

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.

Case No. IPR2024-01186
U.S. Patent No. 10,574,894

PATENT OWNER'S RESPONSE

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EXHIBIT LIST

No.	Exhibit
2001	Declaration of Hassan Foroosh, Ph.D.
2002	<i>Curriculum vitae</i> of Hassan Foroosh, Ph.D.
2003	“GoPro Celebrates Surpassing 50 Million Cameras Sold,” produced as GOPRO_00063291 in <i>In the Matter of Certain Cameras, Camera Systems, and Accessories Used Therewith</i> , Inv. No. 337-TA-1400
2004	CONFIDENTIAL BUSINESS INFORMATION SUBJECT TO PROTECTIVE ORDER [REDACTED] produced as GOPRO_00009580 in <i>In the Matter of Certain Cameras, Camera Systems, and Accessories Used Therewith</i> , Inv. No. 337-TA-1400
2005	“NHL, NHLPA Partner with GoPro To Deliver Hockey Fans Unique Perspectives Of The Game,” produced as GOPRO_00063270 in <i>In the Matter of Certain Cameras, Camera Systems, and Accessories Used Therewith</i> , Inv. No. 337-TA-1400
2006	Complaint, <i>In the Matter of Certain Cameras, Camera Systems, and Accessories Used Therewith</i> , Inv. No. 337-TA-1400
2007	E-mail from Alex S. Yap on October 9, 2024
2008	“GoPro Named Exclusive Action Camera of Red Bull Rampage, the World’s Biggest Freeride Mountain Bike Event,” produced as GOPRO_00063323 in <i>In the Matter of Certain Cameras, Camera Systems, and Accessories Used Therewith</i> , Inv. No. 337-TA-1400
2009	“GoPro and Adobe Collaborate to Bring Unique Content to Adobe Stock Users,” produced as GOPRO_00063341 in <i>In the Matter of Certain Cameras, Camera Systems, and Accessories Used Therewith</i> , Inv. No. 337-TA-1400

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2010	"73 rd Annual Technology & Engineering Emmys," produced as GOPRO_00000009 in <i>In the Matter of Certain Cameras, Camera Systems, and Accessories Used Therewith</i> , Inv. No. 337-TA-1400
2011	"Believe the Hype: GoPro Showcases Award-Winning HERO7 Cameras at CES 2019," produced as GOPRO_00063251 in <i>In the Matter of Certain Cameras, Camera Systems, and Accessories Used Therewith</i> , Inv. No. 337-TA-1400
2012	"GoPro Wins Second Emmy® Award for Groundbreaking Digital Imaging Technology," produced as GOPRO_00063339 in <i>In the Matter of Certain Cameras, Camera Systems, and Accessories Used Therewith</i> , Inv. No. 337-TA-1400
2013	"J.P. Morgan – North America Equity Research (21 September 2018)," produced as GOPRO_00359592 in <i>In the Matter of Certain Cameras, Camera Systems, and Accessories Used Therewith</i> , Inv. No. 337-TA-1400
2014	"GoPro Hero 9 Black vs Hero 8 Black: 9 key differences you need to know," produced as GOPRO_00010039 in <i>In the Matter of Certain Cameras, Camera Systems, and Accessories Used Therewith</i> , Inv. No. 337-TA-1400
2015	CONFIDENTIAL BUSINESS INFORMATION SUBJECT TO PROTECTIVE ORDER - [REDACTED] [REDACTED] in <i>In the Matter of Certain Cameras, Camera Systems, and Accessories Used Therewith</i> , Inv. No. 337-TA-1400
2016	CONFIDENTIAL BUSINESS INFORMATION – SOURCE CODE - SUBJECT TO PROTECTIVE ORDER – [REDACTED] [REDACTED] served in <i>In the Matter of Certain Cameras, Camera Systems, and Accessories Used Therewith</i> , Inv. No. 337-TA-1400

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2017	Declaration of Patrick T. Schmidt in Support of Patent Owner's Motion for <i>Pro Hac Vice</i> Admission (March 14, 2025)
2018	Supplemental Declaration of Hassan Foroosh, Ph.D.
2019	U.S. provisional patent application Ser. No. 61/407,630 filed on Oct. 28, 2010 ("Kwatra provisional application")
2020	Transcript of April 4, 2025, Deposition of Petitioner's Expert Dr. Katsaggelos
2021	Excerpt of ITC Trial Transcript including Testimony of Petitioner's Expert Mr. Goodin
2022	Screenshot of Dr. Katsaggelos lecture on Coursera
2023	U.S. Patent 10,027,893 ("Bell")
2024	CONFIDENTIAL BUSINESS INFORMATION SUBJECT TO PROTECTIVE ORDER - Declaration of Pablo Lema
2025	CONFIDENTIAL BUSINESS INFORMATION SUBJECT TO PROTECTIVE ORDER - [REDACTED]
2026	CONFIDENTIAL BUSINESS INFORMATION SUBJECT TO PROTECTIVE ORDER - [REDACTED]
2027	CONFIDENTIAL BUSINESS INFORMATION – SOURCE CODE - SUBJECT TO PROTECTIVE ORDER - [REDACTED]
2028	CONFIDENTIAL BUSINESS INFORMATION – SOURCE CODE - SUBJECT TO PROTECTIVE ORDER [REDACTED]
2029	CONFIDENTIAL BUSINESS INFORMATION – SOURCE CODE - SUBJECT TO PROTECTIVE ORDER [REDACTED]
2030	User Manuel for GoPro HERO7 Black (CX-0522)

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2031	CONFIDENTIAL BUSINESS INFORMATION – SOURCE CODE - SUBJECT TO PROTECTIVE ORDER - [REDACTED] [REDACTED]
2032	CONFIDENTIAL BUSINESS INFORMATION – SOURCE CODE - SUBJECT TO PROTECTIVE ORDER - [REDACTED] [REDACTED]
2033	CONFIDENTIAL BUSINESS INFORMATION – SOURCE CODE - SUBJECT TO PROTECTIVE ORDER - [REDACTED] [REDACTED]
2034	CONFIDENTIAL BUSINESS INFORMATION – SOURCE CODE - SUBJECT TO PROTECTIVE ORDER - [REDACTED] [REDACTED]
2035	CONFIDENTIAL BUSINESS INFORMATION – SOURCE CODE - SUBJECT TO PROTECTIVE ORDER - [REDACTED] [REDACTED]
2036	CONFIDENTIAL BUSINESS INFORMATION – SOURCE CODE - SUBJECT TO PROTECTIVE ORDER - [REDACTED] [REDACTED]
2037	CONFIDENTIAL BUSINESS INFORMATION – SOURCE CODE - SUBJECT TO PROTECTIVE ORDER - [REDACTED] [REDACTED]
2038	CONFIDENTIAL BUSINESS INFORMATION – SOURCE CODE - SUBJECT TO PROTECTIVE ORDER - [REDACTED] [REDACTED]
2039	CONFIDENTIAL BUSINESS INFORMATION – SOURCE CODE - SUBJECT TO PROTECTIVE ORDER - [REDACTED] [REDACTED]
2040	CONFIDENTIAL BUSINESS INFORMATION SUBJECT TO PROTECTIVE ORDER – [REDACTED] [REDACTED]

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2041	CONFIDENTIAL BUSINESS INFORMATION SUBJECT TO PROTECTIVE ORDER – [REDACTED]
2042	Technical Review of HERO8 Black (CX-1388)
2043	CONFIDENTIAL BUSINESS INFORMATION SUBJECT TO PROTECTIVE ORDER [REDACTED]
2044	CONFIDENTIAL BUSINESS INFORMATION SUBJECT TO PROTECTIVE ORDER [REDACTED]
2045	CONFIDENTIAL BUSINESS INFORMATION SUBJECT TO PROTECTIVE ORDER - [REDACTED]
2046	CONFIDENTIAL BUSINESS INFORMATION SUBJECT TO PROTECTIVE ORDER [REDACTED]
2047	CONFIDENTIAL BUSINESS INFORMATION SUBJECT TO PROTECTIVE ORDER - [REDACTED]
2048	Insta360 Speeds Up Workflow with New 360 Reframing Tool, Better Stabilization & Quick Reader (CX-0077)

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I. INTRODUCTION

GoPro is an industry leader in developing innovative video stabilization technologies. Its Emmy Award-winning HyperSmooth technology brought a step-change improvement to digital video stabilization, enabling the capture of professional-quality footage in dynamic environments. The challenged claims reflect these innovations and should be upheld.

Arashi Vision (U.S.) LLC (d/b/a Insta360) (“Petitioner”) challenges independent claims 1 and 11 and dependent claims 2-10 and 12-20 of U.S. Patent No. 10,574,894 (Ex. 1001, “the ’894 patent”) on two grounds, both of which rely on the disclosure of *linear motion models* in Kwatra (Ex. 1005). In instituting this proceeding, the Board recognized a disputed fact issue regarding whether Kwatra teaches or suggests a process for minimizing *rotational* velocity and acceleration.

As the evidence presented herein confirms—including statements from Kwatra’s own inventors, who explicitly rejected non-linear (rotational) optimizations in favor of simpler linear methods due to computational complexity (as “not fast enough for real-time performance”)—Kwatra neither teaches nor suggests, but rather intentionally avoids a process, as claimed,

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“that minimizes a combination of rotational velocity and acceleration of the [camera] housing.”

Specifically, Kwatra's motion estimation and optimization process depends upon two-dimensional, linear motion models of trackable features extracted from the image data itself. While Kwatra recognizes that certain of these models may include a rotational degree of freedom parameter, Kwatra expressly avoids applying its smoothing constraints directly on any rotational parameter because doing so would result in complex, non-linear calculations that Kwatra seeks to avoid. Ex. 1005 at 17:5-22. Indeed, Kwatra accepts that in its approach “rotation and scale may not remain smooth,” and instead addresses this issue by applying bounding constraints to make sure that scale and rotation “do not deviate too much.” *Id.* at 17:18-49.

Critically, Petitioners fail to address these disclosures or explain how, considering them, Kwatra renders the '894 patent's unique optimization approach obvious. As Dr. Foroosh explains, it does not. Applying a boundary constraint to limit the amount a trackable feature is permitted to rotate is in no way analogous to determining a capture trajectory that minimizes a combination of rotational velocity and rotational acceleration of the camera housing as claimed.

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Petitioner further fails to account for the fact that Kwatra's image "feature tracking" approach to motion estimation and modeling is inherently two dimensional in nature, at most considering up to only one degree of freedom for rotational motion of the image plane (not the camera housing). Not only is this irreconcilable with the claim language, but Petitioner fails to adequately explain how a POSITA would be motivated to combine Kwatra's optimization of *two*-dimensional, linear motion models with Shi and Zhou, which model camera trajectory and rotation in three dimensions based on motion sensors such as gyroscopes and accelerometers. Indeed, Kwatra's optimization techniques would not be compatible with the three-dimensional trajectory modeling techniques of Shi and Zhou, and a person of ordinary skill in the art would not have had a reasonable expectation of success in combining them.

At a minimum, Petitioner's combination fails to teach or suggest claim 5, which expressly excludes performing motion estimation based on analysis of the image data itself as taught by Kwatra. Using hindsight, Petitioner's theory improperly seeks to combine the motion estimation techniques of Zhou based on sensor measurements with the optimization techniques of Kwatra that depend on image features. But Kwatra's optimization techniques are

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inextricably based on its unique approach to motion estimation, and the prior art cannot be cherry picked in this fashion.

Finally, secondary considerations—including, amongst others, commercial success, widespread industry recognition and awards for GoPro's HyperSmooth technology, and copying by competitors—further underscore the non-obviousness of the claimed invention. This objective evidence demonstrates that the innovations disclosed in the '894 patent provided significant advantages previously unachievable by the prior art, strongly supporting the validity of the challenged claims.

II. OVERVIEW OF THE '894 PATENT

The '894 patent, titled “Systems and Methods for Stabilizing Videos,” discloses a video stabilization system that determines a capture trajectory to smooth the observed trajectory of the camera by minimizing a combination of rotational velocity and rotational acceleration of the camera housing. Ex. 1001, 10:61-11:15; Ex. 2018, ¶ 35.

Rotational Motion of the Camera Housing

Rotational motion is typically described using yaw, pitch, and roll angles (“Euler angles”), which represent rotation around three perpendicular axes:

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- **Yaw**– Rotation around the **vertical axis** (turning left or right).
- **Pitch**– Rotation around the **lateral axis** (tilting up or down).
- **Roll**– Rotation around the **longitudinal axis** (tilting side to side).

Ex. 2018, ¶ 36.

While the claims do not explicitly reference **yaw**, **pitch**, or **roll**, minimizing rotational velocity and acceleration of a camera housing—a three-dimensional object in space—necessarily involves at least one of these rotational angles.¹ *Id.* at ¶ 37.

Minimizing a Combination of Rotational Velocity and Acceleration of the Camera Housing

The '894 patent improves video stability by computing a capture trajectory that smooths camera motion through the minimization of a combination of rotational velocity and rotational acceleration of the camera housing. This sort of optimization inherently involves non-linear and

¹ Furthermore, claim 5 in the '894 patent limits the position sensor in independent claim 1 to be “a gyroscope, an accelerometer, and/or an inertial measurement unit” (IMU). Both gyroscope and IMU are sensors that are used to provide yaw, pitch, roll angular measurements for a moving body in the 3D space. Ex. 2018, ¶ 37, n.1.

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trigonometric relationships to account for rotational motion accurately. *Id.* at ¶ 38.

In the preferred embodiment, a cost function applies weighting factors to different motion derivatives to balance stabilization performance. *Id.* at ¶ 39. Specifically, Equation 54 (*id.* at 11:2-22) minimizes both the first and second time derivatives of a function expressed in terms of rotational angle (θ)—These derivatives correspond to rotational velocity and rotational acceleration of the housing:

$$\min \left(\left\| \frac{d}{dt} \theta \right\|^2 + \left\| \frac{d^2}{dt^2} \theta \right\|^2 + \dots \right)$$

Eq. 54, highlighting angle theta; *see also* Ex. 2018 at ¶ 39.

Minimizing these derivatives is one example of optimizing rotational velocity and acceleration in accordance with the '894 patent claims. By minimizing rotational velocity and acceleration of the camera housing, the '894 patent accounts for real-world motion variations of a camera rotating in space, ensuring smoother video output. Ex. 2018 at ¶ 40.

Sensor-Based Position Determination

The '894 patent's approach to stabilization is further distinguished by its reliance on onboard motion sensors to determine camera position,

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independent of image data. *Id.* at ¶ 41. Claim 5 explicitly requires that position information be determined “*independent of the image information*,” meaning the system utilizes gyroscopes, accelerometers, and/or inertial measurement units (IMUs) to measure the camera’s movement directly.² *Id.*

This sensor-based measurement method contrasts with image-based stabilization approaches, which estimate camera motion by tracking image features across frames. *Cf.* Ex. 1004 (“Zhou”) at 1:29-34 (“One way to stabilize a video is to track a salient feature in the image and use this as an anchor point to cancel out all perturbations relative to it. This approach requires a priori knowledge of the image’s content to, for example, identify and track a person or other salient object in the scene.”); Ex. 2018, ¶ 42. By relying on sensor-based motion estimation rather than feature tracking from image data, the ’894 patent ensures that stabilized videos appear as if they were captured by a camera whose rotational velocity and rotational acceleration were minimized during the capture duration. *Id.* at ¶ 42.

² By contrast, image-based stabilization methods estimate position by tracking visual features across frames, meaning their accuracy depends on image content rather than direct motion sensing. Ex. 2018 at ¶ 41, n.2.

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III. OVERVIEW OF THE CITED ART

The Petition challenges claims 1-20 of the '894 patent on two grounds. Ground 1 asserts that the combination of Zhou and Kwatra renders the claims obvious, while Ground 2 asserts that the combination of Zhou, Kwatra, and Shi renders the claims obvious. Below are summaries of the cited references.

B. Ground 1 Cited Art

1. Zhou (Ex. 1004)

Zhou discloses a system for stabilizing video by smoothing camera motion using a “stabilization metric” derived from motion data obtained from gyroscopes or accelerometers. Ex. 1004, Abstract, 3:47-4:19; Ex. 2018 at ¶ 44. Zhou's approach is designed for handheld cameras in low-light conditions and estimates motion blur in each frame to improve video quality. Ex. 1004, 1:5-25; Ex. 2018 at ¶ 44.

However, as Petitioner concedes, Zhou does not disclose or suggest minimizing a combination of rotational velocity and acceleration of the camera housing, as required by the '894 patent. Ex. 2018 at ¶ 45

2. Kwatra (Ex. 1005)

Kwatra discloses a video stabilization method that estimates camera motion by tracking image features across frames and fitting *linear motion models* to the detected feature motion. Ex. 1005, 13:23-14:52; Ex. 2018 at ¶

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46. Kwatra then solves for a smoothed camera path comprised of linear segments using a cost function that minimizes at least one derivative along each segment. Ex. 1005, 1:48-57, 2:6-14, 6:1-28, 6:40-42, 13:23-48; Ex. 2018 at ¶ 46.

As shown below, Kwatra's optimization framework is based entirely around linear motion models and explicitly avoids the complexities involved in minimizing rotational dynamics. Ex. 2018 at ¶ 47.

Kwatra's Camera Path Model Uses Linear Motion Fitting

Kwatra's video stabilization methodology begins by using "feature tracking" of the image data to determine an "original camera path" ("C(t)"). The camera path is modeled by fitting a linear motion model describing the motion of tracked features from one frame to the next. The concatenation of a sequence of linear motion models for the tracked features over time provides a model for the original camera path, "C(t)." Ex. 1005, 5:41-53, 12:11-37, 19:39-58, claim 6; Ex. 2018 at ¶ 48.

Kwatra then conceptualizes a "smooth" or "optimal" camera path ("P(t)"), wherein P(t) is a function of the original camera path C(t) multiplied by some linear transformation B(t), Ex. 1005, 13:49-56 (Ex. 2018 at ¶ 49):

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$$P(t)=C(t)*B(t)$$

Kwatra teaches solving for the B(t) transformation to be applied to each video frame to obtain the smoothed camera path. *Id.* at 13:57-62; Ex. 2018 at ¶ 50.

For example, Kwatra teaches that the “smooth” camera path can be “partitioned” into segments, and B(t) can be solved for each segment to either result in a “static camera” path, a “constant velocity” path,” or a “path of constant acceleration.” Ex. 1005, 13:23-49. A “stable” camera path may be determined by minimizing a cost function of the first, second, and third-order derivatives of the smoothed camera path. *Id.* at 13:62-14:13; *see also* Ex. 2018 at ¶¶ 51-52.

Kwatra's Cost Function Minimizes Only Derivatives of a Linear Path Representation

Kwatra's optimization may involve minimizing the cost function (Equation 7) comprised of the first, second, and third derivatives of the smoothed camera path P(t) as follows:

$$a \left| \frac{dP}{dt} \right| + b \left| \frac{d^2 P}{dt^2} \right| + c \left| \frac{d^3 P}{dt^3} \right|$$

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where a , b , c are weighting factors. Ex. 1005, 13:62-14:12. “Equation (7) can be minimized by setting each derivative equal to zero and solved, for example. Thus, the derivatives can be defined at different points along the camera path (e.g., per frame), and a derivative can be determined at every point (every frame).” *Id.* at 14:8-12; Ex. 2018, ¶ 52.

Kwatra Intentionally Avoided Non-Linear Minimization

Kwatra's stabilization method is based on linear motion models and explicitly avoids non-linear formulations due to computational constraints. Ex. 2018, ¶ 54. Kwatra's inventors expressly chose a linear framework and rejected non-linear (e.g., rotational) optimization due to computational complexity, stating that such an approach was “not fast enough for real-time performance.” Instead, they deliberately constrained their approach to linear programming, as confirmed in Kwatra's provisional application (incorporated by reference in Kwatra) (Ex. 2019) (emphasis added below):

- “The optimal algorithm could estimate all parameters for all frames jointly, similar to Bundle Adjustment. *However, the concatenation of parameters is not linear anymore, requiring a more complex non-linear optimization method which is not fast enough for real-time performance. We therefore opt for a simpler linear update scheme*, here described” (*Id.* at 3).
- “*Since imposing smoothness constraints directly on s and θ would be non-linear, we instead constrain just a and b* but use

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the estimated camera path to ensure that s and θ do not deviate too much from that.” (*Id.* at 5).

- “**Linear programming:** This results in a constrained L1 minimization problem which *can be solved using linear programming.*” (*Id.* at 4).
- “*We fit several 2D linear motion models (translation, similarity, affine)* to the tracked features describing the motion of the camera between two frames.” (*Id.* at 1).
- “Another interpretation is that rotational motion can be well *approximated by a series of parabolic [2D] motion segments.*” (*Id.* at 12).
- “Note that the objective *now becomes linear in the number of slack variables and this optimization can be solved using linear programming.*” (*Id.* at 4).
- “This formulation can be extended to other *linear transforms* such as similarity and affine transforms (for $P(t)$) easily, since *all terms above are linear in $P(t)$ or parameters of $P(t)$.*” (*Id.* at 5).
- “*This, however is expressed in terms of inverse of A , which is non-linear (specifically quadratic) in the parameters of A . To preserve our linear framework, we make the assumption* 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 window corner.” (*Id.* at 7).

By deliberately avoiding non-linear computations, Kwatra's method is fundamentally incapable of minimizing rotational velocity and acceleration of a camera housing. Ex. 2018, ¶¶ 54-55.

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Kwatra's References to Rotation

Kwatra's references to rotation appear in contexts unrelated to its cost function and optimization framework, *i.e.* nowhere teaching the minimization of the angular velocity and angular acceleration of the camera housing. Ex. 2018, ¶ 56. Kwatra's references to rotation are restricted to stating that its 2D linear transformation models have one degree of freedom associated with image plane rotation, and rather than optimizing this rotation Kwatra merely bounds image plane rotation to assert a quality control (Ex. 1005, 11:5-11, 11:63-66, 16:31-35; Ex. 2018, ¶ 56):

- **Rotation as an Image Degree of Freedom, Not Camera Housing Rotation:** Kwatra defines rotation of an image as a degree of freedom within its linear transformation model (*id.* at 11:5-11) but does not describe the rotation of a camera housing, *i.e.* no mention of the three degrees of freedom associated with the rotation of camera housing.
- **Rotation Flags Unreliable Feature Matching, Not an Optimization Criterion:** Kwatra detects “too much rotation” as a quality-control measure to flag unreliable frame-pair linear motion models, rather than incorporating it into its optimization function by directly minimizing its derivatives. Ex. 1005, 11:63-66.
- **Bounding Constraints on Rotation:** Kwatra applies bounding constraints on scale and rotation (*id.* at 16:31-35) to limit excessive image transformations. However, these bounding constraints are applied to prevent excessive motion changes in the optimized linear path model, which is not the same as

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minimizing the rotational velocity or acceleration of the camera housing.

C. Ground 2 Cited Art

1. Shi (Ex. 1006)

Shi focuses on trajectory estimation and correction to stabilize videos by adjusting camera position and rotation based on motion data. The system applies: (1) a first transformation using optical image stabilization (OIS) data, and (2) then calculates a second transformation based on additional positional data collected after the capture of the frame. Ex. 1006, 3:52-4:11; Ex. 2018, ¶ 57.

The '894 patent advances beyond Shi by focusing on rotational stabilization and requiring a minimization of a combination of rotational velocity and rotational acceleration of the camera housing. Therefore, it teaches determining an optimal capture trajectory that yields rotational stabilization of the camera housing, which Shi does not disclose. Ex. 2018, ¶ 58.

IV. LEVEL OF ORDINARY SKILL IN THE ART

Petitioners propose that the level of a POSITA at the time of the '894 patent “would have a bachelor’s degree in engineering or computer science, or equivalent field, and two years of experience working on image or video

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processing, or digital cameras” or “four years of experience working on image or video processing, or digital cameras.” Pet. 6.

Patent Owner applies Petitioner's proposed level of skill. Patent Owner's expert, Dr. Hassan Foroosh, was a POSITA under Petitioner's definition at the time of the '894 patent. Ex. 2018, ¶¶ 17-21.

V. CLAIM CONSTRUCTION

In an *inter partes* review, claim terms receive their plain and ordinary meaning in light of the specification of the patent in which they appear, following the same standard used in district court. 37 C.F.R. § 42.100(b); *see Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005). Petitioner states that no constructions are necessary. See Pet. at 6. Patent Owner agrees that no claim terms presently require construction to resolve any current dispute between the parties. Ex. 2018, ¶ 34.

VI. GROUND 1: PETITIONER FAILS TO ESTABLISH THAT ZHOU AND KWATRA RENDER CLAIMS 1-20 OBVIOUS

A. Claims 1 and 11: The Petition Fails to Show a Capture Trajectory “That Minimizes a Combination of Rotational Velocity and Acceleration of the [Camera] Housing”

Claims 1 and 11 require that the “*capture trajectory is determined to include a path that minimizes a combination of rotational velocity and rotational acceleration of the housing.*”

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Petitioner does not assert that Zhou itself discloses the determination of such a trajectory, instead relying on a combination with Kwatra. However, Kwatra similarly fails to disclose this limitation and, in fact, intentionally avoided the type of non-linear motion models that a minimization of *rotational* velocity and acceleration would entail. Ex. 2018, ¶¶ 59-60.

1. *Kwatra's Linear Framework Does Not Result In A Path That Minimizes Rotational Velocity And Rotational Acceleration of the Housing As Claimed*

Due to concerns regarding computational constraints, Kwatra's motion estimation and smoothing approach is fundamentally based on linear motion models. Ex. 2018, ¶ 61. Kwatra expressly rejects the sort of non-linear computations that would be required to optimize rotational dynamics. *Id.* Thus, Kwatra's technique is incapable of resulting in a path that minimizes a combination of rotational velocity and acceleration as required by the claim. *Id.*

Kwatra discloses a video stabilization method that estimates camera motion by tracking image features across frames and fitting *linear motion models* to the detected feature motion. Ex. 1005, 13:23-14:52; Ex. 2018, ¶ 62. The motion trajectory is then smoothed using an optimization framework that minimizes derivatives of the estimated motion path based on a linear cost

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function. Ex. 1005, 1:48-57, 2:6-14, 6:1-28, 6:40-42, 13:23-48; Ex. 2018, ¶ 62.

Kwatra's approach begins with an analysis of the image information to determine an "original camera path" ($C(t)$). First, "trackable features between two frames may be extracted by extracting a number of features in a first video frame (e.g., based on x and y location) and tracking the extracted features in a next video frame." Ex. 1005, 7:58-62; Ex. 2018, ¶ 63. Once features are extracted and tracked, "two-dimensional (2D) linear motion models" are "fit to the trackable feature-matches to describe motion of the camera between video frames. Ex. 1005, 9:51-45; Ex. 2018, ¶ 63. "An estimate of the original camera path ($C(t)$) can be determined by fitting linear motion models to the tracked feature pair matches resulting in a linear transform for each feature pair." Ex. 1005, 9:57-60; Ex. 2018, ¶ 63. The original camera path $C(t)$ is a simple concatenation of the linear 2D motion models for feature-pair matches between consecutive frames. Ex. 1005, 12:11-21; *see also* claim 6; Ex. 2018, ¶ 63.

Kwatra then conceptualizes a "smooth" or "optimal" camera path ($P(t)$), wherein $P(t)$ is defined as:

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$$P(t)=C(t)*B(t)$$

where $C(t)$ represents the estimated original camera path and $B(t)$ is a linear transformation matrix applied to each frame to generate a stabilized sequence.

Ex. 1005, 13:52-56; Ex. 2018, ¶ 64.

Petitioner contends that the cost function (Equation 7) discloses that the first, second, and third derivatives of the smoothed camera path $P(t)$ are minimized:

$$a \left| \frac{dP}{dt} \right| + b \left| \frac{d^2 P}{dt^2} \right| + c \left| \frac{d^3 P}{dt^3} \right|$$

Ex. 1005, 13:62-14:12; Ex. 2018, ¶ 65.

However, minimizing the derivatives of the smoothed camera path as discussed in Kwatra does ***not*** result in minimization of a combination of ***rotational*** velocity and acceleration as claimed. Ex. 2018, ¶ 66. As the discussion from columns 14 through 15 make clear, the derivatives in column 7 are computed strictly as a function of the *linear* transforms between a series of consecutive frames. *See, e.g.*, Ex. 1005 at 14:54-15:56; Ex. 2018, ¶ 66. Equation 12, for example, makes this clear. Equation 12 expresses the linear frame-pair transform that represents motion from a first position (x_1) to a

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second position (x_2) based on linear relationship between four degree of freedom parameters (a_t , b_t , c_t , and d_t) and the translation in the x and y dimensions (dx_t and dy_t). Ex. 2018, ¶ 66.

As the Board recognized in its Institution Decision, Kwatra does teach that the 2-dimensional linear motion model may be represented as a “similarity” or “affine” transformation with degrees of freedom for scale and rotation. Ex. 1005 at 11:3-21; Ex. 2018, ¶ 67. Kwatra, however, expressly rejects an approach that minimizes rotation or scale in its smoothing/optimization step. Ex. 2018, ¶ 67.

As an initial matter, it is important to note that the rotation degree of freedom parameter discussed in Kwatra refers to the rotation of a trackable feature in an image, *not* rotation of the camera housing. *See* Ex. 2018, ¶ 68, n.3. As discussed below, rotation of a trackable feature and rotation of the camera housing are not the same. *Id.* Even more fundamentally, however, despite teaching motion models that may include a rotation or scale parameter, Kwatra expressly rejects an approach that would attempt to minimize these changes to rotation or scale as part of its smoothing/optimization step. *Id.*

Specifically, for similarity or affine transformations, Kwatra teaches to impose smoothness constraints only on the degree of freedom elements “a”

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and “b,” rather than directly on the scale (“s”) and the image rotation angle (“ θ ”) of the trackable features. Ex. 1005, 17:5-20; Ex. 2018, ¶ 69. Kwatra acknowledges that this approach of constraining smoothness only on a and b results in a path where “rotation and scale may not remain smooth.” *Id.* at 17:11-18. To address this issue, Kwatra teaches instead to place bounding constraints (*i.e.*, numerical limits) on changes to scale and rotation in the smoothed camera path “to ensure s and theta do not deviate too much.” Ex. 1005 at 17:19-20; Ex. 2018, ¶ 69.

Thus, even setting aside the fact that the angle “theta” in Kwatra is referring to the image rotation (not camera housing rotations), Kwatra itself recognizes that its linear optimization model does not result in a smoothed theta—*i.e.*, it does not minimize any derivatives of theta. Ex. 2018, ¶ 70. As Kwatra teaches, this simplification is necessary because “imposing smoothness constraints on s and theta may be non-linear,” *id.* at 17:18-19, which would subvert Kwatra’s consistent teaching for linear models and using linear programming. Ex. 2018, ¶ 70.

It is also worth noting that Kwatra does not even teach bounding theta itself but rather discloses bounding the sine or cosine of the image rotation angle, which is not the same as bounding the image angle theta itself. Ex. 1005

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at 17:37-38; Ex. 2018, ¶ 71. But more importantly, placing bounds on the extent the scale s and the cosine or sine of the 2D image rotation are allowed to change during estimation of the smooth camera path is not the same as computing a smooth 3D camera path that minimizes a combination of rotational velocity and acceleration of the camera housing over the smoothed path. Ex. 2018, ¶ 71.

Kwatra's provisional application (Ex. 2019), which is incorporated into Kwatra by reference, Ex. 1005 at 1:8-11, provides further explanation and support for the foregoing understanding of Kwatra. Ex. 2018, ¶ 72. The provisional application notes how the "optimal algorithm could estimate all parameters for all frames jointly," however 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 at 6 (emphasis added). Kwatra's inventors noted that they "therefore opt for a simpler linear update scheme" *Id.* "To preserve our linear framework," Kwatra 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 (emphasis added). Thus, by deliberately avoiding non-linear computations, Kwatra does

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not and cannot minimize rotational velocity and acceleration of a camera housing path. Ex. 2018, ¶ 72.

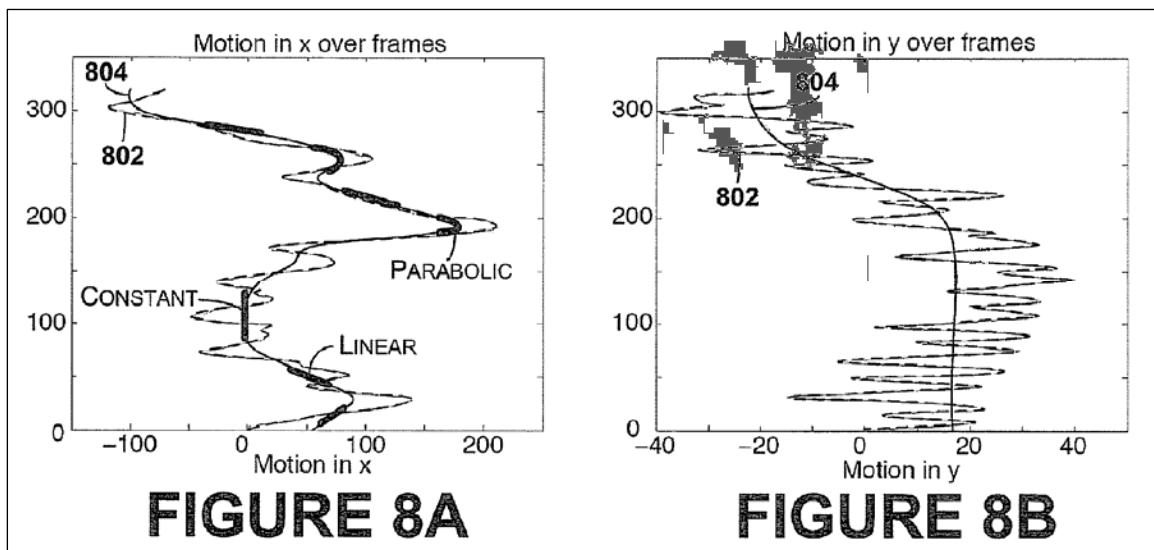
In forming his invalidity opinions, Petitioner's expert Dr. Katsaggelos did not review Kwatra's provisional application which was incorporated by reference in Kwatra. *See* Ex. 2020, Depo. Tr. at 19:25-20:5 ("Q. So in forming your invalidity opinions, you did not review the provisional application that the inventors in Kwatra filed; is that correct? . . . THE WITNESS: This is a document that -- application that I did not analyze."). Thus, Dr. Katsaggelos was not aware of and did not consider the inventors statements that they avoided more complex nonlinear optimization methods, as "not fast enough for real-time performance." *See id.* at 21:1-14 ("Q. Do you understand what's being described there? . . . THE WITNESS: As I mentioned, I haven't analyzed this document. So I cannot offer an opinion just on the fly by just looking at a sentence or two."); Ex. 2018, ¶ 73.

Further demonstrating that Kwatra fails to render the '894 minimization requirements obvious are Kwatra Figures 8A and 8B and their associated description. Ex. 2018, ¶ 74. Figures 8A and 8B depict the "original camera path motion 802 versus an updated or smooth camera path motion 804." Ex. 1005 at 19:4-6. Kwatra states that Figures 8A and 8B are depicting the

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“optimal L1 path” comprised of segments with minimized derivatives of the smooth camera path $P(t)$ consistent with Equation 7. Ex. 2018, ¶ 74. Yet, Figures 8A and 8B track camera motion (both original and smooth) exclusively as a function of position in the X and Y dimensions, respectively.

Id.



Figures 8A and 8B make clear that Kwatra's aim is not to minimize any combination of rotational velocity and rotational acceleration. Ex. 2018, ¶ 75. Indeed, Petitioner's own expert at trial, Mr. Goodin, conceded that a POSITA would understand Kwatra's smoothed motion model "P," as represented in Figure 8, to be translational, not rotational. Ex. 2021, Trial Tr. (Goodin) at 1368:6-1369:7. And, of course, there is no teaching or suggestion in Kwatra that results in any smoothed camera position as a function of a rotational

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position or angle. Ex. 2018, ¶ 75. This directly contradicts Petitioner's assertion that Kwatra teaches minimizing rotational velocity and acceleration of the camera housing. *Id.* Indeed, Kwatra's express rejection of non-linear optimization precludes it from teaching or suggesting the claimed minimization approach of the '894 patent. *Id.*

2. *Kwatra's Two-Dimensional Approach To Motion Estimation And Optimization Is Inconsistent With Determining A Path That Minimizes Rotational Velocity And Rotational Acceleration of the Housing As Claimed*

Moreover, Dr. Katsaggelos conceded at deposition that modeling rotational velocity of a camera housing requires a three-dimensional model. Ex. 2020 at 79:2-22 (“Q. Can you have angular velocity considered in a two dimensional model? . . . THE WITNESS: The two dimensional models we talk about cannot – cannot cover that, cannot cover the camera rotation in the 3D space, cannot cover the ang[ular] velocity of the camera. I need a 3D model to be able to capture this quantity.”). Kwatra's motion estimation and optimization techniques, however, are consistently described in the context of *two-dimensional* linear models. Ex. 1005 at 9:41-43 (“two-dimensional (2D) linear motion models (e.g., translation, similarity, affine) can be fit to the trackable feature-matches . . .”), at 19:39-41 (“As described above using the example methods shown in FIGS. 3-4, a 2D original camera path $C(t)$ may be

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first estimated, and a new camera path $P(t)$ can be determined.”); Ex. 2018, ¶ 76.

While Dr. Katsaggelos opined that Kwatra suggested modeling and optimizing motion in three dimensions, he failed to identify anything in the reference that actually discloses such an approach. Ex. 2018, ¶ 77. For example, despite using the word “dimensional” Kwatra’s mentioning of “estimates from lower to higher dimensional motion models (e.g., similarity -> homography)” at column 11, lines 58-61 are understood by a POSITA as merely referring to an estimate of a 2D model with more degrees of freedom (*i.e.*, a homography transform) from another 2D model with fewer degrees of freedom (*i.e.*, a similarity). Ex. 2018, ¶ 77. Again, the actual motion modeling and optimization disclosures of Kwatra that are relied upon by Petitioner are exclusively described in the context of two-dimensional models. *Id.* Nowhere does Kwatra teach or disclose a method for modeling or optimizing three-dimensional motion. *Id.*

Thus, because the motion modeling and optimization that Petitioner relies upon is inherently a two-dimension model, and because Petitioner’s own expert agrees that the claimed minimization of rotational velocity and rotational acceleration of the camera housing inherently requires a three-

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dimensional model, Kwatra fails to disclose or render obvious the claim limitation. *See* Ex. 2018, ¶¶ 78-79. Petitioner's theory fails for this independent reason. *Id.*

3. *Kwatra Solves for a Linear Transform $B(t)$ of Each Video Frame, Not for a Capture Trajectory that Minimizes Rotational Velocity and Acceleration of a Camera Housing, as Claimed*

The Petition also fails to disclose the claimed limitation because it conflates minimizing derivatives of what Kwatra refers to as the smooth camera path $P(t)$ with minimizing rotational velocity and acceleration of a ***camera housing*** as claimed. Ex. 2018, ¶ 80.

As discussed above, Kwatra's motion model is based on extracting and tracking feature pairs across successive frames. *Id.*, ¶ 81. Thus, Kwatra's "camera path" does *not* represent the motion of the physical camera housing in space. *Id.* Rather, it "describe[s] motion of pixels between frames—such as feature moved 10 pixels to the right, equivalent to movement of the camera to the left by 10 pixels." Ex. 1005 at 9:49-54; Ex. 2018, ¶ 81.

The number of pixels that a particular feature moves across a frame is ***not*** equivalent to the amount of rotation of the camera housing in three-dimensional space. Ex. 2018, ¶ 82. Rather, the relationship between movement of a feature and motion of the camera depends critically upon the

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distance of that trackable feature from the camera. *Id.* For example, a background feature and a foreground feature at different depths will move by a different number of pixels for a given displacement (translation and rotation) of the camera housing in physical space. *Id.* Petitioner's expert admitted this fact at his deposition, Ex. 2020 at 52:13-21, but did not account for it in his analysis. *See* Ex. 2018, ¶ 82.

Thus “minimizing” derivatives of Kwatra’s “camera path,” at most, minimizes the apparent motion of pixels for some composite set of features in the image. *See* Ex. 2018, ¶¶ 83-84. Petitioner fails to demonstrate how this results in the minimization of a combination of rotational velocity and acceleration ***of the camera housing*** as claimed. *See Univ. of Strathclyde v. Clear-Vu Lighting LLC*, 17 F.4th 155, 160-62 (Fed. Cir. 2021) (reversing obviousness decision in IPR where substantial evidence did not support finding that prior art taught all claim limitations).

The failure of Kwatra to teach or disclose an approach that minimizes motion of the camera housing speaks to the fundamental differences between Kwatra and the '894 patented approach. Ex. 2018, ¶ 85. Kwatra is directed to optimizing a 2-dimensional camera path based on linear motion models extracted from trackable features. *Id.* The '894 patent, by contrast, is directed

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to optimizing the trajectory of a video so that it appears as if it were captured by a camera whose housing underwent a minimal combination of rotational velocity and acceleration *of the camera* during capture. *Id.* Kwatra fails to render the claim obvious for this independent reason. *Id.*

B. Claim 5: The Petition Fails to Show “The Position Information is Determined Independent of the Image Information”

Claims 5 requires that the “the position sensor includes a gyroscope, an accelerometer, and/or an inertial measurement unit, *and the position information is determined independent of the image information.*”

As discussed above, Petitioner relies exclusively on Kwatra for the requirement that the capture trajectory minimizes the rotational velocity and acceleration of the camera housing. Kwatra’s approach to motion estimation and minimization, however, contradicts the additional limitations of dependent claim 5. Ex. 2018, ¶¶ 86-87. Again, Kwatra extracts motion exclusively from tracked image features. Ex. 1005, 5:43-45; Ex. 2018, ¶ 87. Kwatra’s “determination of position information” is entirely dependent on, not independent of, image information as claimed. Ex. 2018, ¶ 87.

Petitioner purports to rely on Zhou’s use of a gyroscope to compensate for Kwatra’s failure to satisfy this limitation. Ex. 2018, ¶ 88. But Petitioner

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cannot simply cherry-pick the disclosures from the prior art in this manner without a reasoned basis for doing so. *Id.* The minimization disclosures that Petitioner relies upon from Kwatra are inextricably intertwined with how Kwatra measures and estimates the original camera path using two-dimensional linear motion models. *Id.* Petitioner, for example, offers no explanation of how Kwatra's optimization techniques (which are fundamentally based on its 2D linear motion modeling) could be implemented in a device like Zhou with a completely different estimated motion model derived from gyroscope data. *Id.*

Petitioner has therefore failed to meet its burden to show that its purported combination renders claim 5 obvious. *See Juniper Networks, Inc. v. Correct Transmission, LLC*, --- F.4th ---, 2024 WL 3517862, at *6 (Fed. Cir. July 24, 2024) ("It was Juniper's burden to establish a reasonable expectation of success, and Juniper presented no theory other than that the combination was simple.").

C. A POSITA Would Not Have Been Motivated to Combine Zhou (and/or Shi) and Kwatra

The Petition fails to account for the fundamental different image stabilization techniques employed by Zhou and Shi on the one hand, and Kwatra on the other hand. Ex. 2018, ¶ 89. The embodiments that Petitioner

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relies upon from Zhou and Shi teach video image stabilization strategies, implemented in mobile devices that make use of an on-board position sensor to estimate the 3-dimensional motion of the mobile device itself. *Id.* Kwatra, on the other hand, teaches a post-processing, server-based approach that estimates motion through feature tracking within the image data. Ex. 1005 at 3:47 (“In one example, a video may be stabilized by performing post-processing techniques.”), at 5:21-26 (“The video hosting service 200 comprises the camera path translation system 202, a video server 210, an ingest server 212, and a video database 216.”); *see also* FIG. 2; Ex. 2018, ¶ 89.

While Petitioner's expert contends that Kwatra contemplates implementing its techniques in a mobile device, this assertion is unsupported and contradicted by Kwatra itself. Ex. 2018, ¶ 90. For example, while Dr. Katsaggelos cites Figure 13 and its associated discussion, Ex. 1002 at ¶ 117, that discussion merely provides that generic “computing device 1300” can comprise a server or a mobile device and “may be implemented as a client device, a server, a system, a combination thereof, or as a portion of components *described in FIGS. 1-2.*” Ex. 1005 at 26:11-21 (emphasis added); Ex. 2018, ¶ 90. Figures 1 and 2 provide an architecture in which the “camera

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path translation system” (202) is implemented exclusively in the “video hosting service” (200) and only communicates with mobile “client” devices (204) through a “network” (206). *Id.* Thus, while Kwatra’s disclosure of generic “computing device 1300” is broad, Kwatra teaches that this computing device is for implementing components of the specific architecture of Figure 2, in which camera path estimation and modeling are performed exclusively in a server-based system. *Id.*

This understanding of Kwatra is consistent with the relevant state of the art. Ex. 2018, ¶ 91. A POSITA would have recognized that solving for a complex, multi-derivative trajectory optimization problem was a computationally intensive process that was not considered suitable for a resource-constrained mobile device. *Id.* Moreover, performing this sort of trajectory optimization on a real-time stream of three-dimensional gyroscope data (*i.e.*, like that collected by systems disclosed in Zhou and Shi), would have been a complex, challenging endeavor that is not contemplated by any of the prior art of record. *Id.* A POSITA would have recognized that Kwatra’s server-based, post-processing optimization of two-dimensional linear motion models was not compatible with Zhou/Shi’s mobile-device based stabilization of three-dimensional rotational data. *Id.* Nor is there any reason to believe that

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a POSITA would have had a reasonable expectation of success in attempting to perform this combination. *Id.*

Petitioner's expert admitted that the image-based approach of motion estimation taught by Kwatra was a different approach from the gyroscope based motion estimation approach taught by Shi and Zhou. Ex. 2020 at 14:12-19; *see also* Ex. 1004 at 1:29-34 (teaching that stabilizing a video by tracking salient features requires "a priori knowledge of the image's content to, for example, identify and track a person or other salient object in the scene."); Ex. 2018, ¶ 92. And, while not at issue in this Petition, U.S. Patent 10,027,893 ("Bell") (Ex. 2022) which is relied on by Petitioner in parallel cases for related technology, explains why a POSITA implementing a gyroscope-based system like Zhou or Shi would not be motivated to look to the image-based systems like Kwatra:

Using the on-board multi-axis motion sensing system of a mobile phone or other device for motion tracking has a number of advantages. ***Filtering and analyzing the motion sensing system measurements in real time requires much less processing power in comparison to trying to estimate camera rotations from the image data after the fact.*** Motion sensing system estimates can be calculated with a relative few multiplications and additions, while ***image-based methods require processing on thousands or even millions of picture elements.*** Additionally, image-based motion estimation methods can fail when features are sparse or when large objects move in the foreground. A motion sensing system, by contrast, always

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reports the device motion regardless of how much and in which direction(s) the objects in the scene move.

Ex. 2023 at 6:45-59 (emphasis added); Ex. 2018, ¶ 92. This passage underscores the clear differences between the two alternative approaches to motion sensing and smoothing and demonstrates why a POSITA would not consider the teachings from one to be easily substituted into the other.

Petitioner's asserted motivation to combine is conclusory and unsupported by substantial evidence, merely suggesting—without detailed analysis or explanation—that combining Zhou and Shi's 3D sensor-based approaches with Kwatra's 2D image-based linear optimization would yield better stabilization results. Ex. 2018, ¶ 93. Such generalized assertions are insufficient to establish obviousness. *See Teleflex, Inc. v. Ficosa North America Corp.*, 299 F.3d 1313, 1334 (Fed. Cir. 2002).

Given the clear computational and functional disparities between the references, there is no persuasive motivation or reasonable expectation of success for a POSITA to combine Zhou and Shi with Kwatra. Ex. 2018, ¶ 94. Therefore, the Petition fails to demonstrate obviousness and claims 1-20 should be upheld. *Id.*

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VII. GROUND 2 FAILS ON THE MERITS

Petitioner asserts that the combination of Zhou, Kwatra, and Shi renders claims 2, 3, 7, 12, 13, and 17 of the '894 patent obvious. However, this combination fails for the same reason as Ground 1, as Shi does not (and is not even alleged to) cure the deficiencies of Zhou and Kwatra with respect to the requirements of independent claims 1 and 11 or dependent claim 5. Ex. 2018, ¶ 95.

VIII. SECONDARY CONSIDERATIONS CONFIRM THE NON-OBVIOUSNESS OF THE '894 PATENT

Secondary considerations, or “objective indicia,” of non-obviousness are critical in the overall inquiry under 35 U.S.C. § 103. As the Federal Circuit has noted, these indicia can “often establish that an invention appearing to have been obvious in light of the prior art was not.” *See Stratoflex, Inc. v. Aeroquip Corp.*, 713 F.2d 1530, 1538 (Fed. Cir. 1983); *Liqwd, Inc. v. L'Oreal USA, Inc.*, 941 F.3d 1133, 1136-37 (Fed. Cir. 2019). Objective indicia ““may often be the most probative and cogent evidence’ of nonobviousness.” *Liqwd*, 941 F.3d at 1136. When a nexus exists between these secondary considerations and the claimed invention, this evidence can carry substantial weight. *See Rambus Inc. v. Rea*, 731 F.3d 1248, 1256 (Fed. Cir. 2013).

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Moreover, as emphasized in *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 421 (2007), secondary considerations play a pivotal role in avoiding the pitfalls of hindsight bias, which can improperly influence the determination of obviousness. Objective indicia offer concrete evidence that helps ground the analysis in real-world achievements and market realities, rather than retrospective rationalization of prior art.

In considering secondary consideration evidence, the Board should conduct a “a reasoned, collective weighing of its evidence of secondary considerations,” and not rely on “overly vague and ambiguous” “assignments of weight to different considerations.” *Volvo Penta of the Americas v. Brunswick Corp.*, 81 F.4th 1202, 1213-16 (Fed. Cir. 2023).

A. Nexus

Here, a number of secondary considerations—commercial success, industry praise, long-felt need, failure of others, unexpected results, and copying by competitors—are specifically attributable to the unique stabilization approach claimed in the '894 patent, notably the minimization of a combination of rotational velocity and rotational acceleration feature. This rotational optimization technique was a substantial departure from prior approaches (like Kwatra's linear image-dependent framework), enabling

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GoPro's HyperSmooth technology to achieve the unprecedented stabilization praised by consumers and industry experts alike. Ex. 2018, ¶¶ 96, 123-129.

It is undisputed that HyperSmooth, as implemented in GoPro's HERO7 Black camera, practices claims 1 and 5 of the '894 patent. Ex. 2018, ¶ 124. Petitioner did not dispute and its expert at the ITC trial provided no opinion regarding the '894 patent's coverage of GoPro's domestic industry product the HERO7 Black camera. *See generally* Ex. 2021, Trial Tr. (Goodin) at 1134:9-1135:6. Here, Dr. Foroosh has confirmed that HyperSmooth embodies each and every limitation of claims 1 and 5 of the '894 patent. *See* Ex. 2018 at ¶¶ 97-122.

The transformative stabilization experience provided by HyperSmooth is based on the novel features claimed in the '894 patent, including: the minimization of a combination of rotational velocity and rotational acceleration (Claim 1) and the use of gyroscope and accelerometer data to obtain position information independent of image information (Claim 5). *Id.*, ¶ 125.

The HERO7 Black was the first GoPro product to commercialize HyperSmooth and thus the first to embody the claimed invention of the '894 patent. *See* Ex. 2024 (Lema Decl.), ¶¶ 6, 10. The launch of the HERO7 Black

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marked a paradigm shift for both GoPro and the action camera industry, driven by the capabilities of HyperSmooth. *See id.* at ¶ 10. The widespread commercial success and industry recognition that followed—including HERO7 Black being heralded as one of GoPro's most important releases—were directly tied to the stabilization performance enabled by the claimed inventions of the '894 patent. *See id.* at ¶ 11; Ex. 2018, ¶ 126.

Dr. Foroosh also reviewed the domestic industry claim charts from the ITC investigation and the HyperSmooth technical documents including the [REDACTED] (Ex. 2026) and confirmed that the HERO7 Black practices the asserted claims of the '894 patent. Ex. 2018, ¶ 127. [REDACTED]

[REDACTED]
[REDACTED]. Ex. 2026 at CX-0609C.0003. [REDACTED]

[REDACTED]
[REDACTED]
[REDACTED]
[REDACTED]
[REDACTED]

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[REDACTED]

[REDACTED]. *Id.* at CX-0609C.0002; Ex. 2018, ¶ 127.

The HERO7 Black's commercial success, industry praise, and Petitioner's reverse engineering and copying is specifically tied to the claimed features of Claims 1 and 5. *See* Ex. 2024 (Lema Decl.), at ¶¶ 11, 21. Accordingly, the record establishes a clear nexus between Claims 1 and 5 of the '894 patent and the secondary considerations attributable to these claimed features in the HERO7 Black. Ex. 2018, ¶ 128.

In the case of GoPro's '894 patent, the following secondary considerations strongly support non-obviousness (*id.*, ¶ 129):

B. Commercial Success

GoPro's HyperSmooth technology, which practices the claimed inventions of the '894 patent, has driven significant commercial success. *Id.*, ¶¶ 97-122, 130-135. According to GoPro's head of product, Mr. Pablo Lema, whose declaration is attached hereto:

The release of HyperSmooth was a "shock to the market." HERO7 Black became the fastest-selling production launch in GoPro's history at the time. Our sales jumped 170% compared to HERO6 in the same post-launch window, driven almost entirely by the introduction of HyperSmooth. From a feature standpoint, the HERO6 camera is nearly indistinguishable from the HERO7 Black with the exception of HyperSmooth.

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Ex. 2024 at ¶ 11.

Further, according to Mr. Lema, internal survey data confirmed that HyperSmooth and immersive lens options were among “the most important and valued features driving customer demand across our HERO customer base,” and that GoPro’s “product planning decisions—including resource allocation and feature prioritization—relied heavily on this data.” *Id.* at ¶ 19.

Specifically, in a [REDACTED] (Ex. 2040, also Ex. A to Lema Dec., CX-590C), “Advanced video stabilization” ranked as the number one most important feature for the Core HEROes segment, and within the top three for the market segments representing GoPro’s historical customer base, including Lightweighters, Easygoing HEROes, and Overcapturers. *Id.* at ¶¶ 14-19.

In a separate [REDACTED] (Ex. 2041, also Ex. B to Lema Dec., CX-649C), actual HERO11 Black buyers selected “Advanced video stabilization (HyperSmooth 5.0 with AutoBoost)” as the number one driver of purchase—above all other listed features. *Id.* at ¶ 20.

According to Mr. Lema, these survey results “reflect the role that GoPro’s patented stabilization and lens features play in driving consumer demand and purchasing behavior,” and in his view, “the patented technologies

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in the '894, '840, '832, and '413 patents were directly responsible for GoPro's sustained commercial success with HERO cameras, especially from the HERO7 onward." *Id.* at ¶ 21.

GoPro's dominant position in the U.S. action camera market, holding a larger share than all competitors combined, further illustrates the commercial strength of its patented technologies. GoPro's partnerships with leading brands like Red Bull, NHL, and Adobe reflect the substantial demand for and market confidence in GoPro's products, driven in large part by its stabilization technologies. *See* Ex. 2005 (NHL Senior VP of Programming and Production said, "[O]nly GoPro has the technology to help us and our media partners showcase the beauty and intensity of hockey in new and deeper ways."); Ex. 2008 (GoPro "named the exclusive action camera of Red Bull" mountain bike competition; GoPro athletes will capture their runs wearing HERO11 featuring "GoPro's Emmy Award-winning HyperSmooth video stabilization"); Ex. 2009 (Vice President of Adobe Stock said, "Adding GoPro's unique footage to Adobe Stock gives our community access to a library of immersive 'wow' moments that will take their audience to new places and deliver an additional level of depth and perspective to their creations"); Ex. 2018, ¶¶ 130-135.

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C. Industry Praise and Recognition

GoPro's HyperSmooth technology has garnered widespread industry recognition. Ex. 2018, ¶¶ 136-139. It earned a CES Innovation Award in 2019 and a Technology and Engineering Emmy in 2022, further confirming the value and non-obviousness of GoPro's patented stabilization methods. *See* Ex. 2010 ("73rd Annual Technology & Engineering Emmys" . . . "In Camera Sensor and Software Stabilization – Awarded to GoPro and Socionext" . . . "The technology has created the ability for camera operators and producers to obtain stabilized action footage when a subject is rapidly moving easily and economically in unstable situation."); Ex. 2011 ("GoPro Showcases Award-Winning HERO7 Cameras at CES 2019"); Ex. 2012 ("GoPro Wins Second Emmy® Award for Groundbreaking Digital Imaging Technology"; "This Emmy is in recognition of the technology powering GoPro's industry-leading HyperSmooth video stabilization").

As Mr. Lema explains in his declaration, "GoPro won the 73rd Technology and Engineering Emmy award specifically for its in-camera sensor and software image stabilization, introduced with HERO7." Ex. 2024, Lema Dec. at ¶¶ 13, 22. GoPro also received "a vast amount of industry praise for HyperSmooth and HERO7 generally in the form of customer reviews,

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industry publications, tech blogs over the years.” *Id.* at ¶ 23. According to Lema, these technologies enabled “a step-change” in user experience, which in turn drove consumer demand, sales growth and “recognition for GoPro’s products.” *Id.* at ¶ 24.

Third-party reviews consistently highlight HyperSmooth as a groundbreaking feature that sets GoPro apart from competitors, with praise for its ability to deliver stable, smooth video footage in challenging conditions. Ex. 2013 (analysts at JP Morgan stating GoPro’s “gimbal like hypersmooth stabilization (developed in-house software and hardware)” was “a significant upgrade” when introduced and was the “key selling point” in the HERO7 camera); Ex. 2014 at 5 (“GoPro’s HyperSmooth image stabilization is the best we’ve seen on any action camera”).

Technical reviews of the subsequently released HERO8 Black note how HyperSmooth had already “eliminated the need for using a motorized gimbal,” and how the electronic image stabilization of HyperSmooth 2.0 was “unfathomably good.” Ex. 2042 (CX-1388) at 3.

D. Long-Felt but Unmet Need

Before the introduction of HyperSmooth, users of action cameras faced persistent challenges in capturing stable footage during high-vibration

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activities like mountain biking, hiking, or surfing. Mechanical gimbals, while used for stabilization, were bulky, fragile, and unsuitable for dynamic environments of such applications. Ex. 2018, ¶¶ 140-142. This long-standing issue, now addressed by the digital stabilization system claimed in the '894 patent, underscores the invention's non-obvious nature. *Id.* As the Federal Circuit has recognized, solving a long-felt but unmet need supports a finding of non-obviousness. *See Tec Air, Inc. v. Denso Mfg. Michigan Inc.*, 192 F.3d 1353, 1360 (Fed. Cir. 1999).

According to GoPro's head of product, Mr. Lema, the release of HyperSmooth was a "shock to the market." Ex. 2024 at ¶ 10. The initial public reaction was "one of disbelief at the quality of the stabilization technology—some assumed we had faked the footage using mechanical stabilizers. But once users got the product in hand, their response was overwhelmingly positive." *Id.* at ¶ 12.

The success of these advanced methods filled a long-felt gap in the market, further demonstrating the non-obviousness of the claimed inventions. Ex. 2018, ¶¶ 140-142.

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E. Failure of Others

GoPro was not the only camera maker seeking to perfect digital image stabilization in 2018. Ex. 2018, ¶ 143. Some of the world's greatest technology leaders, including Sony, Google, Samsung, and Apple, were all intently pursuing their own solutions. Many of these approaches involved hybrid electronic image stabilization ("EIS") and optical image stabilization ("OIS") solutions—as disclosed in Shi, a Google patent, Ex. 1006 at 1:36-44 and Zhou, an Apple patent, Ex. 1004 at 1:34-45—which were widely believed to be necessary given the computational requirements of pure EIS solutions and the limitations of mobile devices. As reflected in GoPro's [REDACTED]

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Ex. 2043 (RX-0168C) at 4; *see also id.* at 13 [REDACTED]

[REDACTED]

[REDACTED]

The failure of others in the industry to achieve HyperSmooth-level results, particularly in a software-only solution, is strong evidence of non-obviousness. *See Advanced Display Sys, Inc. v. Kent State Univ.*, 212 F.3d 1272, 1285 (Fed. Cir. 2000) (suggesting that such evidence may be “determinative” and “virtually irrefutable of nonobviousness”).

F. Unexpected Results

GoPro's system consistently outperformed traditional stabilization techniques, which often failed to maintain stabilization under rapidly

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changing motion characteristics, showcasing the unexpected success of the HyperSmooth system over prior technologies. Ex. 2018, ¶¶ 144-145. Ex. 2014 (“GoPro’s HyperSmooth image stabilization is the best we’ve seen on any action camera”); Ex. 2024 at ¶ 11 (introduction of HyperSmooth was a “shock to the market”).

These unexpected results further reinforce the non-obviousness of the ’894 patent. Ex. 2018, ¶¶ 144-145.

G. Copying by Competitors

Copying by competitors is a strong indicator of non-obviousness. *See Liqwd, Inc. v. L’Oreal USA, Inc.*, 941 F.3d 1133, 1137 (Fed. Cir. 2019). In this case, Insta360, a direct competitor, copied GoPro’s HyperSmooth technology, further highlighting the innovative and valuable nature of the ’894 Patent. Ex. 2006 (Complaint); Ex. 2018, ¶¶ 146-148. Importantly, “the copying inquiry involves a comparison of the competitor’s product with the allegedly copied product, rather than the patent’s claims.” *Medtronic, Inc. v. Teleflex Innovations S.a.r.l.*, 70 F.4th 1331, 1340 (Fed. Cir. 2023). Copying can be established by circumstantial evidence such as access to and development of a substantial similar product. *Id.*

PUBLIC VERSION

Here, Insta360 has repeatedly sought to copy GoPro's patented HyperSmooth features. Beginning in 2021, Insta360 began releasing its own version of "in-camera" electronic image stabilization technology that relied upon look-ahead smoothing, optimization of the smooth camera trajectory path, and specialized tunable parameters to control the strength of smoothing. Ex. 2048 (Insta360 Speeds Up Workflow with New 360 Reframing Tool, Better Stabilization & Quick Reader). Additionally, [REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

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[REDACTED]

[REDACTED]

[REDACTED]

PUBLIC VERSION

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

These secondary considerations—commercial success, industry praise, long-felt need, unexpected results, and copying by competitors—collectively confirm that the inventions claimed in the '894 patent were not obvious. GoPro's HyperSmooth technology has revolutionized the action camera market, driving consumer demand, earning industry recognition, and prompting competitors to replicate its success. For these reasons, the Board should find that the claims of the '894 patent are non-obvious and uphold their validity. Ex. 2018, ¶¶ 96-148.

IX. CONCLUSION

For the foregoing reasons, Patent Owner respectfully requests that the Board uphold the challenged claims. The Petition mischaracterizes Kwatra, which expressly rejects non-linear optimization, including any process that would minimize rotational velocity and acceleration of a camera housing. Kwatra's inventors deliberately constrained their method to a linear framework, avoiding rotational minimization as computationally prohibitive.

PUBLIC VERSION

The proposed combination with Zhou (and/or Shi) uses improper hindsight to reconstruct GoPro's invention from a combination of Kwatra's offline, 2D image-based stabilization with Zhou and Shi's 3D sensor-driven techniques, without any reasoned motivation to do so or reasonable expectation of success. The Board should deny the Petition and confirm the validity of the challenged claims.

Date: April 18, 2025

By: /s/ James Glass

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PUBLIC VERSION

CERTIFICATE OF LENGTH (37 C.F.R. §§ 42.24)

The undersigned hereby certifies that, according to the word-processing system used to prepare the foregoing document, this document has 9,251 words and thus complies with the applicable word limit.

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PUBLIC VERSION

CERTIFICATE OF SERVICE (37 C.F.R. §§ 42.6(E), 42.105(A))

The undersigned hereby certifies that the foregoing document was served in its entirety on April 18, 2025 upon the following parties via

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