

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

ARASHI VISION (U.S.) LLC (D/B/A INSTA360),
Petitioner,

v.

GOPRO, INC.,
Patent Owner

IPR2024-01186
Patent No. 10,574,894

ARASHI VISION (U.S.) LLC (D/B/A INSTA360)'S NOTICE OF APPEAL

via P-TACTS
Patent Trial and Appeal Board

via Email
Director of the United States Patent and Trademark Office
c/o Office of the General Counsel
efileSO@uspto.gov

via CM/ECF
United States Court of Appeals for the Federal Circuit

INTRODUCTION

Arashi Vision (U.S.) LLC (d/b/a Insta360)’s (“Insta360”) appeal stems from the Patent Trial and Appeal Board’s Final Written Decision (Paper 50) (the “Final Written Decision”), entered on December 10, 2025, in the above-captioned *inter partes* review of United States Patent No. 10,574,894 (“the ’894 patent”). This notice is timely filed within 63 days of the Final Written Decision. 37 C.F.R. § 90.3(a)(1).

INSTA360’S APPEAL

Please take notice that—under 35 U.S.C. §§ 141(c), 142, 319; 37 C.F.R. §§ 90.2(a), 90.3(a); and Federal Rule of Appellate Procedure and Federal Circuit Rule 15—Insta360 hereby appeals to the United States Court of Appeals for the Federal Circuit from the Final Written Decision and all underlying decisions and orders in this action on which that decision is based.

INSTA360’S ISSUES ON APPEAL

Insta360’s issues on appeal include at least (37 C.F.R. § 90.2(a)(3)(ii)):

- (1) the Board’s conclusion that challenged claims 1-20 of the ’894 patent had not been shown unpatentable;
- (2) any findings, analysis, or determinations supporting or related to that issue, including but not limited to the Board’s analysis of the Petition and the asserted prior art, and its determination that the prior art fails to teach or suggest

“wherein the capture trajectory is determined to include a path that minimizes a combination of rotational velocity and rotational acceleration of the housing”; and

(3) all other issues decided adversely to Insta360 in any orders, decisions, rulings, or opinions in this action.

Simultaneously with this submission, Insta360 is filing a true and correct copy of this Notice of Appeal with the Director of the United States Patent and Trademark Office and a true and correct copy (or copies) of the same, along with the required filing fee, with the Clerk of the United States Court of Appeals for the Federal Circuit as set forth in the accompanying Certificate of Filing.

Dated: February 6, 2026

Respectfully submitted,

By: /s/ Alex S. Yap

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CERTIFICATE OF FILING

The undersigned hereby certifies that, in addition to being electronically filed through P-TACTS, a true and correct copy of the above ARASHI VISION (U.S.) LLC (D/B/A INSTA360)'S NOTICE OF APPEAL is being filed via email with the Director on February 6, 2026, at efileSO@uspto.gov, the email address indicated on the United States Patent and Trademark Office's web page for the Office of the General Counsel.

The undersigned also hereby certifies that a true and correct copy (or copies) of the above ARASHI VISION (U.S.) LLC (D/B/A INSTA360)'S NOTICE OF APPEAL and the filing fee is being filed via CM/ECF with the Clerk's Office of the United States Court of Appeals for the Federal Circuit on February 6, 2026.

Dated: February 6, 2026

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CERTIFICATE OF SERVICE

The undersigned hereby certifies that on February 6, 2026, the above ARASHI VISION (U.S.) LLC (D/B/A INSTA360)'S NOTICE OF APPEAL was served in its entirety via electronic mail on the following:

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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

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GOPRO, INC.,
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IPR2024-01186
Patent 10,574,894 B2

Before WILLIAM V. SAINDON, NABEEL U. KHAN, and
BRIAN D. RANGE, *Administrative Patent Judges*.

RANGE, *Administrative Patent Judge*.

DECISION
Final Written Decision
Determining No Challenged Claims Unpatentable
35 U.S.C. § 318(a)

I. INTRODUCTION

Arashi Vision (U.S.) LLC (d/b/a Insta360) (“Petitioner”) filed a Petition requesting *inter partes* review of claims 1–20 of U.S. Patent No. 10,574,894 B2 (Ex. 1001, “the ’894 patent”). Paper 2 (“Pet.”). GoPro, Inc. (“Patent Owner”) filed a Preliminary Response. Paper 6 (“Prelim. Resp.”).¹ On January 22, 2025, we instituted *inter partes* review. Institution Decision, Paper 9 (“Inst. Dec.”).

After institution, Patent Owner filed a Patent Owner Response (Paper 17, “PO Resp.”), Petitioner filed a Reply (Paper 25, “Pet. Reply”), and Patent Owner filed a Sur-Reply (Paper 32, “PO Sur-Reply”).² An oral hearing was held on October 23. We have jurisdiction under 35 U.S.C. § 6. This decision is issued pursuant to 35 U.S.C. § 318(a). For the reasons that follow, we determine that Petitioner has not shown, by a preponderance of the evidence, that claims 1–20 of the ’832 patent are unpatentable.

II. BACKGROUND

A. *Real Parties in Interest*

Petitioner identifies Arashi Vision Inc. (d/b/a Insta360) as the real party in interest. Pet. 74. Patent Owner identifies itself as the real party in interest. Paper 4, 2.

¹ A public, redacted, version of the Preliminary Response is available at Paper 7.

² Redacted and public versions of these documents are available at Paper 19 (Patent Owner Response), Paper 26 (Petitioner’s Reply), and Paper 33 (Patent Owner’s Sur-Reply).

B. Related Matters

The parties identify the following matters as related to this proceeding:

1. *In the Matter of Certain Cameras, Camera Systems, and Accessories Used Therewith*, Inv. No. 337-TA-1400 (USITC)
2. *GoPro, Inc. v. Arashi Vision Inc.*, No. 8:24-cv-00681-HDE-JCV (C.D. Cal.)
3. *Arashi Vision Inc. v. GoPro, Inc.*, IPR2024-00984
4. *Arashi Vision Inc. v. GoPro, Inc.*, IPR2024-01052
5. *Arashi Vision Inc. v. GoPro, Inc.*, IPR2024-01164
6. *Arashi Vision Inc. v. GoPro, Inc.*, IPR2024-01165

Pet. 74–75; Paper 4, 2.

C. The '894 patent (Ex. 1001)

The '894 patent is titled “Systems and Methods for Stabilizing Videos” and relates to “stabilizing videos” so as to not appear “jerky/shaky” despite “motion of the image capture device during the capture.” Ex. 1001, 1:6–18. “Stabilization of such videos . . . us[es] smaller visual content portions of the images to provide a punch-out view of the images that creates a more stable view than when generating videos by using the entire visual content of the images.” *Id.* at 8:2–6. Generally, “[a]n observed trajectory of the image capture device reflects the positions of the image capture device at different moments.” *Id.* at code (57). “A capture trajectory of the image capture device . . . is determined based on a subsequent portion of the observed trajectory.” *Id.* “Orientations of punch-outs for the images are determined based on the capture trajectory.” *Id.*

Figures 6A and 6B, reproduced below with Figure 6A at respectively top and Figure 6B at bottom-left and bottom-right, each illustrate an optical field of view and capture field of view for each of three video images captured by a different orientation of the image capturing device; i.e., each captured at different moments. *Id.* at 12:3–5, 13:18–22, 13:28–31.

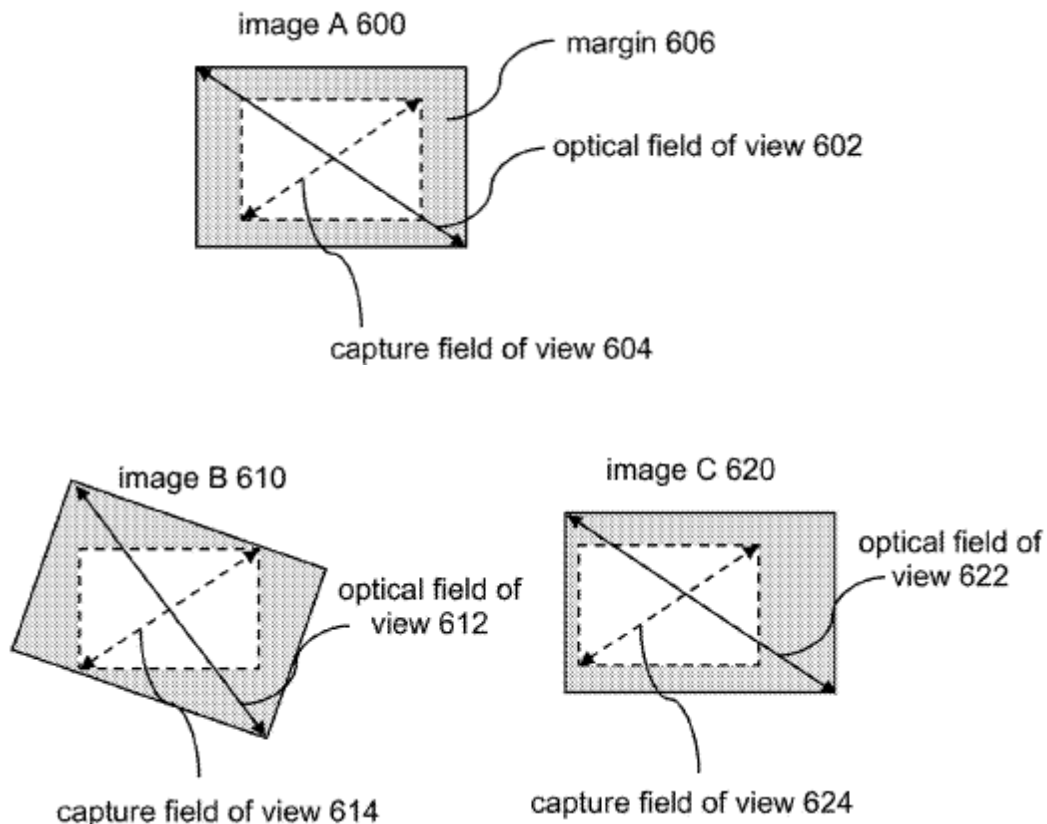


Figure 6A (at top) “illustrates example optical field of view and capture field of view.” *Id.* at 3:29–30. Figure 6B (at bottom left and bottom right) “illustrates example orientations of a capture field of view with respect to an optical field of view.” *Id.* at 3:31–32. As shown, the optical field of view 602, 612, 622 is the image captured by the image capture device. *Id.* at 1:18–20. The capture field of view 604, 614, 624 is the image cropped (i.e., punched-out from the optical field of view 602, 612, 622) and displayed to maintain a video stabilized to the capture trajectory intended by the user of

the image capture device as opposed to the observed actual trajectory. *Id.* at 1:24–46. In addition to illustrating orientation of the capture field of view 604, 614, 624 to stabilize the video (based on the capture trajectory), Figures 6A and 6B illustrate that the orientation of the capture field of view 604, 614, 624 is restricted by the margin 606 and particularly the correspondingly permitted disparity of orientation between the capture field of view 604, 614, 624 and respective optical field of view 602, 612, 622. *Id.* at 12:3–22.

Figure 5C, reproduced below, illustrates a determination of whether to regard the observed trajectory (i.e., actual) as being the capture trajectory (i.e., intended by the user). *Id.* at 10:11–23.

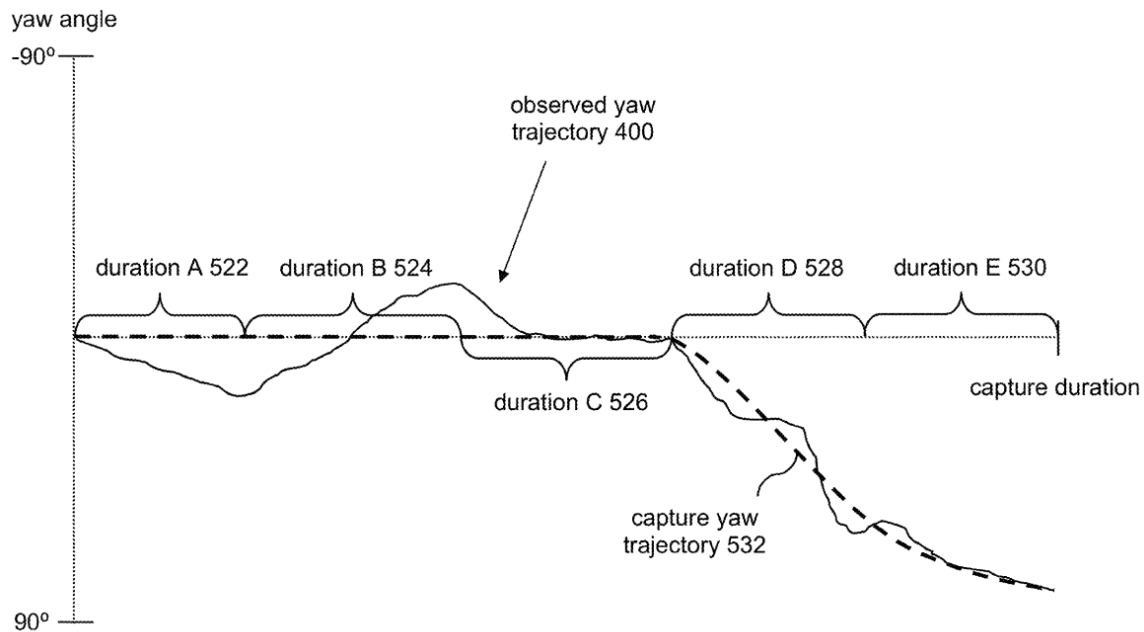


Figure 5C “illustrates an example capture trajectory.” *Id.* at 3:28. “The observed trajectory [is] an observed yaw trajectory 400 of the image capture device” and “reflect[s] yaw angle positions (e.g., rotational positions defined with respect to a yaw axis, rotation to the left or right) . . . of the image capture device at different moments within the capture duration.” *Id.* at 7:39–45. Here, a first duration A 522 (of the yaw angle over time) is

ascribed from the start of imaging to the first significant change in the observed yaw trajectory 400 (e.g., a threshold change in the magnitude and/or sign (plus or minus) of the yaw angle). *Id.* at 8:19–53 (describing durations A 502, B 504 of Figure 5A). A second duration B 524 is ascribed from the end of the first duration A 522 to the next (second) significant change in the observed yaw trajectory 400. *Id.* And, subsequent durations C 526, D 528, and E 530 are likewise ascribed. *Id.* at Fig. 5C.

“The capture trajectory [is] a capture yaw trajectory 532” and “reflect[s] yaw angle positions 15 . . . of the image capture device to be used in determining which portions of the visual content of the images (punch-outs) may be used to generate a video.” *Id.* at 10:12–19. “The capture yaw trajectory 532 [is] determined such that [each] portion . . . is determined based on a subsequent portion of the observed yaw trajectory 400.” *Id.* at 10:26–30. Here, the capture yaw trajectory 532 for the first duration A 522 is based on the observed yaw trajectory 400 of the next two durations B 524, C 526 and indicates that the change of yaw angle ending the first duration A 522 was unintended (i.e., undesired by the user of the image capture device). *Id.* at 10:30–44. The determination is that the two changes of yaw angle respectively ending the first and second durations A 522, B 524 represent the user unintentionally rotating the image capture device to the right, overly correcting by overly rotating the device to the left, and then correcting by properly rotating the device to the right (stopping at a yaw angle of 0 midway through duration C 526). *Id.* at 10:44–52. A similar determination is made that durations 528, 530 show an intended continuous rotation to the right (overall slope of observed yaw trajectory 400 included by capture yaw trajectory 532) and concurrent unintended rotations

(staggering of the observed yaw trajectory 400 omitted by capture yaw trajectory 532). *Id.* at 10:52–59.

D. Illustrative Claims

Claims 1 and 11 are independent. *See* Ex. 1001, 17:49–18:45. These two claims are substantially the same except that claim 1 is a system claim with the system having various elements “configured to” perform various functions, and claim 11 is a method claim directed at performance of the functions. *Id.* The other challenged claims 2–10 and 12–20 respectively depend from claims 1 and 11. *Id.*

Claim 1 is illustrative and is reproduced below (with Petitioner’s identifiers of claim elements, *see, e.g.*, Pet. 10–38).

1. [Preamble] A system that stabilizes videos, the system comprising:

[a] a housing of an image capture device;

[b][i] an optical element carried by the housing and configured to guide light within an optical field of view to an image sensor, [b][ii] the optical field of view being greater than a capture field of view for generating video content;

[c][i] the image sensor carried by the housing and configured to generate an image output signal based on light that becomes incident thereon during a capture duration, [c][ii] the image output signal conveying image information that defines images with the optical field of view;

[d][i] a position sensor carried by the housing and configured to generate a position output signal based on positions of the housing during the capture duration, [d][ii] the position output signal conveying position information that characterizes the positions of the housing at different moments within the capture duration, the positions of the housing including rotational positions of the housing; and

[e] one or more physical processors configured by machine-readable instructions to:

[f][i] determine an observed trajectory of the housing during the capture duration based on the position information, the observed trajectory reflecting the positions of the housing at the different moments within the capture duration, [f][ii] the observed trajectory including a first portion corresponding to a first moment within the capture duration and a second portion corresponding to a second moment subsequent to the first moment within the capture duration;

[g][i] determine a capture trajectory of the housing based on a look ahead of the observed trajectory, [g][ii] the capture trajectory reflecting actual and/or virtual positions of the housing from which orientations of the capture field of view with respect to the optical field of view of the images are determined, [g][iii] the look ahead of the observed trajectory including use of a subsequent portion of the observed trajectory to determine a preceding portion of the capture trajectory such that a portion of the capture trajectory corresponding to the first portion of the observed trajectory, which corresponds to the first moment within the capture duration, is determined based on the second portion of the observed trajectory, which corresponds to the second moment within the capture duration, [g][iv] the capture trajectory having smoother changes than the observed trajectory, [g][v] wherein the capture trajectory is determined to include a path that minimizes a combination of rotational velocity and rotational acceleration of the housing, [g][vi] the combination of the rotational velocity and the rotational acceleration of the housing weighing the rotational velocity and the rotational acceleration equally or differently;

[h] determine the orientations of the capture field of view for the images with respect to the optical field of view of the images based on the capture trajectory of the housing; and

[i][i] generate the video content based on a punch-out of visual content of the images within the capture field of view, [i][ii] wherein use of the visual content of the images within the capture field of view to generate the video content provides

stabilization that creates a more stable view than use of entire visual content of the images.

Ex. 1001, 17:49–18:45.

E. Asserted Grounds of Unpatentability

Petitioner, supported by the declaration of Dr. Aggelos Katsaggelos (Ex. 1002), asserts the following grounds of unpatentability (Pet. 8):

Claims Challenged	35 U.S.C. §	References/Basis
1–20	103	Zhou, ³ Kwatra ⁴
2, 3, 7, 12, 13, 17	103	Zhou, Kwatra, Shi ⁵

Patent Owner disputes the grounds and supports its position with declarations of Dr. Hassan Foroosh. PO Resp., *passim* (citing Ex. 2001, Ex. 2018).

III. ANALYSIS OF PETITIONER’S GROUNDS

A. Legal Standard

A patent claim is unpatentable under 35 U.S.C. § 103 “if the differences between the claimed invention and the prior art are such that the claimed invention as a whole would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to which the claimed invention pertains.” 35 U.S.C. § 103; *see also KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 406 (2007). The question of obviousness is resolved on the basis of underlying factual determinations including: (1) the scope and content of the prior art; (2) any differences between the claimed subject matter and the prior art; (3) the level of ordinary

³ US 9,674,438 B2, issued June 16, 2017, Ex. 1004.

⁴ US 8,531,535 B2, issued September 10, 2013, Ex. 1005.

⁵ US 10,462,370 B2, issued October 29, 2019, Ex. 1006.

skill in the art; and (4) when in evidence, objective evidence of nonobviousness.⁶ *Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966).

B. Level of Ordinary Skill in the Art

In order to determine whether an invention would have been obvious at the time the application was filed, we consider the level of ordinary skill in the pertinent art at the critical time. *Graham*, 383 U.S. at 17. The resolution of this question is important because it allows us to “maintain[] objectivity in the obviousness inquiry.” *Ryko Mfg. Co. v. Nu-Star, Inc.*, 950 F.2d 714, 718 (Fed. Cir. 1991). In assessing the level of ordinary skill in the art, various factors may be considered, including the “type of problems encountered in the art; prior art solutions to those problems; rapidity with which innovations are made; sophistication of the technology; and educational level of active workers in the field.” *In re GPAC, Inc.*, 57 F.3d 1573, 1579 (Fed. Cir. 1995). Generally, it is easier to establish obviousness under a higher level of ordinary skill in the art. *Innovation Toys, LLC v. MGA Entm’t, Inc.*, 637 F.3d 1314, 1323 (Fed. Cir. 2011) (“A less sophisticated level of skill generally favors a determination of nonobviousness . . . while a higher level of skill favors the reverse.”).

Petitioner contends that a person of ordinary skill in the art (POSITA) would have the following characteristics: “a bachelor’s degree in engineering or computer science, or equivalent field, and two years of experience working on image or video processing or digital cameras.” Pet. 6 (citing Ex. 1002 ¶¶ 36–37). Petitioner states that, “[a]lternatively, a POSITA would have four years of experience working on image or video processing

⁶ Patent Owner asserts objective evidence of nonobviousness. Prelim. Resp. 19–27.

or digital cameras.” *Id.* Petitioner further contends “[a]n advanced graduate degree in the disciplines cited above may make up for the work experience indicated above.” *Id.* Patent Owner does not dispute the level of ordinary skill in the art. Prelim Resp. 14–15.

For purposes of this Decision, we adopt Petitioner’s proposal as reasonable and consistent with the ’894 patent specification and the prior art. *See Okajima v. Bourdeau*, 261 F.3d 1350, 1355 (Fed. Cir. 2001) (the prior art may reflect an appropriate level of skill in the art).

C. Claim Construction

In *inter partes* reviews, the Board interprets claim language using the district-court-type standard, as described in *Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005) (en banc). *See* 37 C.F.R. § 42.100(b). Under that standard, we generally give claim terms their ordinary and customary meaning, as would be understood by a person of ordinary skill in the art at the time of the invention, in light of the language of the claims, the specification, and the prosecution history. *See Phillips*, 415 F.3d at 1313–14. Although extrinsic evidence, when available, may also be useful when construing claim terms under this standard, extrinsic evidence should be considered in the context of the intrinsic evidence. *See id.* at 1317–19.

Petitioner “does not believe any terms require a formal construction.” Pet. 6. Patent Owner agrees “no claim terms presently require construction to resolve any current dispute between the parties.” PO Resp. 15.

We do not discern a need to construe explicitly any claim language at this juncture because doing so would have no effect on our analyses below of Petitioner’s asserted grounds and will not assist in resolving the present controversy between the parties. *See Realtime Data, LLC v. Iancu*, 912 F.3d

1368, 1375 (Fed. Cir. 2019) (“The Board is required to construe ‘only those terms . . . that are in controversy, and only to the extent necessary to resolve the controversy.’”) (quoting *Vivid Techs., Inc. v. Am. Sci. & Eng’g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999)).

D. Overview of the Asserted Art

1. Zhou (Exhibit 1004)

Zhou relates to “the field of digital photography” and particularly “improved stabilization of video frames captured in low light conditions by taking into account motion blur within the video frames.” Ex. 1004, 1:13–17. “Motion blur” is streaking of pixels in an image due to concurrent rapid movement and long exposure (i.e., a long integration time)⁷ of the image capture device. *Id.* at 1:49–55; *see also* Ex. 1002 ¶ 162. Motion blur is generally increased by the longer exposure of an image capture device during low light conditions. Ex. 1004, 1:56–61.

Zhou’s technique “to more effectively stabilize low light video in real-time (i.e., as it is captured)” includes “using an ‘overscan’ region and a look-ahead buffer comprising a number of video input frames” (*id.* at 2:59–64) to “estimat[e] the amount of motion blur in ‘future’ and ‘past’ motion data” and perform “stabilization adjustments (the movement of individual frames within their overscan) of a current frame . . . using motion data from either or both of ‘past’ and ‘future’ frames” (*id.* at 3:4–6). The adjustment includes “adjust[ing] or modulat[ing] the strength of a video stabilization metric value.” *Id.* at 3:7–8. “A stabilization strength value may be thought of as a value used, in part, to determine a weighting or correction factor used to

⁷ We take official notice that integration time of an image is the duration that the image sensing substrate senses light to generate the image.

moderate movement of an image within its overscan region during stabilization operations.” *Id.* at 5:11–14.

“One approach to video stabilization that makes use of a tunable video stabilization strength value is to first determine what sort of activity is causing the detected camera motion, set the tuning value accordingly, and stabilize in accordance with that value . . . [; e.g.,] if no motion is detected, . . . classify the ‘type of motion’ as stationary and . . . apply very strict stabilization.” *Id.* at 3:47–53. Zhou further explains:

One approach . . . monitors the motion of each frame, . . . buffer[s] some number of incoming video frames, delay[s] the production of stabilized video output frames by the time required to capture these frames, . . . [and thus] permits a ‘current frame’ to use both ‘future’ and ‘past’ motion data[, and], in turn, permits stabilization adjustments (the movement of individual frames within their overscan) of a current frame in a way that . . . anticipates[] the motion in future frames.”

Id. at 3:59–4:4.

Figure 2B of Zhou is a block diagram illustrating a frame buffer system. *Id.* at 2:40–41.

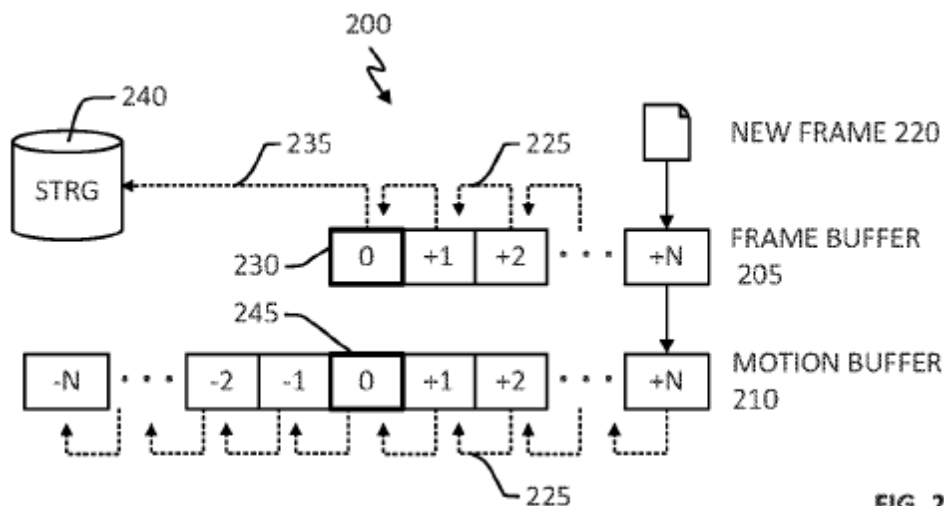


Figure 2B “show[s], in block diagram form, a frame buffer system” in accordance with a Zhou embodiment. *Id.* Here, “image data and motion data . . . [is] buffered for a specified number of frames before a first stabilized output frame is generated.” *Id.* at 4:24–29. The “buffer system 200 . . . includes (N+1) entry frame buffer 205[] and (2N+1) entry motion buffer 210” (*id.* at 4:30–32); N images being captured before (negative N) and after (positive N) the frame 0 currently being stabilized (*id.* at 4:47–56), i.e., “current frame” 0 stored at the frame entry 230 and motion entry 245 (*id.* at 4:48–49, 5:8–11).

As each frame arrives, “it is placed into the +Nth frame buffer entry with the frame’s corresponding motion data placed into the +Nth motion buffer entry.” *Id.* at 4:32–34. “[E]very entry already in frame buffer 205 and every entry in motion buffer 210 may be shifted to the left by one position as indicated by dotted lines 225.” *Id.* at 4:39–42. “After being stabilized, frames shifted out of frame buffer entry 230 (the 0th entry) may be routed 235 to long-term storage 240” and “[m]otion data shifted out of motion buffer entry 245 (the 0th entry) may be discarded or retained.” *Id.* at 4:42–46.

Using the above frames, Zhou calculates an “image blur vector” from the following data: starting and ending integration times; camera orientation and rotation at the start and end of integration; and camera lens position. *Id.* at 5:30–53. Operation proceeds to calculating “a target max stabilization strength value for the current image.” *Id.* at 6:38–40. “[I]f the amount of blur in the image is smaller (typically found in brighter images with shorter integration times), larger stabilization strengths may be employed” *Id.* at 6:41–44. “[I]f the amount of blur in the image is larger (typically

found in darker images with longer integration times), smaller stabilization strengths may be employed” *Id.* at 6:46–48.

Figure 3 of Zhou illustrates the resulting stabilization movement that can be applied to a visible region of a frame within its overscan. *Id.* at 2:42–44.

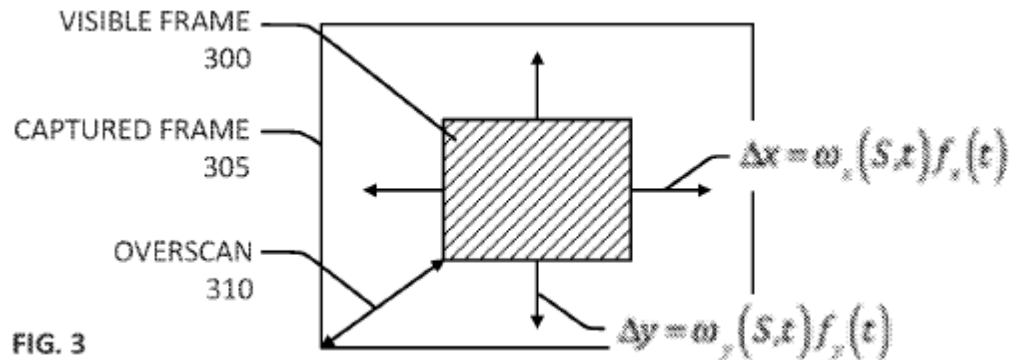


Figure 3 “illustrates the movement that can be applied to a visible region of a frame within its overscan during stabilization operations” in accordance with Zhou. *Id.* at 2:42–44. Here, the movement constitutes translational motion of visible frame 300 within captured frame 305, i.e., within their difference constituting overscan 310, “where Δx and Δy represent the amount of motion along x and y coordinate axes that the current frame should be moved in accordance with stabilization operation 100, $\omega_x()$ and $\omega_y()$ represent x and y coordinate weighting functions 35 respectively, and functions $f_x()$ and $f_y()$ represent arbitrary movement functions (linear or non-linear) that are up to the discretion of the designer.” *Id.* at 7:24–38. Though the Δx and Δy equations “describe translation only[,], actual correction may include other axes and other artifacts[, e.g.,] . . . using gyroscope output (represented as quaternions) against rotation, perspective distortion and rolling shutter artifacts.” *Id.* at 7:38–43. “For a given stabilization strength S (as optionally limited by the calculated ‘target max

strength' for the current frame . . .), a frame's Δx and Δy values are simply functions of time (e.g., motion buffer entry index)" *Id.* at 8:7–11. "[A] test may be made to determine if the current frame remains within its overscan" *Id.* at 8:26–28. "The remaining actions . . . seek to predict if the current frame's future frames will fit in their overscan using the same strength parameter[and, a]s long as the current stabilization strength value is found to do this, that value is used." *Id.* at 8:32–36. "When one of the current frame's future frames does not fit in its overscan, the stabilization strength value may be lowered until a value is found that predicts it will fit." *Id.* at 8:36–40.

We reproduce Figure 6 of Zhou below.

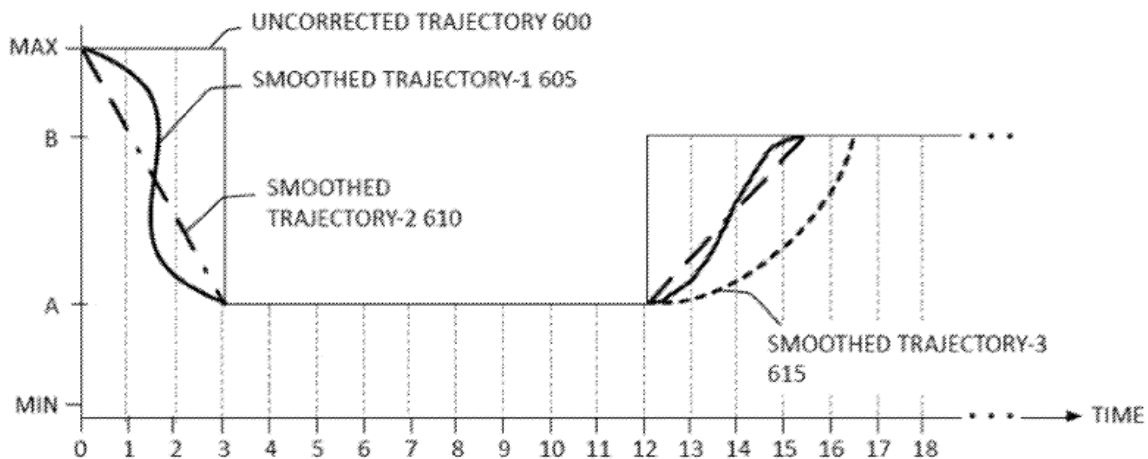


Figure 6 shows, in accordance with a Zhou embodiment, "illustrative stabilization strength trajectories." *Id.* at 2:52–53. "[W]hen the future frame necessitating the change in stabilization strength values becomes the 'current frame,' the stabilization strength value will have gradually and smoothly reached its new target value, thus avoiding any abrupt or jarring changes in the stabilization strength value or the resulting stabilized video." *Id.* at 8:46–52. "Uncorrected trajectory 600 represents . . . abrupt changes in

stabilization strength at $t=3$ and 12 (necessitated by motion of the image capture device . . .) [that] may cause a visual flicker, jump, or other discontinuity during video stream playback.” *Id.* at 10:19–27. [E]ach of smooth trajectory 1 605 and smooth trajectory 2 610 represent but two possible smoothed trajectories” *Id.* at 10:28–30. Zhou explains:

[A]ny smoothing function that changes the stabilization strength value over time so as to result in a smoothened frame-to-frame adjustment of video images that meets the needs or goals of the system under design may be used, e.g., a linear function, an exponential function, a parabolic function, a quadratic function, a stair step function, etc.

Id. at 10:57–63. The process likewise “increase[s] the stabilization strength slowly, resulting in a more gradually corrected trajectory, . . . in smoothed trajectory-3 615.” *Id.* at 11:16–19.

2. *Kwatra (Exhibit 1005)*

Kwatra relates to “processing a video for stabilization and retargeting.” Ex. 1005, 1:45–46. Kwatra summarizes the processing as follows (in part):

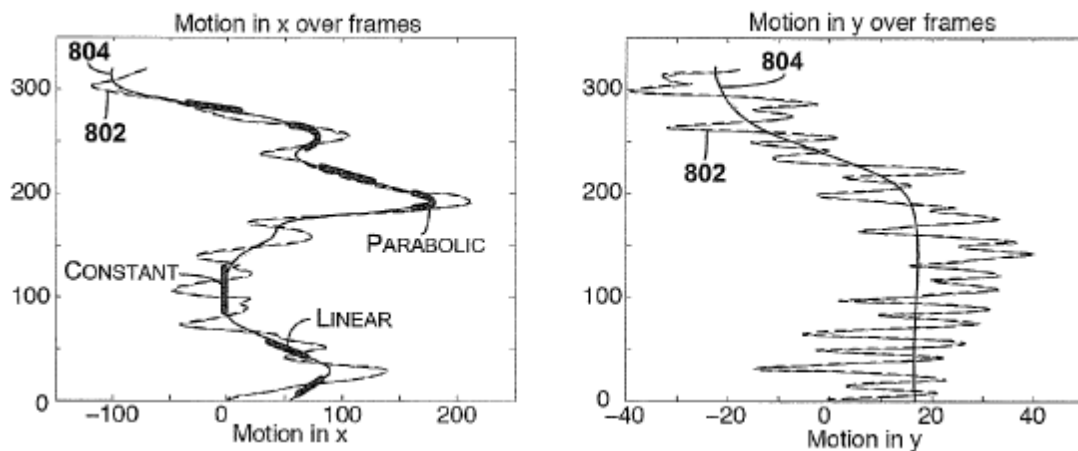
[P]rocessing a video . . . may comprise[:] estimating an original motion path of a camera that recorded a video[:] . . . determining[,] at each time t [,] a substantially constant path, a substantially constant velocity, or a substantially constant acceleration of the original motion path of the camera[:] . . . determining a modified motion camera path of the original motion path of the camera including[,] for each time t [,] the substantially constant path, the substantially constant velocity, or the substantially constant acceleration of the original motion path of the camera[: and] . . . based on the modified motion camera path and the original motion path of the camera, determining a crop window transform that describes how to modify the original motion path of the camera to the modified motion camera path

Id. at 1:46–61. Kwatra describes example aspects as follows:

The video may be processed to estimate an original path (e.g., motion) of a camera that recorded the video, to estimate a new steady/smooth camera path, and to recast the video from the original path to the smooth camera path. In one example, to estimate a new camera path, a virtual crop window of a pre-defined scale less than one with respect to an original frame size can be designated. A difference transformation between the original and smooth camera path can be applied to the recorded video using the crop window to recast the recorded video as if the video had been recorded from the smooth camera path to remove shake from the recorded video, for example. If the crop window does not fit in the original frame, in one example, undefined areas may be filled using motion-in-painting. In another example, constraints can be imposed to prevent undefined areas from occurring.

Id. at 3:48–63.

We reproduce Figures 8A and 8B of Kwatra below.



Figures 8A–B of Kwatra, reproduced above, left and right, illustrate example graphs of an original camera path motion versus an updated or smooth camera path motion. *Id.* at 3:3–5. Figure 8A shows “motion along the x-axis (or horizontal motion)” and particularly the “original camera path motion 802 . . . as compared to the optimal L1 path.” *Id.* at 19:6–10. As shown, “portions of the optimal L1 path . . . have a constant path[] representing a

static camera, . . . a linear path of constant velocity[] representing a panning or a dolly shot, . . . and a parabolic path of constant acceleration[] representing an ease-in and out transition between static and panning cameras.” *Id.* at 19:9–27.

Figure 8B shows “motion along the y-axis (or vertical motion)” and particularly the “low-frequency bounce originating from a person walking while recording the video.” *Id.* at 19:33–35. The bouncing is “replaced by a static camera model, . . . represented by a straight line . . . as function of time on the graph.” *Id.* at 19:33–38.

3. *Shi (Exhibit 1006)*

Shi relates to “[o]ptical image stabilization (OIS)” and “[e]lectronic image stabilization (EIS).” Ex. 1006, 1:16–44. “Optical image stabilization (OIS) can decrease shaking and blur present in a video by mechanically moving components of the recording device, such as a lens or the image sensor.” *Id.* at 1:18–21. “Electronic image stabilization (EIS) can also reduce shaking present in video, for example, by aligning and shifting image frames based on analysis of the images.” *Id.* at 1:27–29.

Shi summarizes the system as follows (in part):

An OIS module can stabilize frames during video capture, and position information (e.g., lens shift information) from the OIS module can be captured and used in EIS processing. By using OIS lens shift positions, the stabilization processing can correct for distortion caused by the OIS system as well as avoid making adjustments or motion that was already compensated for by the OIS system. . . .

The system can use the device position data and OIS position data during EIS processing to take into account the actual pose of the recording device during capture as well as adjustments to the camera view caused by OIS. As a result, the EIS processing

can compensate for motion of the recording device as a whole (e.g., camera shake or other extrinsic movement of the recording device) as well as image shifts due to operation of the OIS module (e.g., internal lens movements).

Id. at 1:37–55.

In an embodiment, a “frame 211 is . . . captured by an image sensor” and an “EIS module 155 defines a first transformation 162 from data indicating the real positions of the recording device 102 during capture” and “camera elements such as the OIS module elements and lens focus position.” *Id.* at 12:30–35. “The EIS module 155 uses a second transformation 162 . . . [that] corresponds to a virtual lens position, e.g., a hypothetical position that would have resulted in more stable video if used to capture the frame 211,” and “fully defines the data for the output frame 235.” *Id.* at 12:44–51.

A “virtual camera position . . . represent[s] an adjusted or hypothetical pose of the recording device 102 that would stabilize the video being recorded.” *Id.* at 10:63–66. “[T]he virtual camera position can be adjusted through filtering of device positions based on movement detected before and after a frame, based on an amount of blur in the frame, based on a likelihood that panning is occurring, through adjustments to prepare for motion in future frames, and/or to ensure that image data covers an entire output frame.” *Id.* at 11:18–24. Thus, “a range of time around the capture of the frame 211 . . . is analyzed to determine how to transform the frame 211.” *Id.* at 12:15–18. “The time of exposure, T , . . . under analysis can be used as the center of the range.” *Id.* at 12:18–20. “A predetermined time offset, L , can be used to set the range, e.g., a time range from $[T-L, T+L]$,” e.g., “about 7 frames before and about 7 frames after the frame.” *Id.* at 12:20–25.

E. Unpatentability Grounds

1. Unpatentability over Zhou and Kwatra (Ground 1)

Petitioner asserts that claims 1–20 are unpatentable under 35 U.S.C. § 103 as obvious over Zhou and Kwatra. Pet. 8–63.

For this decision, we focus on one recitation that appears identically in both claim 1 and claim 11:

wherein the capture trajectory is determined to include a path that **minimizes a combination of rotational velocity and rotational acceleration** of the housing.

Ex. 1001, 18:29–31 (emphasis added), 20:3–10. The parties do not dispute the meaning of this key recitation. Pet. 6; PO Resp. 15.

Patent Owner explains the technical purpose of the key recitation’s minimizing of rotational velocity and rotational acceleration, and Petitioner does not dispute Patent Owner’s explanation. PO Resp. 5–6. The ’894 patent seeks to improve video stability (i.e., make the video smoother). *Id.* In particular, it may perform this smoothing by presenting video that minimizes, via use of a cost function, the first and second derivatives of a rotational angle function for the housing. *Id.* at 6. The first derivative of rotational angle is angular velocity; the second derivative is angular acceleration. *Id.*; *see also* Ex. 1001, 11:2–22 (’894 patent equation showing minimization of the theta, angular rotation, variable).

Petitioner relies solely on the Kwatra reference as teaching or suggesting minimization of a combination of rotational velocity and rotational acceleration of the housing. Pet. 31–35. Patent Owner argues that Kwatra does not teach or suggest this minimization. PO Resp. 15–24. Patent Owner raised this minimization issue in its preliminary response, and our institution decision acknowledges that whether or not Kwatra teaches or

suggests the recited minimization function presented a disputed fact issue to finally resolve at trial. Inst. Dec. 32. Now, for the reasons explained below and based on a full trial record, we decide this dispositive issue in Patent Owner's favor.

a) Findings of Fact

We begin our analysis with the following findings of fact (“FF”) enumerated with paragraph numbers:

1. Kwatra is, similar to the '894 patent, directed to stabilizing video by estimating a new camera path: “a video may be processed to estimate an original path of a camera that recorded the video, to estimate a new camera path, and to recast the video from the original path to the new camera path.” Ex. 1005, code (57); *see also id.* at Fig. 4.
2. Kwatra explains that a “new camera path” can be applied using a “difference transformation.” *Id.* at 3:25–59.
3. In general, Kwatra teaches a video stabilization method that estimates camera motion by tracking image features across frames and fitting linear motion models to the detected motion. *Id.* at 13:23–14:52; Ex. 2018 ¶ 62. Kwatra identifies “translation, similarity, and affine” as example linear models “to describe motion of the camera between video frames or between two consecutive video frames.” Ex. 1005, 9:42–45.
4. A linear motion model is a mathematical model that describes how the state of a moving object evolves over time using linear transformations. Ex. 1017 ¶ 22.
5. A mathematical model being linear *does not* necessarily mean that it can only represent linear movement. Ex. 1017 ¶¶ 26–31.

6. Kwatra teaches, at Equation (7), minimization of the following cost function. We reproduce Equation (7) below.

$$a \left| \frac{dP}{dt} \right| + b \left| \frac{d^2P}{dt^2} \right| + c \left| \frac{d^3P}{dt^3} \right| \quad \text{Equation (7)}$$

Ex. 1005, 14:1–4. The equation can be expressed, in words, as the sum of three components: (first) a multiplied by the derivative of P with respect to t plus (second) b multiplied by the second derivative of P with respect to t plus (third) c multiplied by the third derivative of P with respect to t.

7. Kwatra explains that a, b, and c are “linear weights.” *Id.* at 14:6.

8. The lowercase t, within Kwatra Equation (7), refers to time. *Id.* at 1:52–57 (referring to “each time t”).⁸ A person of ordinary skill in the art would know this because it states that a “static camera” can be represented by the first derivative of P with respect t equaling zero. *Id.* at 5:64–6:4. Similarly, Kwatra states that a path of constant velocity (as with “a panning or dolly shot”) is indicated by the second derivative of P with respect to t equaling zero. *Id.* at 6:5–12. Kwatra also states that a path of constant acceleration (which “may represent ease-in and out transitions”) is indicated by the third derivative of P with respect to t equaling zero. *Id.* at 6:13–20.

9. Kwatra uses P(t) to refer to a function representing camera path with path being dependent on time. *See, e.g. id.* at 6:1–4 (“P is a function representing the camera path”); *see also id.* at 2:1–24 (summary of invention referring to “motion path” and “motion camera path”); 6:47–61 (referring to “camera path P(t)”).

⁸ In other contexts, Kwatra sometimes uses “t” to refer to translation movement. Ex. 1005, 17:10–12.

10. Patent Owner's witness, Dr. Foroosh, testifies that Kwatra's minimization of derivatives does not result in minimization of a combination of rotational velocity and acceleration. Ex. 2018 ¶ 66. We find this testimony credible because it is supported by the text of Kwatra as a whole (as further explained herein) and a reasoned technical explanation. Dr. Foroosh explains, for example, that this opinion is confirmed by Equation 12 of Kwatra which relates only to translation in the x and y dimensions. *Id.*; *see also* Ex. 1005, 14:54–15:56.

11. Kwatra teaches that a similarity model can fit “2 DOF [degrees of freedom] translation, 1 DOF scale, and 1 DOF rotation.” Ex. 1005, 11:5–11.

12. Kwatra teaches, for similarity or affinity transformations, to impose smoothness constraints only on degree of freedom elements “a” and “b” rather than directly on scale (“s”) and image rotation angle (“ θ ”) of the trackable features. Ex. 1005, 17:5–20; Ex. 2018 ¶ 69. Kwatra states that that, when constraining smoothness on a and b, “rotation and scale may not remain smooth.” Ex. 1005, 17:17–18.

13. Kwatra teaches that “imposing smoothness constraints on s [the variable for scale] and theta [the variable for rotation] *may be non-linear*.” *Id.* at 17:18–19. Thus, Kwatra suggests that the linear techniques Kwatra explains elsewhere may not be appropriate for addressing rotation. Dr. Foroosh provides credible testimony (consistent with Kwatra as a whole) supporting this point. Ex. 2018 ¶¶ 69–71.

14. To address rotation (θ), Kwatra constrains the sine and cosine of θ using a different approach than the minimization Kwatra applies to path $P(t)$. Ex. 1005, 17:37–49. Notably, this equation does not minimize velocity or

acceleration of rotation (first and second derivatives of angle). Ex. 2018 ¶ 71 (Dr. Foroosh providing credible testimony on this point).

15. Kwatra incorporates the text of its provisional application, U.S. provisional patent application Serial Number 61/407,630, filed October 28, 2010, by reference. Ex. 1005, 1:8–11.

16. The Kwatra provisional further explains Kwatra’s approach regarding rotation. In particular, the Kwatra provisional states that the “optimal algorithm could estimate all parameters for all frames jointly” except that such an approach is problematic because this “concatenation of parameters is not linear anymore, requiring a more complex, non-linear optimization method *which is not fast enough for real-time performance.*” Ex. 2019, 3 (emphasis added). Kwatra explains that it does opt for a “simpler linear update scheme.” *Id.*

17. The Kwatra provisional further explains that “[t]o preserve our linear framework,” its method assumes that “the rotation and scale components of A are small enough that if we would transform the frame window corners, they would not move by more than the distance to the nearest crop corner.” *Id.* at 10. Given this context, Dr. Foroosh credibly explains that by choosing to avoid non-linear computations, Kwatra does not and cannot minimize rotational velocity and acceleration. Ex. 2018 ¶ 72.

18. The Kwatra provisional explains that “restrictive constraints” are applied to rotation, and this is reasonable because “rotation and scale are expected to be small.” Ex. 2019, 8.

19. Petitioner’s witness, Dr. Katsaggelos, did not review the Kwatra provisional application when forming his opinions in his original declaration. Ex. 2020, 19:25–20:5; 21:1–14; Ex. 2018 ¶ 73.

20. In 2011,⁹ Matthias Grundman, Vivek Kwatra, and Irfan Essa published a paper entitled, “Auto-Directed Video Stabilization with Robust L1 Optimal Camera Paths.” Ex. 1023 (“the Kwatra paper”), 225; *see also* Ex. 1022, 7 (providing citation).¹⁰

21. For context, the Kwatra patent’s provisional application was filed October 28, 2010. Ex. 1005, code (60). The non-provisional patent was filed February 8, 2011. *Id.* at code (22). The ’894 patent was filed August 22, 2019, and it claims priority to a May 18, 2018, provisional application. Ex. 1001, codes (22), (60).

22. Grundman and Kwatra are the two named inventors of the Kwatra patent at issue. Ex. 1005, code (75). Herein, we refer to Exhibit 1023 as the “Kwatra paper.”

23. The Kwatra paper has many disclosures substantially similar to that of the Kwatra patent. *See, e.g.*, Ex. 1023, 227; *see also* Ex. 1017 ¶ 69. The Kwatra paper, like the Kwatra patent, teaches minimizing a path function by minimizing position, velocity, and acceleration. Ex. 1023, 227.

24. In an internal GoPro document, Patent Owner personnel discuss various video stabilization approaches. Ex. 1022, *passim*.

25. The GoPro document refers to “a function to be minimised [sic, European spelling] (objective function).” *Id.* at 18.

⁹ Exhibit 1023 does not indicate a date. The internal GoPro document citing Exhibit 1023, however, indicates publication in 2011.

¹⁰ Petitioner moved to seal Exhibit 1022 because it includes Patent Owner’s confidential information. Paper 27. Here, we address the document without disclosing confidential information of potential commercial value.

26. That GoPro document describes “an attempt” based on the “method” of the Kwatra paper. *Id.* In particular, under the bold heading “Method based on linear programming,” the document states:

A first attempt was based on the method of [the Kwatra paper]. This method is characterized by:

- **the objective function** is expressed as a combination of the camera’s angular velocity and acceleration over time.

Id. (emphasis original).

27. The GoPro document then explains, “[w]e prototyped and tested this method on a test platform.” *Id.* It appears, however, that the GoPro document’s authors abandoned this method (at least at the time) because of after determining the linear programming would be too complex. The GoPro document explains that “the solver code for the linear programs used for the prototype on the test platform could not be deployed on the camera because of differences in environments and dependencies on external libraries.” The GoPro document then states, “However, according to our analysis, given the high complexity of linear programming, we decided not to prototype it on the camera.” *Id.*

b) Analysis of arguments

The Petition cites Equation (7) Kwatra’s cost function as meeting the claim’s requirement that “the capture trajectory is determined to include a path that minimizes a combination of rotational velocity and rotational acceleration of the housing.” Pet. 32–33, 35. The Petition further cites Kwatra as teaching that it seeks to compensate for angular movement and compensate for rotation. *Id.* at 32.

Patent Owner argues that Kwatra does not teach determining a capture trajectory that minimizes a combination of rotational velocity and rotational acceleration of the housing. PO Resp. 16. As we explain below, the preponderance of the evidence best supports Patent Owner's position.

Kwatra teaches, at Equation 7, minimizing velocity and acceleration of a function representing *camera path* (P). FF ¶¶ 6, 8–9. Kwatra does not state that this camera path function considers rotation. Rather, the words “camera path” suggest x, y, z movement of the camera rather than rotation of the camera. Dr. Foroosh's testimony that Kwatra's minimization of a smoothed camera path does not result in minimizing rotational velocity and acceleration is credible because this testimony is consistent with Kwatra as a whole and consistent with the other evidence of record. *Id.* ¶ 10.

Kwatra recognizes that image rotation angle (“ θ ”) may not remain smooth. *Id.* ¶ 12. But rather than attempting to minimize velocity and acceleration of rotation of the camera housing, Kwatra states that applying a smoothness constraint on rotation angle “may be non-linear.” *Id.* ¶ 13. Consistent with Kwatra, Dr. Foroosh credibly explains the difficulty of applying linear techniques to rotation. *Id.* Thus, Kwatra proposes instead constraining the sine and cosine of theta. *Id.* ¶ 14.

The Kwatra provisional application is part of the Kwatra reference (*id.* ¶ 15), and it similarly opts for simpler schemes rather than estimating all parameters for all frames jointly. *Id.* ¶ 16. The provisional explains that the rotational component is relatively small such that non-linear computations minimizing velocity and rotation can be avoided. *Id.* ¶¶ 17–18. The testimony of Patent Owner's witness, Dr. Foroosh, explaining the provisional is credible (Ex. 2018 ¶ 72) because it is consistent with Kwatra's

complete disclosure. Dr. Foroosh’s testimony is more credible than the testimony of Petitioner’s witness, Dr. Katsaggelos, because Dr. Katsaggelos did not review the Kwatra provisional application and, thus, did not review the entire disclosure of Kwatra. *Id.* ¶ 19; *see also In re Etter*, 756 F.2d 852, 859 (Fed. Cir. 1985) (en banc) (obviousness analysis considers whether “the claimed inventions are rendered obvious by the teachings of the prior art *as a whole*” (emphasis added)).

With regard to the GoPro document at Exhibit 1022, which characterizes the Kwatra paper, we determine that the document is too unclear to meaningfully weigh for or against any particular interpretation of Kwatra. The GoPro document indicates that “[t]his method” included minimizing the camera’s angular velocity and acceleration. FF ¶ 26. The document is unclear, however, as to whether “this method” refers to the method of the Kwatra paper or instead refers to the Patent Owner’s “first attempt.” *Id.* There is no testimony of record clarifying this point. Also, the GoPro document indicates that GoPro ultimately abandoned the approach due to complexity. *Id.* ¶ 27. This is the same difficulty identified by Kwatra. *Id.* ¶¶ 13, 16.

Petitioner argues that Patent Owner does not contend that linear motion models cannot represent rotational motion. Pet. Reply 3–4. We agree, but this does not squarely address the issue of whether or not Kwatra teaches or suggests minimizing a combination of rotational velocity and rotational acceleration of the housing. As explained above, Kwatra is best understood as rejecting such minimization because of computational *difficulty*—not because of computational *impossibility*.

Petitioner also argues that “Kwatra discloses smoothing rotation.” Pet. Reply 4 (emphasis removed). We agree, but again, this argument is off point. As explained above, Kwatra teaches constraining the sine and cosine of rotation, but the preponderance of the evidence does not establish that Kwatra teaches or suggests minimizing a combination of rotational velocity and rotational acceleration of the housing. *See* PO Sur-Reply 3–5.

Petitioner further argues that the Kwatra provisional supports Petitioner’s reading of Kwatra. Pet. Reply 7–9. We disagree. Although the Kwatra provisional teaches a similarity transform as “a combination of scale, rotation and translation” (*id.* at 8–9 (quoting Ex. 2019, 5)), the Kwatra provisional discusses constraining the sine and cosine of the rotation variable, theta. Ex. 2019, 5. We do not understand the Kwatra provisional as teaching or suggesting minimizing a combination of rotational velocity and rotational acceleration of the housing. *See* PO Sur-Reply 5–6.

Petitioner also argues that Patent Owner misplaces its reliance on Figures 8A and 8B because those are a single embodiment. Pet. Reply 9–10. Petitioner does not dispute that these figures show only translational motion. *Id.* Here, our analysis is based on Kwatra as a whole. We do not focus only Figures 8A and 8B because we agree these are examples.

c) Conclusion

Based on the preponderance of the evidence and the analysis above, we determine that, when read as a whole including the provisional application, Kwatra does not teach or suggest minimizing rotational velocity and acceleration as required by the challenged claims. Alternatively, Kwatra’s suggestions are, at best, unclear in this regard. Thus, Petitioner has

not established by a preponderance of the evidence that any claim of the '894 patent is unpatentable.¹¹

IV. RESOLUTION OF MOTION TO STRIKE

Patent Owner moves to strike Petitioner's discussion and analysis of the Kwatra paper and the GoPro document referencing the Kwatra paper. Patent Owner's Motion to Strike, Paper 30, 1. We deny this motion to strike as moot because, as we explain above, Petitioner does not establish unpatentability by a preponderance of the evidence even if we consider this evidence.

V. CONCLUSION¹²

For the reasons above, we determine that Petitioner has not proven, by a preponderance of the evidence, that any claim of the '894 patent is unpatentable. The following table provides a summary:

¹¹ We note that the International Trade Commission reached a similar determination. In particular, the evidence before the ITC supported that "even if Pixel 2 and Kwatra were combined, the claimed invention, which requires 'a path that minimizes a combination of rotational velocity and acceleration,' would not result." Ex. 2052, 67–68.

¹² Should Patent Owner wish to pursue amendment of the challenged claims in a reissue or reexamination proceeding subsequent to the issuance of this decision, we draw Patent Owner's attention to the April 2019 Notice Regarding Options for Amendments by Patent Owner Through Reissue or Reexamination During a Pending AIA Trial Proceeding. *See* 84 Fed. Reg. 16,654 (Apr. 22, 2019). If Patent Owner chooses to file a reissue application or a request for reexamination of the challenged patent, we remind Patent Owner of its continuing obligation to notify the Board of any such related matters in updated mandatory notices. *See* 37 C.F.R. § 42.8(a)(3), (b)(2).

Claims	35 U.S.C. §	Reference(s)/ Basis	Claim(s) Shown Unpatentable	Claim(s) not Shown Unpatentable
1–20	103(a)	Zhou, Kwatra		1–20
2, 3, 7, 12, 13, 17	103(a)	Zhou, Kwatra, Shi		2, 3, 7, 12, 13, 17
Overall Outcome				1–20

VI. ORDER

For the foregoing reasons, it is

ORDERED that Petitioner has *not* demonstrated by a preponderance of the evidence that claims 1–20 of the '894 patent are unpatentable;

ORDERED that Patent Owner's motion to strike (Paper 30) is denied as moot; and

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

IPR2024-01186
Patent 10,574,894 B2

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