

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

SZ DJI TECHNOLOGY CO., LTD.,
Petitioner,

v.

DRONE-CONTROL, LLC,
Patent Owner.

Case IPR2018-00208
Patent 9,568,913 B2

Before PATRICK R. SCANLON, FRANCES L. IPPOLITO, and
TIMOTHY J. GOODSON, *Administrative Patent Judges*.

SCANLON, *Administrative Patent Judge*.

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

I. INTRODUCTION

Petitioner, SZ DJI Technology Co., Ltd., filed a Petition (Paper 1, “Pet.”) requesting an *inter partes* review of claims 1–15 of U.S. Patent No. 9,568,913 B2 (Ex. 1001, “the ’913 patent”).¹ Patent Owner, Drone-Control, LLC, did not file a Preliminary Response. The Board instituted an *inter partes* review on all challenged claims under all asserted grounds. Paper 7 (“Institution Decision,” “Dec.”).

After institution of trial, Patent Owner filed a Patent Owner Response (Paper 17, “PO Resp.”), Petitioner filed a Reply (Paper 22, “Reply”), and Patent Owner filed a Sur-Reply (Paper 25, “Sur-Reply”). In addition, Patent Owner filed a Contingent Motion to Amend (Paper 15, “Mot. Amend”), Petitioner filed an Opposition to Patent Owner’s Contingent Motion to Amend (Paper 23, “Opp. Amend”), Patent Owner filed a Reply to Petitioner’s Opposition (Paper 26, “Reply Amend”), and Petitioner filed a Sur-Reply to Patent Owner’s Reply (Paper 27, “Sur-Reply Amend”). To support its arguments, Petitioner relies on the testimony of R. John Hansman, Jr., Ph.D. (see Ex. 1003), while Patent Owner relies on testimony from Edmond J. Murphy, Ph.D. (see Ex. 2006).

An oral hearing was held on February 27, 2019, and the record contains a transcript of this hearing. Paper 45 (“Tr.”).

We have jurisdiction under 35 U.S.C. § 6. This Final Written Decision is issued pursuant to 35 U.S.C. § 318(a) and 37 C.F.R. § 42.73.

¹ The Petition was filed jointly by SZ DJI Technology Co., Ltd. and Parrot Inc. After oral argument, however, this proceeding was terminated with respect to Parrot Inc. Paper 44. As such, Parrot Inc. is no longer a party to this proceeding, leaving SZ DJI Technology Co., Ltd., as the sole Petitioner.

For the reasons that follow, we determine that Petitioner has shown by a preponderance of the evidence that claims 1–15 of the '913 patent are unpatentable. In addition, we deny Patent Owner's Contingent Motion to Amend to replace claims 1–15 with substitute claims 16–30.

II. BACKGROUND

A. *Related Matters*

The parties indicate that the '913 patent is at issue in *Synergy Drone LLC v. SZ DJI Technology Co.*, No. 1:17-cv-00242 (W.D. Tex. Mar. 17, 2017) and *Synergy Drone LLC v. Parrot S.A.*, No. 1:17-cv-00243 (W.D. Tex. Mar. 17, 2017). Pet. 70; Paper 4, 2. In addition, U.S. Patent Nos. 8,200,375 B2, 8,380,368 B2, 8,649,918 B2, and 9,079,116 B2, which are related to the '913 patent, are the subject of related *inter partes* review proceedings IPR2018-00204, IPR2018-00205, IPR2018-00206, and IPR2018-00207, respectively. Pet. 70–71; Paper 4, 2.

B. *The '913 patent*

The '913 patent, titled “Radio Controlled Aircraft, Remote Controller and Methods for Use Therewith,” issued February 14, 2017, with claims 1–15. Ex. 1001, (54), (45), 9:28–11:15. The '913 patent is directed generally to “radio controlled toys such as airplanes and helicopters.” *Id.* at 1:36–37. Figure 1 of the '913 patent is reproduced below.

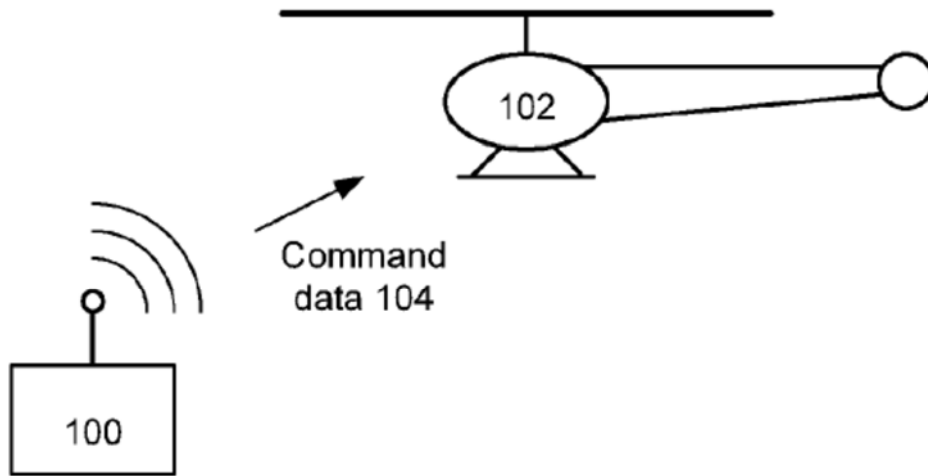


FIG. 1

Figure 1 depicts remote control device 100 and radio controlled aircraft 102 in accordance with one embodiment. *Id.* at 2:44–46. Radio controlled aircraft 102 operates in response to command data 104 received from remote control device 100. *Id.* at 2:47–49.

Figure 2 of the '913 patent is reproduced below.

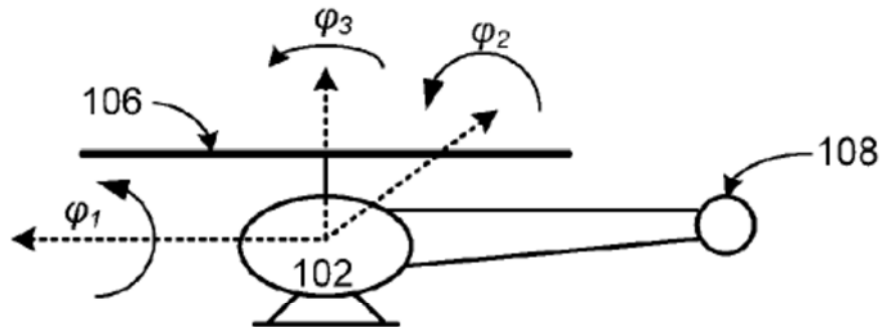


FIG. 2

Figure 2 depicts roll (ϕ_1), pitch (ϕ_2), and yaw (ϕ_3) axes from the perspective of aircraft 102. *Id.* at 2:58–60. As such, a coordinate system that is aligned from the perspective of aircraft 102 “provides a way to describe the orientation of the RC aircraft 102 in three-dimensional space in terms of the angular displacements, roll, pitch and yaw.” *Id.* at 2:61–67.

In operation, a user generates command data from remote control device 100 in a different coordinate system, such as a user coordinate system that corresponds to the orientation of the user. *Id.* at 3:24–27. This command data can be transformed into control data in the aircraft’s coordinate system, thus allowing control of RC aircraft 102 based on its orientation to the user, rather than the orientation of an imaginary pilot. *Id.* at 3:27–31.

Figures 3 and 4 of the ’913 patent are reproduced below.

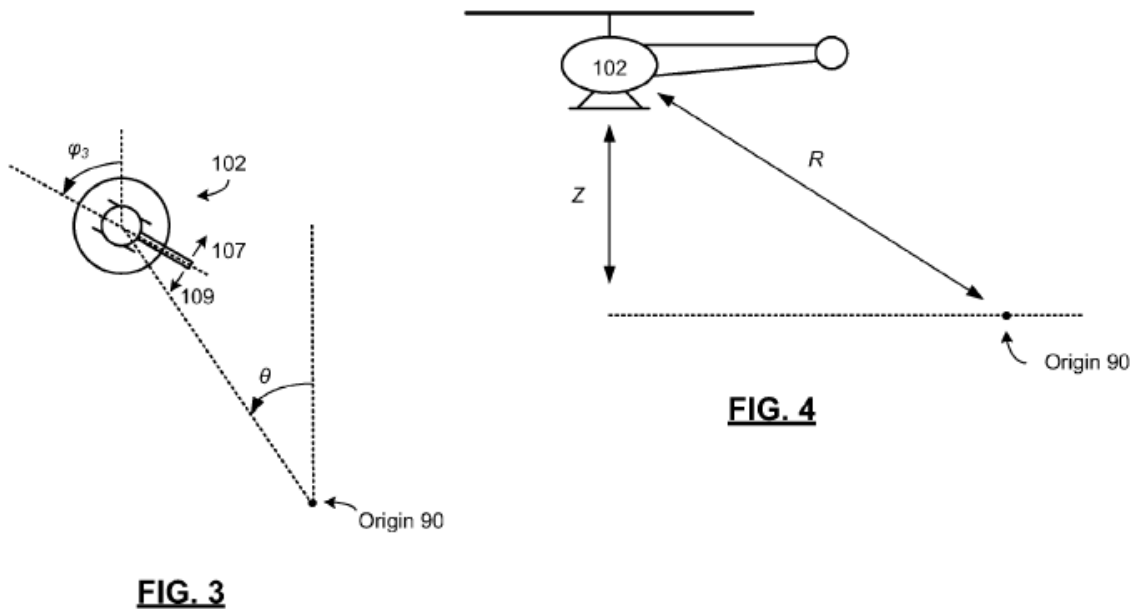


Figure 3 shows a yaw-axis from the perspective of radio controlled aircraft 102 and an angular orientation with respect to a user coordinate system. *Id.* at 2:11–15, 3:35–38. Figure 4 illustrates distance and altitude

coordinates of radio controlled aircraft 102 with respect to the user coordinate system. *Id.* at 2:16–19, 3:39–42. Referring to Figures 3 and 4, the '913 patent teaches that origin 90 indicates the placement of the origin of a polar coordinate system that corresponds to the perspective of the user. *Id.* at 3:53–55. The altitude of aircraft 102 relative to origin 90 is represented by Z, R represents the distance from aircraft 102 to origin 90, and θ represents the angular displacement of aircraft 102. *Id.* at 3:56–60. Thus, “the position of the RC aircraft 102 in three dimensional space can be represented in terms of (R, θ , Z) and the orientation of the aircraft can be represented in terms of (ϕ_1 , ϕ_2 , ϕ_3).” *Id.* at 3:60–63.

Figure 6 of the '913 patent is reproduced below.

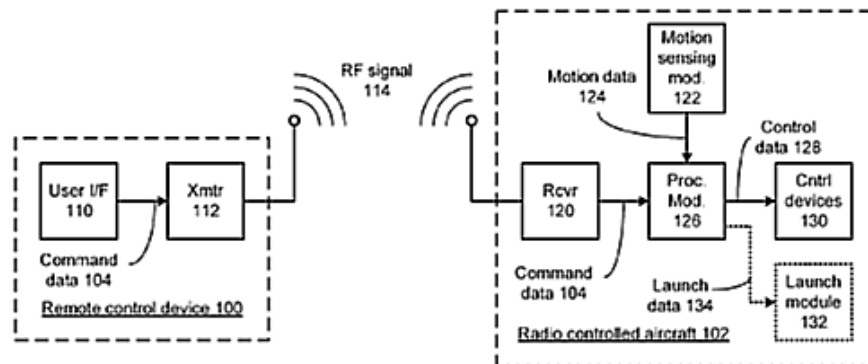


FIG. 6

Figure 6 is a schematic block diagram of remote control device 100 and aircraft 102. *Id.* at 4:65–66. Remote control device 100 includes user interface 110, such as a joy-stick or the like, that generates command data 104 in response to user actions. *Id.* at 4:67–5:4. Radio transmitter 112 transmits RF signal 114 containing command data 104. *Id.* at 5:5–6.

Aircraft 102 includes receiver 120 for receiving RF signal 114 and motion sensing module 122 that generates motion data 124 based on motion of the aircraft. *Id.* at 5:7–18. Processing module 126 transforms command data 104 into control data 128, based on command data 104 and motion data 124. *Id.* at 5:25–27. For example, pitch-axis and roll-axis controls ϕ_1 , ϕ_2 , are obtained from pitch-axis and roll-axis commands ψ_1 , ψ_2 and the sensed motion data (i.e., yaw angle ϕ_3 and angular displacement θ) with the following equations:

$$\phi_1 = \psi_1 \cos (\phi_3 - \theta) + \psi_2 \sin (\phi_3 - \theta)$$

$$\phi_2 = \psi_2 \cos (\phi_3 - \theta) - \psi_1 \sin (\phi_3 - \theta)$$

Id. at 3:64–4:25. “In this fashion, when a user commands the RC aircraft 102 to pitch forward, the RC aircraft will pitch forward from the perspective of the user, regardless of the actual orientation of the RC aircraft.” *Id.* at 4:26–29. Control data 128 are provided to a plurality of control devices 130 for controlling the motion of aircraft 102. *Id.* at 5:30–33.

C. Challenged Claims

As noted above, Petitioner challenges claims 1–15, which are all of the claims in the ’913 patent. Claims 1, 6, and 11 are independent. Claims 2–5 depend, directly or indirectly, from independent claim 1, claims 7–10 depend, directly or indirectly, from independent claim 6, and claims 12–15 depend, directly or indirectly, from independent claim 11. Independent claim 1 (with bracketed labels as added by Petitioner for ease of reference) and claim 11 are reproduced below:

1. [a] A method for use with a radio controlled (RC) aircraft, the method comprising:

[b] receiving an RF signal from a remote control device that includes command data to control motion of the RC aircraft;

[c] generating motion data from at least one sensor of the RC aircraft based on motion of the RC aircraft; and

[d] controlling the RC aircraft based on the command data and the motion data, wherein the command data correspond to user commands in a first coordinate system from a perspective of the remote control device and the command data are transformed into control data in a second coordinate system that is from a perspective of the RC aircraft;

[e] wherein the user commands includes lift command data that indicates a hovering state and controlling the RC aircraft includes controlling the RC aircraft to a hovering state in response to the lift command data.

Ex. 1001, 9:28–45.

11. A method for use with a radio controlled (RC) aircraft, the method comprising:

generating an RF signal from a remote control device that includes command data that indicates user commands to control motion of the RC aircraft, wherein the user commands to control the motion of the RC aircraft are in a first coordinate system from a perspective of the remote control device;

generating a mode control signal that indicates one of: a first mode of operation and a second mode of operation;

wherein the RC aircraft is controlled based on the RF signal and motion data generated by at least one sensor of the RC aircraft that indicates motion of the RC aircraft, wherein the user commands includes lift command data that indicates a hovering state and control of the RC aircraft includes:

controlling the RC aircraft to a hovering state in response to the lift command data; and

when the mode control signal indicates the first mode of operation:

the user commands indicated by the command data are transformed into transformed commands in a second coordinate system that is from a perspective of the RC aircraft; and

the RC aircraft is controlled based on the transformed commands; and

when the mode control signal indicates the second mode of operation:

the RC aircraft is controlled directly based on the user commands indicated by the command data in the first coordinate system.

Id. at 10:37–67.

D. The Prior Art

Petitioner's asserted grounds of unpatentability for the challenged claims rely on the following references:

Thornberg '983	US 5,552,983	Sept. 3, 1996	Ex. 1006
Muramatsu	JP 2001-209427	Aug. 3, 2001	Ex. 1007
Karem	US 6,584,382 B2	June 24, 2003	Ex. 1008
Rivers	US 2005/0127242 A1	June 16, 2005	Ex. 1010

E. Grounds of Unpatentability at Issue

We instituted trial on all grounds of unpatentability proposed by Petitioner, and for all claims 1–15 challenged subject to each asserted ground, as shown below. Dec. 2, 27; Pet. 4.

References	Basis	Claim(s) Challenged
Thornberg '983 in view of Karem	§ 103	1, 3–6, 8–11, and 13–15
Thornberg '983 in view of Karem further in view of Rivers	§ 103	2, 7, and 12
Muramatsu in view of Karem and, optionally Thornberg '983	§ 103	1 and 3–5
Muramatsu in view of Karem and, optionally Thornberg '983, further in view of Rivers	§ 103	2
Muramatsu in view of Karem further in view of Thornberg '983	§ 103	6, 8–11, and 13–15

References	Basis	Claim(s) Challenged
Muramatsu in view of Karem further in view of Thornberg '983 and Rivers	§ 103	7 and 12

III. ANALYSIS

A. Relevant Legal Principles

To prevail in challenging Patent Owner's claims, Petitioner must demonstrate by a preponderance of the evidence that the claims are unpatentable. 35 U.S.C. § 316(e); 37 C.F.R. § 42.1(d). "In an [*inter partes* review], the petitioner has the burden from the onset to show with particularity why the patent it challenges is unpatentable." *Harmonic Inc. v. Avid Tech., Inc.*, 815 F.3d 1356, 1363 (Fed. Cir. 2016) (citing 35 U.S.C. § 312(a)(3) (requiring *inter partes* review petitions to identify "with particularity . . . the evidence that supports the grounds for the challenge to each claim")). The burden of persuasion rests with Petitioner. See *Dynamic Drinkware, LLC v. Nat'l Graphics, Inc.*, 800 F.3d 1375, 1378 (Fed. Cir. 2015) (citing *Tech. Licensing Corp. v. Videotek, Inc.*, 545 F.3d 1316, 1326–27 (Fed. Cir. 2008)) (discussing the burden of proof in *inter partes* review). Furthermore, Petitioner cannot satisfy its burden of proving obviousness by employing "mere conclusory statements." *In re Magnum Oil Tools Int'l, Ltd.*, 829 F.3d 1364, 1380 (Fed. Cir. 2016).

A 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; and, (4) where in evidence, so-called secondary considerations, including commercial success, long-felt but unsolved needs, failure of others, and unexpected results. *Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966).

For an obviousness analysis, prior art references must be “considered together with the knowledge of one of ordinary skill in the pertinent art.” *In re Paulsen*, 30 F.3d 1475, 1480 (Fed. Cir. 1994) (quoting *In re Samour*, 571 F.2d 559, 562 (CCPA 1978)). Moreover, “it is proper to take into account not only specific teachings of the reference but also the inferences which one skilled in the art would reasonably be expected to draw therefrom.” *In re Preda*, 401 F.2d 825, 826 (CCPA 1968). That is because an obviousness analysis “need not seek out precise teachings directed to the specific subject matter of the challenged claim, for a court can take account of the inferences and creative steps that a person of ordinary skill in the art would employ.” *KSR*, 550 U.S. at 418.

B. Level of Ordinary Skill in the Art

Petitioner contends that a person having ordinary skill in the art to which the '913 patent pertains

would have an equivalent of a Bachelor’s degree from an accredited institution in electrical engineering, mechanical engineering, aeronautical or astronautical engineering, robotics, computer science, or any other discipline covering principles of design, operation, and/or control of unmanned aerial vehicles, including remote-controlled vehicles, and would have a working knowledge of the design, development, implementation, or deployment of

such technologies. Additional education could substitute for experience, and significant experience could substitute for formal education.

Pet. 12 (citing Ex. 1003 ¶ 28). Patent Owner does not dispute Petitioner’s proposed level of ordinary skill in the art. *See* Tr. 77:1–6; *see also* Ex. 2006 ¶ 48 (Patent Owner’s declarant adopting this definition of the person of ordinary skill in the art for purposes of declaration testimony).

Factual indicators of the level of ordinary skill in the art include “the various prior art approaches employed, the types of problems encountered in the art, the rapidity with which innovations are made, the sophistication of the technology involved, and the educational background of those actively working in the field.” *Jacobson Bros., Inc. v. U.S.*, 512 F.2d 1065, 1071 (Ct. Cl. 1975); *see also Orthopedic Equip. Co. v. U.S.*, 702 F.2d 1005, 1011 (Fed. Cir. 1983) (quoting with approval *Jacobson Bros.*). We find, based on our review of the complete record, that Petitioner’s stated level of ordinary skill in the art is reasonable because it is consistent with the evidence before us, including the asserted prior art, and we adopt Petitioner’s definition.

C. Claim Construction

Under the version of our rules applicable to this *inter partes* review,² 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); *see also Cuozzo Speed Techs., LLC v. Lee*, 136 S. Ct.

² The claim construction standard to be employed in *inter partes* reviews has changed for proceedings in which the petition was filed on or after November 13, 2018. *See* Changes to the Claim Construction Standard for Interpreting Claims in Trial Proceedings Before the Patent Trial and Appeal Board, 83 Fed. Reg. 51,340 (Oct. 11, 2018) (to be codified at 37 C.F.R. pt. 42). The Petition in this proceeding was filed in November 2017.

2131, 2142–46 (2016) (concluding that 37 C.F.R. § 42.100(b) “represents a reasonable exercise of the rulemaking authority that Congress delegated to the Patent Office”). Under the broadest reasonable construction standard, claim terms are given their ordinary and customary meaning, as would be understood by one of ordinary skill in the art in the context of the entire disclosure. *In re Translogic Tech., Inc.*, 504 F.3d 1249, 1257 (Fed. Cir. 2007). Also, we are careful not to read a particular embodiment appearing in the written description into the claim if the claim language is broader than the embodiment. *See In re Van Geuns*, 988 F.2d 1181, 1184 (Fed. Cir. 1993) (“[L]imitations are not to be read into the claims from the specification.”).

We determine that “motion data” is the only term requiring construction in order to resolve the disputed issues in this proceeding. *See Vivid Techs., Inc. v. Am. Sci. & Eng’g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999) (“[O]nly those terms need be construed that are in controversy, and only to the extent necessary to resolve the controversy.”); *see also Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co.*, 868 F.3d 1013, 1017 (Fed. Cir. 2017) (citing *Vivid Techs.* in the context of an *inter partes* review).

This claim construction dispute is case dispositive. All of Patent Owner’s rebuttal arguments against Petitioner’s challenges depend on its proposed construction of “motion data.” *See* PO Resp. 7–15; Sur-Reply 3–10. At the hearing, Patent Owner agreed that if we decline to adopt Patent Owner’s proposed construction, that determination would be dispositive of the case in chief (i.e., Petitioner’s challenges to the issued claims, as

opposed to the claims proposed in Patent Owner's Contingent Motion to Amend). Tr. 103:1–8.

We also note that the claim term “motion data” appears in related patents, and the parties' arguments concerning this term's meaning in the '913 patent are substantially identical to the arguments in Case IPR2018-00204 (“the -204 IPR”) concerning the same term in U.S. Patent No. 8,200,375. The parties agree that the construction of “motion data” should be the same in these related patents. See Tr. 42:5–8, 77:7–11. That agreement is consistent with the general rule that “where multiple patents ‘derive from the same parent application and share many common terms, we must interpret the claims consistently across all asserted patents.’” *Trustees of Columbia University v. Symantec Corp.*, 811 F.3d 1359, 1369 (Fed. Cir. 2016) (quoting *NTP, Inc. v. Research in Motion, Ltd.*, 418 F.3d 1282, 1293 (Fed. Cir. 2005)). Because the evidence and arguments are the same here as in the -204 IPR and the parties agree that the construction of “motion data” should be the same in both patents, our claim construction analysis in this proceeding mirrors the analysis in our Final Written Decision in the -204 IPR. Nevertheless, for completeness, we set out that analysis hereinbelow.

Limitation [c] of claim 1 recites that a motion sensing module “generating motion data from at least one sensor of the RC aircraft based on motion of the RC aircraft” and limitation [d] recites “controlling the RC aircraft based on the command data and the motion data.” Ex. 1001, 9:33–41. The term “motion data” also appears in independent claims 6 and 11. *Id.* at 9:66, 10:48. The Petition did not propose a construction for “motion data” and our Institution Decision did not adopt a construction. See Pet. 12–15; Dec. 10.

In its Patent Owner Response, Patent Owner proposes that “motion data” should be construed to mean “data indicative of a change in position.” PO Resp. 3. Patent Owner supports this proposed construction with dictionaries defining “motion” to include a change in position. *Id.* at 3–4 (citing Ex. 2002; Ex. 2003). Patent Owner also cites the Specification of the ’913 patent and the testimony of Dr. Murphy. *Id.* at 3–7 (citing Ex. 1001, 3:44–52, 3:56–60, 4:3–13, 4:45–52, 7:52–56, Fig. 3; Ex. 2006 ¶¶ 49–68). According to Patent Owner, “[a] change in orientation is different from a change in position. Orientation describes a *direction*.” *Id.* at 4. Patent Owner urges that data indicative only of orientation is not motion data. *Id.* at 6–7. In its Sur-Reply, Patent Owner clarifies its position that “motion data is properly construed as explicitly requiring data indicating a change in position, but use of orientation data in this transformation as well is not prohibited” Sur-Reply 5.

Petitioner argues that “motion data only needs to be based on the motion of the RC aircraft and can reflect, for example, data indicative of the aircraft’s orientation, the aircraft’s position, or both the aircraft’s orientation and the aircraft’s position.” Reply 5. To support its position, Petitioner relies on the Specification, including dependent claims 3 and 5, as well as the testimony of Dr. Hansman and the cross examination testimony of Dr. Murphy. *Id.* at 3–6.

The disputed claim construction issue is whether “motion data” is satisfied by data indicative of the aircraft’s orientation, as Petitioner contends, or whether that term requires data indicative of a change in the aircraft’s position, as Patent Owner contends. The emphasis in the Patent Owner Response on the distinction between a change in orientation and a

change in position suggests that Patent Owner does not consider orientation to be motion data. *See* PO Resp. 4. But Patent Owner’s subsequent briefing and arguments at the hearing clarify that Patent Owner does not dispute that an aircraft’s orientation is one type of “motion data.” *See* Tr. 77:20–78:4 (answering a question of whether motion data includes information as to whether an object is spinning about its own axis by responding that “angular motion would be included. Rotation is part of [it] but it’s only an aspect of motion data. Motion data also requires position data, the change in position to be reflected as part of the motion data in these patents”); Sur-Reply 5 (arguing that “[y]aw-axis motion data’ could indeed include data indicative of a change in orientation” and that claim 1 “encompasses transformations based on a change in orientation so long as they also include transformation based on data indicative of a change in position”) (emphasis omitted).

Thus, the parties agree that “motion data” as that term is used in the ’913 patent includes data indicative of the aircraft’s orientation. *See id.*; Reply 5; Tr. 30:7–9. The intrinsic record supports that view, because the Specification explains that yaw angle ϕ_3 represents the aircraft’s orientation, Ex. 1001, 3:62–63, 3:43–47, Fig. 3, and further describes that ϕ_3 is motion data. *Id.* at 5:29–30 (referring to “motion data 124 such as θ , ϕ_3 ”); *see also id.* at 9:52 (dependent claim 3 reciting that “motion data includes yaw-axis motion data”). The testimony of both parties’ experts further supports that data indicating the vehicle’s orientation is motion data. *See* Ex. 1019, 61:16–19, 63:11–13, 89:19–21, 96:12–15; Ex. 1023 ¶¶ 33–35.

The only question, then, is whether orientation data can suffice by itself to qualify as “motion data,” as Petitioner contends, or whether data indicating a change in the vehicle’s position is essential, as Patent Owner

argues. On that question, we agree with Petitioner that orientation data is sufficient. The Specification describes that motion sensing module 122 generates motion data 124 based on the motion of the aircraft and that

motion sensing module 122 includes **one or more** axes of accelerometers **or** gyroscopes **or** other devices that alone, or with further processing by processing module 126, can generate data that represents θ , ϕ_3 , **and/or** other motion parameters such as R, Z, etc., that can be used in transforming the command data 104 to control data 128.

Ex. 1001, 5:19–24 (emphases added). This disclosure supports a broad understanding of “motion data” as any data generated by the sensing module that represents a position, orientation, or motion parameter.

Looking at the first portion of the block quote, as Dr. Hansman observes, “[m]otion sensing module 122 is not limited to any specific technology and can therefore include gyroscopes that measure changes in orientation or accelerometers used to measure change in position.” Ex. 1023 ¶ 32. The Specification’s description that the “motion sensing module 122 includes **one or more** axes of accelerometers **or** gyroscopes **or** other devices” indicates that some embodiments include only gyroscopes, which Dr. Hansman testifies are devices that provide information about orientation. See Ex. 1001, 5:19–20 (emphases added); Ex. 1023 ¶ 32.

Turning to the second portion of the passage block quoted above — i.e., that motion sensing module 122 includes devices that “can generate data that represents θ , ϕ_3 , and/or other motion parameters such as R, Z, etc., that can be used in transforming the command data 104 to control data 128” (Ex. 1001, 5:21–24) — we find persuasive Dr. Hansman’s testimony that an ordinarily skilled artisan would understand this passage to signify that “the motion data generated by motion sensing module 122 can be data reflecting

any one, or several, or all of the mentioned parameters.” Ex. 1023 ¶ 32. Because ϕ_3 , which represents the aircraft’s orientation, is one of the mentioned parameters, this means that motion data can reflect orientation data alone. Ex. 1001, 3:62–63, 3:43–47, 5:22. We also note that Dr. Murphy’s testimony was in accord when he testified during cross-examination that “[m]otion data could be position data, it could be orientation data, or it could be a combination of position and orientation” and that he understands his own declaration to “say[] the same thing.” Ex. 1019, 96:12–15; *see also id.* at 61:18–19 (“Motion could be a change in only Phi 3. Yes. That’s correct.”).

We have considered the other intrinsic and extrinsic evidence cited by Patent Owner, but that evidence does not persuade us that a narrower understanding of “motion data” is appropriate. *See* PO Resp. 3–6; Sur-Reply 3–6. Patent Owner points out that transformation equations disclosed in the ’913 patent include θ , which reflects a change in position, and that the transformation makes the RC aircraft more user-friendly for unskilled operators. PO Resp. 5–6. However, the claims do not require the use of the particular transformation equations set forth in the Specification. The paragraph in which the transformation equations appear begins with “[i]n an embodiment of the present invention” (Ex. 1001, 4:14), signaling that the use of these transformation equations is not a requirement.

For the foregoing reasons, we construe “motion data” to include data indicative of an aircraft’s orientation, position, or a combination thereof.

D. Asserted Obviousness Based on Thornberg ’983 and Karem

Petitioner contends claims 1, 3–6, 8–11, and 13–15 are obvious over Thornberg ’983 and Karem. Pet. 4, 27–46. Petitioner relies upon the

testimony of Dr. Hansman (Ex. 1003) in support of its contentions. *Id.* Patent Owner disputes Petitioner’s contentions. PO Resp. 7–13. Patent Owner cites the testimony of Dr. Murphy (Ex. 2006) in support. *Id.*

1. *Overview of Thornberg ’983*

Thornberg ’983 “relates to the control of remotely operated vehicles, and more particularly to a variable reference for the control of a remotely operated vehicle.” Ex. 1006, 1:8–10. According to Thornberg ’983, “[a] problem associated with operating remotely operated vehicles is that when the vehicle operator controls the vehicle from a distant location, commands referenced to the operator’s body or operator frame of reference may result in undesired vehicle motion.” *Id.* at 1:48–52. For example, when a remotely controlled vehicle is moving toward the operator, a control input by the operator for a right turn will result in the vehicle turning left with respect to the operator. *Id.* at 1:62–67.

To solve this problem, Thornberg ’983 describes a variable referenced control system for a remotely operated vehicle that “provides for the referencing of vehicle commands based on an operator frame of reference so that control commands provided by the operator remain intuitive and independent of the orientation of the vehicle with respect to the operator.” *Id.* at 3:36–44. In one embodiment, the system includes unmanned aerial vehicle (UAV) 100 and control panel 200 for remotely controlling UAV 100. *Id.* at 3:62–63, 4:29–30, Figs. 3, 4.

Figure 5 of Thornberg ’983 is reproduced below.

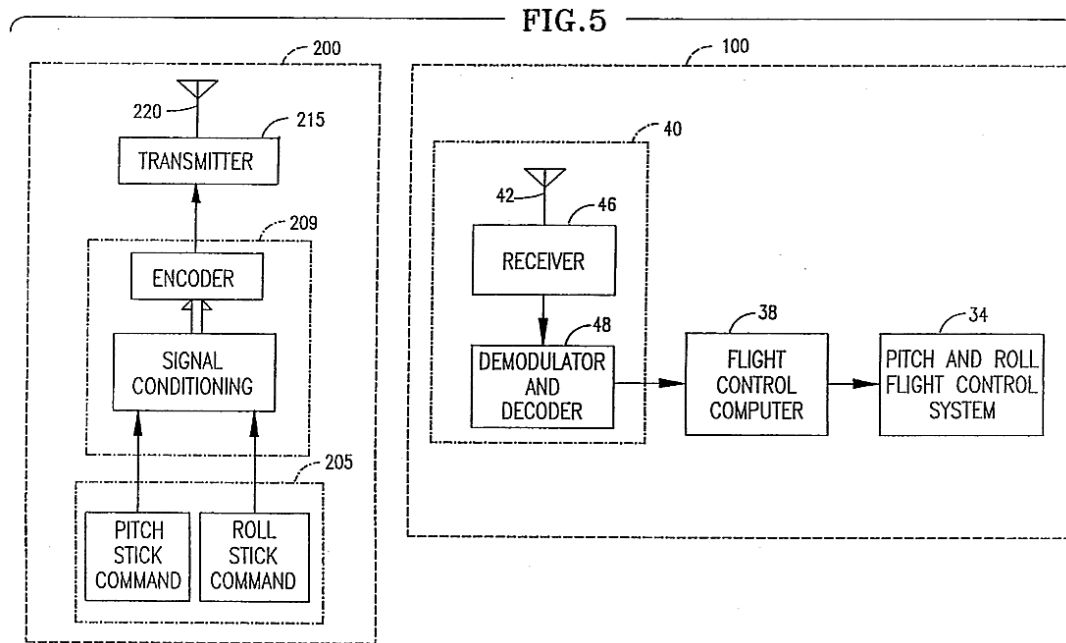


Figure 5 schematically depicts the transmission of control signals from the control panel to the remotely operated vehicle. *Id.* at 3:26–28. In particular, control panel 200 includes control stick 205, control panel computer 209, transmitter 215, and antenna 220. *Id.* at 4:29–43, Figs. 3, 5. UAV 100 includes avionics 34, navigation equipment 36, flight control computer 38, and communications gear 40. *Id.* at 4:12–16, Figs. 4, 5. Communications gear 40 includes antenna 42, receiver 46, and demodulator/decoder 48. *Id.* at 4:45–49, Fig. 5. Control signals from control panel 200 are transmitted via antenna 200 and received by antenna 42 and provided to communications gear 40. *Id.* at 4:44–46. From there, demodulated and decoded control signals are provided to fight control computer 38 and avionics equipment 34, which process the signals to provide control commands to perform the desired maneuvers. *Id.* at 4:50–56.

Figure 6 of Thornberg '983 is reproduced below.

FIG. 6

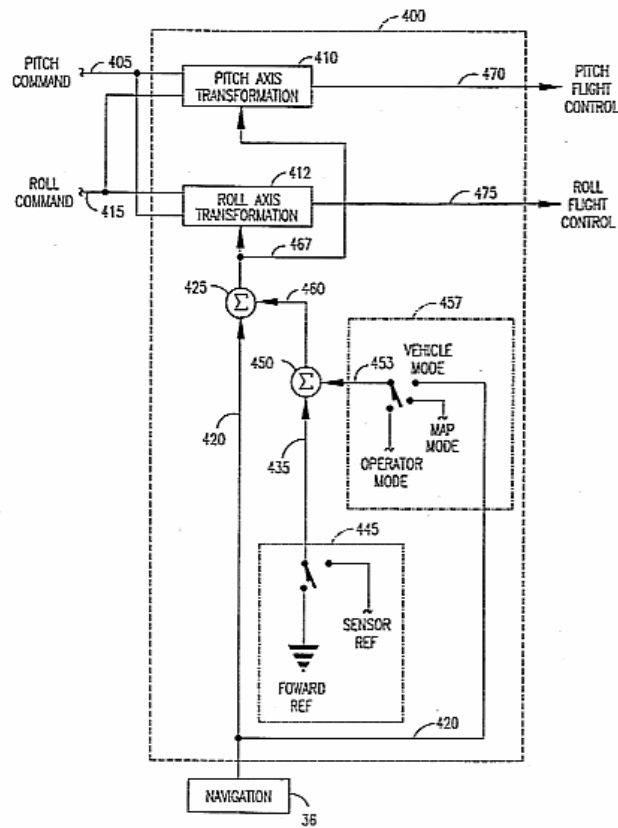


Figure 6 is a schematic block diagram showing a command transformation used by the flight control computer. *Id.* at 3:29–31. Namely, the flight control computer is provided with transformation function 400 that “allows the operator to select between a variety of control references for controlling the remotely operated vehicle.” *Id.* at 5:9–12, Fig. 6. Transformation function 400 includes pitch axis transformation function 410 and roll axis transformation function 412, both of which receive the pitch command and the roll command from the control panel. *Id.* at 5:19–28, Fig. 6.

Pitch axis transformation function 410 and roll axis transformation function 412 also receive input of the transformation angle, θ , which is

output by summing junction 425. *Id.* at 5:29–31, 6:13–14, Fig. 6. “The transformation angle is determined based on the true heading of the vehicle as determined by the navigation system 36 and the desired vehicle reference and vehicle reference mode.” *Id.* at 5:31–34. More specifically, summing junction 425 receives a signal representative of the vehicle’s true heading from navigation system 36. *Id.* at 5:35–46, Fig. 6. Summing junction 425 also receives a reference heading signal output by summing junction 450. *Id.* at 5:46–49, 6:11–13, Fig. 6. This reference heading signal is subtracted from the vehicle heading signal in summing junction 425 to determine the transformation angle. *Id.* at 6:42–46, 7:6–9.

With these inputs, pitch axis transformation function 410 determines a transformed pitch stick signal (TPSS) using the equation:

$$\text{TPSS} = \text{pitch command} * \cos(\theta) - \text{roll command} * \sin(\theta),$$

and roll axis transformation function 412 determines a transformed roll stick signal (TRSS) using the equation:

$$\text{TRSS} = \text{roll command} * \cos(\theta) + \text{pitch command} * \sin(\theta).$$

Id. at 6:17–28.

Transformation function 400 also includes reference mode switch 457, which is controlled by a switch on control panel 200. *Id.* at 6:1–4, Fig. 6. Reference mode switch 457 provides three modes of operation:

In a vehicle reference mode, the vehicles reference axis is used for purposes of controlling the vehicle from the control panel. In a map reference mode, an earth reference, such as North, is used for control of the vehicle. In an operator reference mode, the orientation of the operator upon activation of the operator mode is used as the reference axis.

Id. at 6:5–11.

2. *Overview of Karem*

Karem is directed to a control machine/operator interface and a method for controlling complex machines or moving vehicles. Ex. 1008, Abstract [57]. Referring to Figure 1B, Karem teaches man-machine interface 100 that allows a vehicle operator to control the magnitude and direction of the velocity of a remotely-operated rotorcraft. *Id.* at 7:3–8. According to Karem, control unit 100 includes a right control stick 110 and left controller 112. *Id.* at 7:9–39. The right control stick 110 provides horizontal velocity control and is spring-loaded to return to a center position when no force is applied. *Id.* at 7:9–17. The left-hand controller 112 provides vertical (altitudinal) velocity control of the rotorcraft and has an indent at its center position. *Id.* at 7:24–36. Releasing both the right and left controllers to their center positions provides “a complete rotorcraft hover,” i.e., with zero horizontal or vertical velocity. *Id.* at 7:21–23, 7:36–39.

3. *Independent Claim 1*

Petitioner contends claim 1 is rendered obvious by the combination of Thornberg '983 and Karem. Pet. 27–35. The only aspect of Petitioner's contentions that Patent Owner contests is whether Thornberg '983 discloses controlling an RC aircraft based on motion data, as recited in limitation [d]. See PO Resp. 7–13; Sur-Reply 6–8. Patent Owner's arguments regarding this limitation are premised on its proposed construction of “motion data,” which we do not adopt for the reasons discussed in Section III.C. See *id.*; see also Tr. 103:1–8 (Patent Owner agreeing that a determination not to adopt Patent Owner's proposed construction of “motion data” would be

dispositive as to case in chief because all of Patent Owner’s arguments flow from that proposed construction). The remaining aspects of Petitioner’s arguments challenging claim 1 are uncontested. “The Board is ‘not required to address undisputed matters’ or arguments about limitations with which it was never presented.” *LG Elecs., Inc. v. Conversant Wireless Licensing S.A.R.L.*, 759 F. App’x 917, 925 (Fed. Cir. 2019) (quoting *In re Nuvasive, Inc.*, 841 F.3d 966, 974 (Fed. Cir. 2016)). Nevertheless, to provide a complete record, we set forth our findings on each limitation below.

a) *Preamble/Limitation [a]: “A method for use with a radio controlled (RC) aircraft”*

Petitioner contends that Thornberg ’983 applies “to any remotely operated vehicle provided that the vehicle contains a navigation system or other means for determination changes in vehicle orientation with respect to an operator or fixed frame of reference,” and “[s]uch remotely-operated vehicles include aircraft such as airplanes and helicopters.” Pet. 27 (citing Ex. 1006, 1:8–10, 1:17–19, 3:54–61, Title). In addition, Petitioner contends that Thornberg ’983’s remotely operated vehicle is radio controlled because Thornberg ’983 discloses transmitting signals from antenna 220 of control panel 200 to antenna 42 of the vehicle, and one of ordinary skill in the art would understand that these signals are radio frequency (RF) signals. *Id.* (citing Ex. 1006, 4:39–50, Figs. 3, 5; Ex. 1003 ¶ 486). Alternatively, Petitioner contends that it would have been obvious to one of ordinary skill in the art to use RF signals in Thornberg ’983’s system because RF signals provide the necessary range for controlling a remotely operated vehicle. *Id.* at 28 (citing Ex. 1003 ¶ 487).

Based on the complete record, we are persuaded by Petitioner’s contention. Although Thornberg ’983 does not state explicitly that the signals transmitted from the control panel to the vehicle are RF signals, we agree that a skilled artisan, considering the context of Thornberg ’983’s disclosure, would have recognized that the transmitted signals would have comprised RF signals. “What a reference teaches or suggests must be examined in the context of the knowledge, skill, and reasoning ability of a skilled artisan,” and “is not . . . limited to what a reference specifically ‘talks about’ or what is specifically ‘mentioned’ or ‘written’ in the reference.” *Syntex (U.S.A.) LLC v. Apotex, Inc.*, 407 F.3d 1371, 1380 (Fed. Cir. 2005); see also Manual of Patent Examining Procedure (“MPEP”) § 2144.01 (“[I]n considering the disclosure of a reference, it is proper to take into account not only specific teachings of the reference but also the inferences which one skilled in the art would reasonably be expected to draw therefrom.”) (quoting *In re Preda*, 401 F.2d 825, 826 (CCPA 1968)). Furthermore, we credit Dr. Hansman’s testimony that an ordinarily skilled artisan would have understood Thornberg ’983’s disclosure to mean that the transmitted control signals “are radio frequency (RF) signals, as antennas are most commonly used for.” Ex. 1003 ¶ 486.

b) *Limitation [b]: “receiving an RF signal from a remote control device that includes command data to control motion of the RC aircraft”*

Petitioner contends that communications equipment 40—including antenna 42 and receiver 46—of Thornberg ’983 receives an RF signal from control panel 200. Pet. 28 (citing Ex. 1006, 4:44–50, Fig. 5). According to Petitioner, the RF signal includes command data, in the form of pitch and

roll commands, which control motion of the RC aircraft. *Id.* (citing Ex. 1006, 4:29–43, 5:20–35). Petitioner notes that “[t]he pitch and roll commands from the control stick 205 are converted into the RF signals that the control panel 200 transmits to UAV 100.” *Id.* at 29 (citing 4:36–56, Fig. 5).

We are persuaded by Petitioner’s contentions. Thornberg ’983 discloses control panel 200 provides remote operator control of UAV 100. Ex. 1006, 4:29–30. Control panel computer 209 converts control commands provided by control stick 205 into signals that are transmitted by communications equipment 212. *Id.* at 4:36–39. These transmitted control signals are received by antenna 42 of the UAV and then processed by flight control computer 38 and avionics equipment 34 to “provide the appropriate control surface commands to the UAV control surfaces to perform the desired maneuvers.” *Id.* at 4:44–56. Thus, Thornberg ’983’s UAV 100 receives signals from control panel 200 (a remote control device), and these control signals include data for controlling motion of the UAV. For the reasons discussed above, we determine that one of ordinary skill in the art would have recognized that these transmitted control signals would have comprised RF signals.

c) Limitation [c]: “generating motion data from at least one sensor of the RC aircraft based on motion of the RC aircraft”

Petitioner contends that Thornberg ’983’s navigation system 36 generates motion data based on motion of the vehicle. Pet. 29 (citing Ex. 1006, 3:55–61, 4:11–16, 5:32–43, 7:51–54, Fig. 6). Petitioner also contends that the measurement of the vehicle’s true heading by navigation system 36 corresponds to the claimed motion data. *Id.*

We find Petitioner’s contention persuasive. Thornberg ’983 discloses that navigation system 36, which can be a ring laser gyro or an inertial navigation system, provides the vehicle’s true heading signal, and the true heading signal is indicative of the vehicle’s orientation with respect to true north. Ex. 1006, 5:36–40. As Petitioner points out, gyroscopes are among the devices that the ’913 patent teaches the motion sensing module includes to generate motion data. See Ex. 1001, 5:16–24. The vehicle’s true heading in Thornberg ’983 indicates its orientation, and we have construed “motion data” to include data indicative of an aircraft’s orientation. See *supra* § III.C.

d) Limitation [d]: “controlling the RC aircraft based on the command data and the motion data, wherein the command data correspond to user commands in a first coordinate system from a perspective of the remote control device and the command data are transformed into control data in a second coordinate system that is from a perspective of the RC aircraft”

Petitioner asserts that Thornberg ’983 discloses that “flight control computer 38 includes a transformation function 400 that generates TPSS and TRSS ‘control data’ to control the motion of the RC aircraft based on the received pitch and roll commands (claimed ‘command data’) and a transformation angle θ .” Pet. 30 (citing Ex. 1006, 6:8–28, 5:20–35). Thus, according to Petitioner, “the TPSS and TRSS control data are generated based on both command data and motion data” because the transformation angle is generated from a measurement of the vehicle’s true heading (i.e., motion data). *Id.* at 30–31 (citing Ex. 1006, 2:56–60, 2:63–67, 6:2–11, Fig. 3). Petitioner further asserts that Thornberg ’983 teaches providing the user commands “in a first coordinate system from a perspective of the

remote control device” because “the OPERATOR frame of reference” is from the perspective of the remote control or the vehicle operator. *Id.* at 31–32 (citing Ex. 1006, 2:41–49 (“based on the orientation of the vehicle operator”), 7:19–26 (“based on the orientation of the operator control panel”)). Additionally, Petitioner argues that Thornberg ’983’s TPSS and TRSS signals constitute “control data in a second coordinate system that is from a perspective of the RC aircraft” as claimed because these data control the vehicle in the vehicle’s coordinate system and the vehicle’s coordinate system is aligned with the direction of a forward reference position of the vehicle and, thus, based on the vehicle’s orientation. Pet. 32–33 (citing Ex. 1006, 5:53–61; Ex. 1003 ¶ 495).

We are persuaded by Petitioner’s assertion that Thornberg ’983 discloses this limitation [d]. As discussed above (*see supra* § III.D.1), flight control computer 38 is provided with transformation function 400. Ex. 1006, 5:9–12. Transformation function 400 receives an input of command data (the pitch command and the roll command) from the control panel through antenna 42 and an input of the transformation angle, θ , which is based on the true heading of the vehicle provided by navigation system 36. *Id.* at 5:19–31, Fig. 6. For the reasons discussed below, we determine that the transformation angle is “motion data,” such that Thornberg ’983 discloses controlling the vehicle based on command data (the pitch and roll commands) and motion data.

In addition, Thornberg ’983 discloses that its “system provides for the referencing of vehicle commands *based on an operator frame of reference* so that control commands provided by the operator remain intuitive and independent of the orientation of the vehicle with respect to the operator.”

Id. at 3:40–45 (emphasis added). Transformation function 400 (via pitch axis transformation function 410 and roll axis transformation function 412) transforms the pitch command and the roll command into a transformed pitch stick signal (TPSS) and a transformed roll stick signal (TRSS) using equations that are based on the transformation angle. *Id.* at 6:17–28. When the system is in the operator reference mode, the pitch and roll commands are transformed based on the difference between the vehicle heading and the orientation of the operator control panel. *Id.* at 7:9–11 (describing that, in the map reference mode, the pitch and roll commands are transformed based on the difference between the vehicle heading and the reference heading), 19–24 (describing that operation of the operator reference mode essentially is identical to the operation of the map reference mode, except the reference axis is based on orientation of the operator control panel for purposes of transformation); *see also id.* at 6:8–11 (“In an operator reference mode, the orientation of the operator upon activation of the operator mode is used as the reference axis.”). Thus, in the operator reference mode, the pitch and roll commands (i.e., user commands or command data) are in accordance with a first coordinate system that is from a perspective of the operator control panel, and the TPSS and the TRSS (i.e., control data) are in accordance with a second coordinate system that is from a perspective of the vehicle.

Patent Owner argues that Thornberg ’983 does not disclose controlling an RC aircraft based on motion data. PO Resp. 8–13; Sur-Reply 6–8. Patent Owner agrees that Thornberg ’983 discloses creating TPSS and TRSS through the transformation of transformation angle θ , which is determined based on the vehicle’s true heading. PO Resp. 8. But Patent

Owner contends that transformation angle θ is not “motion data” because it is solely an indication of orientation. *Id.* (citing Ex. 2006 ¶¶ 74–75). The distinction Patent Owner urges between Thornberg ’983 and the claimed subject matter is based on Patent Owner’s proposed construction of “motion data” as requiring data indicative of a change in position. *See id.* at 8–9; *see also* Tr. 103:1–8. For the reasons discussed in Section III.C., we decline to adopt Patent Owner’s proposed construction. Under the construction we have adopted, Thornberg ’983’s transformation angle θ is motion data because, as both parties agree, it indicates the vehicle’s orientation.

e) *Limitation [e]: “wherein the user commands includes lift command data that indicates a hovering state and controlling the RC aircraft includes controlling the RC aircraft to a hovering state in response to the lift command data”*

Petitioner asserts that, although not expressly disclosing controlling an RC aircraft to a hovering state in response to lift command data, Thornberg ’983 discloses that “its system is applicable to ‘any’ remotely-operated vehicle, and describes that such a vehicle may be used for tasks that typically require hovering, such as inspection, maintenance, repair, and surveillance.” Pet. 33 (citing Ex. 1006, 1:18–24, 3:54–61, 7:46–51). Petitioner adds that “[i]t would have been obvious to a POSITA that the ability to hover in response to lift command data would be implemented in a remotely-operated vehicle adapted, e.g., to perform airborne surveillance as *Thornberg* teaches, in view of *Karem*.” *Id.* (citing Ex. 1003 ¶ 497). Petitioner argues further that *Karem* discloses controlling a rotorcraft into a “complete rotorcraft hover,” which Petitioner asserts indicates that *Karem*’s control unit 100 sends lift command data to instruct the rotorcraft to enter

the hovering state. *Id.* at 34 (citing Ex. 1008, 7:13–23, 32–39; Ex. 1003 ¶ 500). Petitioner further asserts that

[a] POSITA would have been motivated to modify *Thornberg*’s control panel 200 to “control” the UAV 100 in a hovering state, i.e., by sending appropriate lift command data to the vehicle when the operator releases the input controls as *Karem* teaches, in order to facilitate aerial tasks that may involve a hovering state, such as airborne surveillance, inspection, maintenance, and repair, that *Thornberg* teaches were “well known” uses of UAVs.

Id. at 35 (citing Ex. 1006, 1:15–24; Ex. 1003 ¶ 502).

We are persuaded by Petitioner’s arguments that the combination of *Thornberg* ’983 and *Karem* teaches limitation [e], and that an ordinarily skilled artisan would have been motivated to combine the references as claimed and would have had a reasonable expectation of success in doing so. Specifically, Petitioner’s arguments are supported by the disclosure of *Karem*, which teaches a remotely-operated vehicle in a hovering state (Ex. 1008, 7:13–23, 32–39), and *Thornberg* ’983 teaches remotely operated vehicles include helicopters (Ex. 1006, 1:14–17). Further, Petitioner’s arguments are supported by Dr. Hansman’s undisputed testimony that one of ordinary skill in the art would have been motivated to modify *Thornberg* ’983’s control panel 200 to control UAV 100 in a hovering state by sending appropriate lift command data to the vehicle when the operator releases the input controls, as *Karem* teaches, to facilitate aerial tasks that may involve a hovering state, such as airborne surveillance, inspection, maintenance, and repair. Ex. 1003 ¶ 502. This testimony is supported by *Thornberg* ’983’s teaching that (1) airborne surveillance, inspection, maintenance, and repair were well known uses of UAVs; and (2) remote operation of UAVs apply to remotely operated helicopters. See Ex. 1006, 1:15–24.

f) Conclusion

For the foregoing reasons, we determine that Petitioner has shown by a preponderance of the evidence that the combination of Thornberg '983 and Karem renders claim 1 unpatentable as obvious.

4. Independent Claims 6 and 11

Like claim 1, independent claims 6 and 11 are both directed to a method for use with a radio controlled (RC) aircraft, and both include limitations that are substantially similar to limitations [b]–[e] of claim 1. Ex. 1001, 9:61–10:9, 10:37–44, 47–54. For these limitations, Petitioner primarily relies on the arguments discussed above with respect to independent claim 1, with minor variations. *See* Pet. 35–46. Patent Owner argues claims 1, 6, and 11 together, and thus relies on the same arguments for these limitations of claims 6 and 11 as it did in connection with limitations [b]–[e] of claim 1. PO Resp. 8–13; Sur-Reply 6–8. For the reasons discussed above, we find Patent Owner's arguments unpersuasive and are persuaded on the full record that the combination of Thornberg '983 and Karem discloses these limitations of claims 6 and 11. *See supra* § III.D.3.

In addition, claim 6 recites:

in a first mode of operation:

the user commands indicated by the command data are transformed into transformed commands in a second coordinate system that is from a perspective of the RC aircraft; and

the RC aircraft is controlled based on the transformed commands; and

in a second mode of operation:

the RC aircraft is controlled directly based on the user commands indicated by the command data in the first coordinate system.

Ex. 1001, 10:10–20. Similarly, claim 11 further recites:

generating a mode control signal that indicates one of: a first mode of operation and a second mode of operation . . .

when the mode control signal indicates the first mode of operation:

the user commands indicated by the command data are transformed into transformed commands in a second coordinate system that is from a perspective of the RC aircraft; and

the RC aircraft is controlled based on the transformed commands; and

when the mode control signal indicates the second mode of operation:

the RC aircraft is controlled directly based on the user commands indicated by the command data in the first coordinate system.

Id. at 10:45–46, 55–67.

For these limitations, Petitioner asserts that Thornberg '983 teaches “various different frames of reference for controlling the UAV.” Pet. 39 (citing Ex. 1006, 5:3–8). According to Petitioner, Thornberg '983 discloses switch 257 on control panel 200 that the vehicle operator uses to select a VEHICLE, MAP, or OPERATOR frame of reference for the pitch and roll commands. *Id.* (citing Ex. 1006, 2:56–60, 2:63–67, 6:2–11, Fig. 3 (switch 257), Fig. 6 (switch 457)). Petitioner asserts that the position of switch 257 is transmitted to the vehicle to set the corresponding value of switch 457. *Id.* (citing Ex. 1006, 6:2–5); *see also id.* at 43 (“A signal indicating the position of switch 257 is transmitted from the control panel 200 to the vehicle to set the corresponding value of switch 457.”) (citing

Ex. 1006, 6:2–5). In the Operator reference mode, Petitioner contends that the OPERATOR frame of reference provides a frame of reference with respect to the vehicle operator. *Id.* at 39 (citing Ex. 1006, 2:41–49, 7:19–26). Petitioner adds that Thornberg '983 teaches that the OPERATOR frame of reference may vary with the orientation of the operator's control panel 200, in which case Thornberg '983 refers to the mode as a “variable operator reference mode,” which Petitioner argues teaches the claimed “first mode of operation.” *Id.*; *see id.* at 44 (making same assertion with respect to claim 11).

For the second mode of operation, Petitioner contends that Thornberg '983 teaches a VEHICLE reference mode

with the vehicle reference defined as the forward vehicle axis (i.e., switch 245 in Fig. 3 set to FORWARD), the transformation angle θ is zero, and the pitch command data 405 and roll command data 415 received by the UAV are directly provided as the control data 470 and 475, with no transformation.

Id. at 41 (citing Ex. 1006, Fig. 3 (switch 257 showing “VEHICLE” reference mode), Fig. 6 (switch 457 showing “VEHICLE” mode), 6:2–7, 6:17–49); *see id.* at 44 (making same assertion with respect to claim 11).

We are persuaded by Petitioner's undisputed arguments that Thornberg '983 discloses these additional limitations of claims 6 and 11. As noted above (*see supra* § III.D.1), Thornberg '983 discloses three reference modes: (1) a vehicle reference mode, in which the vehicle's reference axis is used for purposes of controlling the vehicle; (2) a map reference mode, in which an earth reference, such as North, is used for control of the vehicle; and (3) an operator reference mode, in which the orientation of the operator is used as the reference axis. Ex. 1006, 6:5–11. These reference modes (i.e.,

modes of operation) are selected by reference mode switch 457, which is operated by control panel reference mode switch 257. *Id.* at 5:67–6:5.

For the reasons discussed above, we determine Thornberg '983 discloses that, when the system is in the operator reference mode, the user commands/command data (i.e., pitch command 405 and roll command 415) are transformed into transformed commands (i.e., TPSS and TRSS) in a second coordinate system that is from a perspective of the RC aircraft (i.e., the UAV). *See supra* § III.D.3.d. As such, we agree that the operator reference mode (or its variation, the variable operator reference mode) satisfies the claimed first mode of operation.

Thornberg '983 further discloses that “the transformation function should not make any changes in the pitch command 405 and roll command 415” when the vehicle is being operated in the vehicle reference mode (and when the vehicle reference is the forward vehicle axis),³ such that the TPSS output by transformation function 400 is equal to the pitch command and the TRSS is equal to the roll command. *Id.* at 6:30–36. Pitch command 405 and roll command 415 represent the control signals or commands received from the control panels. *Id.* at 5:19–28. Therefore, we agree that, when in the vehicle reference mode, Thornberg '983's vehicle is controlled directly based on the user commands (i.e., the unchanged pitch command 405 and roll command 415), such that the vehicle reference mode satisfies the claimed second mode of operation.

³ The vehicle reference is determined by vehicle reference switch 445, which is operated by control panel vehicle reference switch 245. Ex. 1006, 5:51–56.

Upon considering all of the evidence of record, we determine that Petitioner has shown by a preponderance of the evidence that the combination of Thornberg '983 and Karem renders claims 6 and 11 unpatentable as obvious.

5. *Dependent Claims 3–5, 8–10, and 13–15*

Claims 3–5 depend from claim 1, claims 8–10 depend from claim 6, and claims 13–15 depend from claim 11. Petitioner argues that these claims would have been obvious over the combination of Thornberg '983 and Karem, providing detailed explanations supported by the testimony of Dr. Hansman and specific citations to Thornberg '983 indicating where in the reference the limitations of claims 3–5, 8–10, and 13–15 are taught. Pet. 44–46. Patent Owner does not dispute Petitioner's contentions regarding these dependent claims separately from its arguments concerning claims 1, 6, and 11. *See* PO Resp. 7–13 (arguing only claims 1, 6, and 11); Sur-Reply 6–8 (same); *see also LG Elecs.*, 759 F. App'x at 925 ("The Board is 'not required to address undisputed matters' or arguments about limitations with which it was never presented."). We are persuaded by Petitioner's uncontested evidence and arguments regarding these claims, as discussed in greater detail below.

We find that Thornberg '983 discloses the subject matter of claims 3, 8, and 13 because it describes control panel 200 producing signals or command data in the form of a pitch command (i.e., pitch-axis command data) and a roll command (i.e., roll-axis command data). *See* Ex. 1006, 4:29–43, 5:20–35; *see also* Pet. 44. Thornberg '983 also describes that navigation system 36 determines the true heading of the vehicle, which is yaw-axis motion data. *See* Ex. 1006, 5:31–34; *see also* Pet. 45.

As discussed above (*see supra* § III.D.1), Thornberg '983 discloses that pitch axis transformation function 410 determines a transformed pitch stick signal (TPSS) using the equation:

$$\text{TPSS} = \text{pitch command} * \cos(\theta) - \text{roll command} * \sin(\theta),$$

and roll axis transformation function 412 determines a transformed roll stick signal (TRSS) using the equation:

$$\text{TRSS} = \text{roll command} * \cos(\theta) + \text{pitch command} * \sin(\theta).$$

Ex. 1006, 6:17–28. Accordingly, we find that Thornberg '983 discloses the subject matter of claims 4, 9, and 14 because the TRSS (i.e., roll-axis control data or roll-axis data) is determined as a function of the roll command (i.e., roll-axis command data), the pitch command (i.e., pitch-axis command data), and the transformation angle (which is dependent on yaw-axis motion data). *See* Pet. 45. Similarly, we find that Thornberg '983 discloses the subject matter of claims 5, 10, and 15 because the TPSS (i.e., pitch-axis control data or pitch-axis data) is determined as a function of the roll command (i.e., roll-axis command data), the pitch command (i.e., pitch-axis command data), and the transformation angle (which is dependent on yaw-axis motion data). *See id.* at 46.

E. Asserted Obviousness based on Thornberg '983, Kareem, and Rivers

Petitioner contends claims 2, 7, and 12 are unpatentable over Thornberg '983, Kareem, and Rivers. Pet. 4, 46–48.

Claim 2 depends from claim 1 and further recites that “the command data includes launch data, and wherein controlling the RC aircraft includes launching an object from the RC aircraft in response to the launch data.”

Ex. 1001, 9:46–49. Claims 7 and 12 depend from claims 6 and 11,

respectively, and add the same limitations as claim 2. *Id.* at 10:22–25, 11:1–4.

Petitioner argues that Thornberg '983 discloses using UAVs to deliver ordinance or supply materials. Pet. 47 (citing Ex. 1006, 1:25–34). In addition, Petitioner contends Rivers discloses that payload dispenser 60, which coupled to receiver 30, launches an object from an aircraft in response to launch data. *Id.* (citing Ex. 1010 ¶¶ 21, 22, 24, 27). According to Petitioner, it would have been obvious to one of ordinary skill in the art

to mount the payload dispensing system of *Rivers*, which satisfies the limitations of claims 2, 7, and 12, on the remotely-operated vehicle in *Thornberg*, since *Thornberg* teaches delivery of ordinance or supplies using UAVs (Ex-1006, 1:25–34) and *Rivers* describes a known payload dispenser system to effect such delivery by launching an object from the UAV in response to received launch data as claimed.

Id. at 48 (citing Ex. 1003 ¶ 531).

We are persuaded that *Rivers* teaches the subject matter added by claims 2, 7, and 12. Patent Owner does not dispute Petitioner's contentions regarding claims 2, 7, and 12 separately from its arguments concerning claim 1. See PO Resp. 7–13. Accordingly, we determine that Petitioner has shown by a preponderance of the evidence that the combination of *Thornberg* '983, *Karem*, and *Rivers* renders claims 2, 7, and 12 unpatentable as obvious.

F. Grounds Based on Muramatsu

In Petitioner's grounds 3–6, *Muramatsu* is the primary reference. In a final decision, the Board is required to address the patentability of all claims challenged in a petition. See 35 U.S.C. § 318(a) (providing that the Board "shall issue a final written decision with respect to the patentability of any

patent claim challenged by the petitioner and any new claim added” by amendment during the proceeding); *SAS Inst., Inc. v. Iancu*, 138 S. Ct. 1348, 1354 (2018) (“[W]hen § 318(a) says the Board’s final written decision ‘shall’ resolve the patentability of ‘any patent claim challenged by the petitioner,’ it means the Board *must* address *every* claim the petitioner has challenged.”); Guidance on the Impact of SAS on AIA Trial Proceedings (Apr. 26, 2018)⁴ (“[I]f the PTAB institutes a trial, the PTAB will institute on all challenges raised in the petition The final written decision will address, to the extent claims are still pending at the time of decision, all patent claims challenged by the petitioner and all new claims added through the amendment process.”).

However, we are not aware of any requirement that once all challenged claims have been determined unpatentable, the Board must go on to analyze additional grounds challenging the same claims.⁵ In some cases,

⁴ Available at www.uspto.gov/patents-application-process/patent-trial-and-appeal-board/trials/guidance-impact-sas-aia-trial.

⁵ We note that in *Adidas AG v. Nike, Inc.*, 894 F.3d 1256 (Fed. Cir. 2018), the Federal Circuit remanded to the Board to consider a second ground when the Board’s final decision had only addressed a first ground covering the same claims. *Id.* at 1258. But in *Adidas*, the Board’s final decision held that the challenged claims were not unpatentable based on the first ground. *Id.* at 1257. Thus, unlike the circumstances here, the Board’s decision in *Adidas* was not dispositive of the petitioner’s challenges. Similarly, in *AC Technologies S.A. v. Amazon.com, Inc.*, 912 F.3d 1358 (Fed. Cir. 2019), the Federal Circuit held that the Board properly considered a ground on which it did not initially institute, when the originally non-instituted ground challenged claims that were not shown unpatentable based on the originally instituted grounds. *Id.* at 1364–65. The reasoning of *AC Technologies* is that SAS requires the Board to address all claims challenged by a petitioner, so a final decision holding that some challenged claims were not shown unpatentable without addressing all of the grounds presented in the petition

doing so is an inefficient use of the Board’s resources, in that it may detract from the time and attention that is available to analyze and explain our reasoning for the dispositive issues. In this regard, an early Federal Circuit decision concerning the International Trade Commission explained that an administrative agency “is at perfect liberty” to reach a decision based on a single dispositive issue because doing so “can not only save the parties, the [agency], and [the reviewing] court unnecessary cost and effort, it can greatly ease the burden on [the agency] faced with a . . . proceeding involving numerous complex issues and required by statute to reach its conclusion within rigid time limits.” *Beloit Corp. v. Valmet Oy*, 742 F.2d 1421, 1423 (Fed. Cir. 1984).

Returning to the context of the Board’s decisions, in final written decisions both before and after SAS, the Board has declined to reach grounds challenging claims that were already held unpatentable. *See, e.g., Sure-Fire Elec. Corp. v. Yongjiang Yin*, Case IPR2014-01448, slip op. at 25 (PTAB Feb. 22, 2016) (Paper 56), *aff’d*, 702 F. App’x 981 (Fed. Cir. 2017); *SK Hynix Inc. v. Netlist, Inc.*, Case IPR2017-00692, slip op. at 40 (PTAB July 5, 2018) (Paper 25). Similarly, the Federal Circuit generally declines to reach additional grounds of unpatentability when it affirms determinations of unpatentability for the same claims. *See, e.g., Trading Techs. Int’l, Inc. v. IBG LLC*, 921 F.3d 1378, 1386 (Fed. Cir. 2019) (“In light of this conclusion [that claims 1–22 are ineligible], we need not address Petitioners’ separate ground that claims 12–22 are directed to non-statutory subject matter.”);

would violate the statutory scheme. *Id.* But we do not understand AC Technologies to require the Board to address grounds that challenge claims that have already been held unpatentable on other grounds.

Victaulic Co. v. Iancu, 753 F. App'x 895, 901–02 (Fed. Cir. 2018) (“We discern no error in the Board’s analysis and affirm its conclusion that claims 2 and 10 would have been obvious in view of Lewis and Lane. We thus do not reach the question of whether claims 2 and 10 would have been obvious in view of Vieregge and Lane.”); *Cole Kepro Int’l, LLC v. VSR Indus., Inc.*, 695 F. App'x 566, 570 n.2 (Fed. Cir. 2017) (“Because we determine that the Board did not err in concluding that claims 1–14 of the ’814 [patent] are unpatentable as obvious in view of Runte, we do not address the other instituted grounds analyzed by the Board.”); *In re Gleave*, 560 F.3d 1331, 1338 (Fed. Cir. 2009) (not reaching obviousness after finding anticipation).

Here, the grounds led by Muramatsu (i.e., grounds 3–6) challenge claims we have already determined are unpatentable based on the grounds led by Thornberg ’983 (i.e., grounds 1 and 2). In addition, Petitioner’s Muramatsu-led challenges hinge on the same issue as the grounds already addressed, because Patent Owner’s sole argument against the Muramatsu-led challenges is based on its proposed construction for “motion data.” See PO Resp. 13–15; see also Tr. 103:1–8 (Patent Owner agreeing at the hearing that the claim construction of “motion data” is dispositive of all disputed issues).

Accordingly, in the circumstances of this case, we decline to address the challenges presented in Petitioner’s grounds 3–6.

IV. MOTION TO AMEND

In its Motion to Amend, Patent Owner requests that we cancel claims 1–15 of the ’913 patent and replace them with proposed substitute claims 16–30. Mot. Amend 1. This Motion is contingent on our determination that any of claims 1–15 is unpatentable. *Id.*

A. Statutory and Regulatory Requirements

In reviewing a motion to amend, we consider whether the motion meets the statutory and regulatory requirements set forth in 35 U.S.C. § 316(d) and 37 C.F.R. § 42.121. *Lectrosonics, Inc. v. Zaxcom, Inc.*, Case IPR2018-01129 (PTAB Feb. 25, 2019) (Paper 15) (precedential). That is, the patent owner must demonstrate the following: (1) the amendment proposes a reasonable number of substitute claims; (2) the amendment responds to a ground of unpatentability involved in the trial; and (3) the amendment does not seek to enlarge the scope of the claims of the patent or introduce new subject matter. *See* 35 U.S.C. § 316(d); 37 C.F.R. § 42.121; *see also Lectrosonics, Inc.*, slip op. at 4–8. The patent owner, however, “does not bear the burden of persuasion to demonstrate the patentability of [the proposed] substitute claims.” *Lectrosonics, Inc.*, slip op. at 4 (citing *Aqua Prods., Inc. v. Matal*, 872 F.3d 1290 (Fed. Cir. 2017); *Bosch Auto. Serv. Sols. LLC v. Matal*, 878 F.3d 1027 (Fed. Cir. 2017)). “Rather, as a result of the current state of the law and [U.S. Patent and Trademark Office] rules and guidance, the burden of persuasion will ordinarily lie with the petitioner to show that any proposed substitute claims are unpatentable by a preponderance of the evidence.” *Lectrosonics, Inc.*, slip op. at 4.

Patent Owner asserts “[o]nly one substitute claim of the set of claims (Claims 16–30) is proposed to replace each of the challenged claims (Claims 1–15), and thus this motion presents a presumptively reasonable number of substitute claims in accordance with 37 C.F.R. § 42.121(a)(3).” Mot. Amend 1. Patent Owner also asserts that substitute claims 16–30 do not enlarge the scope of the originally issued claims 1–15, are supported by the original specification, and are responsive to the grounds of unpatentability

involved in the proceeding. *Id.* at 1–2. Petitioner does not dispute Patent Owner’s assertion that substitute claims 16–30 meet the requirements of responding to a ground of unpatentability involved in the trial and proposing a reasonable number of substitute claims.

Petitioner does argue, however, that Patent Owner has failed to meet its burden of production to show substitute claims 17, 22, 25, 27, and 30 do not enlarge the scope of the claims. Opp. Amend 6–7. Petitioner asserts that by deleting all the limitations of the corresponding original claims, Patent Owner impermissibly broadened the scope of these substitute claims. *Id.* at 6. Petitioner cites to several Board decisions for the proposition that a proposed substitute claim may never remove a claim feature. *Id.* at 6–7 (citing *Western Digital Corp. v. SPEX Techs., Inc.*, Case IPR2018-00082, 00084, slip op. at 6 (PTAB Apr. 25, 2018) (Paper 13); *MRSI Sys., LLC v. Palomar Techs., Inc.*, Case IPR2016-00043, slip op. at 27–28 (PTAB Mar. 29, 2017) (Paper 29); *Microsoft Corp v. Proxyconn, Inc.*, Case IPR2012-00026, slip op. at 59–61 (PTAB Feb. 19, 2014) (Paper 73); *American Megatrends, Inc. v. Kinglite Holdings Inc.*, Case IPR2015-01094, slip op. at 29 (PTAB Nov. 4, 2016) (Paper 48)).

We disagree with Petitioner’s per se reading of this requirement to proscribe removal of any claimed features. Our precedential decision in *Lectrosonics, Inc.* instructs that

[a] patent owner may not seek to broaden a challenged claim in any respect that enlarges the scope of the claims of the patent, for example, in the name of responding to an alleged ground of unpatentability. Likewise, a proposed substitute claim may not remove a feature of the claim in a manner that broadens the scope of the claims of the challenged patent. *A substitute claim will meet the*

requirements of § 42.121(a)(2)(i) and (ii) if it narrows the scope of at least one claim of the patent, for example, the challenged claim it replaces, in a way that is responsive to a ground of unpatentability involved in the trial.

Lectrosonics, Inc., slip op. 6–7 (emphasis added). Here, we determine that substitute claim 16 narrows the scope of original issued claim 1 by requiring that, *inter alia*, the command data includes an operation to establish an initial position of the RC aircraft. See Ex. 2005, 2. We also determine that substitute claim 21 narrows the scope of original issued claim 6 by requiring, *inter alia*, generating initial position data indicating an initial position of the RC aircraft at a first time. See *id.* at 4. Furthermore, we determine that substitute claim 26 narrows the scope of original issued claim 11 by requiring that, *inter alia*, the command data includes an operation to establish an initial position of the RC aircraft. See *id.* at 6. Substitute claim 17 depends from substitute independent claim 16 and includes all the limitations recited in substitute claim 16. Thus, substitute claim 17 is, at least, narrower in scope than originally issued claim 1. Additionally, substitute claims 22 and 25 depend from substitute independent claim 21 and include all the limitations recited in substitute claim 21. Thus, substitute claims 22 and 25 are, at least, narrower in scope than originally issued claim 6. Last, substitute claims 27 and 30 depend from substitute independent claim 26 and include all the limitations recited in substitute claim 26. Thus, substitute claims 27 and 30 are, at least, narrower in scope than originally issued claim 11. Accordingly, substitute claims 17, 22, 25, 27, and 30 meet the requirements of § 42.121(a)(2)(i) and (ii) because each of these claims narrows the scope of at least one claim of the patent.

Petitioner also argues that Patent Owner has failed to meet its burden of production to show substitute claims 16–30 do not introduce new matter. Opp. Amend 2–6. In its Motion, Patent Owner notes that the ’913 patent issued from U.S. Patent Application No. 14/724,037 (“the ’037 application”).⁶ Mot. Amend 7. Patent Owner, however, then argues that proposed substitute claims 16, 21, and 26 are supported by “the ’995 Application” (*id.* at 7–10), and proposed substitute claims 17–20, 22–25, and 27–30 are supported by “the originally filed disclosure of the ’913 Patent” (*id.* at 11–12). We agree with Petitioner’s assessment that Patent Owner’s references to “the ’995 Application” are inadvertent errors that were intended to refer to the ’037 application. See Opp. Amend 2 n.1.

We do not reach Petitioner’s argument that substitute claims 16–30 introduce new matter because we find that these proposed substitute claims are not patentable over the cited art, as discussed below. See *Beloit Corp.*, 742 F.2d at 1423 (finding that an administrative agency is at liberty to reach a decision based on a single dispositive issue because doing so “can not only save the parties, the [agency], and [the reviewing] court unnecessary cost and effort,” but can “greatly ease the burden on [the agency] faced with a . . . proceeding involving numerous complex issues and required by statute to reach its conclusion within rigid time limits”).

⁶ Patent Owner did not file the ’037 application as part of the record in this proceeding. Under our rules, “[a]ll evidence must be filed in the form of an exhibit.” 37 C.F.R. § 42.63(a). Nevertheless, we have obtained a copy of the ’037 application and include it in the record as Exhibit 3001.

B. Patentability

1. *Dr. Hansman's Testimony*

As an initial point, Patent Owner argues that Dr. Hansman's testimony regarding the substitute claims (Exhibit 1023) is speculative and should be given no weight. Reply Amend 3–5. The primary basis for this argument is Patent Owner's assertion that Dr. Hansman relies on the variable operator reference mode of Thornberg '983, but the entirety of the description of this mode is:

To overcome this short coming, a variable operator reference mode may be provided wherein the operator reference changes based upon changes in the orientation of the operator control panel. This may be accomplished by mounting the operator control panel on a pedestal and providing a servo or gyro signal indicative of the change in the position of the control panel with respect to the initial operator reference.

Id. at 3 (quoting Ex. 1006, 7:31–38).

Although Thornberg '983's discussion of the variable operator reference mode is not extensive, we note that the variable operator reference mode is described as overcoming a problem associated with the standard operator reference mode. Ex. 1006, 7:27–35. As such, the variable operator reference mode is a variant of the standard operator reference mode and one of ordinary skill in the art would recognize that it would include many of the features described in connection with the standard operator reference mode. Furthermore, Thornberg '983 discloses that the operation of the standard operator reference mode “is basically identical” to the map reference mode, with the exception of the reference axis used. *Id.* at 7:19–23. This disclosure further suggests that Thornberg '983 contemplates that the variable operator reference mode is the same as the standard operator

reference mode except for the functionality of changing the operator reference in accordance with changes in the orientation of the control panel.

In view of the above, we disagree with Patent Owner's contention that Dr. Hansman's testimony is impermissibly speculative.

2. *Substitute Claim 16*

In its Motion to Amend, Patent Owner requests that we cancel independent claim 1 and replace it with substitute independent claim 16. Mot. Amend 2–3. Proposed substitute claim 16 is reproduced below, with bracketing to indicate deletions and underscoring to indicate additions:

16. A method for use with a radio controlled (RC) aircraft, the method comprising:

receiving ~~[[an]]~~ a radio frequency (RF) signal from a remote control device that includes command data to control motion of the RC aircraft, wherein the command data includes an operation to establish an initial position of the RC aircraft;

generating motion data from at least one sensor of the RC aircraft based on motion of the RC aircraft, wherein the motion data is distinct from the command data;

generating first position data indicating a first position of the RC aircraft at a first time;

generating second position data indicating a second position of the RC aircraft at a second time; and

controlling the RC aircraft based on the command data, the first position data, the second position data, and the motion data, wherein the command data correspond to user commands in a first coordinate system from a perspective of the remote control device and the command data are transformed into control data in a second coordinate system that is from a perspective of the RC aircraft;

wherein the user commands includes lift command data that indicates a hovering state and controlling the RC aircraft

includes controlling the RC aircraft to a hovering state in response to the lift command data.

Ex. 2005, 2.

Petitioner asserts that claim 1 is unpatentable over Thornberg '983 in view of Karem, and the newly added limitations of substitute claim 16 are disclosed in and rendered obvious by Thornberg '983. Opp. Amend 12. Specifically, regarding the added limitation “wherein the command data includes an operation to establish an initial position of the RC aircraft,” Petitioner argues that Thornberg '983 teaches that selection of the OPERATOR mode via switch 257 triggers the activation of the operator reference mode and establishment of the initial operator reference axis. *Id.* at 13 (citing Ex. 1006, 7:19–43). Thus, according to Petitioner, when the vehicle operator initially sets the position of switch 257 to the OPERATOR reference mode while facing the UAV, command data from control panel 200 includes an operation to establish an initial position of the RC aircraft “because establishing the ‘initial operator reference’ axis establishes the vehicle’s initial position.” *Id.* (citing Ex. 1023 ¶¶ 191–195). In addition, Petitioner argues that the phrase “command data includes an operation” is indefinite because one of ordinary skill in the art would understand that “data” and “operation” have different meanings and “data” could not include “an operation.” *Id.* at 12 (citing Ex. 1023 ¶ 191).

Patent Owner contends that Thornberg '983 is silent regarding an operation or command being generated when the switch is changed to the operator reference mode. Reply Amend 10. Further, Patent Owner asserts that when the switch is changed, a reference axis is established based on an *orientation* of the operator control panel, and not the initial position of the vehicle. *Id.* at 10–11. Patent Owner contends also that Thornberg '983 does

not teach that the operator control panel must be pointed at the vehicle. *Id.* at 11.

Based on the entire record, we are persuaded by Petitioner's arguments that Thornberg '983 discloses the newly added limitation "wherein the command data includes an operation to establish an initial position of the RC aircraft." As discussed in detail below, we find that Thornberg '983 teaches that when the operator reference mode is selected, the reference mode signal will be provided on line 453. Ex. 1006, 5:67–6:2, Fig. 6; *see also id.* at 7:24–26 ("[I]f the operator is facing North upon activation of the operator mode, the North reference will be provided on the line 453."). If the operator is directly facing the remotely operated vehicle (*see* Ex. 1006, Fig. 2) at initialization, for example directly facing North at the remotely operated vehicle, the orientation of the operator, which is the North reference provided on line 453, is also the angular position of the remotely operated vehicle. *See* Ex. 1006, 6:8–11 ("In an operator reference mode, the orientation of the operator upon activation of the operator mode is used as the reference axis."). Further, we credit Dr. Hansman's testimony that the command data indicates an operation to determine an initial position of the vehicle because one of ordinary skill in the art would have understood the command data from control panel 200 includes an operation to determine the "initial operator reference" direction corresponding to the vehicle's initial position when the operator sets switch 257 to the OPERATOR mode. Ex. 1023 ¶ 195. In view of our determination that Thornberg '983 discloses this newly added limitation, we do not reach Petitioner's assertion of indefiniteness. For purposes of evaluating the patentability of the claim, however, we consider the phrase "command data includes an operation" as

meaning the command data includes data that causes the recited operation to occur.

Regarding the newly added limitation “wherein the motion data is distinct from the command data,” Petitioner argues that Thornberg ’983’s measurement of the vehicle’s true heading by navigation system 36 corresponds to the claimed motion data, and this motion data is distinct from the command data that Thornberg ’983’s vehicle receives from control panel 200. Opp. Amend 13 (citing Pet. 29; Ex. 1023 ¶ 196; Ex. 1006, 4:29–56, 5:32–43, Figs. 3, 5, 6; Ex. 1003 ¶¶ 297–302).

In response, Patent Owner argues “Petitioners assert that the operator control panel’s orientation is provided on line 453 of the stick transformation function 400 of [Thornberg ’983] illustrated in FIG. 6.” Reply Amend 9. Patent Owner argues further that the data sent by Thornberg ’983 is the command data (citing Ex. 1006, 4:39–43), and the command data thus would necessarily include the orientation of the operator control data. *Id.*

Patent Owner, however, appears to have misinterpreted Petitioner’s position. Specifically, Petitioner does not assert that the “orientation of the operator control data” in Thornberg ’983 is the claimed motion data that is distinct from the command data. Rather, Petitioner contends that the vehicle’s true heading detected by navigation system 36 corresponds to the claimed motion data and is distinct from the command data in Thornberg ’983. Opp. Amend 13; *see also* Sur-Reply Amend 8 (arguing claim 16 does not require “position data” or “control panel orientation data” be distinct from “command data,” and Thornberg ’983 teaches “motion data” and “command data” that are distinct).

Having reviewed the entire record, we find Petitioner's arguments that Thornberg '983 discloses the newly added limitation "wherein the motion data is distinct from the command data" persuasive. As discussed above, we are persuaded that Thornberg '983's determination of the vehicle's true heading by navigation system 36 corresponds to the claimed motion data. *See supra* § III.D.3.c. Furthermore, this motion data is generated by navigation system 36 and provided to stick transformation function 400 of the flight control computer from navigation system 36 (Ex. 1006, 5:19–22, 5:29–34), while the command data of Thornberg '983 is generated by control panel 200 and provided to stick transformation function 400 from control panel 200 (*id.* at 4:29–39, 5:19–28). The motion data and the command data are thus distinct from each other.

Next, Petitioner asserts that Thornberg '983 discloses the newly added limitations "generating first position data indicating a first position of the RC aircraft at a first time" and "generating second position data indicating a second position of the RC aircraft at a second time." Opp. Amend 13–16. Petitioner contends Thornberg '983 discloses that, in the variable operator reference mode, the operator's frame of reference is determined from an angular displacement between the operator's initial reference direction (i.e., corresponding to a first position of the UAV at a first time) and the operator's current reference direction (i.e., corresponding to a second position of the UAV at a second time). *Id.* at 14 (citing Ex. 1006, 7:31–43; Ex. 1023 ¶ 197). Referring to Figure 6 of Thornberg '983, Petitioner asserts that one of ordinary skill in the art would understand the signals generated on line 453, at a first time (initialization) and a second time (current time), respectively correspond to the operator's orientation, and are also position

data indicating the position of the UAV at the first and second times. *Id.* (citing Ex. 1023 ¶¶ 60, 197). Petitioner further asserts that the reference heading signal on line 460 is also position data indicating the UAV's position at the first and second times, because line 460 is generated by adding the operator's orientation on line 453 to the vehicle's forward reference direction at each of those times. *Id.* (citing Ex. 1023 ¶¶ 60, 197; Ex. 1019, 120:17–122:17).

Additionally, Petitioner argues that GPS receivers such as those in Thornberg-1995⁷ or Rios⁸ were known to track the position of the UAV, and that one of ordinary skill in the art would have been motivated to combine a GPS receiver with Thornberg '983 because Thornberg '983 “*does not explicitly disclose how its UAV position is determined* and it would have been obvious to implement the positioning using conventional technology like GPS to determine its position at first and second times as claimed.” *Id.* at 15 (citing Ex. 1023 ¶¶ 63–64) (emphasis added).

Petitioner also argues that Thornberg '983 discloses controlling the RC aircraft based on the command data, the first position data, the second position data, and the motion data. *Id.* at 16–17. In particular, Petitioner

⁷ Thornberg, *Sikorsky Aircraft's Unmanned Aerial Vehicle, Cypher: System Description and Program Accomplishments*, Proceedings of American Helicopter Society 51st Annual Forum, Fort Worth, Texas, May 9–11, 1995, at 804–811 (“Thornberg-1995”). Petitioner and Patent Owner refer to Thornberg-1995 as Exhibit 1012. However, the title “Exhibit 1012” was reserved, but not used, for an exhibit in this record. See Paper 43, 1 (“Petitioner's Updated Exhibit List”). Nonetheless, because both parties have substantively discussed and cited to the contents of Thornberg-1995 in this proceeding, we include this reference as Exhibit 3002.

⁸ U.S. Patent No. 6,694,228 B2, issued Feb. 17, 2004 (Ex. 1025).

asserts that Thornberg '983 transforms the pitch and roll command data into TPSS and TRSS control data using the transformation angle, and the transformation angle is based on motion data (the vehicle's true heading) and position data indicating the vehicle's position at a second time relative to the vehicle's initial position at a first time. *Id.* (citing Ex. 1023 ¶ 205).

In response, Patent Owner argues that Thornberg '983 describes determining only an orientation of the vehicle, not a position of the vehicle. Reply Amend 5. Patent Owner argues that Thornberg '983 discloses transforming command data into control data based on orientation data only because Thornberg '983 describes creating TPSS and TRSS data based on pitch commands, roll commands, and transformation angle (θ). *Id.* at 5–6 (citing Ex. 1006, 5:30–32, 6:17–27). Patent Owner adds that there is no disclosure in Thornberg '983 that the transformation angle (θ) is indicative of anything other than orientation. *Id.* at 6 (citing Ex. 1006, 5:32–35, 5:38–40). Further, Patent Owner asserts that the orientation of the operator control panel in variable operator reference mode is not the same as determining the position of the vehicle. *Id.* at 6–7 (citing Ex. 1006, 7:31–35).

To start, we find that in the operator reference mode, Thornberg '983 teaches that “the reference axis for purposes of transformation is based on the *orientation* of the operator control panel upon activation of the operator reference mode.” Ex. 1006, 7:21–24 (emphasis added). In the variable operator reference mode, the “operator reference changes based upon changes in the *orientation* of the operator control panel.” *Id.* at 7:29–35 (emphasis added). Thornberg '983 further teaches that the operator control panel may be provided with a position indicator or mounted on a pedestal

with a servo or gyro signal indicative of the change in the position of the control panel with respect to the initial operator reference. *Id.* at 7:35–38. In this respect, the operator reference mode in Thornberg '983 tracks the *orientation* and *position* of the operator control panel.

Additionally, we understand Petitioner's arguments rely on a manner of operation in which the operator (and operator control panel) directly faces the remotely operative vehicle. In this way, Petitioner asserts that the operator's frame of reference corresponds to the angular position of the vehicle and is determined from an angular displacement from the operator's initial reference direction. Opp. Amend 14. In other words, when the operator control panel is directly facing the vehicle, the orientation of the control panel provides angular position data for the vehicle. Thornberg '983's Figure 2 shows this method of operation in which a remotely operated vehicle and operator control panel with "opposing frames of reference" are directly facing. Ex. 1006, 3:16–19.

With this manner of operation in mind, we turn to the question of whether the orientation of the control panel in Thornberg '983 indicates a position of the vehicle when the control panel is directed towards the vehicle. We first consider Dr. Hansman's testimony. Referring to Figure 5 of the '116 patent, Dr. Hansman testifies that the '913 patent teaches that angular displacement θ of an aircraft relative to the operator's origin point provides position data. Ex. 1023 ¶ 46. Figure 5 of '913 patent is reproduced below.

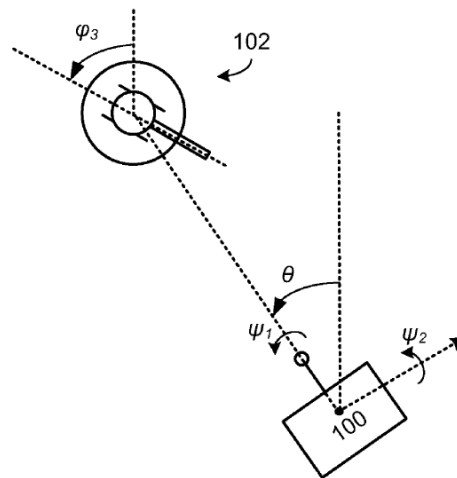


FIG. 5

Figure 5 shows the perspective of radio controlled aircraft 102 with respect to remote control device 100. Ex. 1001, 3:64–67. Dr. Hansman testifies that

θ is the angle between a reference line (dashed vertical line) and the line drawn from the user to the aircraft, therefore representing the user's orientation. At the same time, θ is also the angular displacement of the aircraft and is part of the position data (R , θ , Z) representing the aircraft's position in three-dimensional space defined with the user at the origin.

Ex. 1023 ¶ 46.

In the same manner described in the '913 patent, we find that the orientation of the control panel in Thornberg '983 indicates the angular displacement (i.e., position data) of the vehicle relative to the operator mode reference axis because the control panel is directed toward the vehicle.

Thornberg '983's Figure 2 discloses that the control panel is directly facing the remotely operated vehicle, which is nearly identical to placement of the remote control device and RC aircraft in Figure 5 of the '913 patent.

Ex. 1001, 4:1–3, Fig. 5; Ex. 1006, Fig. 2.

We find that Thornberg '983 further describes that when the operator reference mode is activated, “the reference axis for purposes of

transformation is based on the orientation of the operator control panel upon activation of the operator reference mode.” Ex. 1006, 7:21–24. As an example, Thornberg ’983 discloses that in the operator reference mode, “if the operator is facing North upon activation of the operator mode, *the North reference will be provided on the line 453.*” Ex. 1006, 7:24–26 (emphasis added). When operated in the manner shown in Figure 2 (i.e., “opposing frames of reference”), the control panel would be facing North, which would also be directly facing the remotely operated vehicle. Thus, the orientation of the control panel would also indicate the angular displacement (e.g., “first position data”) of the vehicle at the initialization, which we determine teaches the step of “generating first position data indicating a first position of the RC aircraft at a first time” upon the activation of the operator mode.

Additionally, we find in the variable operator reference mode, the operator reference changes based on the changes in the orientation of the operator control panel. Ex. 1006, 7:32–35. Thornberg ’983 explains that this may be accomplished by mounting the operator control panel on a pedestal and providing a servo or gyro signal indicative of the change in the position of the control panel with respect to the initial operator reference. *Id.* at 7:35–38. Continuing with the operation shown in Figure 2 of Thornberg ’983, the operator control panel’s orientation continues to correspond to the angular displacement position of the aircraft in that the control panel continues to be directly facing the remotely operated vehicle subsequent to initialization. We find this post-initialization angular displacement position data discloses “generating *second position data* indicating a second position of the RC aircraft at a second time” as recited in substitute claim 16.

Thornberg '983 also teaches controlling the RC aircraft based on the first position data and the second position data, in addition to the command data and the motion data, because the orientation of the operator control panel, which corresponds to the angular position of the remotely operated vehicle, is used to control the vehicle in the operator reference mode, as described above. Patent Owner argues that the orientation of the operator control panel is not used in the transformation process described in Thornberg '983. See Reply Amend 7. However, the amendments presented in the instant proceeding for substitute claim 16 do not require a transformation based on the position data. All that is recited is the generation of the position data and the controlling of the aircraft using the position data, which we determine is disclosed in Thornberg '983.

Therefore, based on the entire record, we are persuaded by Petitioner's arguments that Thornberg '983 discloses the limitations "generating first position data indicating a first position of the RC aircraft at a first time," "generating second position data indicating a second position of the RC aircraft at a second time," and "controlling the RC aircraft based on the command data, the first position data, the second position data, and the motion data."

For the above reasons, we determine that Petitioner has demonstrated by a preponderance of the evidence that substitute claim 16 would be unpatentable as obvious over Thornberg '983 and Karem. Accordingly, we deny Patent Owner's Motion to Amend as to substitute claim 16.

3. *Substitute Claim 17*

Proposed substitute claim 17 recites that the "remote control device displays an operating mode of the RC aircraft." Ex. 2005, 2–3. Petitioner

argues this limitation is satisfied by Thornberg '983's disclosure of reference mode switch 257 on control panel 200, which visually displays the selected operating mode of the vehicle. Opp. Amend 17 (citing Ex. 1006, 6:2–5, Fig. 3; Ex. 1023 ¶ 206). Patent Owner does not dispute Petitioner's contentions regarding substitute claim 17 separately from its arguments concerning independent claim 16. See Reply Amend 12.

Thornberg '983 discloses that summing junction 450 receives a reference mode signal provided by reference mode switch 457 on line 453. Ex. 1006, 5:67–6:2, Fig. 6. The operation of reference mode switch 457 depends on the position of control panel reference mode switch 257 on control panel 200. *Id.* at 6:2–4, Fig. 3. Figure 3 of Thornberg '983 depicts control panel reference mode switch 257 as having three labeled modes to select: "VEHICLE," "MAP," and "OPERATOR." These labeled modes are visible to the user. Each of these three modes causes the vehicle to be controlled in a different manner. *Id.* at 6:5–11. Based on this disclosure, and in particular the depiction of control panel 200 in Figure 3, we agree with Petitioner that the position of switch 257 would provide a visual indication, or display, of the selected operating mode of the vehicle.

Accordingly, we determine that Petitioner has shown by a preponderance of the evidence that substitute claim 17 would be unpatentable as obvious over Thornberg '983 and Karem. We deny Patent Owner's Motion to Amend as to substitute claim 17.

4. *Substitute Claim 18*

Proposed substitute claim 18 modifies original claim 3 by adding the limitations "generating first orientation data indicating a first orientation of the RC aircraft at the first time" and "generating second orientation data

indicating a second orientation of the RC aircraft at the second time, wherein the RC aircraft is controlled based further on the first orientation data and the second orientation data.” Ex. 2005, 3.

Petitioner argues that Thornberg ’983’s transformation is based on first and second position data corresponding to the operator’s change in orientation when facing the UAV at first and second times. Opp. Amend 18 (citing Ex. 1023 ¶ 209). Thus, according to Petitioner, Thornberg ’983’s transformation also is based on the UAV’s change in orientation at the first and second times. *Id.* (citing Ex. 1023 ¶ 209). Petitioner further argues that the UAV’s orientation is its true heading as measured by navigation equipment 36, which measures the true heading upon activation of the variable operator reference mode (i.e., the “first orientation data”) and continuously integrates the vehicle’s rotation from its first orientation (i.e., the “second orientation data”). *Id.* (citing Ex. 1006, 5:32–35; Ex. 1023 ¶ 207–212). Patent Owner does not dispute Petitioner’s contentions regarding substitute claim 18 separately from its arguments concerning independent claim 16. *See* Reply Amend 12.

Having reviewed the entire record, we find Petitioner’s arguments with respect to substitute claim 18 persuasive. In particular, we credit Dr. Hansman’s undisputed testimony that Thornberg ’983’s transformation is based on “position data” corresponding to the operator’s change in orientation when facing the UAV at first and second times, and also is based on the UAV’s change in *orientation* at the first and second times. Ex. 1023 ¶ 209.

Accordingly, we determine that Petitioner has shown by a preponderance of the evidence that substitute claim 18 would be

unpatentable as obvious over Thornberg '983 and Karem. We deny Patent Owner's Motion to Amend as to substitute claim 18.

5. *Substitute Claim 19*

Proposed substitute claim 19 modifies original claim 4 by adding the limitation

wherein the second position is associated with a first angle, the first angle comprising an angle between an initial direction of the remote control device at the first time and a direction of the remote control device at the second time, wherein the second orientation is indicated by a second angle, wherein the second angle comprises an angle between an initial direction of the RC aircraft at the first time and a direction of the RC aircraft at the second time, wherein the first angle is different than the second angle, and wherein the command data is transformed based on a difference between the first angle and the second angle.

Ex. 2005, 3. Petitioner asserts that Thornberg '983 discloses this limitation. Opp. Amend 18–19. Specifically, Petitioner argues that in Thornberg '983, the claimed “first angle” is the angle between the current and initial direction of the remote control (or the operator), and the claimed “second angle” is the angle between current and initial directions of the UAV. *Id.* at 19 (citing Ex. 1023 ¶¶ 214–15). Petitioner also argues that Thornberg '983's transformation is based on the difference between the first angle and the second angle. *Id.* (citing Ex. 1023 ¶ 216). Patent Owner does not dispute Petitioner's contentions regarding substitute claim 19 separately from its arguments concerning independent claim 16. *See* Reply Amend 12.

As discussed above, we find that the orientation of the control panel in Thornberg '983 indicates the angular displacement (i.e., position data) of the

vehicle, wherein the orientation or direction of the control panel at initialization of the variable operator reference mode would indicate the angular displacement of the vehicle in a first position and a change in the orientation or direction of the control panel subsequent to initialization would indicate the angular displacement of the vehicle in a second position. *See supra* § IV.B.2. Thus, the second position of the vehicle is associated with a first angle between the first and second directions of the control panel. Furthermore, changes in the true heading of Thornberg '983's vehicle, as measured by navigation equipment 36, correspond to changes in the orientation of the vehicle, with the orientation of the vehicle at initialization of the variable operator reference mode defining a first direction of the vehicle at a first time, and a second orientation of the vehicle when the vehicle rotates after initialization defining a second direction of the vehicle at a second time. *See supra* § IV.B.4. Thus, the second orientation of the vehicle is indicated by a second angle between the first and second directions of the vehicle.

Accordingly, we determine that Petitioner has shown by a preponderance of the evidence that substitute claim 19 would be unpatentable as obvious over Thornberg '983 and Karem. We deny Patent Owner's Motion to Amend as to substitute claim 19.

6. *Substitute Claim 20*

Proposed substitute claim 20 modifies original claim 5 by adding the limitation

wherein the command data includes a roll-axis command angle associated with a first command and a pitch-axis command angle associated with the first command, wherein the first command is associated with the second

time, wherein transforming the command data into the control data comprises transforming the roll axis command angle into a roll axis control angle and transforming the pitch axis command angle into a pitch axis control angle, wherein the roll axis control angle is equal to $\psi_1 \cos(\phi - \theta) + \psi_2 \sin(\phi - \theta)$, wherein the pitch axis control angle is equal to $\psi_2 \cos(\phi - \theta) + \psi_1 \sin(\phi - \theta)$, wherein ψ_1 comprises the roll axis command angle, wherein ψ_2 comprises the roll axis command angle, wherein ϕ comprises the orientation angle, and wherein θ comprises the first angle.

Ex. 2005, 3–4.

Petitioner argues that claim 20 is indefinite for lack of antecedent basis for the term “the orientation angle.” Opp. Amend 12. Patent Owner does not respond to this argument. Upon review of the entire record, we agree that there is not antecedent basis for the recitation of “the orientation angle” in claim 20. Accordingly, we find that proposed substitute claim 20 is indefinite under 35 U.S.C. § 112 ¶ 2.

In addition, Petitioner argues that claim 20 recites the precise transformation disclosed in the '913 patent, and Thornberg '983 teaches this same transformation. Opp. Amend 20 (citing Ex. 1023 ¶¶ 217–219; Ex. 1003 ¶¶ 44, 45, 53, 54). Patent Owner does not dispute Petitioner's contentions regarding substitute claim 20 separately from its arguments concerning independent claim 16. See Reply Amend 12.

We agree with Petitioner that Thornberg '983 discloses the transformation recited in claim 20. Specifically, Thornberg '983 discloses determining a transformed pitch stick signal (TPSS) using the equation:

$$\text{TRSS} = \text{roll command} * \cos(\theta) + \text{pitch command} * \sin(\theta)$$

and determining a transformed roll stick signal (TRSS) using the equation:

$$\text{TPSS} = \text{pitch command} * \cos(\theta) - \text{roll command} * \sin(\theta).$$

Ex. 1006, 6:17–28. The “roll command” and “pitch command” of these equations correspond to the roll axis command angle, ψ_1 , and the pitch axis command angle, ψ_2 . See Ex. 1006, 5:19–28 (describing the roll and pitch commands). Also, θ represents the transformation angle, which is “determined based on the true heading of the vehicle as determined by the navigation system 36 and the desired vehicle reference and vehicle reference mode.” *Id.* at 5:29–34. More specifically, summing junction 425 receives a signal representative of the vehicle’s true heading from navigation system 36. *Id.* at 5:35–46, Fig. 6. Summing junction 425 also receives a reference heading signal output by summing junction 450. *Id.* at 5:46–49, 6:11–13, Fig. 6. This reference heading signal is subtracted from the vehicle heading signal in summing junction 425 to determine the transformation angle. *Id.* at 6:42–46, 7:6–9. Thus the transformation angle, θ , of Thornberg ’983 corresponds to $\phi - \theta$ in claim 20, i.e., the difference between the orientation angle, ϕ , and the first angle, θ .

For the above reasons, we determine that Petitioner has shown by a preponderance of the evidence that substitute claim 20 would be unpatentable as obvious over Thornberg ’983 and Karem. We deny Patent Owner’s Motion to Amend as to substitute claim 20.

7. *Substitute Claim 21*

In its Motion to Amend, Patent Owner requests that we cancel independent claim 6 and replace it with substitute independent claim 21. Mot. Amend 2–4. Proposed substitute claim 21 is reproduced below, with bracketing to indicate deletions and underscoring to indicate additions:

21. A method for use with a radio controlled (RC) aircraft, the method comprising

receiving [[an]] a radio frequency (RF) signal from a remote control device that includes command data that indicates user commands to control motion of the RC aircraft;

generating motion data from at least one sensor of the RC aircraft that indicates motion of the RC aircraft;

generating initial position data indicating an initial position of the RC aircraft at a first time;

generating initial orientation data indicating an initial orientation of the RC aircraft at the first time;

generating position data indicating a position of the RC aircraft at a second time;

controlling the RC aircraft based on the RF signal, the position data, and the motion data, wherein the user commands includes lift command data that indicates a hovering state and controlling the RC aircraft includes controlling the RC aircraft to a hovering state in response to the lift command data, and wherein the user commands to control the motion of the RC aircraft are in a first coordinate system from a perspective of the remote control device and,

in a first mode of operation:

the user commands indicated by the command data are transformed into transformed commands in a second coordinate system that is from a perspective of the RC aircraft; and

the RC aircraft is controlled based on the transformed commands; and

in a second mode of operation:

the RC aircraft is controlled directly based on the user commands indicated by the command data in the first coordinate system.

Ex. 2005, 4–5.

Petitioner argues that the newly added limitations of claim 21 are the same as limitations added to substitute claims 16 and 18 and, therefore, are taught by Thornberg '983 for the same reasons asserted in connection with claims 16 and 18. Opp. Amend 20 (citing Ex. 1023 ¶ 220). Patent Owner makes the same arguments for claim 21 that it makes in connection with claim 16 and does not dispute Petitioner's contentions regarding claim 18 separately from its arguments concerning independent claim 16. Reply Amend 5–8, 12.

As discussed above, we find that Thornberg '983 discloses the newly added subject matter of substitute claims 16 and 18. *See supra* §§ IV.B.2, IV.B.4. Accordingly, we determine that Petitioner has shown by a preponderance of the evidence that substitute claim 21 would be unpatentable as obvious over Thornberg '983 and Karem. We deny Patent Owner's Motion to Amend as to substitute claim 21.

8. *Substitute Claim 22*

Proposed substitute claim 22 recites that

the motion data is distinct from the command data, wherein the initial position data and the initial orientation data are generated based on the command data including an operation to establish the initial position data and the initial orientation data, and wherein the remote control device is configured to display an operating mode of the RC aircraft.

Ex. 2005, 5. Petitioner argues that the limitation “the motion data is distinct from the command data” is disclosed by Thornberg '983 for the same reasons asserted in connection with substitute claim 16, the limitation “wherein the initial position data and the initial orientation data are generated based on the command data including an operation to establish the

initial position data and the initial orientation data” is disclosed by Thornberg ’983 for the same reasons asserted in connection with substitute claims 16 and 18, and limitation “wherein the remote control device is configured to display an operating mode of the RC aircraft” is disclosed by Thornberg ’983 for the same reasons asserted in connection with substitute claim 17. Opp. Amend 20–21. Petitioner also argues that in the variable operator mode of Thornberg ’983, the command data from control panel 200 includes an operation to establish the “initial operator reference” direction that serves as the reference direction for measuring changes in vehicle position and orientation. *Id.* at 21 (citing 1006, abstract, 7:31–38). Thus, according to Petitioner, the command data to set the initial operator reference is an operation to establish both the initial position data and the orientation data. *Id.* (citing Ex. 1023 ¶ 223). Patent Owner does not dispute Petitioner’s contentions regarding substitute claim 22 separately from its arguments concerning independent claim 21. See Reply Amend 12.

For the reasons discussed above, we are persuaded that Thornberg ’983 discloses that the motion data is distinct from the command data, the command data includes an operation to establish the initial position data, and the remote control device displays an operating mode of the RC aircraft. See *supra* §§ IV.B.2–4. Furthermore, we are persuaded by Petitioner’s argument—supported by Dr. Hansman’s undisputed testimony—that Thornberg ’983 discloses the command data includes an operation to establish the initial orientation data.

Accordingly, we determine that Petitioner has shown by a preponderance of the evidence that substitute claim 22 would be

unpatentable as obvious over Thornberg '983 and Karem. We deny Patent Owner's Motion to Amend as to substitute claim 22.

9. *Substitute Claim 23*

Proposed substitute claim 23 modifies original claim 8 by adding the limitation “wherein the transformed commands include pitch-axis data generated as a function of the roll-axis command data, the pitch-axis command data, and the yaw-axis motion data.” Ex. 2005, 5. Petitioner argues that Thornberg '983 satisfies this claim limitation because it discloses a transformation angle determined based on the true heading of the vehicle (the claimed “motion data”) a transformation that generates TPSS data (claimed “pitch-axis data”) using received roll-axis and pitch-axis commands and the transformation angle. Opp. Amend 22–23 (citing Ex. 1006, 5:30–35; Ex. 1023 ¶¶ 224–225). Patent Owner does not dispute Petitioner's contentions regarding substitute claim 23 separately from its arguments concerning independent claim 21. See Reply Amend 12.

We find that Thornberg '983 discloses the subject matter of substitute claim 23 because it describes that roll and pitch commands received from the control panel are used by flight control computer 38 to generate TRSS data and TPSS data, and transformation angle θ is “yaw-axis motion data” and flight control computer 38 uses transformation angle θ to generate TRSS data and TPSS data. See Ex. 1006, 5:9–35, 6:16–28.

Accordingly, we determine that Petitioner has shown by a preponderance of the evidence that substitute claim 23 would be unpatentable as obvious over Thornberg '983 and Karem. We deny Patent Owner's Motion to Amend as to substitute claim 23.

10. *Substitute Claim 24*

Proposed substitute claim 24 modifies original claim 9 by adding the limitation “wherein the command data includes roll-axis command data and pitch-axis command data, wherein the motion data includes yaw-axis motion data.” Ex. 2005, 6. Petitioner argues that Thornberg ’983 satisfies this claim limitation because it discloses roll and pitch commands received from control panel 200 corresponding to the claimed roll-axis and pitch-axis command data, and it also discloses the vehicle’s true heading corresponding to the claimed yaw-axis motion data. Opp. Amend 23 (citing Ex. 1006, 5:30–40, 6:17–22; Ex. 1023 ¶¶ 226–227). Patent Owner does not dispute Petitioner’s contentions regarding substitute claim 24 separately from its arguments concerning independent claim 21. See Reply Amend 12.

We are persuaded by Petitioner’s argument that the roll and pitch commands of Thornberg ’983 correspond to the claimed roll-axis command data and pitch-axis command data. Thornberg ’983 discloses that the roll and pitch commands are provided to pitch *axis* transformation function 410 and roll *axis* transformation function 412. Ex. 1006, 5:22–28. In view of this disclosure, one of ordinary skill in the art would understand the roll and pitch commands to include roll-axis and pitch-axis command data. Furthermore, we find that Thornberg ’983’s transformation angle θ is “yaw-axis motion data.” See *supra* § IV.B.9.

Accordingly, we determine that Petitioner has shown by a preponderance of the evidence that substitute claim 24 would be unpatentable as obvious over Thornberg ’983 and Karem. We deny Patent Owner’s Motion to Amend as to substitute claim 24.

11. *Substitute Claim 25*

Proposed substitute claim 25 recites that

the position is associated with a distance from the RC aircraft to the remote control device at the second time, an altitude of the RC aircraft at the second time, and an angle between an initial direction of the remote control device and a direction of the remote control device at the second time.

Ex. 2005, 6. Petitioner argues that, because claim 25 merely requires that the position is “associated with” the distance, altitude, and angle, one of ordinary skill in the art “would understand this claim merely requires the claimed position is ‘associated with’ its position in 3D space using conventional polar coordinates (R, θ , Z).” Opp. Amend 21 (citing Ex. 1023 ¶ 231). Petitioner adds that one of ordinary skill in the art would have understood the position of Thornberg ’983’s UAV is necessarily “associated with” its polar coordinates corresponding to the vehicle’s distance to the remote control device (R), altitude (Z), and change in position angle (θ) from an initial direction and a final direction. *Id.* at 21–22 (citing Ex. 1023 ¶ 231). Patent Owner does not dispute Petitioner’s contentions regarding substitute claim 25 separately from its arguments concerning independent claim 21. *See* Reply Amend 12.

Petitioner also asserts that claim 25 is indefinite, although the basis for this assertion is not articulated clearly. *See* Opp. Amend 12. It appears that Petitioner may be asserting that it is unclear to what “the position” in claim 25 refers. *Id.* We do not reach Petitioner’s assertion of indefiniteness, given the lack of clarity in Petitioner’s assertion, but we do note that substitute claim 21, from which substitute claim 25 depends, recites both “an initial position of the RC aircraft at a first time” and “a position of the RC aircraft

at a second time.” Ex. 2005, 4. Because substitute claim 25 refers to each of the distance, altitude, and angle “at the second time,” we will consider “the position” in substitute claim 25 to refer to the “position of the RC aircraft at a second time” for purposes of considering the patentability of the claim.

Based on the entire record, we find Petitioner’s arguments with respect to substitute claim 25, and Dr. Hansman’s undisputed testimony, persuasive. Substitute claim 25 does not require a particular position having specific coordinates. Rather, as argued by Petitioner, the claimed position need only be associated with a distance, altitude, and angle. We agree that any given position or point in space necessarily is defined by conventional polar coordinates corresponding to the position’s distance from an origin (R), altitude with respect to the origin (Z), and angular position (θ) relative to an initial direction from the origin. As such, the position of Thornberg ’983’s UAV will necessarily be associated with a set of polar coordinates (R, θ , Z).

For the above reasons, we determine that Petitioner has shown by a preponderance of the evidence that substitute claim 25 would be unpatentable as obvious over Thornberg ’983 and Karem. We deny Patent Owner’s Motion to Amend as to substitute claim 25.

12. *Substitute Claim 26*

In its Motion to Amend, Patent Owner requests that we cancel independent claim 11 and replace it with substitute independent claim 26. Mot. Amend 2, 4–5. Proposed substitute claim 26 is reproduced below, with bracketing to indicate deletions and underscoring to indicate additions:

26. A method for use with a radio controlled (RC) aircraft, the method comprising:

generating [[an]] a radio frequency (RF) signal from a remote control device that includes command data that indicates user commands to control motion of the RC aircraft, wherein the user commands to control the motion of the RC aircraft are in a first coordinate system from a perspective of the remote control device, wherein the command data includes an operation to establish an initial position of the RC aircraft, wherein the command data is distinct from motion data generated at the RC aircraft;

generating a mode control signal that indicates one of: a first mode of operation and a second mode of operation;

wherein the RC aircraft is controlled based on the RF signal and motion data generated by at least one sensor of the RC aircraft that indicates motion of the RC aircraft, wherein the user commands includes lift command data that indicates a hovering state and control of the RC aircraft includes:

controlling the RC aircraft to a hovering state in response to the lift command data; and

when the mode control signal indicates the first mode of operation:

the user commands indicated by the command data are transformed into transformed commands in a second coordinate system that is from a perspective of the RC aircraft; [[and]]

the RC aircraft is controlled based on the transformed commands; and

selection of the second coordinate system is displayed at the remote control device; and

when the mode control signal indicates the second mode of operation:

the RC aircraft is controlled directly based on the user commands indicated by the command data in the first coordinate system; and

selection of the first coordinate system is displayed
at the remote control device.

Ex. 2005, 6–7.

Regarding the newly added limitations “wherein the command data includes an operation to establish an initial position of the RC aircraft” and “wherein the command data is distinct from motion data generated at the RC aircraft,” Petitioner argues that these limitations are the same as limitations added to substitute claims 16. Opp. Amend 23. Patent Owner makes the same arguments for these limitations of claim 26 that it makes in connection with claim 16. Reply Amend 8–11. As discussed above, we find that Thornberg ’983 discloses these limitations. *See supra* § IV.B.2.

As for the newly added limitations “selection of the second coordinate system is displayed at the remote control device” and “selection of the first coordinate system is displayed at the remote control device,” Petitioner argues that Thornberg ’983 discloses switch 257 on control panel 200 displays selection of the VEHICLE reference mode, which uses a first coordinate system, or an OPERATOR reference mode, which uses a second coordinate system. Opp. Amend 23–24 (citing Ex. 1023 ¶ 234). Patent Owner does not dispute Petitioner’s contentions regarding these limitations.

Thornberg ’983 discloses that summing junction 450 receives a reference mode signal provided by reference mode switch 457 on line 453. Ex. 1006, 5:67–6:2, Fig. 6. The operation of reference mode switch 457 depends on the position of control panel reference mode switch 257 on control panel 200. *Id.* at 6:2–4, Fig. 3. Figure 3 of Thornberg ’983 depicts control panel reference mode switch 257 as having three labeled modes to select: “VEHICLE,” “MAP,” and “OPERATOR.” These labeled modes are visible to the user. Each of these three modes causes the vehicle to be

controlled in a different manner. *Id.* at 6:5–11. Based on this disclosure, and in particular the depiction of control panel 200 in Figure 3, we agree with Petitioner that the position of switch 257 would provide a visual indication, or display, of the selected operating mode of the vehicle.

Furthermore, as discussed above, we find that Thornberg '983 discloses that, in the *operator reference mode*, the pitch and roll commands are in accordance with a first coordinate system that is from a perspective of the operator control panel, and the TPSS and the TRSS (i.e., control data) are in accordance with a second coordinate system that is from a perspective of the vehicle. *See supra* § III.D.3.d. We also find that Thornberg '983 discloses that, in the *vehicle reference mode*, the transformation function does not change the pitch and roll commands such that the TPSS is equal to the pitch command and the TRSS is equal to the roll command. *See supra* § III.D.4. In this case, the TPSS and the TRSS remain in accordance with the first coordinate system that is from a perspective of the operator control panel. Accordingly, we agree that selection of the vehicle reference mode corresponds to a selection of the first coordinate system that is from a perspective of the operator control panel, and selection of the operator reference mode corresponds to a selection of the second coordinate system that is from a perspective of the vehicle.

For the above reasons, we determine that Petitioner has shown by a preponderance of the evidence that substitute claim 26 would be unpatentable as obvious over Thornberg '983 and Karem. We deny Patent Owner's Motion to Amend as to substitute claim 26.

13. *Substitute Claim 27*

Proposed substitute claim 27 recites that “the remote control device includes a plurality of spring-loaded interface devices, each spring-loaded interface device of the plurality of spring-loaded interface devices configured to return to a corresponding particular position, the particular position comprising a center position of multiple axes of operation.” Ex. 2005, 7–8.

Petitioner argues that Thornberg ’983 discloses control panel 200 having two-axis control stick 205 and additional input mechanisms. Opp. Amend 25 (citing Ex. 1006, 4:28–36, Fig. 3). Petitioner does not assert that any of Thornberg ’983’s input mechanisms are spring-loaded. Rather, Petitioner argues that Thornberg-1995 “teaches a ‘conventional hand-held control unit’ with a pair of multi-axis ‘spring-centered’ joysticks, the right for pitch/roll control and the left for lateral axis and yaw control.” *Id.* (citing Ex. 1012, 809).⁹ Petitioner then argues that it would have been obvious to one of ordinary skill in the art to use Thornberg-1995’s multi-axis, spring-centered joysticks on Thornberg ’983’s control panel because such an arrangement would be conventional, obvious to try, and known to provide advantages. *Id.* (citing Ex. 1003 ¶¶ 107–110; Ex. 1023 ¶ 237).

Patent Owner argues that Thornberg-1995 “discloses a left joystick that returns to center in the lateral axis, but would stay put in the longitudinal direction due to friction,” such that it would not have been obvious to try the arrangement suggested by Petitioner. Reply Amend 11–12 (citing Ex. 1012, 6).¹⁰ In response, Petitioner argues that substitute claim 27 does not require

⁹ See Ex. 3002, 809.

¹⁰ See Ex. 3002, 809.

that the spring-loaded interface devices be spring-loaded in all directions. Sur-Reply Amend 11. Petitioner also argues that both of Thornberg-1995's spring-centered joysticks return to a "corresponding particular position," with the left joystick returning to a center position along the lateral axis. *Id.* As for the claim 27 requirement that the particular position comprise a center position of multiple axes of operation, Petitioner argues that the particular position along a center line of the lateral axis to which the left joystick returns comprises "a center position of multiple axes of operation" because the center line comprises the center point of both orthogonal axes of the left joystick. *Id.* at 11–12.

Based on the entire record, we are persuaded by Petitioner's arguments that the cited combination discloses the subject matter of substitute claim 27. Thornberg-1995 discloses that the right joystick is spring-centered in both axes, and the left joystick is spring-centered in the lateral axis but held by friction in the longitudinal axis. Ex. 3002, 809. Substitute claim 27 requires a plurality of spring-loaded interface devices, with each device being configured to return to a corresponding center position of multiple axes of operation. We agree with Petitioner's contention that Thornberg-1995's right joystick meets these limitations, a contention that Patent Owner does not dispute. We also agree that Thornberg-1995's left joystick meets these limitations. First, it is undisputed that the left joystick is spring-loaded. Second, although the left joystick is held by friction along the longitudinal axis, there is no disclosure that the left joystick cannot be returned to the center position of the longitudinal axis by a force sufficient to overcome the friction, such as may be applied by the user. In this sense, the left joystick is configured to return

to a center position of multiple axes of operation; claim 27 does not require that the interface devices return to the center position by virtue of the spring-loading.

We are also persuaded that an ordinarily skilled artisan would have been motivated to combine the references in the manner proposed because such an arrangement would be conventional, obvious to try, and known to provide advantages. *See* Opp. Amend 25 (citing Ex. 1003 ¶¶ 107–110; Ex. 1023 ¶ 237). We credit Dr. Hansman’s testimony that the modification “would have facilitated ease of controlling the horizontal and vertical motions of the RC helicopter, which is a goal of both references.” Ex. 1003 ¶ 108.

For the above reasons, we determine that Petitioner has shown by a preponderance of the evidence that substitute claim 27 would be unpatentable as obvious over Thornberg ’983, Karem, and Thornberg-1995. We deny Patent Owner’s Motion to Amend as to substitute claim 27.

14. Substitute Claim 28

Proposed substitute claim 28 modifies original claim 13 by adding the limitation “wherein the transformed commands include pitch-axis data generated as a function of the roll-axis command data, the pitch-axis command data, and the yaw-axis motion data.” Ex. 2005, 8. Substitute claim 28 adds the same subject matter added to substitute claim 23, and Petitioner argues that Thornberg ’983 satisfies this claim limitation for the same reasons asserted in connection with claim 23. Opp. Amend 22–23 (citing Ex. 1006, 5:30–35; Ex. 1023 ¶¶ 224–225). Patent Owner does not dispute Petitioner’s contentions regarding substitute claim 28 separately from its arguments concerning independent claim 26. *See* Reply Amend 12.

We find that Thornberg '983 discloses the subject matter of substitute claim 28 for the same reasons Thornberg '983 discloses the subject matter of substitute claim 23. *See supra* § IV.B.9. Accordingly, we determine that Petitioner has shown by a preponderance of the evidence that substitute claim 28 would be unpatentable as obvious over Thornberg '983 and Karem. We deny Patent Owner's Motion to Amend as to substitute claim 28.

15. *Substitute Claim 29*

Proposed substitute claim 29 modifies original claim 14 by adding the limitation "wherein the command data includes roll-axis command data and pitch-axis command data, wherein the motion data includes yaw-axis motion data." Ex. 2005, 8. Substitute claim 29 adds the same subject matter added to substitute claim 24, and Petitioner argues that Thornberg '983 satisfies this claim limitation for the same reasons asserted in connection with claim 24. Opp. Amend 23 (citing Ex. 1006, 5:30–40, 6:17–22; Ex. 1023 ¶¶ 226–227). Patent Owner does not dispute Petitioner's contentions regarding substitute claim 29 separately from its arguments concerning independent claim 26. *See* Reply Amend 12.

We find that Thornberg '983 discloses the subject matter of substitute claim 29 for the same reasons Thornberg '983 discloses the subject matter of substitute claim 24. *See supra* § IV.B.10. Accordingly, we determine that Petitioner has shown by a preponderance of the evidence that substitute claim 29 would be unpatentable as obvious over Thornberg '983 and Karem. We deny Patent Owner's Motion to Amend as to substitute claim 29.

16. *Substitute Claim 30*

Proposed substitute claim 30 recites that “the remote control device comprises a hand-held device, wherein the remote control device is located at a first position at a first time, and wherein the remote control device is located at a second position at a second time, the first position different than the second position.” Ex. 2005, 8. Petitioner argues that Thornberg ’983 discloses a hand-held control panel 200 and the position of the control panel may change at different times. Opp. Amend 24 (citing Ex. 1006, 4:29–30, 7:35–38, Fig. 3; Ex. 1023 ¶ 240). Patent Owner does not dispute Petitioner’s contentions regarding claim 30 separately from its arguments concerning independent claim 26. See Reply Amend 12.

Having reviewed the entire record, we find Petitioner’s arguments with respect to substitute claim 30 persuasive. In particular, we credit Dr. Hansman’s undisputed testimony that Thornberg ’983 discloses a hand-held control panel that can have changes in position. Ex. 1023 ¶ 240. Accordingly, we determine that Petitioner has shown by a preponderance of the evidence that substitute claim 30 would be unpatentable as obvious over Thornberg ’983 and Karem. We deny Patent Owner’s Motion to Amend as to substitute claim 30.

V. ORDER

In consideration of the foregoing, it is hereby:

ORDERED that claims 1–15 of the ’913 patent have been shown to be unpatentable;

FURTHER ORDERED that Patent Owner’s Contingent Motion to Amend is denied; and

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

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