

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.

Patent No. 10,574,894

Inter Partes Review No. IPR2024-01186

PETITIONER'S REPLY TO PATENT OWNER RESPONSE

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I. INTRODUCTION

The Board was right that all claims of the '894 patent are obvious over prior art. It correctly found that Kwatra discloses the disputed limitation of minimizing rotational velocity and rotational acceleration. It also rightfully found motivations to combine.

GoPro raises convoluted arguments that misrepresent video stabilization basics and mischaracterize the art and the '894 patent. Its lead argument misunderstands the concepts of linear motion model and linear optimization. Both relate to the mathematical principle of linearity and do not exclude rotation. Nor does GoPro seriously contend that Kwatra discloses smoothing rotation. Its complaint that Kwatra does not do so by directly addressing the rotational parameter has no relevance to the claim language.

GoPro's emphasis on 2D versus 3D motion also fails, as the '894 patent is not confined to either model. Equally unavailing is GoPro's reliance on the distinctions between 2D versus 3D motion and image-based versus sensor-based motion estimation techniques for a purported lack of motivation to combine. Contrary to GoPro's position, the references are not limited to any single approach. And even if they were, a POSITA would not have been dissuaded from combining them.

GoPro's own development documentation confirms this. GoPro itself considered a range of references employing different stabilization approaches, including Kwatra's related and highly similar Kwatra paper. In stark contrast to GoPro's now litigation-driven arguments, GoPro's engineers acknowledged that Kwatra paper addressed rotational velocity and rotational acceleration.

Finally, no secondary considerations support non-obviousness. GoPro fails to show that its product practices the '894 claims. Nor does it demonstrate any nexus between its objective evidence and the purported novelty of the '894 inventions.

II. GROUNDS 1 AND 2: EVERY CLAIM IS OBVIOUS OVER PRIOR ART¹

A. Ground 1: Zhou and Kwatra Render Claims 1-20 Obvious

1. Kwatra discloses minimizing rotational movement in claims 1 and 11

a) Kwatra minimizes rotational velocity and rotational acceleration

(1) GoPro misunderstands linear motion model / linear transformation

GoPro is wrong that Kwatra's linear framework does not result in minimization of rotational movement. As an initial matter, Kwatra's technique is not limited to linear motion models. (EX1017, ¶¶20; EX1005, 5:48-50.)

Further, linear motion models characterize rotation. It is simply a mathematical model that describes how the state of a moving object evolves over time using linear transformations. (EX1017, ¶¶22.) Kwatra teaches various linear models, including similarity, affine, and homography. (EX1017, ¶¶22-28.) It explicitly states that those models include rotation. (EX1005, 17:5-8, 11:4-11.)

Models like similarity and affine are referred to as linear motion models because they satisfy the additivity and homogeneity properties of linearity—not because they can model only linear motion. (EX1017, ¶¶26-31.) Tellingly, GoPro

¹ In the related ITC proceeding, the initial determination found claims 1 and 5 not obvious under the clear and convincing standard.

does not *actually* contend that linear motion models cannot represent rotational motion. The reason is obvious: both Kwatra and a POSITA's understanding contradict any such notion. (EX1017, ¶¶21-32.)

Nor does Kwatra's disclosure of linear transformation preclude minimization of rotational movement (POR, 18-19). A POSITA would have understood that linear transformation encompasses rotation. (EX1017, ¶30.) As GoPro concedes, "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*."² (POR, 19 (citing EX1005, 11:3-21; EX2018, ¶67.) Its expert similarly concedes that "Kwatra's teaching is [] about the 2D rotation." (EX2018, fn. 3.)

(2) Kwatra discloses smoothing rotation

GoPro's three convoluted arguments in Section 1 all fail.

Its first argument is that Kwatra discloses the "rotation of a trackable feature in an image, not rotation of the camera housing." (POR, 19.) Its third argument is that restricting a 2D image rotation theta is not the same as computing a smooth 3D camera path. (POR, 21.) GoPro provides no explanation for either argument in Section 1. These two arguments are related to the following two sections of this Reply and are thus addressed there.

² Unless specified, emphasis in quoted language is added.

GoPro’s second argument is that Kwatra “expressly rejects” an approach that minimizes rotation as part of its smoothing step. (POR, 19.) GoPro relies on the disclosure that “Kwatra teaches to impose smoothness constraints only on the degree of freedom elements ‘a’ and ‘b,’ rather than directly on the scale (‘s’) and the image rotation angle (‘θ’) of the trackable features.” (*Id.*, 19-20.)

GoPro’s own cited portion of Kwatra (in column 17) refutes its argument. Kwatra teaches: “plac[ing] bounding constraints (i.e., numerical limits) on changes to scale and rotation in the smoothed camera path ‘to ensure that s and theta do not deviate too much.’” (EX1005, 17:19-20). This makes clear that rotational movement is bounded and smoothed. (EX1017, ¶34.) In addition, column 17 of Kwatra discloses smoothing rotation (θ) as explained below. (EX1017, ¶¶35-39.)

Kwatra first states that “in a similarity transform, a combination of scale, **rotation** and translation can be used.” (EX1005, 17:7-8.) Scale and rotation are represented using parameters *a* and *b*. (*Id.*, 17:11-16.)

$$\text{Scale: } s = \sqrt{a^2 + b^2}$$

Equation (17)

$$\text{Rotation angle: } \theta = a \tan(b/a)$$

Equation (18)

Kwatra then discloses that enforcing smoothness on scale (s) and rotation (θ) directly is non-linear. (*Id.*, 17:17-19.) Rather than solving a nonlinear optimization problem by directly smoothing scale (s) and rotation (θ), Kwatra uses

an estimated camera path (represented by a linear motion model) to constrain how much scale (s) and rotation (θ) vary indirectly. (*Id.*, 17:18-20.)

Kwatra explicitly discloses that “[f]or rotation, $a=s*\cos(\theta)$, $b=s*\sin(\theta)$, and $\sin(\theta)$ and $\cos(\theta)$ can be constrained to be bounded near the estimated camera rotation”:

$$\cos\left(\frac{a_0}{s_0} - \varepsilon_1\right) < a < \cos\left(\frac{a_0}{s_0} + \varepsilon_1\right) \quad \text{Equation (23)}$$

$$\sin\left(\frac{b_0}{s_0} - \varepsilon_2\right) < b < \sin\left(\frac{b_0}{s_0} + \varepsilon_2\right) \quad \text{Equation (24)}$$

(*Id.*, 17:37-46.)

Thus, a POSITA would have understood that Kwatra teaches smoothing scale and rotation. (EX1017, ¶¶38-39.) Although Kwatra does not perform calculations directly on scale (s) and rotation (θ), it achieves smoothing through the parameters a and b, which in turn determine scale (s) and rotation (θ). (*Id.*)

Specifically, rotation (θ) is represented as:

$$\text{Rotation angle: } \theta = a \tan(b/a) \quad \text{Equation (18)}$$

(Ex. 1005, 17:15-17.) Because rotation (θ) is only related to a and b, imposing smoothness constraints on a and b results in smoothing rotation (θ). (EX1017, ¶37.)

GoPro’s argument that rotation (θ) is not directly bounded (POR, 19) misses the point. Kwatra need not explicitly bound θ to control rotation. It constrains the trigonometric components a and b in a way that is mathematically and functionally equivalent to directly bounding θ itself. (EX1017, ¶38.)

(3) The provisional patent application supports Insta360, not GoPro

GoPro’s reliance on Kwatra’s provisional patent application fares no better. It cites disclosures preferring linear framework and disfavoring non-linear optimization. (POR, 21.) GoPro then concludes that “by deliberately avoiding non-linear computations, Kwatra does not and cannot minimize rotational velocity and acceleration.” (*Id.*, 21-22.)

But a linear computation simply means a computation where all operations involve linear relationships—that is, the output is a linear function of the inputs. (EX1017, ¶40.) That Kwatra employs linear optimization for efficiency does not preclude smoothing of rotation. (*Id.*)

Neither GoPro nor its expert provides any explanation for why Kwatra’s preference for linear computation precludes minimization of rotational movement. As explained above and in the Petition, Kwatra provides ample disclosures of smoothing rotation. (*See* Paper 2, 32-33.) For example, it discloses that “[i]mage stabilization techniques may compensate for . . . angular movement[] of a camera.” (EX1005, 1:17-19.) It also discloses that “constraints can be imposed on the

optimal camera path” such that “a range of change in zoom and rotation” can be limited. (*Id.*, 16:13-32.) And as the Board pointed out, Kwatra teaches “use of a model that accounts for rotation as a degree of freedom (DOF)” and that its motion model might identify “too much rotation.” (Paper 11, 32 (citing EX1005, 11:5-11, 11:63-66.) “This discussion precedes Kwatra’s discussion of minimizing position, velocity, and acceleration cost functions.” (*Id.* (citing EX1005, 13:23–16:50).)

Unable to offer any explanation for its stretched reading of Kwatra’s provisional application, GoPro faults Insta360’s expert for not considering the provisional application (POR, 22). But the provisional application instead confirms that Kwatra smooths rotation.

For example, on page 4, Kwatra’s provisional application teaches how to solve a linear optimization problem if the optimal camera path $P(t)$ “is restricted to be a translation.” (EX2019, 4.) It then describes on the next page that “[t]his formulation can be extended to other linear transforms such as similarity and affine,” implying that those linear models are not restricted to a translation. (*Id.*, 5; EX1017, ¶41.) In other words, Kwatra’s provisional application understands that similarity and affine models include rotation.

Kwatra’s provisional application also discloses that “[w]hen the camera motion model is pure translation, minimizing derivatives of $P(t)$ is straightforward. When it is a similarity transform however, it is a combination of scale, rotation and

translation.” (EX2019, 5.) A POSITA would have understood that these disclosures confirm that Kwatra’s linear motion models (*e.g.*, similarity and affine) include rotation. (EX1017, ¶42.)

Thus, consistent with Kwatra, Kwatra’s provisional application discloses linear motion model and linear transformation. (EX1017, ¶43.) It likewise shows that Kwatra’s motion path includes rotation. (*Id.*) It does not support GoPro’s contention that Kwatra does not minimize or smooth rotational movement. (*Id.*)

(4) GoPro’s reliance on Figures 8A and 8B is misplaced

GoPro improperly relies on a single embodiment: Figures 8A and 8B. It argues because that embodiment tracks camera motion in the X and Y dimensions, Kwatra does not teach minimizing rotation. (POR, 22-24.) But that is merely one embodiment. GoPro ignores numerous explicit disclosures of rotational movement in Kwatra, including Figure 5D. (EX1017, ¶45.)

GoPro further cherry-picks the testimony of Insta360’s expert for the ITC proceeding, Mr. Goodin (POR, 23-24). Although Mr. Goodin stated that Figures 8A and 8B “appear to be dealing with translational motion” (EX2021, 1369:1-5), he also testified that he did not understand that P in “Kwatra is representing a linear path model” (EX2021, 1368:3-11). Mr. Goodin further stated that P in Kwatra “represent[s] a combination of linear and rotational motion.” (*Id.*) Mr. Goodin’s testimony is thus consistent with Dr. Katsaggelos’s opinion. (EX1017,

¶46.) That one embodiment Figures 8A and 8B show motion as translational does not suggest that Kwatra excludes rotation. (*Id.*)

b) GoPro’s argument regarding “two-dimensional approach” fails

GoPro’s next argument mischaracterizes Dr. Katsaggelos’s deposition testimony. (POR, 24-25.) It argues that because Kwatra discloses only two-dimensional models and Dr. Katsaggelos testified that such models cannot cover rotation in the 3D space, Kwatra fails to disclose the minimization limitation.

But the cited testimony makes clear that Dr. Katsaggelos did not testify that *all* two-dimensional models cannot cover camera rotation in the 3D space—only the ones they “talk[ed] about” (*e.g.*, translation model). (EX1017, ¶¶47-51.) To the contrary, certain two-dimensional models discussed in Kwatra, such as affine and homography, can represent 3D motion. (*Id.*)

Indeed, Dr. Katsaggelos explicitly stated that Kwatra discloses models such as homography and affine that can be “a three-dimensional modeling.” (EX2020, 73:19-75:25.) For example, Kwatra discloses “lower to higher dimension motion models (*e.g.*, similarity→homography).” (EX1005, 11:58-61; EX1017, ¶52.)

Moreover, GoPro’s emphasis on 2D vs 3D modelling is a red herring. The ’894 patent does not limit its purported inventions to 3D motion. GoPro’s expert concedes that “the claims do not explicitly” reference 3D rotation. (EX2018, ¶37.)

A POSITA would have also understood that minimizing rotational movement does not require 3D modelling. (EX1017, ¶¶53-54.)

Even if the '894 patent is limited to 3D modeling and Kwatra is limited to 2D modeling, Zhou and Kwatra still render the '894 claims obvious. As GoPro concedes, Zhou “estimate[s] the 3-dimensional motion.” (POR, 30.) It is undisputed that Zhou discloses 3D rotation. (EX1017, ¶55; EX1004, 5:48-64, 6:2-6, 7:41-42.) It would have been obvious to combine Zhou’s stabilization of 3D rotation and Kwatra’s minimization of rotational velocity and rotational acceleration. (EX1017, ¶55.)

c) Kwatra discloses minimizing rotational movement of the camera housing

GoPro’s final argument is because Kwatra’s motion model is based on tracking feature pairs across frames (*i.e.*, image-based motion estimation), it cannot represent the physical camera’s motion. (POR, 26.) Not so.

First, Kwatra is not limited to an image-based motion estimation approach. It instead makes clear that a “camera path *may be* estimated by extracting trackable features in frames of the video.” (EX1005, 4:43-46.)

Second, GoPro’s argument contradicts video stabilization basics. (EX1017, ¶¶59-60.) As a POSITA would have understood, the movement of the feature in a frame is directly proportional to camera rotation. (*Id.*) At the time of the claimed invention, computer vision systems routinely inferred and corrected motion,

including rotation, using image-based motion estimation techniques. (*Id.*)

Similarly, industry-standard practices have relied on 2D pixel displacement to infer and smooth camera motion—including rotation—in the 3D space. (EX1017, ¶62.)

GoPro’s emphasis on 2D versus 3D also misses the point: in video stabilization, the important factor is not the actual 3D camera angle, but how rotational motion manifests in the image. (EX1017, ¶61.) Minimizing how much a feature moves in pixels directly reduces perceived rotational movement. (*Id.*)

Further, a POSITA would have known that 3D information (*e.g.*, depth) can be reconstructed from a 2D video. (EX1017, ¶64.) GoPro’s expert’s own experience confirms this. (EX1018, 24:16-25:5.) Kwatra’s provisional application also shows that 3D motion can be estimated by analyzing a 2D video. (EX1017, ¶64; EX2019, 11-12.)

Third, Kwatra itself discloses that an approach based on tracking features between frames can estimate camera motion. Kwatra teaches: “Linear motion models (*e.g.*, translation, similarity, affine) may be fit to the tracked features to *estimate a motion of the camera* between two frames.” (EX1005, 5:48-53; EX1017, ¶63.) Kwatra also teaches “estimate[ing] *an original motion path of a camera* that recorded the video based on motion of objects within the video.” (EX1005, 2:28-31.) Thus, Kwatra’s image-feature-based motion estimation

approach estimates the motion of a camera (and by extension, the camera's housing). (EX1017, ¶63.)

d) GoPro's own characterization of Kwatra's related publication contradicts its position

GoPro's own development of the claimed technologies confirms that Kwatra discloses the claimed "minimiz[ing] a combination of rotational velocity and rotational acceleration."

GoPro's own development documentation shows that its research is based on a publication titled "Auto-directed video stabilization with robust L1 optimal camera paths" published in 2011. (EX1022, 7.) The authors of that publication also include the inventors of Kwatra: Vivek Kwatra and Matthias Grundmann. (EX1023.) The Reply refers to this publication as "Kwatra paper."

Kwatra paper discloses similar subject matter as Kwatra. (EX1017, ¶68.) It teaches that its stabilization technique can use an image-based motion estimation approach and employs a linear motion model. (*Id.*) It discloses: "the camera path $C(t)$ of the original video footage has been computed (e.g. from feature tracks) and is described by a parametric linear motion model." (EX1023, 227.)

Kwatra paper further teaches that its technique uses linear programming and minimizes derivatives of a motion. (EX1017, ¶68.) It discloses that its "algorithm is based on a linear programming framework to minimize the first, second, and third derivatives of the resulting camera path." (EX1023, 225.)

It also discloses using 2D motion models: “While we focus our discussion on 2D parametric motion models F_t , our system is theoretically applicable to higher dimensional linear motions.” (*Id.*, 227; EX1017, ¶68.)

Critically, Kwatra paper teaches the same minimization approach as Kwatra. It discloses that the “optimization serves to find the optimal stable camera path $P(t)$ minimizing the objective” function below:

$$\mathcal{O}(P) = w_1|D(P)|_1 + w_2|D^2(P)|_1 + w_3|D^3(P)|_1 \quad (3)$$

(EX1023, 227.) Kwatra likewise discloses: “The optimization may determine a stable camera path $P(t)$ by minimizing the cost function:”

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

(EX1005, 13:65-14:5.)

The two disclosures are the same. (EX1017, ¶69.)

Even though Kwatra paper explicitly mentions rotation only twice (*id.*, ¶70; EX1023, 228), GoPro’s engineers understood that it discloses rotational movement. GoPro’s own documentation describes that Kwatra paper (referred to as Grundmann) teaches that “the objective function is expressed as a combination of the camera’s angular velocity and acceleration over time.” (EX1022, 18.)

Method based on linear programming

A first attempt was based on the method of [Grundmann *et al.*, 2011]. This method is characterised by :

- **the objective function** is expressed as a combination of the camera's angular velocity and acceleration over time.
- **the set of acceptable solutions** is represented by a polytope in 3-dimensional Euclidean space, whose interior points represent the rotations for which the stabilised image remains entirely within the source image!
- **the numerical method** is linear programming.

Angular velocity means rotational velocity; angular acceleration means rotational acceleration. (EX1017, ¶72.) Thus, GoPro itself understood that Kwatra paper—and by extension, its related Kwatra—discloses rotational velocity and rotational acceleration. (*Id.*)

GoPro's own understanding of Kwatra's highly similar Kwatra paper confirms that its now characterizations about Kwatra is wrong. For example, GoPro engineers understood that even though Kwatra paper employs linear programming, it is still capable of characterizing rotational movement. (EX1017, ¶73.) Similarly, GoPro understood Kwatra paper's 2D linear motion model characterizes rotation. (*Id.*)

GoPro also understood that the objective function in Kwatra paper—the same as Equation 7 in Kwatra—is expressed as a combination of the camera's rotational velocity and rotational acceleration. (EX1017, ¶74.) This confirms that Kwatra discloses minimizing rotational velocity and rotational acceleration.

2. Zhou and Kwatra disclose “the position information is determined independent of the image information” in claim 5

GoPro does not dispute that the Zhou-Kwatra combination disclose a “position sensor” required by claim 5. It nevertheless argues that the combination fails to disclose that “the position information is determined independent of the image information.” (POR, 18.) Per GoPro, this is because “Kwatra’s ‘determination of position information’ is entirely dependent on, not independent of, image information.” (*Id.*) But as explained, Kwatra is not limited to an image-based motion estimation approach. (EX1017, ¶76.)

Further, GoPro ignores that the Petition relies on Zhou, not Kwatra, for the additional limitation in claim 5. The additional limitation concerns the determination of position information. A POSITA would have understood that this refers to the first step of video stabilization, *i.e.*, motion estimation. (EX1017, ¶82.)

As Dr. Katsaggelos explains, there are three basic steps of video stabilization. (EX1017, ¶¶78-81; *see also* EX1024, 295 (video stabilization “is essentially a three-stage process”).)

Motion estimation. The first step is estimating the motion of the camera. It can be achieved by image-based or sensor-based approaches. Using either approach results in an estimated camera trajectory.

Motion smoothing. The second step is generating smoothed camera motion. After the actual camera trajectory is estimated, the second step generates a smoothed camera trajectory.

Video generation. The last step uses the smoothed camera motion to generate a stable video. Stabilization reframes each original frame to make it look as if it were captured from the smoothed trajectory.

The additional limitation in claim 5—regarding collecting position information—concerns motion estimation, not motion smoothing. (Dec. ¶¶83-84.) Insta360 relies on Zhou for motion estimation. Zhou discloses “a position sensor” that conveys “position information.” (Paper 2, 16-18.) That information is determined independent of the image information. (*Id.*) Thus, Zhou and Kwatra render claim 5 obvious.

GoPro’s argument that the “minimization disclosures” in Kwatra “are inextricably intertwined with how Kwatra estimates the camera path using two-dimensional linear motion models” is unfounded. (POR, 28-29.) GoPro provides no explanation for why the minimization disclosures in Kwatra must be tied to a specific way to estimate motion. Quite the contrary. As explained earlier, motion estimation is the first step of video stabilization. Insta360 relies on Kwatra for the second step of video stabilization, motion smoothing. That step smooths the estimated camera trajectory, regardless of whether the estimated trajectory is a

result of an image-based or sensor-based motion estimation approach. (EX1017, ¶84.)

When combining Kwatra with Zhou, a POSITA would have understood to perform Kwatra's Equation 7 using P, camera trajectory estimated using position information generated by the position sensor in Zhou. Equation 7 is a straightforward equation, and does not require linear or non-linear, two-dimensional or three-dimensional motion models. (EX1017, ¶¶85-87.)

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

B. Ground 2: Zhou, Kwatra, and Shi Render Obvious Claims 2, 3, 7, 12, 13, and 17

In the POR, GoPro raises no arguments regarding Shi's disclosures. (POR, 34.) Its argument regarding ground 2 relies solely on its argument for ground 1. Its validity arguments for ground 2 thus also fail.

C. Grounds 1 & 2: It would have been obvious to combine Zhou (and Shi) with Kwatra

GoPro's sole argument for no motivation to combine is that Kwatra, compared to Zhou and Shi, has different image stabilization techniques. (POR, 29-33.) Its argument contradicts the teachings of the prior art references.

1. GoPro mischaracterizes Zhou and Shi

Contrary to GoPro's contention, Zhou and Shi are not limited to video stabilization techniques implemented in mobile devices to estimate the 3-dimensional motion of the mobile device itself. (POR, 30; EX1017, ¶¶90-92.)

Instead, Zhou teaches that its "disclosure relates generally to the field of digital photography." (EX1004, 1:13-14.) Zhou's stabilization technique can be implemented in an electronic device, that "could be [] a mobile telephone, personal media device, portable camera, or a tablet, notebook or desktop computer system." (*Id.*, 11:55-67.) Zhou is not limited to a mobile device.

Similarly, Shi teaches that its stabilization technique "can be performed by a computing system, such as the recording device 102 (e.g., a camera, a mobile phone, a tablet computer, etc.)." (EX1006, 14:53-56.) Shi makes clear that its stabilization technique is not limited to implementations on a mobile device or in real-time processing, although in some examples it may be applied in such contexts. (*See, e.g., id.*, 5:28-35; EX1017, ¶92.)

2. GoPro mischaracterizes Kwatra

Also incorrect is GoPro's characterization that "Kwatra teaches a post-processing, server-based approach that estimates motion through feature tracking within the image data." (POR, 30.) The disclosure that GoPro relies on makes

clear that post-processing technique is just one example. (*Id.* (citing EX1005, 3:47); EX1017, ¶93.)

Kwatra’s stabilization technique is not limited to implementation on a server. (EX1017, ¶¶93-95.) Kwatra discloses that “a method to process a video to estimate an original motion of the camera or camera path” (i.e., motion estimation) “may be performed by *a device*, a server, or a combination of the device and the server.” (EX1005, 7:6-13.) It similarly discloses that “a method to process a video to estimate an updated or modified motion of the camera or camera path” (i.e., motion smoothing) “may be performed by *a device*, a server, or a combination of the device and the server.” (EX1005, 12:57-64.)

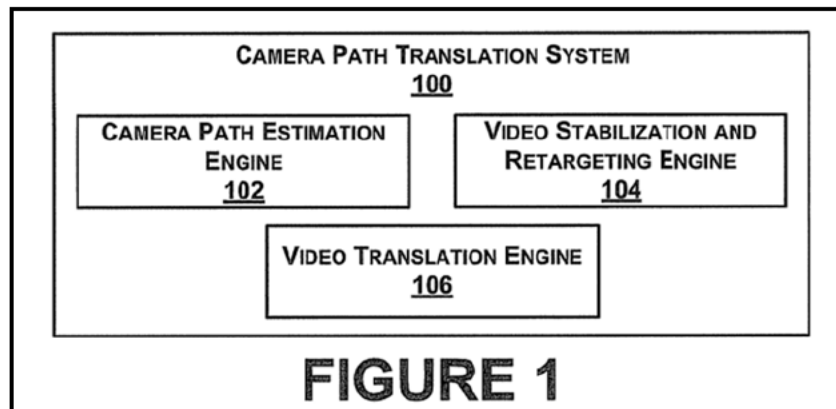
Like Zhou and Shi, Kwatra’s technique can be broadly implemented in a generic device, including a mobile device. As GoPro concedes, Kwatra teaches that its technique can be implemented on a “computing device” shown in Figure 13, which “may be a personal computer, *mobile device, cellular phone . . .*” (POR, 30 (citing EX1005, 26:12-21).)

GoPro misrepresents Kwatra’s disclosure about Figure 13. GoPro relies on Kwatra’s teaching that its stabilization technique can be implemented on a generic “computing device 1300,” which may be “may be a personal computer, mobile device, cellular phone” 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.” (POR, 30; EX1005, 26:11-21.) Ignoring the other parts of this disclosure, GoPro argues that Kwatra’s technique is limited to the specific architecture of Figures 1 and 2, which are server-based systems. This is wrong.

The “components described in FIGS. 1-2” are merely an exemplary implementation. Kwatra makes plain that its technique can be implemented in other configurations, including a mobile device, etc. (EX1017, ¶¶98.)

Moreover, Figures 1 and 2 are not limited to server-based systems. (EX1017, ¶¶99-101.)



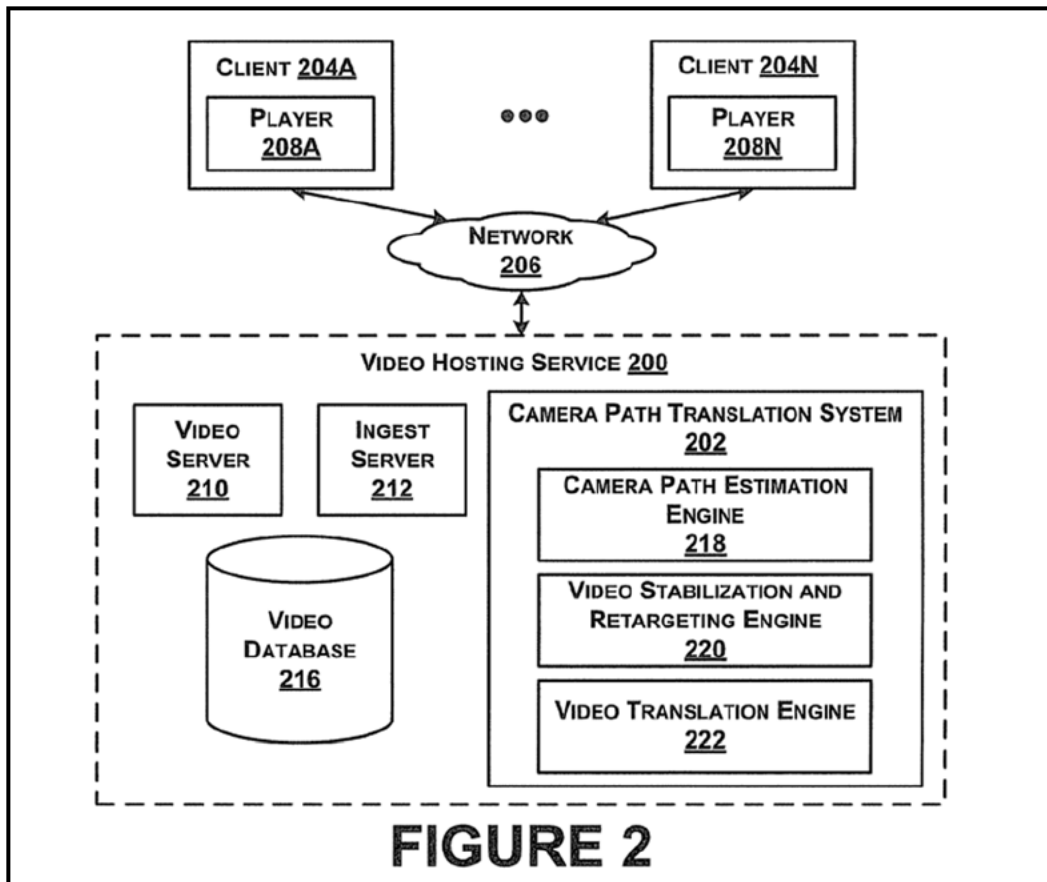


Figure 1, which describes a “camera path translation system” (*i.e.*, Kwatra’s video stabilization system), does not mention server. (EX1005, 5:37-39 (The camera path translation system is the component that “perform[s] video stabilization of the videos.”).) GoPro does not explain why such a system cannot be a mobile device. The three engines included in the “camera path translation system” are merely representations of the three steps of video stabilization. (EX1017, ¶100.)

Nor does Figure 2’s camera path translation system mention server. Kwatra discloses that Figure 2 is “a video hosting service 200 that includes a camera path translation system.” (EX1005, 4:31-33.) That the video hosting service in Figure

2 includes certain servers for storing videos does not mean that Kwatra's video stabilization technique is limited to implementation on a server. (EX1017, ¶101.)

3. GoPro's understanding contradicts relevant state of the art

Doubling down on its mischaracterizations of the art, GoPro contends that its understanding is "consistent with the relevant state of the art." (POR, 31.) It argues that a "POSITA would have recognized that solving for a complex, multiderivative trajectory optimization problem was a computationally intensive process that was not considered suitable for a resource-constrained mobile device." (*Id.*) But GoPro provides no explanation for how purportedly complex the optimization problem is or how resource-constrained a mobile device is. At the time of Kwatra (around 2013), mobile devices could perform many computations. (EX1017, ¶102.) Nor is the computation required for Kwatra's stabilization technique a "computationally intensive process." For example, Equation 7 is a simple equation that does not require complex computation. (*Id.*)

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

A POSITA would have understood that a mobile device is more than capable for performing the computation involved in Kwatra's stabilization technique. (*Id.*) This is consistent with Kwatra's own teachings. (*Id.*; EX1005, 26:11-21.)

4. GoPro’s argument regarding lack of motivation to combine fails

GoPro argues that there is no motivation to combine, because “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.” (POR, 32.) But as explained, Kwatra is not limited to an image-based motion estimation approach. (EX1017, ¶103.)

Moreover, even if it was, a POSITA would have still been motivated to combine Kwatra’s minimization approach with Zhou and Shi’s look-ahead approach. Kwatra’s approach to minimize rotational movement would help further reduce the camera shake that Zhou seeks to dampen. (EX1002, ¶¶114-115.)

A POSITA would have understood that once the estimated camera trajectory—regardless of how it is estimated—has been obtained, the downstream motion smoothing step can generate a smoothed trajectory based on the estimated original trajectory. This smoothing step is agnostic as to the source of that estimated trajectory. (EX1017, ¶107.)

Specifically, the combination of Kwatra with Shi and Zhou concerns a step distinct from and after the motion estimation step. Kwatra is used for only the limitation “minimiz[ing] a combination of rotational velocity and rotational acceleration of the housing.” This concerns the second step of video stabilization, the motion smoothing step. (EX1017, ¶¶104-106.)

Thus, when combining Kwatra with Zhou and Shi, a POSITA would have considered Kwatra for the motion smoothing step, not the motion estimation step. For motion estimation, either the image-based or gyroscope-based motion estimation method determines the original trajectory. (EX1017, ¶106.) After the original trajectory is determined, the combination uses Kwatra only for its Equation 7, which concerns the minimization of rotational velocity and rotational acceleration and is agnostic as to how the motion estimation is performed. (*Id.*)

Finally, a POSITA would have understood that at the time of the claimed invention, the industry had adopted hybrid stabilization techniques (*i.e.*, combining sensor and image data). (EX1017, ¶108.) Given that, a POSITA would have had both the knowledge and motivation to apply a smoothing technique discussed in a reference that uses image-based motion estimation technique to a camera trajectory estimated using sensor data. (*Id.*)

5. GoPro's own development confirms a motivation to combine

GoPro's own development documentation undercuts its contention that there would have been no motivation to combine (1) image-based and sensor-based techniques or (2) mobile-device-based and non-mobile-device-based techniques.

GoPro's own development considered and relied on various references:

A.1.1.2.5. Bibliography

Our research is based on the following references:

1. Censi, Alberto, Andrea Fusiello, and Vito Roberto. "Image stabilization by features tracking." *International Conference on Image Analysis and Processing, 1999. Proceedings . IEEE*, 1999.
2. Karpenko, Alexandre, et al. "Digital video stabilization and rolling shutter correction using gyroscopes." *CSTR 1* (2011): 2.
3. Jia, Chao, and Brian L. Evans. "Constrained 3D Rotation Smoothing via Global Manifold Regression for Video Stabilization." *IEEE Trans. Signal Processing* 62.13 (2014): 3293-3304.
4. Grundmann, Matthias, Vivek Kwatra, and Irfan Essa. "Auto-directed video stabilization with robust L1 optimal camera paths." *IEEE Conference on Computer Vision and Pattern Recognition (CVPR), 2011. IEEE*, 2011.
5. Kopf, Johannes, Michael F. Cohen, and Richard Szeliski. "First-person hyper-lapse videos." *ACM Transactions on Graphics (TOG)* 33.4 (2014): 78.
6. Joshi, Neel, et al. "Real-time hyperlapse creation via optimal frame selection." *ACM Transactions on Graphics (TOG)* 34.4 (2015): 63.
7. Fused Video Stabilization on the Pixel 2 and Pixel 2 XL [[HYPERLINK "https://ai.googleblog.com/2017/11/fused-video-stabilization-on-pixel%20-2.html"](https://ai.googleblog.com/2017/11/fused-video-stabilization-on-pixel%20-2.html)]
8. Vankawala, Fagun, Amit Ganatra, and Amit Patel. "A survey on different image deblurring techniques." *International Journal of Computer Applications* 116.13 (2015): 15-18.

(EX1022, 7.)

For example, GoPro considered:

- an image-based technique using features tracking (reference #1)
- a sensor-based technique using gyroscopes (reference #2)
- a mobile-device-based technique based on Pixel 2 (a mobile phone)
(reference #7)
- Kwatra paper (Grundmann) (reference #4)

(EX1017, ¶¶109-110.)

GoPro's development history is consistent with how a POSITA would have approached prior art in the video stabilization space. A POSITA, when developing a stabilization technique, is not limited to reviewing references in one specific, narrow approach. (EX1017, ¶112.) They would have been motivated to combine references using image-based and sensor-based techniques, or references using mobile-device-based and non-mobile-device-based techniques. (*Id.*)

Finally, contrary to GoPro's contention that Kwatra's technique can only be implemented in servers, [REDACTED]

[REDACTED]

(EX1022, 18.)

[REDACTED]

III. THE OBJECTIVE EVIDENCE DOES NOT SUPPORT NON-OBVIOUSNESS

A. HERO7 does not practice the '894 patent

GoPro fails to show that the allegedly practicing product, HERO7, practices any '894 claim. It does not argue that HERO7 practice any claim other than claims 1 and 5. And although it contends that the '894 patent's unique feature is "the minimization of a combination of rotational velocity and rotational acceleration" (POR, 35), GoPro fails to demonstrate that HERO7 includes this feature.

GoPro relies on Dr. Foroosh's analysis as its only affirmative support. He provides two brief paragraphs for limitation 1[g(iii)] (concerning the minimization feature). (EX2018, ¶¶115-116.) The only substantive discussion appears in paragraph 116, which references two .hpp files. But Dr. Foroosh does not opine that these two files minimize rotational velocity and rotational acceleration. (EX2018, ¶116.) He merely states that one function (unclear which file it appears in) [REDACTED] (*Id.*)³

Despite GoPro's emphasis that Kwatra does not minimize *rotational* movement, its expert likewise does not assert that the HERO7 code achieves

³ GoPro relies on a HyperSmooth "White Paper" (POR, 37), but does not show the HyperSmooth technology described therein is implemented in HERO7 or link it to Dr. Foroosh's cited code. (EX1017, ¶121.)

minimization of *rotational* movement. (EX1017, ¶120.) Nor does either .hpp file mention rotation, let alone rotational velocity or rotational acceleration. (EX1017, ¶121.)

Moreover, Dr. Foroosh’s sole reliance on two .hpp files cannot establish that HERO7 implements the minimization feature. A .hpp file is a header file that does not implement the code’s runtime behavior. (EX1017, ¶122.) It does not contain the algorithms that execute any functionality. Actual, executable code that runs as part of a program’s logic resides in implementation files (*e.g.*, .cpp file). (*Id.*) Because Dr. Foroosh fails to cite any implementation file, he cannot establish that any feature is implemented in HERO7, let alone the minimization feature. (*Id.*)

As Dr. Foroosh similarly relies on only header files for other limitations (*e.g.*, 1[g(ii)], 1[i]), he also has failed to show that HERO7 meets those limitations. (EX2018, ¶¶114, 120; EX1017, ¶123.)

B. No nexus to the purported novel features

Nexus requires the “identified objective indicia” be directed to “what was not known in the prior art.” *Novartis AG v. Torrent Pharms. Ltd.*, 853 F.3d 1316, 1330 (Fed. Cir. 2017). But both purported novel features (POR, 36) were known. Kwatra and its related Kwatra paper taught minimizing rotational velocity and rotational acceleration. GoPro’s development of its stabilization technique relied on Kwatra paper. (EX1022, 7, 18.) Nor did GoPro invent the “use of gyroscope

and accelerometer data to obtain position information” (POR, 36). For example, Zhou taught that approach. GoPro’s development documentation also acknowledged that [REDACTED]

[REDACTED]

[REDACTED] (EX1022, 2; EX1017, ¶1254.)

Even assuming HERO7 practices the ’894 patent, GoPro fails to identify any nexus between the objective evidence and the purported novel features. GoPro does not argue presumption of nexus. It makes no attempt to show how HERO7, which includes many other features, are coextensive with the challenged claims.

No commercial success or industry praise. At most, GoPro shows that its stabilization technology, HyperSmooth in general, has allegedly driven commercial success and received industry praise. But other features—not the purported novel ones—are responsible for those outcomes.

The ’894 patent’s lead inventor, Mr. Derbanne, acknowledged that the way HyperSmooth [REDACTED]

[REDACTED]

[REDACTED] (EX1019, 243:2-16, 143:11-13, 242:16-19, 336:11-14.) GoPro concedes that “patented technologies” in other patents, including the “’840, ’832, and ’413 patents,” “were

directly responsible for GoPro’s sustained commercial success.” (POR, 39-40.)

As the Federal Circuit has held, “[s]uch unclaimed features cannot establish objective indicia of nonobviousness of what is claimed.” *In re Li*, No. 2024-1209, 2025 WL 1040066, at *7 (Fed. Cir. Apr. 8, 2025).

Moreover, GoPro’s alleged industry praise is not attributable to the ’894 patent. EX2010 concerns an award for “EIS technology in 2015,” which predates the ’894 patent’s priority date of May 18, 2018. (EX1017, ¶132.) EX2011 and EX2012 are GoPro’s own press releases: EX2011 does not specify any award or accolade; EX2012 concerns HERO10, not the allegedly practicing HERO7. (*Id.*) GoPro has “failed to offer proof that the commercial success” or industry praise is “the direct result of a unique characteristic of the claimed invention.” *SightSound Techs., LLC v. Apple Inc.*, 809 F.3d 1307, 1319 (Fed. Cir. 2015).

No long-felt but unmet need. GoPro offers no evidence that the two features solved any unmet need. Its own witnesses, including the lead inventor, [REDACTED]. (EX1019, 83:16-21; EX1020, 150:20-151:2.) Digital stabilization techniques had been widely used long before the ’894 patent. (EX1017, ¶133.)

No unexpected results/failure of others. The claimed inventions did not yield unexpected results. GoPro relies on two documents. One is an internal study (EX2043), but GoPro engineers’ belief that their technology outperformed other solutions does not establish unexpected results. (EX1017, ¶134.) GoPro also cites

a public document reviewing its products, but that document concerns HERO9 and HERO8—not HERO7. (EX2014; EX1017, ¶134.) Inventor Mr. Derbanne was also [REDACTED]. (EX1019, 83:16-21.)

No copying. GoPro has presented no copying evidence. It relies on a few Insta360 engineering documents comparing Insta360’s products’ performance with GoPro’s. (POR, 66.) But none of these documents mention the purported novel features. These documents at best show benchmarking against GoPro’s products, not copying. (EX1017, ¶135.) [REDACTED]

[REDACTED]

[REDACTED] (EX1020, 160:5-161:6; EX1017, ¶135.)

IV. CONCLUSION

The Board should cancel all claims of the ’894 patent.

Dated: July 18, 2025

Respectfully submitted,

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Certification of Word Count (37 C.F.R. § 42.24)

I hereby certify that this PETITIONER’S REPLY TO PATENT OWNER RESPONSE has 5,591 words (as counted by the “Word Count” feature of the Microsoft Word™ word-processing system), exclusive of “a table of contents, a table of authorities, a listing of facts which are admitted, denied, or cannot be admitted or denied, a certificate of service or word count, or appendix of exhibits.”

Dated: July 18, 2025

By /Lily Yue Li/
Lily Yue Li

Certificate of Service (37 C.F.R. § 42.6(e)(4))

I hereby certify that the attached PETITIONER'S REPLY TO PATENT OWNER'S RESPONSE was served as of the below date on the Patent Owner via e-mail (by agreement) to the following counsel of record:

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