 patent, and because claim terms generally are used consistently throughout a patent, we determine that the same construction is the broadest reasonable interpretation of this term in each case. IPR2017-00321, Paper 44, 10; s*ee Rexnord Corp. v. Laitram Corp.*, 274 F.3d 1336, 1342 (Fed. Cir. 2006).

5. Other Claim Terms

Neither party offers specific constructions of other terms in the challenged claims. *See* Pet. 15 ("All other claim terms should be given their plain and ordinary meaning under the broadest reasonable construction."). Only terms which are in controversy in this proceeding need to be construed, and then only to the extent necessary to resolve the controversy. *See Wellman, Inc. v. Eastman Chem. Co.*, 642 F.3d 1355, 1361 (Fed. Cir. 2011) (explaining that "claim terms need only be construed 'to the extent necessary to resolve the controversy'") (quoting *Vivid Techs., Inc. v. Am. Sci. & Eng'g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999)). Except as provided below, no other claim terms require express construction.

B. Obviousness over Luo and Craw, Alone or in Combination with Other References

1. Overview

Petitioner argues that claim 1–13 are unpatentable under 35 U.S.C. § 103(a) as obvious over Luo and Craw, alone or in combination with other references. *See supra* Section I.E. Because of the deficiencies in Petitioner's arguments noted above, however, we do not consider Petitioner's challenges to claims 3–5 further. *See supra* Section II.A.2. and 3. To support its arguments regarding the remaining challenged claims, Petitioner provides a detailed mapping of limitations of claims 1, 2, and 6–13 to structures taught or suggested by Luo and Craw or by Luo and Craw and one or more additional references. Pet. 15–44. Petitioner also cites Dr. Sarrafzadeh's Declaration for support. *See* Ex. 1003 ¶¶ 79–91, 94–98, 105–129.

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 skill in the art;[10] and (4), when in evidence, objective evidence of nonobviousness, i.e., secondary considerations.[11] *Graham*, 383 U.S. at 17–18. Nevertheless, the Court cautions us against "the temptation to read into the prior art the teachings of the invention in issue." *Id*. at 36.

We begin our analysis of these grounds of unpatentability with a review of the applied art.

2. Luo (Ex. 1055)

Luo teaches noninvasive monitoring systems for continuous, painless, and bloodless health state monitoring of a subject. Ex. 1055, Abstract.

[10] Petitioner proposes an assessment of the level of ordinary skill in the art. Pet. 12; *see* Ex. 1003 ¶ 59. Patent Owner's declarant, Dr. Pollonini, does not contest Petitioner's proposed assessment. Ex. 2006 ¶ 65. Both Dr. Sarrafzadeh and Dr. Pollonini exceed this assessed level. Ex. 1004; Ex. 2006, App'x A. To the extent necessary, we adopt Petitioner's assessment.

[11] Patent Owner did not argue or provide evidence of secondary considerations in its Patent Owner Response. *See* Reply 1; Paper 11, 3; *see also* Inst. Dec. 29–30 (noting deficiencies in possible secondary considerations arguments in the Preliminary Response).

Specifically, a wearable device, such as that depicted in Luo's Figure 1, monitors health conditions, analyzes the subject's health information, and outputs that information. *Id.* ¶¶ 9–13. Luo's Figure 1 is reproduced below with our annotations.

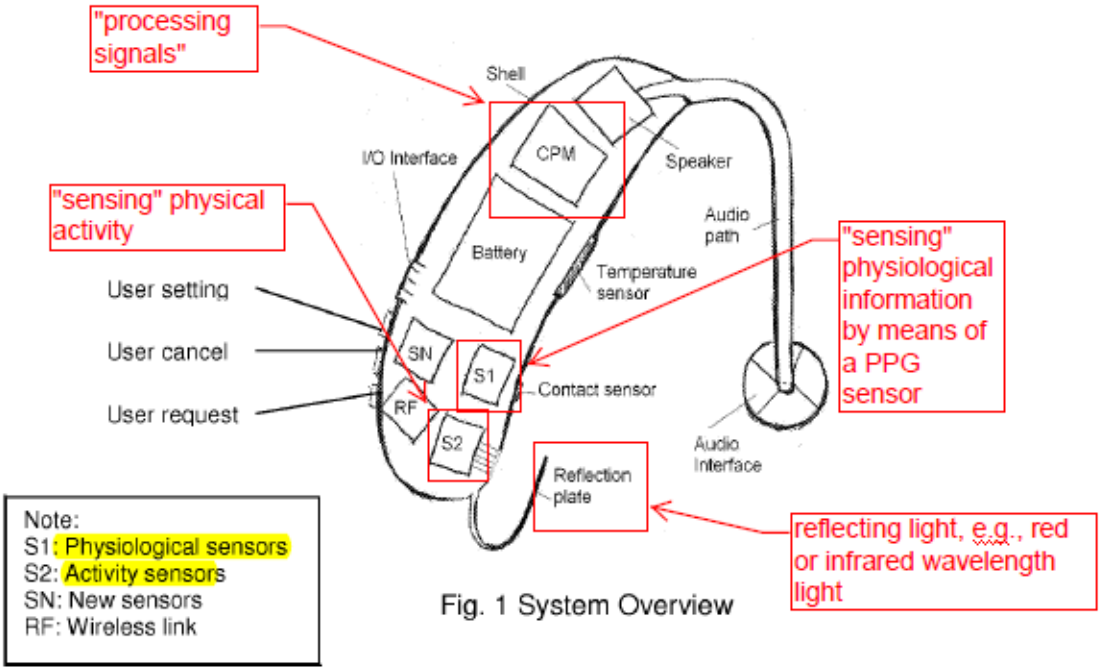


Fig. 1 System Overview

Luo's Figure 1, above, depicts a system configured for positioning around the subject's ear for detection of activity and physiological information. *Id.* ¶ 10. The depicted system includes physiological sign sensors ("S1") for detecting the subject's physiological information (such as heart rate, oxygen saturation ("SpO_2"), and respiration rate (i.e., sleep apnea)); activity sensors ("S2") for detecting the subject's physical activity; a central processing module ("CPM") including a central processing unit ("CPU"); and a shell to contain the system components. *Id.* ¶ 27; *see id.*, Figs. 3 and 4; *see also id.* ¶ 46 ("blood oxygen level, heart rate or pulse, blood flow information, body temperature, sleep apnea, glucose, exercise amount, unexpected fall *or any type of health sign or activity that may be*

detected by the monitoring device" (Emphasis added.)), claim 37 ("respiratory rate"). Physiological sensors ("S1") include red (660 nm) and infrared (910 nm) light sources for emitting light through the subject's body, for example, the earlobe, and optoelectronic sensors for *optically* detecting the intensity of light reflected back through the earlobe from a reflection plate. *Id*. ¶ 28. The CPM extracts physiological parameters from the plethysmographic signals obtained by the optoelectronic sensors. *Id*. Signals from Luo's sensors are processed in real-time to output physiological and activity information. *Id*. ¶¶ 28, 46, claim 37, Fig. 4.

Activity sensors S2 continuously detect a subject's physical activity in three dimensions. *Id*. ¶ 29. The CPM processes signals from 3-axis acceleration sensors to extract activity information, such as activity state, activity strength, and activity duration. *Id*.; *see id*., Fig. 5. Activity information may be correlated with physiological information to more intelligently differentiate normal and dangerous health conditions. *Id*. ¶ 31. For example, a heart rate of 60–100 beats per minute (bpm) may be considered normal for a subject at rest, but a heart rate of 120 bpm may be considered within a normal range if the subject is running. *Id*.

3. Craw (Ex. 1056)

Craw teaches methods for communicating medical information between network devices. Ex. 1056 ¶ 2; *see id*. ¶ 13, Fig. 9A (displaying physiological information based definitions derived from data dictionaries). The health care computing environment includes a variety of medical monitoring and analysis devices that process physiological data, including heart rate and respiration rate, and communicate that physiological data via a network. *Id*. ¶ 4. For example, Craw teaches "a system for interoperability

of medical devices on a network and particularly measurements of non-invasive blood pressure ('NIBP'), but it is understood that this example is merely illustrative and other uses and fields of use are contemplated." *Id*. ¶ 51.

Craw teaches serializing data for transmission using a classification scheme to enable extraction of physiological parameters by a recipient device, such as for displaying information. *See id*. ¶¶ 200–216. "Serialization may be thought of as a process for taking an instance of software structure or class and turning the attributes/members of the class into transferable data encoding." *Id*. ¶ 235. Craw further teaches the use of string tables to provide an interface that may be used by software to manage and access strings of data. *Id*. ¶ 255. The data dictionary may be used with a string table as an interface for managing, extracting, and displaying information from binary information streams. *Id*. ¶ 256, Fig. 7G. Thus, Craw's system may include a protocol for the serializing and deserializing byte streams of information. *Id*. ¶ 15. Accordingly, physiological information may be communicated via known serial communications channels. *Id*. ¶¶ 68–70.

4. Analysis

a. Mapping of Claim 1 onto Teachings of Lou and Craw

As noted above, independent claim 1 recites a method of generating data output containing physiological and motion-related information. Ex. 1001, 30:35–36. Petitioner provides a detailed mapping of the limitations of claim 1 on the teachings of Luo. Pet. 22–24. In particular, Petitioner argues that Luo teaches a method of generating health information derived from physiological information and physical activity information.

Id. at 22 (citing Ex. 1055 ¶ 11); *see* Ex. 1003 ¶ 79. Referring to Luo's Figure 1, Petitioner further argues that Luo teaches sensing physical activity and physiological information by means of a single monitoring device, such as Luo's ear mounted system, which is attached to the subject. Pet. 22 (citing Ex. 1055 ¶¶ 10, 27–29, 45, Figs. 1, 4, and 5); *see* Ex. 1003 ¶ 80.

With respect to the sensors recited in claim 1, Petitioner argues that both types of recited sensors are taught by Luo. First, Petitioner argues that Luo's activity *sensors* S2 teach the "*at least one* motion sensor" of the recited monitoring device. Pet. 22 (emphasis added) (citing Ex. 1055 ¶ 29, Fig. 5); *see* Ex. 1003 ¶ 81. Second, Petitioner argues that Luo's physiological *sensors* S1 teach the "at least one photoplethysmography (PPG) sensor for sensing the physiological information," as recited in claim 1. Pet. 23 (citing Ex. 1055 ¶¶ 27, 28); *see* Ex. 1003 ¶ 82. Although Luo does not expressly describe sensor S1 as a *photo*plethysmography ("PPG") sensor, Petitioner argues that Luo's sensor S1 optically obtains a plethysmographic signal and that a person of ordinary skill in the art would have understood Luo's sensor S1 to be a PPG sensor. Ex. 1003 ¶¶ 26–33, 82; Ex. 1055 ¶ 28 ("In addition to obtaining real-time blood oxygen level and *plethysmographic signal*, the intelligent detection algorithm extracts *heart rate, blood flow information* or even sleep apnea when the subject is in sleep." (emphases added)); *see* Reply 10–11; *supra* Section II.A.4. Moreover, Luo teaches that its sensor S1 may retrieve physiological information, including heart and respiratory rate, as recited in claim 1. *See* Ex. 1055 ¶ 46; *see also* Reply 6–7 (discussing the difference between raw and processed information).

Petitioner also argues that Luo's system teaches the processing of signals from the at least one motion sensor and the at least one PPG sensor "via a processor of the monitoring device into a serial data output of physiological information and motion-related information." Pet. 23–24 (citing Ex. 1055 ¶¶ 28–30, 33–35, 40–42, Figs. 4 and 5); *see* Ex. 1003 ¶¶ 83–85. In particular, referring to Luo's Figure 4, Luo teaches that the monitoring device of Luo's Figure 3 includes standard input/output interfaces, such as a Universal Serial Bus ("USB") port, for outputting health information. Pet. 23 (citing Ex. 1055 ¶¶ 11, 43). Thus, Petitioner argues that, in view of Luo's teaching regarding the use of a USB port, a person of ordinary skill in the art would understand that Luo teaches producing serial data for output. *Id*. at 23–24; *see* Ex. 1003 ¶¶ 83–85, 87.

Finally, although Petitioner argues that Luo teaches outputting serial data, Petitioner acknowledges that "Luo does not expressly state that the data output is serially formatted so that heart rate, respiration rate, and a plurality of physical activity parameters can be extracted." Pet. 24–25. Nevertheless, Petitioner argues that "[a] conventional way to transmit data was to format the data into a serial string of data." *Id*. at 25 (citing Ex. 1003 ¶¶ 36, 86–90, 146). Further, as of the effective date of the '941 patent, Petitioner argues that "there were only two transmission modes to choose from: serial and parallel." *Id*.

Petitioner also argues, however, that:

> Craw in particular addresses the problem of inoperability and seamless transmission of physiological data between varied computing environments. Specifically, Craw teaches a data structure and classification scheme for the transmission and interpretation of physiological information and related data. Specifically, Craw suggests serializing data for transmission

> using a classification scheme to enable extraction of physiological parameters by a recipient device, e.g., for display of the information. Ex. 1056, ¶¶ 0200-0216.

Id. Thus, to the extent serializing data for transmission is not taught expressly by Luo in the context of the manipulation of physiological information, Petitioner argues that Craw teaches this limitation. *See supra* Section II.B.3 (providing a discussion of Craw's teachings).

Petitioner argues that a person of ordinary skill in the relevant art would have had reason to combine the teachings of Luo and Craw to achieve the method recited in claim 1. In particular, Petitioner argues that:

> It would have been obvious to a POSA to serialize Luo's data as described by Craw, such that Luo's subject heart rate and subject respiration rate parameters could be extracted from the physiological information and such that a plurality of subject physical activity parameters could be extracted from the motion-related information.

Pet. 25–26. Specifically, because Luo and Craw are directed to physiological monitoring devices and to the extraction and communication of physiological and activity related information from subjects, "[i]mplementing Craw's technique to output Luo's data would have amounted to the obvious use of known signal processing technique to improve a similar physiological monitoring device." *Id*. at 26 (citing *KSR*, 550 U.S. at 421); Reply 14–15; *see In re Ethicon*, 844 F.3d 1344, 1351 (Fed. Cir. 2017) ("The normal desire of artisans to improve upon what is already generally known can provide the motivation to optimize variables such as the percentage of a known polymer for use in a known device.").

b. Patent Owner's Contentions

Patent Owner contends that Petitioner fails to demonstrate that the combined teachings of Luo and Craw render the method of challenged claim 1 obvious for at least four reasons. *See* PO Resp. 9–26. First, Patent Owner contends that "Luo and Craw do not relate to the same technology and do not attempt to solve the same problems." *Id*. at 10–14. Second, Patent Owner contends that "[n]either Luo nor Craw discloses that respiration rate can be extracted from signals obtained by a PPG sensor." *Id*. at 14–18. Third, Patent Owner contends that neither Luo nor Craw teaches or suggests:

> Limitation 1.4: "processing signals from the at least one motion sensor and signals from the at least one PPG sensor via a processor of the monitoring device into a serial data output of physiological information and motion-related information" or
>
> Limitation 1.5: "the serial data output is configured such that a plurality of subject physiological parameters comprising subject heart rate and subject respiration rate can be extracted from the physiological information and such that a plurality of subject physical activity parameters can be extracted from the motion-related information"

and a person of ordinary skill in the art would not have been motivated to combine the teachings of Luo and Craw to render these limitations obvious. *Id*. at 18–24. Finally, Patent Owner contends that a person of ordinary skill in the art "would not have been motivated to combine Luo and Craw because they are not directed to similar physiological monitoring devices." *Id*. at 24–26. We address each of these contentions in turn.

i. Different Technology and Problems

Patent Owner contends that "Luo and Craw do not relate to the same technology and do not attempt to solve the same problems." *Id*. at 10–14.

In particular, Patent Owner contends that Luo discloses a wearable device for continuous health monitoring of a user and does not teach processing sensor signals into a serial data output. *Id*. at 10–11. Petitioner characterizes Patent Owner's contention as asserting that Luo and Craw are not analogous art. Reply 2–5.

Although Patent Owner acknowledges that Luo teaches outputting information, such as

> emergency call/transmission (page or phone call) through RF 44 for a very serious condition, activation of the smart audio outputs such as beep, advice, reminding or warning through speaker 41, audio path 42 and audio interface 43 to the ear canal for a concerned health condition, data storage on the CPM or transmission through RF 44 for the future analysis or review purpose

(*id*. at 11–12 (quoting Ex. 1055 ¶ 33)), Patent Owner contends that Luo does not teach the use of sensor data "to create a serial data output of physiological and motion information such that a plurality of physiological parameters and activity parameters can be extracted from the sensor information" (*id*. at 12; *see* Ex. 2006 ¶ 49). While Luo teaches that its input/output interface may be a "standard communication interface such as Universal Serial Bus (USB) port between the system and the external computer or device" (Ex. 1055 ¶ 43), Patent Owner contends that "such an interface is merely used for the transmission of data from one device to another" (PO Resp. 12). Patent Owner further contends that the '941 patent discloses and its claims recite "processing signals into a serial data output from which physiological and physical activity parameters can be extracted." *Id*. at 12–13 (citing Ex. 2006 ¶ 80).

Nevertheless, as depicted in Luo's Figure 3, reproduced below, Luo's CMP 11 includes algorithms for the processing of information obtained from sensors (S1) 21 and (S2) 22 for output by input/output interface 45.

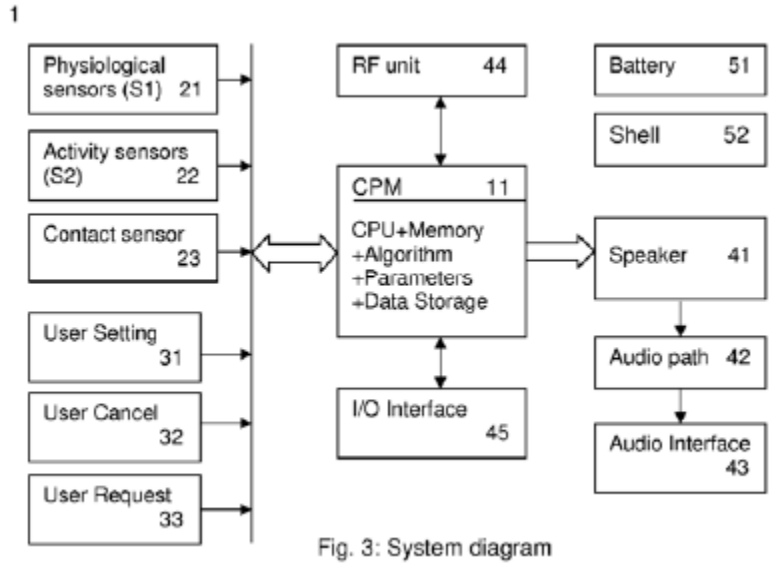


Fig. 3: System diagram

Ex. 1055, Fig. 3. Further, Luo teaches that:

> The present invention uses an intelligent *signal processing algorithm* to continuously monitor a subject's vital signs with real-time detection and analysis, record and storage of the health information running on a powerful but mini-size signal processor with low power consumption in connection with physiological sensors and activity sensors, and utilizing wireless communications technology known in the art to connect with the medical care center, doctor or family member via the available PDA or cell phone. The saved health information may then be downloaded into a computer or medical device for further analysis and evaluation. *In addition, the invented monitoring device may also provide real-time health information to the monitored subject at a touch of a button as either smart audio outputs or display on available PDA or cell phone, or both of them in the same time.*

Id. ¶ 11 (emphases added). The claim does not specify where the "physiological parameters" are extracted. Thus, we are persuaded that Luo

teaches the processing sensor signals into a serial data output for transmission via a USB and that Luo teaches that "real-time health information" can be extracted from obtained data.

Patent Owner further contends that Craw relates to "methods, apparatus and systems for the communication of information among a plurality of network elements, and specifically to a dynamic medical object information base for interoperability of devices and systems." PO Resp. 13 (quoting Ex. 1056 ¶ 2). Specifically, Patent Owner asserts that "Craw has *nothing* to do with monitoring *any* type of health conditions" and "[i]nstead, it is directed to a specific data transmission scheme to address interoperability between medical devices." *Id*. (emphases added, citing Ex. 2006 ¶ 50). Although Craw device may seek to improve interoperability of devices, those devices may include those related to monitoring health conditions. For example, Craw teaches that "one blood pressure device may employ more complex hardware/software combination, which may produce a higher resolution pressure reading[, and a]n algorithm assisting in the calculation of the diagnostic results may provide configuration options that are more complex compared with another manufacturer's algorithms performing the same function." Ex. 1056 ¶ 107. Thus, we are persuaded that Lou and Craw are directed to sufficiently similar technology and problems, such that their teachings would be found pertinent by persons of ordinary skill in the relevant art.

ii. No Extraction of Respiration Rate

Patent Owner contends that "[n]either Luo nor Craw discloses that respiration rate can be extracted from signals obtained by a PPG sensor." PO Resp. 14–18. Referring to Limitations 1.4 and 1.5, quoted above, Patent

Owner notes that claim 1 recites "processing . . . signals from the at least one PPG sensor via a processor of the monitoring device into a serial data output of physiological information" and "the serial data output is configured such that a plurality of subject physiological parameters comprising subject heart rate and subject respiration rate can be extracted from the physiological information." *Id*. at 15. In particular, Patent Owner contends that Petitioner relies solely on Luo to teach this limitation. *Id*. at 14 (citing Pet. 19–26). Because Luo allegedly does not teach or suggest "a PPG sensor produces a signal which can be processed into an output comprising respiration rate" and "[a]ll Luo discloses is a separate processing module that outputs physiological signals that are combined with activity and environmental variables to extrapolate a respiration rate," Patent Owner contends Luo does not teach or suggest the recited limitations. *Id*. at 15–16 (citing Ex. 2006 ¶¶ 76–78).

Petitioner argues that the language of claim 1 is not as limiting as Patent Owner contends and that the language of claim 1 does not exclude the possibility that environmental variables, as well as physiological signals from the PPG sensor, may be used to obtain a processed, serial data output from which respiration rate can be extracted. Reply 6–7. Initially, we note that claim 1 only requires processing signals from the at least one PPG sensor via a processor into a serial data output of physiological information. Ex. 1001, 30:44–47. Contrary to Patent Owner's assertion, the claim does not require that the processed serial data output comprise respiration rate. PO Resp. 16 (citing Ex. 2006 ¶ 76). Instead, claim 1 recites only that the serial data output is configured, such that respiration rate may be *extracted* from the at least one PPG sensor's physiological information. Ex. 1001,

30:48–51. Thus, the physiological information is data, and the respiration rate is extracted from output produced from that data after processing. *See* Reply 6 (citing Ex. 1069, 30:18–33:31, 104:20–107:12, 110:4–115:6).

Luo teaches that:

> In the example of using physiological sensors for oxygen saturation detection, the red light (with 660 nm wavelengths) and infrared light (with 910 nm wavelengths) are emitted through the earlobe by light sources of sensor unit (S1) and to use optoelectronic sensors to detect the amount of light reflected back from the reflection plate, in which lights have gone through the earlobe twice by reflection. In addition to obtaining real-time blood oxygen level and plethysmographic signal, *the intelligent detection algorithm extracts heart rate, blood flow information or even sleep apnea when the subject is in sleep*.

Ex. 1055 ¶ 28 (emphasis added); *see id*. ¶ 3 ("As another example, an early detection of the sleep apnea can give an individual good opportunity to take necessary actions to prevent the serious sleep-disordered breathing problem from developing."), claims 37 and 51 ("wherein the processing module is configured to process the physiological, activity and environment variables to determine a respiratory rate and the output signal is based on the respiratory rate"). Thus, we are persuaded that Luo teaches determining respiratory rates in its specification and claims.

Moreover, Luo teaches processing information obtained from PPG sensors by its intelligent detection algorithm and because processed information may be used to extract sleep apnea information, a condition characterized by a transient cessation of breathing, i.e., a transient, zero respiration rate, during sleep. Pet. 17–18 (citing Ex. 1003 ¶¶ 67–73), 23–26 (citing Ex. 1003 ¶¶ 86–88); Reply 5–6; *see* EX. 1020, 227–28; MCGRAW HILL DICTIONARY OF SCIENTIFIC AND TECHNICAL TERMS, 109 (4th ed. 1989)

(Ex. 3004). Thus, Luo teaches determining respiratory rate, e.g., a respiratory rate of zero, by processing physiological information obtained from a sensor and outputting a signal based on the determined respiratory rate, e.g., sleep apnea detected. *See* Pet. 24–25; *see also* Ex. 1031 ¶ 55 ("Conventionally, sleep apnea detection is performed in a 'sleep laboratory' where a number of vital signs, such as EEG, blood oxygen content, *respiratory rate*, respiratory quality, and head motion, are measured during a night of sleep." (emphasis added)). Consequently, we are persuaded that the respiratory rate, e.g., a respiratory rate of zero, may be *extracted* from Lou's output signal.

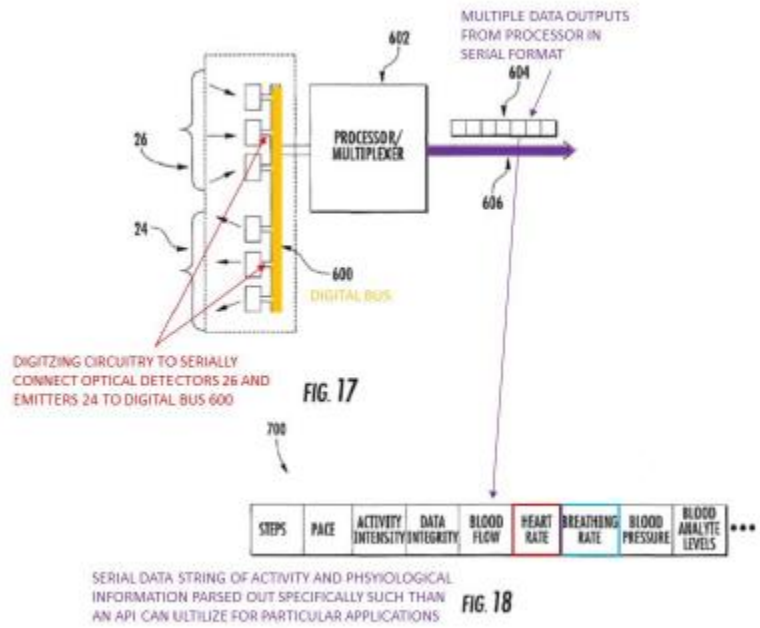
In addition, Craw addresses problems of inoperability and seamless transmission of physiological data between computing environments. Pet. 25. In particular, "Craw teaches a data structure and classification scheme for the transmission and interpretation of physiological information and related data," and "Craw suggests *serializing* data for transmission using a classification scheme to enable extraction of physiological parameters by a recipient device, e.g., for display of the information." *Id*. (emphasis added, citing Ex. 1056 ¶¶ 200–216). Therefore, Petitioner argues that the teachings of Lou and Craw teach or suggest these limitations. We agree.

iii. Allegedly Differing Treatments of Serialized Data

Patent Owner contends that "[n]either Luo nor Craw individually disclose[s] processing signals from a motion sensor and PPG sensor into a serial data output of physiological and motion-related information," and that, if either reference taught these limitations, there would be no reason to combine their teachings. PO Resp. 18. Specifically, referring to Limitations 1.4 and 1.5, Patent Owner contends that:

> When these claim terms are properly viewed in the context of the rest of the claim, it is clear that the serial data output of physiological information and motion-related information is created through *processing* signals and configured such that physiological parameters and physical activity parameters can be extracted from it. *See* [Ex. 2006] ¶¶ 79-80. The claimed method of transmitting the data from the single monitoring device to another device is not related to how the serial data output is created or what the serial data output does. *See id*. ¶ 80.

PO Resp. 18–19. Figures 17 and 18 of the '941 patent, as annotated by Patent Owner, are reproduced below.



Id. at 19–20. Figures 17 and 18 depict receipt of signals from optical detectors 26 and optical emitters 24 and transmission through digital bus 600 to processor 602, which processes those signals into multiple data outputs in serial format 604. *See* Ex. 1001, 25:65–26:14. According to Patent Owner, Figures 17 and 18 depict that the recited, serial data output of physiological and motion-related (activity) information is parsed out, so that an application specific interface ("API") can utilize the information for particular

applications. *Id*. at 20. Processor 602 creates serial data output 604, and, after this output is created, it can be transmitted to another device via output bus 606. *Id*. Patent Owner contends that, although "output bus 606 can be analogized to the USB connectivity in Luo, . . . the activity of output bus 606 occurs after the serial data output has been created by the processor." *Id*. Thus, Patent Owner contends that "simply having a USB interface as an output bus does not fulfill the requirement of processing signals into a serial data output of physiological information and motion-related information," as recited in Limitations 1.4 and 1.5 of claim 1. *Id*. at 20–21 (citing Ex. 2006 ¶ 81).

Nevertheless, as Petitioner notes, Patent Owner reliance on the disclosure of Figures 17 and 18 results in an overly narrow interpretation of the language of claim 1. Reply 12. Figures 17 and 18 depict "a block diagram that illustrates sensor signals being processed into a digital data string including activity data and physiological data" and "a digital data string," respectively, "according to *some* embodiments of the present invention." Ex. 1001, 8:4–9 (emphasis added). It is improper to import limitations suggested by these figures, which describe particular embodiments, into claim 1. Reply 12–13. Moreover, these figures disclose the specific example of "a serial data *string*" while the claim recites more generally "a serial data *output*." *Id*. at 12. Thus, we do not find that claim 1 should be limited to the embodiments of Figures 17 and 18.

Instead, we agree with Petitioner that, regardless whether the combined teachings of Luo and Craw might suggest a serial data string, Luo teaches serial transmission of the physiological and activity information, and Luo does not specify the data format, such that the requisite parameters can

be extracted. *Id*. at 13–14 (citing Pet. 24–25). "Craw, however, teaches a data formatting scheme for sending multiple physiological parameters, so that a receipt device can extract the parameters for display on a remote computing device." *Id*. at 14 (citing Pet. 19–21, 25–26). Petitioner concludes that:

> Like the '941 Patent, Craw's scheme organizes parameterized data into a serial data string. [Pet.] 19-21. A set of dictionary definitions define the particular parameters in the data string and how they are arranged. *Id*. Like Luo, the data may then be serialized into byte streams of information and transmitted via a conventional serial communications channel. *Id*.

Reply 14. We agree and are persuaded that "[i]mplementing Craw's technique to output Luo's data would have amounted to the obvious use of known signal processing technique to improve a similar physiological monitoring device." Pet. 26.

Patent Owner also contends that Luo does not teach that "the serial data output is configured such that a plurality of subject physiological parameters comprising subject heart rate and subject respiration rate *can be extracted* from the physiological information" (Ex. 1001, 30:48–51 (emphasis added)) and that "merely having *the capability to extract* or output information in a serial (as opposed to parallel) format does not meet the limitations of this claim element" (PO Resp. 21 (emphasis added)). Initially, we note that claim 1 recites a *capability* to extract information and the applied references need teach no more than such a *capability*. Moreover, Patent Owner contends that "Petitioner does not argue that Luo *processes* the data from its purported sensors to allow heart rate and respiration rate to be extracted, and acknowledges that 'Luo does not expressly state that the data output is serially formatted so that heart rate, respiration rate, and a

plurality of physical activity parameters can be extracted.'" *Id*. (quoting Pet. 24–25). Patent Owner, however, does not contest the remainder of Petitioner's assertion that "all such parameters were desirable health information as indicated by Luo. Ex. 1055 ¶¶ 10, 27-29, 45, claims 37, 51. Accordingly, configuring Luo's data output into a serial data output so that heart rate, respiration rate, and a plurality of physical activity parameters can be extracted would have been an obvious design choice. Ex. 1003 ¶¶ 86-90." Pet. 24–25. We are persuaded by Petitioner's arguments and evidence. *See supra* Section II.B.4.b.ii.

Finally, Patent Owner contends that "Craw attempts to solve an entirely different problem than the '941 patent or Luo. Craw is not concerned with *processing* sensed signals, but instead with *transmitting* data between devices, including a data structure and scheme for doing so." PO Resp. 22 (citing Ex. 2006 ¶ 82). Although Petitioner does not rely on Craw to teach or suggest processing raw signal data from a PPG sensor in order to output heart rate and respiration rate, Craw states that

> *a health care computing environment may include a variety of medical monitoring and analysis devices that process physiological data and communicate the physiological data via a network*. The physiological data may include subsets of physiological data depending upon the application. For example, subsets of physiological data may include heart rate, respiration rate, blood pressure, and many other subsets of physiological data.

Ex. 1056 ¶ 4 (emphasis added). Thus, Craw teaches processing physiological data, as well as serializing the processed data for transmission. Although "[n]on-obviousness cannot be established by attacking references individually where the rejection is based upon the teachings of a combination of references," we are persuaded that each reference relates to

the processing of physiological data, as recited in claim 1. *See In re Merck & Co., Inc.*, 800 F.2d 1091, 1097 (Fed. Cir. 1986).

iv. No Reason to Combine Teachings of Luo and Craw

Patent Owner also contends that Petitioner fails to provide a sufficient reason to combine the teachings of Luo and Craw. PO Resp. 24–26. In particular, Patent Owner contends that:

> Luo, beyond peripherally identifying a generic USB as a potential method for data extraction, is directed to a wearable system for monitoring and analyzing the health status of a user with the aid of sensors. Its purpose is to detect and monitor the health of a user in real time. Although it could be fairly described as a monitoring device, its purpose is not "communicating physiological parameters" with other devices. Although it allows the parameters to be displayed and has the capability of transmitting the parameters, a POSA would see no particular need to improve Luo by adding the functionality of Craw, which is directed to "interoperability between medical devices."

Id. at 24–25 (citations omitted); *see Heart Failure Tech. v. CardioKinetix, Inc.*, Case IPR2013-00183, slip op. at 9 (PTAB July 31, 2013) (Paper 12). However, Patent Owner provides no evidence – not even testimony by its own declarant – to support this contention. Consequently, we are persuaded that Petitioner has shown sufficient reason with supporting evidence for a person of ordinary skill in the relevant art to have combined the teachings of Luo and Craw to achieve the recited method of claim 1. *See* Pet. 25–26; Reply 14–15.

Further, Patent Owner disputes Petitioner assertion that Luo and Craw teach similar physiological monitoring devices in the same field for similar purposes of communicating physiological parameters and other related parameters. PO Resp. 25–26. In particular, Patent Owner contends that

Craw does not teach a monitoring device. *Id.* Nevertheless, as noted above, although Craw device seeks to improve interoperability of devices, those devices may relate to monitoring health conditions. For example, Craw teaches that "a health care computing environment may include a variety of *medical monitoring* and analysis *devices* that process physiological data and communicate the physiological data via a network." Ex. 1056 ¶ 4 (emphases added); *see supra* Section II.B.4.b.iii. Such physiological data may include subsets of physiological data including heart rate, respiration rate, and blood pressure. Ex. 1056 ¶ 4; *see* Ex. 1055 ¶ 28 (describing monitoring physiological data to extract "heart rate, blood flow information or even sleep apnea when the subject is in sleep"). We disagree with Patent Owner and find that both Luo and Craw teach health monitoring devices.

Accordingly, we are persuaded that Petitioner demonstrates by a preponderance of the evidence that the combined teachings of Luo and Craw would have rendered claim 1 of the '941 patent obvious.

c. Claim 2, 9, and 11–13

Petitioner argues that claims 2, 9, and 11–13 also are rendered obvious over the combined teachings of Luo and Craw and provides a detailed mapping of the limitations of these dependent claims onto the combined teachings of Luo and Craw. Pet. 26–29; *see* Ex. 1003 ¶¶ 91–97. Each of these claims depends directly or indirectly from claim 1. *See supra* Section I.C. Patent Owner does not contest this mapping, but, instead, only contends that Petitioner fails to demonstrate that the combined teachings of Luo and Craw render the dependent claims' base claim, independent claim 1, obvious, for the reasons discussed above. PO Resp. 10, 18, 24, 26, 38; *supra* Section II.B.4.; *see* Reply 21. After reviewing Petitioner's

arguments and supporting evidence regarding claims 2, 9, and 11–13, and, in particular, adopting the mapping of the limitations of these claims onto the teachings of Luo and Craw (Pet. 26–28), and finding persuasive Petitioner's arguments and evidence regarding the reasons to combine the teachings of Luo and Craw (*id*. at 25–26, 28; Reply 11–15; *see* Ex. 1003 ¶¶ 90, 98), we are persuaded that Petitioner demonstrates by a preponderance of the evidence that the combined teachings of Luo and Craw render claims 2, 9, and 11–13 of the '941 patent obvious.

d. Claims 6 and 8

Petitioner argues that claims 6 and 8 are rendered obvious over the combined teachings of Luo, Craw, and Fricke. *See supra* Section I.E. Claim 6 depends from claim 1 and recites that, prior to processing the signals for the at least one motion sensor and the signals from the at least one PPG sensor, the signals are filtered by a band-pass filter to produce pre-conditioned PPG signals and to reduce motion and noise artifacts. Ex. 1001, 31:10–18. Claim 8 depends from claim 6 and recites that a plurality of types of filtering may be applied in the method of claim 6. *Id*. at 31:21–25.

We begin our analysis of this ground of unpatentability with a review of the additional applied art.

i. Fricke (Ex. 1016)

Fricke describes a procedure for obtaining heart rate parameters and respiration rate parameters and reducing artifacts by removing frequency bands from the signals that are outside of a range of interest using a band-pass filter. Ex. 1016 ¶ 53. Fricke's Figure 3 is reproduced below.

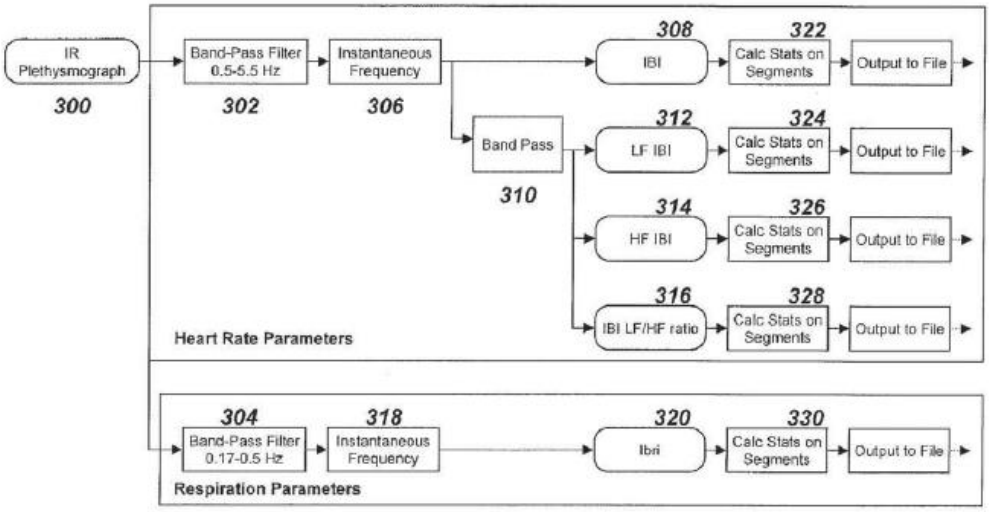


Fig. 3

Fricke's Figure 3 depicts accomplishing band-pass filtering by band-pass filters 302 and 304. *Id.* Fricke explains that, once band-pass filtering is performed on IR plethysmograph parameters signals 300, additional filtering may be performed on the pre-conditioned (i.e., filtered) signals by, for example, instantaneous frequency computation component 306 or 318. *Id.* ¶¶ 53–55, 67–78, 92. The additional filtering may include Hilbert transform (IIR, FIR), Least Mean Square ("LMS") adaptive filtering (IIR), and Kalman filtering (IIR). *Id.* ¶¶ 54, 55, 69, 92.

ii. Analysis

Petitioner relies on the combined teachings of Luo and Craw allegedly to render the base claim, claim 1, of claims 6 and 8 unpatentable and provides a detailed mapping of the additional limitations of these dependent claims onto Fricke. Pet. 32–38; *see* Ex. 1003 ¶¶ 105–110. Patent Owner does not contest this mapping, but, instead, only contends that Petitioner fails to demonstrate that the combined teachings of Luo and Craw render the dependent claims' base claim, independent claim 1, obvious, for the reasons

discussed above. PO Resp. 10, 18, 24, 26, 38; *supra* Section II.B.4.; *see* Reply 21. Moreover, Patent Owner does not contend that Petitioner has failed to demonstrate an adequate reason to combine the teachings of Luo, Craw, and Fricke to achieve the methods recited in the challenged claims. Thus, Patent Owner relies solely on its challenges to claim 1, the base claim for claims 6 and 8, to contest Petitioner's ground for the unpatentability of claims 6 and 8 as rendered obvious over Luo, Craw, and Fricke.

For the reasons set forth above, we are persuaded that Petitioner shows by a preponderance of the evidence that the combined teachings of Luo and Craw render the base claim, independent claim 1, of claims 6 and 8 obvious. *See supra* Section II.B.4. After reviewing Petitioner's arguments and supporting evidence regarding claims 6 and 8, and, in particular, adopting the mapping of the limitations of these claims onto the teachings of Luo, Craw, and Fricke (Pet. 32–37), and finding persuasive Petitioner's arguments and evidence regarding the reasons to combine the teachings of Luo, Craw, and Fricke (*id*. at 36–38; *see* Ex. 1003 ¶¶ 111–118), we are persuaded that Petitioner demonstrates by a preponderance of the evidence that the combined teachings of Luo, Craw, and Fricke render claims 6 and 8 of the '941 patent obvious.

e. Claim 7

Petitioner argues that claim 7 is rendered obvious over the combined teachings of Luo, Craw, Fricke, and Comtois. *See supra* Section I.E. Claim 7 depends from claim 6 and recites that the subject motion noise filtered in claim 6 "comprises subject footstep noise." Ex. 1001, 31:18–19.

We begin our analysis of this ground of unpatentability with a review of the additional applied art.

i. Comtois (Ex. 1032)

Comtois recognized that a primary factor limiting the accuracy of pulse oximetry is poor signal-to-noise ratio because PPG signals, from which SpO2 and heart rate (HR) measurements are derived, are compromised by movement artifacts. Ex. 1032, Abstract. Comtois teaches that "processing motion-corrupted PPG signals by least mean squares ("LMS") and recursive least squares ("RLS") algorithms can be effective to reduce SpO_2 and HR errors during jogging, but the degree of improvement depends on filter order." *Id*.

Comtois's Figure 2 depicts the analysis of data acquired during jogging experiments and shows that adaptive noise cancellation ("ANC") implemented using LMS and RLS algorithms may improve the accuracy of a pulse oximeter. *Id*. at 1530. Thus, Comtois illustrates that the performance effectiveness of wearable physiological monitoring devices may be improved by applying algorithms to reduce limitations imposed by footstep-related motion (e.g., jogging) artifacts. *Id*. at 1531.

ii. Analysis

Petitioner relies on the combined teachings of Luo and Craw to render the base claim, claim 1, of claim 7 unpatentable and the combined teachings of Luo, Craw, and Fricke to render intervening claim 6 unpatentable. *See supra* Section II.B.4.b. and d. Petitioner provides a detailed mapping of the additional limitations of dependent claim 7 onto Comtois. Pet. 38–42; *see* Ex. 1003 ¶¶ 119–123. Patent Owner does not contest this mapping, but, instead, only contends that Petitioner fails to demonstrate that the combined teachings of Luo and Craw render the dependent claims' base claim,

independent claim 1, obvious, for the reasons discussed above. PO Resp. 10, 18, 24, 26, 38; *supra* Section II.B.4.; *see* Reply 21. Moreover, Patent Owner does not contend that Petitioner has failed to demonstrate an adequate reason to combine the teachings of Luo, Craw, Fricke, and Comtois to achieve the methods recited in the challenged claim. Thus, Patent Owner relies solely on its challenges to claim 1, the base claim for claim 7, to contest Petitioner's ground for the unpatentability of claim 7 as rendered obvious over Luo, Craw, Fricke, and Comtois.

For the reasons set forth above, we are persuaded that Petitioner shows by a preponderance of the evidence that the combined teachings of Luo and Craw render the base claim, independent claim 1, of claim 7 obvious and that the combined teachings of Luo, Craw, and Fricke render intervening claim, claim 6, of claim 7 obvious. *See supra* Section II.B.4.b. and d. After reviewing Petitioner's arguments and supporting evidence regarding claim 7, and, in particular, adopting the mapping of the limitations of this claim onto the teachings of Luo, Craw, Fricke, and Comtois (Pet. 38–41) and finding persuasive Petitioner's arguments and evidence regarding the reasons to combine the teachings of Luo, Craw, Fricke, and Comtois (*id.* at 42; *see* Ex. 1003 ¶ 124), we are persuaded that Petitioner demonstrates by a preponderance of the evidence that the combined teachings of Luo, Craw, Fricke, and Comtois render claim 7 of the '941 patent obvious.

f. Claim 10

Petitioner argues that claim 10 is rendered obvious over the combined teachings of Luo, Craw, and Aceti. *See supra* Section I.E. Claim 10 depends from claim 1 and recites that "the at least one PPG sensor comprises

at least one optical emitter, at least one optical detector, and at least one light guide." Ex. 1001, 31:30–32.

We begin our analysis of this ground of unpatentability with a review of the additional applied art.

i. Aceti (Ex. 1031)

Similar to Luo's teachings, Aceti teaches a pulse oximetry sensor (i.e., a PPG sensor) including an optical emitter and optical detector for sensing physiological information. Ex. 1031 ¶ 27. In particular, like Luo, Aceti teaches a health monitoring device configured for positioning around a subject's ear. *See id*., Figs. 1 and 2. Aceti's Figure 4 is reproduced below.

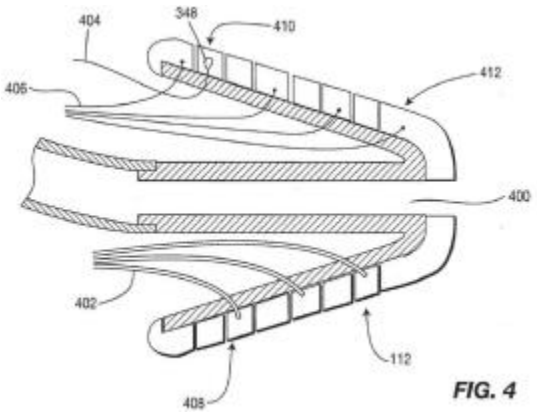


Figure 4 depicts a section of first end 112 of conductor portion 104. *Id*. ¶¶ 22, 33. Fiber optic cables 402 terminate in optically transparent elastomer 408 of first end 112 to allow the communication of light between fiber optic cable 402 and the tissue of the auditory canal wall. *Id*. ¶ 33.

ii. Analysis

Petitioner relies on the combined teachings of Luo and Craw to render the base claim, claim 1, of claim 10 unpatentable. *See supra*

Section II.B.4.b. Petitioner further provides a detailed mapping of the additional limitations of claim 10 onto Aceti. Pet. 42–44; *see* Ex. 1003 ¶¶ 125–127. Patent Owner does not contest this mapping, but, instead, only contends that Petitioner fails to demonstrate that the combined teachings of Luo and Craw render the dependent claim's base claim, independent claim 1, obvious, for the reasons discussed above. PO Resp. 10, 18, 24, 26, 38; *supra* Section II.B.4.; *see* Reply 21. Moreover, Patent Owner does not contend that Petitioner has failed to demonstrate an adequate reason to combine the teachings of Luo, Craw, and Aceti to achieve the methods recited in the challenged claim.[12] Thus, Patent Owner relies solely on its challenges to claim 1, the base claim for claim 10, to contest Petitioner's ground for the unpatentability of claim 10 as rendered obvious over Luo, Craw, and Aceti.

For the reasons set forth above, we are persuaded that Petitioner shows by a preponderance of the evidence that the combined teachings of Luo and Craw render the base claim, independent claim 1, of claim 10 obvious. *See supra* Section II.B.4. After reviewing Petitioner's arguments and supporting evidence regarding claim 10, and, in particular, adopting the mapping of the limitations of these claims onto the teachings of Luo, Craw, and Aceti (Pet. 42–44) and finding persuasive Petitioner's arguments and evidence regarding the reasons to combine the teachings of Luo, Craw, and Fricke (*id*. at 44; *see* Ex. 1003 ¶¶ 128–129), we are persuaded that Petitioner

[12] Patent Owner challenged Petitioner's reasons for combining the teachings of these references in its Preliminary Response, but did not maintain those arguments in its Patent Owner Response. *See* Inst. Dec. 36. Arguments for patentability not raised in the Patent Owner Response are deemed waived. Paper 11, 3.

demonstrates by a preponderance of the evidence that the combined teachings of Luo, Craw, and Aceti render claim 10 of the '941 patent obvious.

iii. Summary

For the reasons set forth above, we are persuaded that Petitioner demonstrates by a preponderance of the evidence that claims 1, 2, and 6–13 of the '941 patent are unpatentable as obvious over Luo and Craw, alone or in combination with other references.

C. Obviousness over Mault and Al-Ali, Alone or in Combination with Other References

1. Overview

Petitioner argues that claims 1, 2, and 6–13 are unpatentable under 35 U.S.C. § 103(a) as obvious over Mault and Al-Ali, alone or in combination with another reference. *See supra* Section I.E. Because of the deficiencies in Petitioner's arguments noted above, we do not consider Petitioner's challenges to claims 3–5 further. *See supra* Section II.A.2. and 3. To support its argument, Petitioner provides a detailed mapping of limitations of claims 1, 2, and 6–13 to structures taught or suggested by Mault and Al-Ali alone or by Mault and Al-Ali and an additional reference.

Pet. 45–68. Petitioner also cites Dr. Sarrafzadeh's Declaration for support. *See* Ex. 1003 ¶¶ 130–156, 169–184.

We begin our analysis of these grounds of unpatentability with a review of the applied art.

2. Mault (Ex. 1057)

Mault describes a diet and activity-monitoring device that monitors body activity and outputs a signal indicative of body activity, including heart rate and respiration rate. Ex. 1057, 3:9–62, 10:56–59, 11:60–64, Figs. 4 and 5. For example, a wristwatch-style monitoring device may include a motion sensor, such as a single or multi-axis accelerometer. *Id*. at 3:63–66. From this physical activity information, the type of activity being performed, the duration of the activity, and the intensity of the activity may be determined. *Id*. at 17:16–36. For example, signals produced by running or walking may be measured by the motion sensor, which are indicative of the respective activity. *Id*. at 17:18–36.

Mault teaches that its monitoring device may include other sensors. *See id*. at 11:60–61, Fig. 4. Mault's Figure 4 is reproduced below with our annotations.

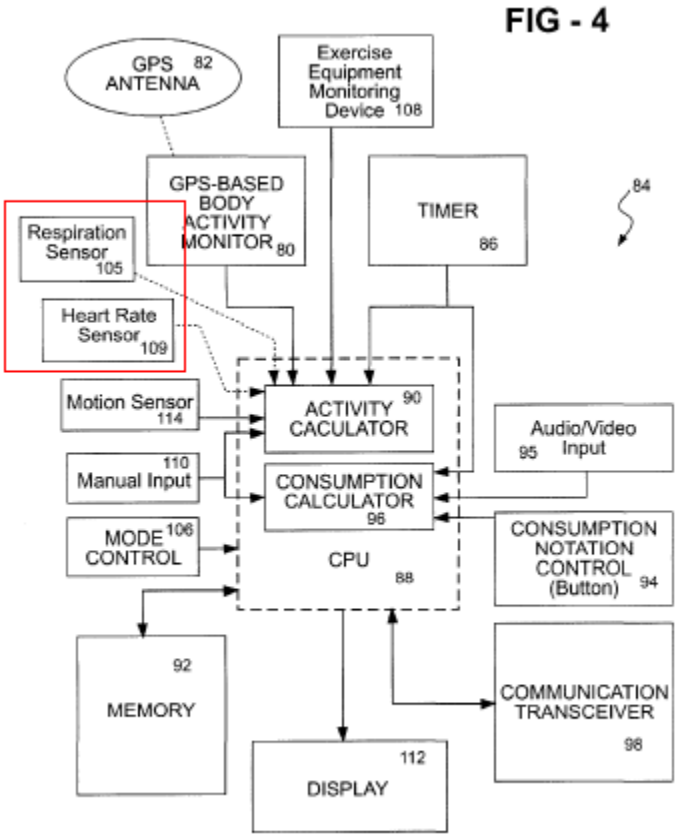


Figure 4 depicts a schematic diagram for monitoring device 84 including respiration sensor 105, heart rate sensor 109, and motion sensor 114. *Id*. at 10:56–59, 11:59–12:11. With regard to measuring activity, Mault teaches various respiration sensors, such as a "chest strap," "ultrasonic sensing . . . to measure expansion and contraction of a subject's chest," and a "flow meter or indirect calorimeter that the subject breathes through. *Other types of respiration sensors may also be used*." *Id*. at 11:60–12:11 (emphasis added); *see id*. at 11:64–66 ("Therefore, monitoring a subject's respiration provides additional data useful in determining activity level."), 20:14–16 (body activity monitor comprising a respiration sensor). With respect to a wrist-mountable device, Mault further teaches that, for sensors such as the heat rate sensor 78, as depicted in Mault's Figure 3B:

> One preferred approach is *photoplethysmography* [(PPG)] where an infrared light source and corresponding sensor measure infrared light either reflected from or transmitted through the wrists or other body part of the user. Other approaches such as pneumatic plethysmography, impedance cardiography, phonocardiography or electrocardiography may be used.

Id. at 8:35–41 (emphasis added).

3. Al-Ali (Ex. 1058)

Al-Ali teaches "a communications adapter that is plug-compatible both with existing sensors and monitors and that implements a wireless link replacement for the patient cable." Ex. 1058 ¶ 4. Al-Ali's Figure 13 is reproduced below with our annotations.

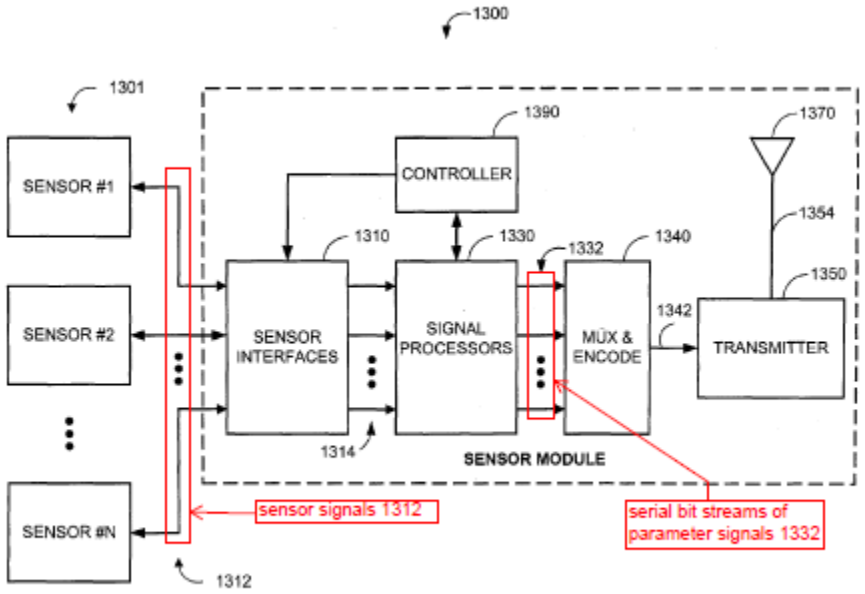


FIG. 13

Al-Ali's Figure 13 depicts multiple parameter sensor module 1300 having sensor interfaces 1310, one or more signal processors 1330, multiplexer and encoder 1340, transmitter 1350, transmitting antenna 1370, and a controller 1390. *Id*. ¶ 62. One or more physiological sensors 1301 provides input sensor signals 1312 (e.g., PPG signals) to sensor module 1300. *Id*. ¶¶ 55,

62; *see id*. ¶ 3 (describing sensors operating at red and infrared wavelengths). For example, parameter signals 1332 may be "physiological measurements such as oxygen saturation, pulse rate, blood glucose, blood pressure, EKG, respiration rate and body temperature to name a few, or may be intermediate results from which the above-stated measurements." *See id*. ¶ 63. Sensor interfaces 1310 receive sensor signals 1312 and output one or more conditioned signals 1314. *Id*. ¶ 62. Conditioned signals 1314 further are processed by signal processors 1330 (via digital filtering, adaptive filtering, etc.). *Id*. ¶¶ 40, 62. In particular, "the sensor interface is operable on the sensor signal to provide a plethysmograph signal output, where the first baseband signal is responsive to the plethysmograph signal." *Id*. ¶ 7; *see id*. ¶ 54 ("In another embodiment, the sensor module 1000 incorporates a decimation processor, not shown, after the sensor interface 1010 so as to provide a plethysmograph signal 1014 having a reduced sample rate."). Sensor module 1300 derives multiple serial bit streams of parameter signals 1332 responsive to sensor signals 1312, which then are coupled to transmitter 1350. *Id*. ¶ 62.

4. Analysis

a. Mapping of Claim 1 onto Teachings of Mault and Al-Ali

As noted above, independent claim 1 recites a method of generating data output containing physiological and motion-related information. Ex. 1001, 30:35–36. Petitioner provides a detailed mapping of the limitations of claim 1 on the teachings of Mault. Pet. 49–53. In particular, Petitioner argues that Mault teaches a method of generating health information derived from physiological information and physical activity information. *Id*. at 49 (citing Ex. 1057, 3:36–4:5, 4:36–47, 9:13–29, 11:48–

12:49); *see* Ex. 1003 ¶ 140. Referring to Mault's Figure 4, Petitioner further argues that Mault teaches sensing physical activity and physiological information by means of a single monitoring device, such as Mault's monitoring device 84, which is attached to the subject. Pet. 49 (citing Ex. 1057, 7:1–22, 7:45–60, Figs. 1–4); Reply 18–19; *see* Ex. 1003 ¶ 141. Further, Mault states that "various components of a monitoring device according to the present invention may be housed within a single housing, or may include multiple discrete components." Ex. 1057, 7:46–56.

With respect to the sensors recited in claim 1, Petitioner argues that both types of recited sensors are taught by Mault. First, Petitioner argues that Mault's motion sensors 114 and 140 for sensing body movement teach the recited, "*at least one* motion sensor." Pet. 49 (emphasis added, citing Ex. 1057, 3:63–4:13, 7:16–22, 17:13–54, Figs. 4 and 6); *see* Ex. 1003 ¶ 142. In particular, Mault's Figure 4, reproduced above, depicts motion sensor 114. *See* Ex. 1057, 11:56–60. Second, Petitioner argues that Mault's physiological sensors 78, 109, and 138 teach the recited, "at least one photoplethysmography (PPG) sensor for sensing the physiological information." Pet. 50 (citing Ex. 1057, 8:31–39); *see* Ex. 1003 ¶ 143. Mault expressly discloses that a preferred embodiment of its physiological sensors utilizes photoplethysmography, and, thus, Mault's physiological sensors may be PPG sensors. Ex. 1057, 8:31–39. Moreover, Mault teaches that its physiological sensors may retrieve physiological information, including heart and respiratory rates, as recited in claim 1. *See id*. at 10:56–59 (heart rate), 11:60–63 (respiration rate).

Petitioner also argues that Mault's monitoring device teaches the processing of signals from the at least one motion sensor and the at least one

PPG sensor "via a processor of the monitoring device into a serial data output of physiological information and motion-related information." Pet. 50–51 (citing Ex. 1057, 5:44–49, 6:34–65, 7:46–8:10, 9:21–24, 16:11–25); *see* Ex. 1003 ¶ 144. In particular, Mault teaches processing signals via CPU 30 or 88. Ex. 1057, 7:56–58, Fig. 2 (depicting CPU 30), 4 (depicting CPU 88); *see* Pet. 50; Ex. 1003 ¶ 144.

Finally, Petitioner acknowledges that "[t]hough Mault does not expressly disclose processing the signals into a serial data output of multi-parameter information, Al-Ali teaches such processing." Pet. 50. In particular, Petitioner argues that Al-Ali teaches processing "signals (i.e., conditioned sensor signals 1314 from multiple physiological sensors 1301) via a processor (i.e., signal processor 1330) of a monitoring device into a serial data output (i.e., a serial bit stream of parameter signals 1332) of multi-parameter physiological information (such as heart rate and respiration rate)." *Id*. at 50–51 (citing Ex. 1058, ¶¶ 38–42, 61–65, Figs. 6 and 13); *see* Ex. 1003 ¶ 145. Moreover, Al-Ali teaches that these processed signals may provide a plethysmograph signal output. Ex. 1058 ¶¶ 7, 54. Thus, Petitioner argues that "[t]hough Mault is silent as to the particular format of the data output, as noted above, Al-Ali teaches configuring the serial data output such that a plurality of parameters can be extracted." Pet. 52–53 (citing Ex. 1003 ¶ 150).

Petitioner further argues that a person of ordinary skill in the relevant art would have had reason to combine the teachings of Mault and Al-Ali to achieve the method recited in claim 1. In particular, Petitioner argues that

> in choosing an appropriate format for the data output of Mault's monitoring device, a POSA would [have] looked to known data format solutions such as the solution taught by Al-Ali. Ex. 1003,

> ¶147. The transmission of multi-parameter measurements is particularly relevant to the problem of transmitting Mault's physiological and motion-related parameters. *Id*. Indeed, like Mault, Al-Ali teaches the determination of multiple physiological parameters, such as heart rate and respiration rate. *Id*. And like the '941 Patent, Al-Ali teaches processing sensor signals to determine parameters, serializing that parameter information, and feeding the combined information to a multiplexer for transmission. [*Id.*] Accordingly, it would have been obvious to combine the teachings of Mault and Al-Ali to process signals from Mault's motion sensor and PPG sensor into a serial data output, as a POSA would have been capable of implementing the known processing technique of Al-Ali with the known device of Mault and the results would have been predictable. *Id*. at ¶ 148.

Pet. 51–52. Further, Petitioner argues that:

> The transmission of data had two basic modes: serial and parallel. It was well within the knowledge of a POSA that the format of data was chosen depending of the choice of transmission mode. Both serial (i.e., sequential on a single channel) and parallel (i.e., simultaneous on different channels) transmission systems were well-known, predictable solutions in the art. Thus, it would have been *obvious to try* a serial data format because of the small number of potential solutions.

Id. at 51 (emphasis added, citations omitted, citing Ex. 1003 ¶ 146).

Finally, because both Mault and Al-Ali are directed to physiological monitoring devices and to the extraction and communication of physiological and activity related information from subjects (*see* Reply 16), a person of ordinary skill in the relevant art "would have recognized that the serial processing technique utilized by Al-Ali for physiological parameters was equally applicable in the same way to the serial processing technique for motion-related parameters." *Id*. at 53 (citing Ex. 1003 ¶ 151). Petitioner argues that "[s]uch a combination would have amounted to the application of

a known processing technique to the known device of Mault, and would have predictably resulted in a data structure that allows for easy extraction of information by a local or remote computing device." *Id*.

b. Patent Owner's Contentions

Patent Owner contends that Petitioner fails to demonstrate that the combined teachings of Mault and Al-Ali render the method of challenged claim 1 obvious for five main reasons. *See* PO Resp. 26–37. First, Patent Owner contends that Mault and Al-Ali describe entirely different technologies which are directed to the solution of different problems. *Id*. at 26–28. Second, Patent Owner contends that neither Mault nor Al-Ali teaches a single monitoring device capable of sensing both heart rate and respiration rate data. *Id*. at 28–30. Third, Patent Owner contends that neither Mault nor Al-Ali teaches a PPG sensor capable of having its signals processed to produce a serial data output from which respiration rate can be extracted. *Id*. at 30–32. Fourth, Patent Owner contends that neither Mault nor Al-Ali teaches the recited step of "processing signals from the at least one motion sensor and signals from the at least one PPG sensor via a processor of the monitoring device into a serial data output of physiological information and motion-related information." *Id*. at 33–36. Finally, Patent Owner contends that a person of ordinary skill in the relevant art would not have had reason to combine the teachings of Mault and Al-Ali to achieve the recited methods. *Id*. at 36–37. We address each of these contentions in turn.

i. Different Technology and Problems

Patent Owner contends that Mault and Al-Ali relate to different technologies and attempt to solve the different problems. *Id*. at 26–28. In

particular, Patent Owner contends that Mault seeks to "improve[] on the prior art by providing a combination diet and activity monitoring device for monitoring both the consumption and activity of the subject." Ex. 1057, 3:9–11. Using a motion sensor, such as motion sensor 114 depicted in Mault's Figure 4, Mault may determine parameters such as the type of activity performed, the duration of activity, and the intensity of activity. *Id.* at 17:16–36. For example, Mault teaches a wristwatch-style device, which may include a PPG sensor and an accelerometer to determine heart rate. *Id.* at 7:16–18, 8:9–41.

Patent Owner further contends that Mault also teaches a "respiration sensor" that helps to determine activity level, but is disposed *separate* from the PPG sensor and wristwatch-style device. PO Resp. 27 (citing Ex. 1057, 11:60–12:11. Patent Owner explains that, although Mault explicitly discloses a number of embodiments of the "respiration sensor," such as a "chest strap," "ultrasonic sensing . . . to measure expansion and contraction of a subject's chest," and a "flow meter or indirect calorimeter that the subject breathes through," none of Mault's "respiration sensors" can be considered a PPG sensor or is housed with a PPG sensor. *Id.*

Contrary to Patent Owner's contentions, however, Mault teaches that "[o]ther types of respiration sensors may also be used." Ex. 1057, 12:11. The use of PPG sensors to measure respiratory rate was known in the art as of the effective filing date of the '941 patent. *E.g.*, Ex. 1016 ¶¶ 5, 40; Ex. 1021, R6; Ex. 1037, 5:5–9; Ex. 1038, 11:44–48; *see* Pet. 1 ("By 2009, the earliest claimed priority date, PPG technology was widely available and was established as a simple, low-cost, readily-portable choice for both clinical and nonclinical physiological measurements."; citing Ex. 1003

¶ 26); *see also Genzyme Therapeutic Prods. Ltd. P'ship v. Biomarin Pharm. Inc.*, 825 F.3d 1360, 1369 (Fed. Cir. 2016) ("This court has made clear that the Board may consider a prior art reference to show the state of the art at the time of the invention, regardless of whether that reference was cited in the Board's institution decision.").

Referring to Mault's Figure 4, reproduced above, Mault discloses "a schematic of another embodiment of a monitoring device according to the present invention," having respiration senor 105, heart rate sensor 109, and motion sensor 114. Mault explains that "the various components of a monitoring device according to the present invention may be housed within a single housing, or may include multiple discrete components." Ex. 1057, 7:48–51; *see* Reply 16–17. Thus, we are persuaded that Mault teaches that the respiration sensor need not be separate from the other sensors, even if, in specific embodiments, the respiration sensor may be separate.

Patent Owner also contends that "Al-Ali seeks to allow traditional medical sensors to communicate wirelessly with their monitors, so that patients will not be tethered by a cable connecting the sensor to the monitor." PO Resp. 27 (citing Ex. 2006 ¶ 55). Al-Ali specifically describes such sensors as including sensors generating a plethysmographic signal. *Id*. ¶¶ 7, 54. Moreover, referring to Figure 13, reproduced above, Al-Ali teaches that sensor module 1300 derives multiple serial bit streams of parameter signals 1332 responsive to sensor signals 1312, which then are coupled to transmitter 1350. *Id*. ¶ 62. As noted above, parameter signals 1332 may be "physiological measurements such as oxygen saturation, pulse rate, blood glucose, blood pressure, EKG, respiration rate and body

temperature to name a few, or may be intermediate results from which the above-stated measurements." *See id*. ¶ 63.

Both Mault and Al-Ali relate to devices for monitoring physiological parameters and to measuring such parameters with plethysmographic sensors. Ex. 1057, 8:9–41; Ex. 1058 ¶¶ 7, 54. Further, both Mault and Al-Ali relate to devices which process plethysmographic signals for transmission to other devices. Ex. 1057, 5:44–49, Fig. 9; Ex. 1058 ¶¶ 4, 26, Fig. 3; *see also* PO Resp. 37 ("Al-Ali would not have solved any problem presented by Mault, because Mault already contemplated both wired and wireless versions of its invention, and the specification did not prefer one over the other."). Thus, we are persuaded that Mault and Al-Ali teach sufficiently similar technologies directed to solving sufficiently similar problems.

ii. No Single Monitoring Device Sensing Heart and Respiration Rate Data

Patent Owner contends that the language of claim 1 requires that "a single monitoring device [is] capable of sensing both heart rate and respiration rate." PO Resp. 28 (citing Ex. 1001, 30:38–43 ("sensing physical activity and physiological information from a subject via a single monitoring device attached to the subject")). Patent Owner further contends that, although Mault may disclose that the PPG sensor senses physiological information from which heart rate can be extracted, Mault teaches respiration sensors that are separate from the device containing the heart rate sensor. *Id*. at 28–29 (citing Ex. 1057, 11:60–12:11). Nevertheless, as discussed above, Mault is not limited to the embodiments showing separate respiration sensors. Other types of respiration sensors, including PPG

sensors, were known as of the effective filing date of the '941 patent (*see supra* Section II.C.4.b.i.), and Mault expressly teaches that the sensors may be housed in a single device (Ex. 1057, 7:48–51; *see id.*, Fig. 4). Consequently, we are persuaded that a person of ordinary skill at the effective filing date of the '941 patent would have understood the combined teachings of Mault and Al-Ali to teach or suggest a single monitoring device containing sensors capable of sensing both heart rate and respiration rate data. *See* Ex. 1003 ¶ 141.

iii. No PPG Sensor Capable of Having Signals Processed to Produce Serial Data Output From Which Respiration Rate Can Be Extracted

Patent Owner contends that Petitioner argues that Mault, not Al-Ali, teaches "the at least one [] PPG sensor for sensing the physiological information," as recited in claim 1. PO Resp. 30 (citing Pet. 50). Consequently, Petitioner's basis for its argument that this limitation reads on Mault is that Mault teaches a PPG sensor is located in the monitoring device for "sensing a PPG signal to determine a heart rate." *Id*. at 30–31. Patent Owner contends, however, that, according to claim 1, one or more PPG sensors must be solely responsible for sensing "the physiological information" that is processed into a serial data output such that "a plurality of subject physiological parameters comprising subject heart rate and subject respiration rate can be extracted from the physiological information." *Id*. at 31 (citing Ex. 1001, 30:35–54). Therefore, Patent Owner contends that "Mault does not teach[] a PPG sensor capable of sensing signals that can be processed into a serial data string from which respiration rate can be extracted." *Id*. at 32 (citing Ex. 2006 ¶ 92). We disagree.

Initially, we note that, although Petitioner does not rely on Al-Ali to teach the "at least one PPG sensor" limitation of claim 1, we are persuaded that Al-Ali teaches such sensors. Ex. 1058 ¶¶ 7, 54. Nevertheless, as noted above, Mault teaches that various types of respiration sensors may be used in its monitoring device (*see* Ex. 1057, 12:11), and, as the record makes clear, PPG sensors were known to be used to obtain respiration rates (*see, e.g.*, Ex. 1016 ¶¶ 5, 40; Ex. 1021, R6; Ex. 1037, 5:5–9; Ex. 1038, 11:44–48). *See* Ex. 1003 ¶¶ 26–33. Thus, we are persuaded that a person of ordinary skill in the relevant art would have understood Mault's teaching to encompass the use of PPG sensors to obtain heart rate data and various respiration sensors within and separate from the monitoring device's housing (Ex. 1057, 7:47–51), including suitable PPG sensors, to obtain respiration rate data. Pet. 52–53; *see* Ex. 1003 ¶ 149 (citing Ex. 1057, 11:60–12:11, Fig. 4).

In addition, although Petitioner and its declarant acknowledge that "Mault does not expressly disclose processing the signals into a serial data output of multi-parameter information, [they assert that] Al-Ali teaches such processing." Pet. 50; *see* Ex. 1003 ¶ 150 ("Mault does not describe the particular format of the data output, Al-Ali teaches configuring the serial data output such that a plurality of parameters can be extracted."); *see* PO Resp. 32. In particular, Petitioner argues that:

> Al-Ali discloses a physiological measurement system that processes signals (*i.e.*, conditioned sensor signals 1314 from multiple physiological sensors 1301) via a processor (*i.e.*, signal processor 1330) of a monitoring device into a serial data output (*i.e.*, a serial bit stream of parameter signals 1332) of multi-parameter physiological information (such as heart rate and respiration rate). Ex. 1058, ¶¶0038-0042, 0061-0065, figs. 6, 13; Ex. 1003, ¶145. Thus, Al-Ali teaches a known processing

> technique for configuring the output data of sensed physiological information into serial format. *Id*.

Pet. 50–51. We agree that Al-Ali teaches a known technique for processing data such as that generated by Mault's at least one PPG sensors.

iv. No Teaching of Step of "Processing Signals"

Patent Owner contends that:

> Neither Mault nor Al-Ali individually, nor a combination of the two, discloses or renders obvious the creation of physiological information and motion-related information outputted in a serial data format by a single monitoring device, where physiological information and motion-related information results from the processing of signals gathered from the at least one PPG sensor and at least one motion sensor.

PO Resp. 33; *see* Ex. 2006 ¶ 94. Specifically, Patent Owner contends that "Petitioner merely alleges that Mault teaches generally processing signals from a motion sensor and that Al-Ali teaches processing physiological signals into a serial data output of multi-parameter physiological information." PO Resp. 33 (citing Pet. 50–51). Patent Owner, however, mischaracterizes Petitioner's arguments.

As noted above, Petitioner argues that Mault teaches a monitoring device includes a PPG sensor, i.e., a heart rate sensor, for sensing a PPG signal to determine a heart rate (Pet. 50 (citing Ex. 1057, 8:31–39; Ex. 1003, ¶ 143)) and that Mault teaches that the monitoring device also determines a plurality of other subject physiological parameters, including subject respiration rate (*id.* at 52 (citing Ex. 1057, 11:60–12:11, Fig. 4; Ex. 1003, ¶ 149)). Further, Petitioner argues that Mault discloses processing signals via a processor, i.e., CPU 30 or 88, from the motion sensor, i.e., the accelerometer, to determine motion of the monitoring device, and, hence,

motion of the subject over a period of time. *Id*. at 51 (citing Ex. 1057, 3:63–4:47, 7:16–22, 7:46–8:10, 17:13–54; Ex. 1003 ¶ 144). Thus, Petitioner argues that Mault teaches the at least one PPG sensors for obtaining physiological information, from which, after processing, heart rate and respiration rate may be extracted, and at least one motion sensor for obtaining motion-related information.

Again, as noted above, Petitioner acknowledges that Mault does not expressly teach processing to obtain serial data output. I*d*. at 50. Contrary to Patent Owner's contention, we find that Petitioner argues persuasively that "Al-Ali discloses processing signals from both a motion sensor and a PPG sensor into a serial data output of physiological and motion-related information." PO Resp. 34; *see* Ex. 2006 ¶ 94. As Patent Owner notes, Petitioner argues that:

> Al-Ali discloses a physiological measurement system that processes signals (i.e., conditioned sensor signals 1314 from multiple physiological sensors 1301) via a processor (i.e., signal processor 1330) of a monitoring device into a serial data output (i.e., a serial bit stream of parameter signals 1332) of multi-parameter physiological information (such as heart rate and respiration rate).

Pet. 50–51. Petitioner also argue, however, that:

> Mault also teaches that the monitoring device determines a plurality of subject physical activity parameters, such as intensity and type of activity. Ex. 1057, 17:13-36; Ex. 1003, ¶149. *These physiological and physical activity parameters are output to a local or remote computing device (for example, to determine activity level, caloric expenditure, and other information). Id.* Though Mault is silent as to the particular format of the data output, as noted above, Al-Ali teaches configuring the serial data output such that a plurality of parameters can be extracted. Ex. 1003, ¶150.

Pet. 52. Consequently, we are persuaded that Petitioner has shown how the combined teachings of Mault and Al-Ali teach or suggest all of the limitations of challenged claim 1. *But see* PO Resp. 35–36.

v. No Reason to Combine Teachings of Mault and Al-Ali

Finally, Patent Owner contends that "Mault is directed to a device that monitors the diet and activity of a person" (Ex. 2006 ¶ 95) but "Al-Ali is merely directed to a modulation technique that allows for information to be wirelessly transmitted between a sensor and a monitor" (*id*.). PO Resp. 36. We disagree and note that both Mault and Al-Ali are directed to devices for obtaining and processing physiological information. *See* Ex. 1057, Fig. 4; Ex. 1058 ¶¶ 7, 54, 63; *see* Ex. 1003 ¶ 139.

Patent Owner further contends that Mault's "method and system already expressly contemplate wireless transmission of the data." PO Resp. 36 (citing Ex. 1057, 6:38–45). Thus, Patent Owner concludes that "Al-Ali would not have solved any problem presented by Mault, because Mault already contemplated both wired and wireless versions of its invention, and the specification did not prefer one over the other." *Id*. at 37 (citing Ex. 2006 ¶ 97). We note, however, that Petitioner does not argue that a person of ordinary skill in the relevant art would combine these references because of their teachings regarding transmission methods (Reply 20), but, rather, because both teach the processing of data and a person of ordinary skill in the relevant art would have recognized the advantages of Al-Ali's teachings of serial processing of data from multiple sensors and would have had reason to apply them to the processing teachings of Mault. Pet. 53 (citing Ex. 1003 ¶¶ 150–151). Thus, we are persuaded that Petitioner has shown that a person of ordinary skill in the relevant art would have had

reason to combine the teachings of Mault and Al-Ali to achieve the device recited in challenged claim 1.

Accordingly, we are persuaded that Petitioner demonstrates by a preponderance of the evidence that the combined teachings of Mault and Al-Ali would have rendered claim 1 of the '941 patent obvious.

c. Claims 2, 9, 11, and 12

Petitioner argues that claims 2, 9, 11, and 12 also are rendered obvious over the combined teachings of Mault and Al-Ali and provides a detailed mapping of the limitations of these dependent claims onto the combined teachings of Mault and Al-Ali. Pet. 54–55; *see* Ex. 1003 ¶¶ 152–156. Each of these claims depends directly or indirectly from claim 1. *See* supra Section I.C. Patent Owner does not contest this mapping, but, instead, only contends that Petitioner fails to demonstrate that the combined teachings of Mault and Al-Ali render the dependent claims' base claim, independent claim 1, obvious, for the reasons discussed above. PO Resp. 26, 30, 38; *supra* Section II.C.4.; *see* Reply 21. After reviewing Petitioner's arguments and supporting evidence regarding claims 2, 9, 11, and 12, and, in particular, adopting the mapping of the limitations of these claims onto the teachings of Mault and Al-Ali (Pet. 54–55), and finding persuasive Petitioner's arguments and evidence regarding the reasons to combine the teachings of Mault and Al-Ali (*id.* at 53; Reply 19–20; *see* Ex. 1003 ¶¶ 146–148), we are persuaded that Petitioner demonstrates by a preponderance of the evidence that the combined teachings of Mault and Al-Ali render claims 2, 9, 11, and 12 of the '941 patent obvious.

d. Claims 6–8

Petitioner argues that claims 6–8 are rendered obvious over the combined teachings of Mault, Al-Ali, and Han. *See supra* Section I.E. Claim 6 depends from claim 1 and recites that, prior to processing the signals for the at least one motion sensor and the signals from the at least one PPG sensor, the signals are filtered by a band-pass filter to reduce motion and noise artifacts. Ex. 1001, 31:10–18. Claim 7 depends from claim 6 and recites that "the subject motion noise comprises subject footstep noise." *Id*. at 31:18–19. Claim 8 depends from claim 6 and recites that a plurality of types of filtering which may be applied in the method of claim 6. *Id*. at 31:20–24.

We begin our analysis of this ground of unpatentability with a review of the additional applied art.

i. Han (Ex. 1025)

Han teaches "a real-time, wearable and motion artifact reduced health monitoring device." Ex. 1025, Abstract, Fig. 1. The wearable device includes a "photoplethysmography (PPG) sensor, 3-axis accelerometer, microprocessor and wireless module." *Id*. Han's PPG sensor may operate in the infrared wavelengths. *Id*. at 1582. Motion artifacts, such as those created by finger movements, may cause the PPG sensor to acquire distorted heart beat signals. *Id*., Abstract. Han teaches the use of active noise cancellation, whereby a motion sensor obtains body movement information and an active noise cancellation algorithm having an adaptive filter removes motion noises. *Id*.

Han's processor conducts pre-processing on the raw PPG signal. *Id.* at 1582. "The raw signal demands a low pass filter for reducing high frequency noise and [a] high pass filter for rejecting a DC component [of the PPG signal] to enhance the AC component. . . . The filters are designed as a 0.5–3 Hz band pass filter, and totally fourth order analog active filter and digital filter are used in this signal processing." *Id.* Han further teaches that Normalized Least Mean Square (NLMS) adaptive filters may be used due to their fast processing speeds and low order filter coefficients. *Id.*

Han's Figure 3 is reproduced below.

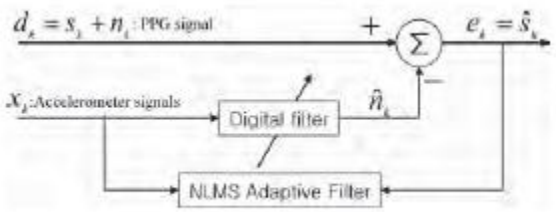


Fig. 3. Block diagram of the active noise cancellation algorithm

Figure 3 depicts

> a block diagram of an active noise cancellation algorithm, which reconstructs a raw pulsation signal (s_k) from the corrupted signal (d_k), using measurable noise signal (x_k). Here, PPG and body motion data correspond to d_k and x_k respectively. This research predominantly used 3-axis accelerometer signals (x_k) for body motion data (n_k).

Id. Such active noise cancellation algorithm techniques may remove artifacts produced by movements, such as walking and running. *Id.* at 1584, Table 2.

ii. Analysis

Petitioner relies on the combined teachings of Mault and Al-Ali allegedly to render the base claim, claim 1, of claims 6–8 unpatentable and provides a detailed mapping of the additional limitations of these dependent claims onto Han. Pet. 61–64; *see* Ex. 1003 ¶¶ 169–174. Patent Owner does

not contest this mapping, but, instead, only contends that Petitioner fails to demonstrate that the combined teachings of Mault and Al-Ali render the dependent claims' base claim, independent claim 1, obvious, for the reasons discussed above.[13] PO Resp. 26, 30, 38; *supra* Section II.C.4.; *see* Reply 21. Moreover, Patent Owner does not contend that Petitioner has failed to demonstrate an adequate reason to combine the teachings of Mault, Al-Ali, and Han to achieve the methods recited in the challenged claims. Thus, Patent Owner relies solely on its challenges to claim 1, the base claim for claims 6–8, to contest Petitioner's ground for the unpatentability of claims 6–8 as rendered obvious over Mault, Al-Ali, and Han.

For the reasons set forth above, we are persuaded that Petitioner shows by a preponderance of the evidence that the combined teachings of Mault and Al-Ali render the base claim, independent claim 1, of claims 6–8 obvious. *See supra* Section II.C.4. After reviewing Petitioner's arguments and supporting evidence regarding claims 6–8, and, in particular, adopting the mapping of the limitations of these claims onto the teachings of Mault, Al-Ali, and Han (Pet. 61–63), and finding persuasive Petitioner's arguments and evidence regarding the reasons to combine the teachings of Mault, Al-Ali, and Han (*id*. at 63–64; *see* Ex. 1003 ¶ 174), we are persuaded that Petitioner demonstrates by a preponderance of the evidence that the combined teachings of Mault, Al-Ali, and Han render claims 6–8 of the '941 patent obvious.

[13] Patent Owner challenged Petitioner's mapping of the claim limitations of claim 7 and reasons for combining the teachings of these references in its Preliminary Response, but did not maintain those arguments in its Patent Owner Response. *See* Inst. Dec. 48–49. Arguments for patentability not raised in the Patent Owner Response are deemed waived. Paper 11, 3.

e. Claim 10

Petitioner argues that claim 10 is rendered obvious over the combined teachings of Mault, Al-Ali, and Numaga. *See supra* Section I.E. Claim 10 depends from claim 1 and recites that "the at least one PPG sensor comprises at least one optical emitter, at least one optical detector, and at least one light guide." Ex. 1001, 31:30–32.

We begin our analysis of this ground of unpatentability with a review of the additional applied art.

i. Numaga (Ex. 1010)

Numaga teaches a wrist-worn pulse wave sensor that emits infrared light directly onto a subject's wrist and detects pulse waves from light reflected by the red corpuscles within the subject's arteries. Ex. 1010 ¶ 1; Figs. 1 and 2. Numaga's Figure 1(a) is reproduced below.

[FIG. 1]

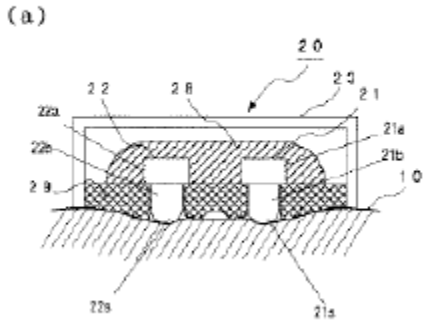


Figure 1(a) depicts pulse wave sensor 20 including light emitting device 21 and light receiving device 22, which are enclosed and supported by sensor case 23 and shell supporting member 29. *Id.* ¶ 9. Sensor 20 also includes light guide 21b extending from light emitting device 21 to direct infrared light to wrist 10 and light guide 22b extending to light receiving device 22 to

capture light from wrist 10. *Id.* Light guides 21b and 22b project from shell supporting member 29 and engage wrist 10, such that distal end of light emitting surface 21s and distal end of light receiving surface 22s are pressed against wrist 10. *Id.*

ii. Analysis

Petitioner relies on the combined teachings of Mault and Al-Ali to render the base claim, claim 1, of claim 10 unpatentable. *See supra* Section II.C.4.b. Petitioner further provides a detailed mapping of the additional limitations of claim 10 onto Numaga. Pet. 64–66; *see* Ex. 1003 ¶¶ 175–179. Patent Owner does not contest this mapping, but, instead, only contends that Petitioner fails to demonstrate that the combined teachings of Mault and Al-Ali render the dependent claim's base claim, independent claim 1, obvious, for the reasons discussed above.[14] PO Resp. 26, 30, 38; *supra* Section II.C.4.; *see* Reply 21. Moreover, Patent Owner does not contend that Petitioner has failed to demonstrate an adequate reason to combine the teachings of Mault, Al-Ali, and Numaga to achieve the methods recited in the challenged claim. Thus, Patent Owner relies solely on its challenges to claim 1, the base claim for claim 10, to contest Petitioner's ground for the unpatentability of claim 10 as rendered obvious over Mault, Al-Ali, and Numaga.

[14] Patent Owner challenged Petitioner's reasons for combining the teachings of these references in its Preliminary Response, but did not maintain those arguments in its Patent Owner Response. *See* Inst. Dec. 51–52. Arguments for patentability not raised in the Patent Owner Response are deemed waived. Paper 11, 3.

For the reasons set forth above, we are persuaded that Petitioner shows by a preponderance of the evidence that the combined teachings of Mault and Al-Ali render the base claim, independent claim 1, of claim 10 obvious. *See supra* Section II.C.4. After reviewing Petitioner's arguments and supporting evidence regarding claim 10, and, in particular, adopting the mapping of the limitations of these claims onto the teachings of Mault, Al-Ali, and Numaga (Pet. 64–65), and finding persuasive Petitioner's arguments and evidence regarding the reasons to combine the teachings of Mault, Al-Ali, and Numaga (*id*. at 66; *see* Ex. 1003 ¶ 179), we are persuaded that Petitioner demonstrates by a preponderance of the evidence that the combined teachings of Mault, Al-Ali, and Numaga render claim 10 of the '941 patent obvious.

f. Claim 13

Petitioner argues that claim 13 are rendered obvious over the combined teachings of Mault, Al-Ali, and Ali. *See supra* Section I.E. Claim 13 depends from claim 1 and recites that "the physiological information and/or motion-related information comprises information on data integrity." Ex. 1001, 31:39–41.

We begin our analysis of this ground of unpatentability with a review of the additional applied art.

i. Ali (Ex. 1064)

Ali teaches devices and methods for measuring and presenting plethysmographic information, such as data from a pulse oximeter. Ex. 1064, 1:14–16, 35–45, Fig. 1. Plethysmographic waveforms are subject to distortion. *Id*. at 2:20–30. Ali teaches that:

> One aspect of the present invention is a processor having a decision element that determines if the waveform has little or no distortion or significant distortion. If there is little distortion, the decision element provides a trigger in real-time with physiologically acceptable pulses recognized by a waveform analyzer. If there is significant distortion, then the decision element provides the trigger based synchronized to an averaged pulse rate, provided waveform pulses are detected.

Id. at 2:59–67. Further, Ali teaches that "[a]nother aspect of the current invention is the generation of *a data integrity indicator* that is used in conjunction with the decision element trigger referenced above to create a visual pulse indicator." *Id*. at 3:24–27 (emphasis added). For example, Ali teaches that "[a] measure of data integrity can also be used to vary the audible or visual indicators to provide *a simultaneous indication of confidence* in measured values, such as oxygen saturation and pulse rate." *Id*. at 3:46–49 (emphasis added).

ii. Analysis

Petitioner relies on the combined teachings of Mault and Al-Ali to render the base claim, claim 1, of claim 13 unpatentable. *See supra* Section II.C.4.b. Petitioner further provides a detailed mapping of the additional limitations of claim 13 onto Ali. Pet. 66–68; *see* Ex. 1003 ¶¶ 180–184. Patent Owner does not contest this mapping, but, instead, only contends that Petitioner fails to demonstrate that the combined teachings of Mault and Al-Ali render the dependent claim's base claim, independent claim 1, obvious, for the reasons discussed above.[15] PO Resp. 26, 30, 38; *supra*

[15] Patent Owner challenged Petitioner's reasons for combining the teachings of these references in its Preliminary Response, but did not maintain those arguments in its Patent Owner Response. *See* Inst. Dec. 53–54. Arguments

Section II.C.4.; *see* Reply 21. Moreover, Patent Owner does not contend that Petitioner has failed to demonstrate an adequate reason to combine the teachings of Mault, Al-Ali, and Ali to achieve the methods recited in the challenged claim. Thus, Patent Owner relies solely on its challenges to claim 1, the base claim for claim 13, to contest Petitioner's ground for the unpatentability of claim 13 as rendered obvious over Mault, Al-Ali, and Ali.

For the reasons set forth above, we are persuaded that Petitioner shows by a preponderance of the evidence that the combined teachings of Mault and Al-Ali render the base claim, independent claim 1, of claim 13 obvious. *See supra* Section II.C.4. After reviewing Petitioner's arguments and supporting evidence regarding claim 13, and, in particular, adopting the mapping of the limitations of these claims onto the teachings of Mault, Al-Ali, and Ali (Pet. 66–67), and finding persuasive Petitioner's arguments and evidence regarding the reasons to combine the teachings of Mault, Al-Ali, and Numaga (*id*. at 67-68; *see* Ex. 1003 ¶¶ 183–184), we are persuaded that Petitioner demonstrates by a preponderance of the evidence that the combined teachings of Mault, Al-Ali, and Ali render claim 13 of the '941 patent obvious.

g. Summary

For the reasons set forth above, we are persuaded that Petitioner demonstrates a reasonable likelihood of prevailing in showing that claims 1, 2, and 6–13 of the '941 patent are unpatentable as obvious over Mault and Al-Ali, alone or in combination with another reference.

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for patentability not raised in the Patent Owner Response are deemed waived. Paper 11, 3.

D. Unpatentability of Challenged Claims

In consideration of the above, we conclude that Petitioner has demonstrated by a preponderance of the evidence that claims 1, 2, and 6–13 of the '941 patent are unpatentable based on the challenges asserted in the Petition, but that Petitioner fails demonstrated by a preponderance of the evidence that claims 3–5 of the '941 patent are unpatentable based on the challenges asserted in the Petition. In particular, we determine that:

References	Basis	Challenged Claim(s)	Determination
Luo and Craw	35 U.S.C. § 103(a)	1–3, 9, and 11–13	Claims 1, 2, 9, and 11–13 unpatentable; claim 3 not unpatentable
Luo, Craw, and Wolf	35 U.S.C. § 103(a)	4 and 5	Not unpatentable
Luo, Craw, and Fricke	35 U.S.C. § 103(a)	6 and 8	Unpatentable
Luo, Craw, Fricke, and Comtois	35 U.S.C. § 103(a)	7	Unpatentable
Luo, Craw, and Aceti	35 U.S.C. § 103(a)	10	Unpatentable
Mault and Al-Ali	35 U.S.C. § 103(a)	1, 2, 9, 11, and 12	Unpatentable
Mault, Al-Ali, and Lee	35 U.S.C. § 103(a)	3	Not unpatentable
Mault, Al-Ali, and Behar	35 U.S.C. § 103(a)	4 and 5	Not unpatentable
Mault, Al-Ali, and Han	35 U.S.C. § 103(a)	6–8	Unpatentable
Mault, Al-Ali, and Numaga	35 U.S.C. § 103(a)	10	Unpatentable

References	Basis	Challenged Claim(s)	Determination
Mault, Al-Ali, and Ali	35 U.S.C. §103(a)	13	Unpatentable

IV. PROCEDURAL ISSUES

Patent Owner objects to the use of *inter partes* reviews as unconstitutional based, at least, upon the reasons presented in the petition for certiorari that was granted in *Oil States Energy Services, LLC v. Greene's Energy Group, LLC*. PO Resp. 38; *see* Reply 21. On April 24, 2018, the U.S. Supreme Court upheld the constitutionality of *inter partes* review; thus, Patent Owner's arguments are moot. *Oil States Energy Servcs. LLC v. Greene's Energy Grp., LLC*, 138 S.Ct. 1365, 1370 (2018).

V. CONCLUSION

For the foregoing reasons, we are persuaded that Petitioner establishes by a preponderance of the evidence that claims 1, 2, and 6–13 of the '941 patent are unpatentable as obvious over Luo and Craw, alone or in combination with other references, and Mault and Al-Ali, alone or in combination with another reference.

VI. ORDER

In consideration of the foregoing, it is

ORDERED that claims 1, 2, and 6–13 of the '941 patent are unpatentable;

FURTHER ORDERED that claims 3–5 of the '941 patent are not unpatentable; 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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