

Patent No. 10,574,894
Expert Declaration in Support of *Inter Partes* Review

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

DECLARATION OF DR. AGGELOS KATSAGGELOS

I, Aggelos Katsaggelos, make this declaration in connection with the proceeding identified above.

I. INTRODUCTION

1. I have been retained by counsel for Arashi Vision (U.S.) LLC (d/b/a Insta360) (“Petitioner” or “Insta360”) as a technical expert in connection with the proceeding identified above. I submit this declaration in support of Petitioner’s Reply to Patent Owner’s Response to Petition for *Inter Partes* Review of United States Patent No. 10,574,894 (“the ’894 patent”) (EX1001). I described my qualifications in detail in my opening declaration dated July 18, 2024, which I understand is Exhibit 1002 to this proceeding.

2. I have been asked to consider GoPro’s Patent Owner Response (Paper 17) and the declarations of Dr. Hassan Foroosh (EX2001 and EX2018) and provide rebuttal opinions regarding the same.

3. I am being compensated at my standard consulting rate. I am also being reimbursed for expenses that I incur during my work. My compensation does not depend on the results of my study and analysis, the substance of my opinions, or the outcome of any proceeding involving the Challenged Claims. I have no personal or financial interest in the outcome of this matter or in any litigation involving the ’894 patent.

4. I have personal knowledge of the facts and opinions set forth in this declaration and believe them to be true. If called upon to do so, I would testify competently thereto. I have been warned that willfully false statements (and the like) are punishable by fine or imprisonment or both.

5. Although I am not a lawyer and will not provide any legal opinions, I have been advised to apply certain legal standards in forming my opinions. I set forth my understanding of those legal standards in my opening declaration.

(EX1002, Section V.)

II. REBUTTAL OPINIONS

6. I understand that GoPro and/or Dr. Foroosh have argued that the prior art does not teach certain limitations of the claims of the '894 patent. I offer the following opinions in response.

III. OVERVIEW OF THE '894 PATENT

7. In my declaration in support of Insta360's petition, I provided a brief summary of the '894 patent. The '894 patent is titled "Systems and Methods for Stabilizing Videos" and relates to smoothing videos by using a "look ahead" approach. (EX1001, Title and Abstract.)

8. I disagree with Dr. Foroosh's narrow and unsupported characterization of the '894 patent. Dr. Foroosh first correctly notes that the '894 patent "smooths camera motion through the minimization of a combination of

rotational velocity and rotational acceleration of the camera housing.” (EX2018, ¶ 38.) He then opines that “[t]his sort of optimization inherently involves non-linear and trigonometric relationships to account for rotational motion accurately.” (*Id.*)

9. But Dr. Foroosh does not identify anywhere in the patent specification that limits the ’894 patent to non-linear relationships or trigonometric relationships. The only support he provides is Equation 54, which he erroneously notes is the “preferred embodiment.” (*Id.* at ¶39.)

$$\min \left(\left\| \frac{d}{dt} \theta \right\|^2 + \left\| \frac{d^2}{dt^2} \theta \right\|^2 + \dots \right) \quad (54)$$

The ’894 patent does not identify any embodiment as a preferred embodiment.

10. Nor does the simple equation in Equation 54 support Dr. Foroosh’s contention that this equation “describe[s] the 3D rotational motion of the camera housing through a set of non-linear relationships (e.g. Euler’s equations for angular velocity).” (*Id.* at ¶39.) All this equation represents is the minimization of the first-order and second-order time derivatives of a rotation. This equation has nothing to do with “a set of non-linear relationships” as Dr. Foroosh suggests. In fact, this minimization results in the straightforward solution of a set of linear (*not* non-linear) equations, where the number of equations depends on the number of discrete time points that comprise the camera path.

11. In sum, I disagree with Dr. Foroosh's characterization that the '894 patent is limited to non-linear relationships or trigonometric relationships.

12. Dr. Foroosh also opines that "[t]he '894 patent's approach to stabilization is further distinguished by its reliance on onboard motion sensors to determine camera position, independent of image data." (*Id.* at ¶41.) He relies solely on claim 5, which requires that the position information be determined "independent of the image information."

13. Claim 5 is a dependent claim, which depends from claim 1. Although I am not a lawyer, I understand that the doctrine of claim differentiation dictates that claim 1 is broader than claim 5 and does not require that the position information be determined "independent of the image information." Thus, I disagree with Dr. Foroosh's characterization that the '894 patent relies on onboard motion sensors to determine camera position, independent of image data.

14. I also disagree with Dr. Foroosh's attempt to draw a clear-cut line between sensor-based and image-based stabilization approaches (EX2018, ¶¶41-42). In reality, this distinction is often blurred. For example, hybrid approaches that combine both sensor-based and image-based stabilization approaches are also used.

IV. OVERVIEW OF THE CITED ART

15. In my declaration in support of Insta360's petition, I provided brief summaries of the cited art.

16. I note that Dr. Foroosh's validity arguments focus on Kwatra. He does not disagree with my opinions regarding Zhou's and Shi's disclosure of the claim limitations.

17. I disagree with Dr. Foroosh's characterizations of Kwatra. I explain my reasoning in the next section.

V. GROUND 1: ZHOU AND KWATRA RENDER CLAIMS 1-20 OBVIOUS

A. Zhou and Kwatra disclose a "capture trajectory" that "minimizes a combination of rotational velocity and rotational acceleration of the housing" in claims 1 and 11

18. Kwatra teaches determining a "capture trajectory" that "include[s] a path that minimizes a combination of rotational velocity and rotational acceleration of the housing." GoPro and Dr. Foroosh raise three arguments in contending that Kwatra does not disclose this limitation. I disagree with each of the three arguments.

1. GoPro and Dr. Foroosh's arguments regarding "linear framework" are wrong.

19. GoPro and Dr. Foroosh first contend that Kwatra's "motion estimation and smoothing approach is fundamentally based on linear motion models" and "expressly rejects the sort of non-linear computations that would be required to

optimize rotational dynamics.” (EX2018, ¶¶61.) This is wrong for multiple reasons.

20. **First**, Dr. Foroosh is wrong about Kwatra’s motion estimation and smoothing approach being limited to linear motion models. Kwatra makes clear that a linear motion model is just one way to describe the camera motion. (EX1005, 5:48-50 (“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[.]”). (See also EX2020, 22:19-23:10.)

21. **Second**, I disagree with GoPro’s and Dr. Foroosh’s contention that Kwatra uses linear motion models and that the minimization in Kwatra (Equation 7) is strictly calculated as a function of “linear” transformation and thus cannot minimize rotation. (EX2018, ¶¶66-67.) GoPro and Dr. Foroosh’s arguments reflect a fundamental misunderstanding of the basic concepts of motion models. To help illustrate GoPro’s and Dr. Foroosh’s erroneous reasoning, I first provide brief explanations of certain concepts described in Kwatra.

22. **Linear motion model.** A linear motion model is a mathematical model that describes how the state of a moving object evolves over time using linear transformations. While some linear motion models are traditionally associated with translational movement, they can also encompass rotational movement. For example, a similarity linear model, an affine linear model, a

linearized 6-DOF model, a homography linear model, and a Euclidean linear model can all describe motions including rotational movement. Kwatra, for example, teaches that a linear motion model can include “similarity (2 DOF translation, 1 DOF scale, 1 DOF rotation), affine (6 DOF), or a homography (8 DOF).” (EX1005, 11:9-11.)

23. **Similarity linear model.** A similarity linear model is a subset of affine transformations. It is a type of geometric transformation that maps one set of points to another while preserving shape and angles, but allowing rotation, uniform scaling, and translation. Kwatra confirms this. As the Board correctly noticed, Kwatra discloses that the similarity model accounts for rotation as a degree of freedom (DOF). (Paper 9, 32.) Kwatra also teaches that “in a similarity transform, a combination of scale, *rotation* and translation can be used.” (EX1005, 17:5-8 (emphasis added).)

24. **Affine linear model.** An affine linear model is a mathematical model that describes how a point or object moves in space using a linear transformation matrix that includes rotation, possibly scaling and shear, along with a translation vector that shifts its position. Kwatra describes that an affine model can have 6 degrees of freedom, which include 2 DOF translation, 1 DOF rotation, 2 DOF scaling, and 1 DOF shearing. (EX1005, 11:9-11.)

25. **Homography linear model.** A homography model is a mathematical model that describes a projective transformation between two planes. It is used to map points from one plane to another, allowing for rotation, translation, scaling, shearing, and perspective distortion. Kwatra describes that a homography model can have 8 degrees of freedom, which include 2 DOF translation, 1 DOF rotation, 2 DOF scaling, 1 DOF shearing, and 2 DOF perspective warp. (EX1005, 11:9-11.)

26. GoPro and Foroosh misunderstand the linear models described by Kwatra. As Dr. Foroosh acknowledges, Kwatra discloses linear models including similarity, affine, and homography. (EX2018, ¶83; EX1005, 11:4-11.) As I explained above and in my April 4, 2025 deposition, those linear models represent rotational motion. (EX2020, 23:24-24:19.) GoPro and Dr. Foroosh appear to mistakenly believe that because those models are called “linear” motion models, they can represent only strictly linear or translational motion, and not rotational movement. That is wrong. Although those models include rotational movement, as I explain later, they are referred to as linear models because they satisfy the additivity and homogeneity properties of linearity.

27. Let us use the similarity model in Kwatra as an example. Kwatra discloses:

In a similarity transform, a combination of scale, rotation and translation can be used. A smoothness constraint can be imposed on $P(t)$ using weights a and b for the similarity transformation $[F(x; t, a,$

$b)=[a-b; b a]*x+t]$. While t corresponds to translation, scale and rotation are related to a, b as:

$$\text{Scale: } s=\sqrt{(a^2+b^2)} \quad \text{Equation (17)}$$

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

(EX1005, 17:5-18.) As Kwatra makes clear, this model includes rotation. It is nevertheless referred to as a linear motion model because it involves a linear transformation. The transformation matrix A given by

$$\begin{bmatrix} a & -b \\ b & a \end{bmatrix}$$

is applied to the input point x linearly to obtain the similarity transformation: $F(x)=Ax+t$. Models like similarity and affine are referred to as linear motion models because they satisfy the additivity and homogeneity properties, as explained below, even though some of the motion (like rotation or scale) arises from underlying nonlinear geometry. It is mentioned here that similarity and affine transformations (or any transformation involving translation) are linear transformations in the homogenous representation of the transformation. For example, the angle of rotation θ is an entry in the rotation matrix through the non-linear trigonometric functions of sine and cosine.

28. As Dr. Foroosh concedes, “Kwatra does teach that the 2-dimensional linear motion model may be represented as a ‘similarity’ or ‘affine’ transformation

with one degree of freedom for scale and one degree of freedom for *rotation*.”

(EX2018, ¶67 (emphasis added).)

29. Dr. Foroosh also cites Kwatra’s disclosure that “[a]n 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.” (*Id.*, ¶63 (citing EX1005, 9:57-60).) But that Kwatra employs a linear transform does not suggest that Kwatra excludes rotational movement.

30. **Linear transformation.** A linear transformation can encompass rotation. A transformation $T(x)$, where x is a vector, is called linear if it satisfies:

(1) Additivity: $T(u+v) = T(u) + T(v)$; and

(2) Homogeneity: $T(cv) = cT(v)$, where c is a scalar.

A rotation satisfies both properties and therefore constitutes a linear transformation. For example, let us consider a 2D rotation around the origin given by the rotation matrix

$$R(\theta) = \begin{bmatrix} \cos \theta & -\sin \theta \\ \sin \theta & \cos \theta \end{bmatrix}$$

For a vector x , the rotated vector is $R(\theta)x$. This rotation is represented by matrix-vector multiplication and therefore satisfies the additivity and homogeneity properties. That is, for any two vectors u and v :

(1) Additivity: $R(\theta)(u+v) = R(\theta)(u) + R(\theta)(v)$; and

(2) Homogeneity: $R(\theta)(cv) = cR(\theta)(v)$.

31. Because the motion models that Kwatra uses to represent the original camera motion path can and do encompass rotational movement, the original camera motion path must also include rotational movement. Kwatra discloses that first, “an estimate of the original camera path motion is received.” (EX1005, 13:5-6.) Kwatra discloses that afterwards, the “optimization may determine a stable camera path $P(t)$ by minimizing the cost function” in equation 7:

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

Ex. 1005, 13:62-14:12. The path that is being minimized in equation 7 must also encompass rotational movement.

32. I note that although Dr. Foroosh contends that Kwatra employs linear motion models, he does not explicitly argue that the original camera motion considered and calculated by Kwatra excludes rotational movement. The reason is obvious: He cannot as Kwatra expressly states that its linear motion models consider and capture rotation; linear transformation also does not exclude rotation.

33. Dr. Foroosh instead contends that Kwatra “expressly rejects an approach that would attempt to minimize rotation or scale as part of its smoothing/optimization step.” (EX2018, ¶68.) His reason is that “for similarity or affine transformations, Kwatra teaches to impose smoothness constraints only on

the elements a and b of its linear transformation matrix rather than directly on the degrees of freedom associated with image scale ('s') and image rotation angle ' θ ' of the trackable 2D image features." (*Id.*) He then erroneously reaches the conclusion that "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." (*Id.* at ¶70.)

34. Again, Dr. Foroosh misunderstands the concepts described by Kwatra. The portion of Kwatra he cites does not mention, or suggest, that rotation is not minimized. Quite the contrary. As Dr. Foroosh himself concedes, Kwatra teaches "plac[ing] 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.'" *Id.* at ¶69 (Ex. 1005 at 17:19-20). The portion of Kwatra that Dr. Foroosh cites makes clear that rotational movement is smoothed.

35. I first explain what column 17 of Kwatra (the portion relied on by Dr. Foroosh) teaches.

36. Kwatra first again reiterates that "in a similarity transform, a combination of scale, rotation and translation can be used." (EX1005, 17:7-8.) Kwatra teaches that scale and rotation are nonlinear related to the parameters a and b:

$$\text{Scale: } s = \sqrt{a^2 + b^2} \quad \text{Equation (17)}$$

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

(*Id.* at 17: 11-16.) It then discloses that enforcing smoothness on scale (s) and rotation (θ) directly is non-linear (i.e., involves nonlinear optimization, which is slower and more complex). (*Id.* at 17: 17-19.) Kwatra teaches that instead of solving a nonlinear optimization problem to smooth scale (s) and rotation (θ) directly, it uses the estimated camera path (represented by a linear motion model) to constrain how much scale (s) and rotation (θ) vary indirectly. (*Id.* at 17:18-20.) Kwatra explicitly discloses that “For rotation, $a = s \cdot \cos(\theta)$, $b = s \cdot \sin(\theta)$, 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.* at 17:37-46.)

37. Thus, Kwatra teaches smoothing scale and rotation. It does not do so by performing calculations directly on scale (s) and rotation (θ), but does so through a and b. Rotation (θ) is only related to a and b as it is represented as:

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

(*Id.* at 17:15-17.)

Thus, imposing smoothness constraints on a and b results in rotation (θ) also being smoothed.

38. Dr. Foroosh's emphasis on rotation (θ) not directly being bounded is misplaced. Kwatra does not need to explicitly bound θ to control rotation. It constrains the trigonometric components a and b in a way that is mathematically and functionally equivalent to bounding θ itself.

39. Dr. Foroosh also argues, with no explanation, that "placing bounds on the extent the scale s and the cosine or sine of the 2D image rotation θ are allowed to change during estimation of the smooth camera path is not the same as computing a smooth 3D camera path." (EX2018, ¶¶71.) I respond to Dr. Foroosh's argument regarding 2D vs 3D motion in the next section.

40. GoPro and Dr. Foroosh also fault me for not reviewing Kwatra's provisional application. (EX2018, ¶¶72-73.) They rely on the provisional application for the sole argument that "by deliberately avoiding non-linear computations, Kwatra does not and cannot minimize rotational velocity and acceleration of a camera housing path." (EX2018, ¶¶72-73.) As I already explained, a linear optimization simply means a computation where all operations involve linear relationships — that is, the unknown parameters (output) are a linear function of the cost function (input of the optimization problem). That Kwatra

employs linear optimization for efficiency does not preclude smoothing of rotational movement.

41. Kwatra's provisional application further confirms that Kwatra's motion includes rotation and that Kwatra smoothes rotation. 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 at 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.* at 5.) In other words, they include rotation.

42. Elsewhere, Kwatra's provisional application makes clear 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." (*Id.*) These disclosures confirm that Kwatra's linear motion models (e.g., similarity and affine) include rotational movement.

43. The fact that I did not consider Kwatra's provisional application when I submitted my declaration in support of Insta360's IPR petition does not affect my invalidity analysis. Consistent with Kwatra, Kwatra's provisional application discloses performing linear computation. But linear computation does not suggest that Kwatra's motion path does not include rotation or that rotational movement is not minimized or smoothed.

44. **Third**, GoPro and Dr. Foroosh’s reliance on Figures 8A and 8B is wrong. They claim that because Figures 8A and 8B “track camera motion (both original and smooth) exclusively as a function of position in the X and Y dimensions, respectively,” Kwatra does not teach minimizing rotational movement. (EX2018, ¶74.)

45. GoPro and Dr. Foroosh selectively rely on one embodiment of Kwatra’s inventions and ignore numerous explicit disclosures of rotational movement in Kwatra. As I have explained in my deposition, Figures 8A and 8B are just “an example.” EX2020, 70:9-20. Figure 5D, for example, shows a figure in which rotational velocity and rotational acceleration are minimized. (*Id.*, 67: 21-68:2.)

46. GoPro and Dr. Foroosh also rely on the testimony of Insta360’s expert for the ITC proceeding, Mr. Goodin. EX2018, ¶75. I have reviewed the transcript and disagree with GoPro’s misleading and selective citation to Mr. Goodin’s testimony. It is true that Mr. Goodin stated that Figures 8A and 8B “appear to be dealing with translational motion” (EX2021, 1369:1-5). But GoPro misleadingly omits that Mr. Goodin answered that he did not understand that P “in Kwatra is representing a linear path model.” (EX2021, 1368:3-11.) Consistent with my opinion, Mr. Goodin testified that P in Kwatra “represent[s] a combination of linear and rotational motion.” *Id.* Mr. Goodin’s testimony at the ITC hearing thus

is in agreement with my opinion. That one particular embodiment Figures 8A and 8B show motion as translational does not suggest that Kwatra is limited to translational motion and excludes rotation.

2. GoPro and Dr. Foroosh’s arguments regarding “Two-Dimensional Approach” are wrong.

47. GoPro’s next argument mischaracterizes my deposition testimony. At my deposition, I testified:

The two-dimensional models *we talked about* cannot -- cannot cover that, cannot cover the camera rotation in the 3D space, cannot cover the angle and velocity of the camera. I need a 3D model to be able to capture this quantity.

(EX2020, 79:2-9 (emphasis added).)

48. It is important to understand that I was referring to specific types of two-dimensional motion models, not all two-dimensional motion models. GoPro simply cites my deposition testimony out of context. Prior to that answer, I was responding to GoPro’s counsel’s questions about column 18, lines 54 through 56 of Kwatra, which reads: “As still another example, for camera rotation, feature point motion derivatives may diminish as a square of angular velocity.” (EX1005, 18:54-56.) I responded to GoPro’s counsel that this is “a clear indication that a three-dimensional model of the camera motion is considered” as opposed to only two-dimension. (EX2020, 78:17-24.) Earlier to that, I testified that Kwatra

discloses models such as a homography model that can be “a three-dimensional modeling.” (*Id.* at 73:19-74:11.)

49. Certain two-dimensional motion models, such as a translation model, do not represent rotation. They thus represent very limited motion and are very limited for approximating 3D motion effects.

50. Other models such as homography, on the other hand, can represent types of 3D motion. A homography, although in strict terms, is a 2D projective transformation, can represent 3D motions and simulate the visual effects of certain 3D motions in the image plane. For example, it captures perspective distortion, vanishing points, and projective warping, which are key perceptual indicators of 3D camera movement.

51. When I was testifying about the “two-dimensional models *we talked about*,” I was referring to the two-dimensional models that cannot represent rotation — the subject of the earlier colloquy. (EX2020, 76:9-15.) I simply meant that some two-dimensional motion models, such as a translation model, cannot represent rotation. I did not suggest that other two-dimensional motion models, such as affine and homography, cannot model rotation or three-dimensional motion.

52. Further, as I clearly explained at my deposition, Kwatra discloses modeling in some sense three-dimensional motion. (EX2020, 74:21-75:25)

(explaining a homography and an affine motion model can be in two or three dimensions).) For example, Kwatra discloses “lower to higher dimension motion models (e.g., similarity→homography).” (EX1005, 11:58-61.) This shows that Kwatra clearly intends to capture increasing complexity of camera motion — from similarity (more basic 2D) to homography (which can simulate full 3D rotation and more complicated motion under certain constraints). So the “higher dimension motion models (e.g., similarity->homography)” in Kwatra can be interpreted as increasing the degrees of freedom in 2D while at the same time allowing the recovery of 3D rotation (and possibly additional 3D motion) from 2D modeling.

53. Finally, GoPro and Dr. Foroosh’s emphasis on 2D vs 3D modelling misses the point. The ’894 patent does not mention 2D or 3D motion at all. The ’894 patent at no point limits its invention to 3D motion only. Nor does Dr. Foroosh or GoPro identify any. Dr. Foroosh in fact concedes that “the claims do not explicitly” reference 3D rotation. (EX2018, ¶37.)

54. Dr. Foroosh also is incorrect that minimizing rotational velocity and rotational acceleration of a camera housing necessarily involves 3D motion modeling. In many imaging and stabilization applications, rotational velocity and acceleration of a camera housing are modeled, estimated, minimized, and corrected from video frames, within 2D image space. It is important to understand that in video stabilization, what ultimately matters is what the stabilized video looks like

(i.e., visual smoothness), and not metric measurements. Therefore, working in the 2D space with the observed video frames will suffice.

55. Finally, even if the '894 patent is limited to 3D motion modeling and Kwatra is limited to 2D motion modeling, that does not mean that Zhou and Kwatra do not render claims 1 and 11 of the '894 patent obvious. As GoPro concedes, Zhou “estimate[s] the 3-dimensional motion.” (Paper 17, 30.) Zhou’s camera motion therefore includes rotational movement. Zhou in fact discloses that its “video may be stabilized . . . against rotation.” (EX1004, 5:48-64, 6:2-6, 7:41-42.) As I explain below, it would have been obvious for a POSITA to combine Zhou’s disclosure of stabilizing against rotation in 3D motion and Kwatra’s disclosure of performing stabilization by minimizing rotational velocity and rotational acceleration. For a POSITA to be motivated to combine two video stabilization references, the two video stabilization references need not have the same approaches.

3. GoPro and Dr. Foroosh’s arguments that Kwatra does not disclose minimizing motion of the camera housing are wrong.

56. GoPro and Dr. Foroosh also argue that “Kwatra’s motion model is based on extracting and tracking feature pairs across successive frames. Thus, Kwatra’s ‘camera path’ does not represent the motion of the physical camera housing in space.” (EX2018, ¶81). I disagree.

57. As I explained in my deposition, Kwatra is not limited to an image-based motion estimation approach. (EX2020, 37:21-38:1.)

58. Dr. Foroosh contends that “[t]he 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.” (EX2018 at ¶82.)

59. While it is technically correct that the pixel displacement of a feature is not numerically identical to the 3D rotation angle of a camera housing, this distinction ignores widely accepted practices of video stabilization.

60. Image-plane feature displacement is a function of camera rotation. When a camera undergoes rotation, static features in the scene move across the image plane. While not numerically identical, pixel displacement is proportional to rotation under standard perspective projection. This relationship is precisely why pixel-based optical flow, visual odometry, and feature tracking are used to infer and correct rotational motion in modern computer vision systems — without requiring physical sensors.

61. Further, Dr. Foroosh’s emphasis on 2D vs 3D ignores that in applications like video stabilization, what is important is not the actual 3D camera angle, but how rotational motion manifests in the image. Minimizing how much a feature moves in pixels — frame to frame — directly reduces perceived angular jitter.

62. The industry standard methods in video stabilization, augmented reality, and visual SLAM routinely rely on 2D pixel displacement to infer and smooth camera motion — including rotation — in the 3D space. In other words, pixel displacement is the observable manifestation of 3D rotation in image-based systems.

63. Kwatra itself discloses that a motion estimation approach based on tracking features between frames can estimate the motion of a camera. Kwatra teaches that: “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, and the motion models can be transformed to a common coordinate system and concatenated to yield an estimated original camera path over all frames of the video.” (EX1005, 5:48-53.) Kwatra also teaches that its “camera path estimation engine may be configured to receive a video, and to estimate an original motion path of a camera that recorded the video based on motion of objects within the video.” (EX1005, 2:28-31.) Thus, a POSITA would have understood that the image-feature-based motion estimation approach disclosed in Kwatra can estimate the motion of a camera (and by extension, the camera’s housing).

64. Dr. Foroosh further argues that Kwatra “by design cannot account for 3D information (i.e. depth)” because “Kwatra is fitting a motion model to a set of tracked image feature points regardless of their depths using least squares.”

(EX2018, ¶¶83-84.) I disagree. It is well-known in computer vision literature that 3D information (e.g., depth) can be reconstructed from a 2D video. For example, this can be achieved from classic methods such as structure from motion (SfM) and optical flow + depth estimation. In fact, the provisional application of Kwatra indicates that 3D motion can be estimated by analyzing a 2D video. (EX2019, at 11-12.) Dr. Foroosh's own research also used 2D video images to calculate depth. (EX1018, 24:16-25:5.)

65. Furthermore, as I explained at my deposition, Kwatra is not limited to an image-based approach using features across frames to estimate camera motion. (EX2020, 37:21-38:1.) Additionally, as I explain below, even if Kwatra is about an image-based approach, a POSITA would have been motivated to combine Zhou and Shi's sensor-based, "look ahead" approach with Kwatra's disclosure of minimizing rotational velocity and rotational acceleration.

4. GoPro's own characterization of Kwatra's related publication contradicts its position.

66. I have also reviewed GoPro's development document relating to the claimed technologies. (EX1022.) I understand that document was produced in the related ITC proceeding.

67. 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. (*Id.* at 7.) The authors of that

publication also are the inventors of Kwatra: Vivek Kwatra and Matthias Grundmann. (EX1023.) I refer to this publication as “Kwatra paper.”

68. The subject matter of the Kwatra paper is very similar to Kwatra. Specifically, like Kwatra, Kwatra paper teaches: “For the following discussion we assume that 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 at each instance of time.” (EX1023, 227.) It also discloses that its “algorithm is based on a linear programming framework to minimize the first, second, and third derivatives of the resulting camera path.” (*Id.* at 1.) It further discloses that “While we focus our discussion on 2D parametric motion models F_t , our system is theoretically applicable to higher dimensional linear motions though we do not explore them in this paper.” (*Id.*, 227.)

69. It further teaches that the “optimization serves to find the optimal stable camera path $P(t)$ minimizing the objective” function below:

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

(*Id.*) A POSITA would have understood that this disclosure is the same as the following disclosure in Kwatra: “The optimization may determine a stable camera path $P(t)$ by minimizing the cost function:”

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

Equation (7)

(EX2005, 13:65-14:5.)

70. Kwatra paper mentions rotation twice. It discloses that “constraints on the optimal camera path” can “limit the range of change in zoom and rotation, while the latter two give the affine transform more rigidity by limiting the amount of skew and non-uniform scale.” (EX1023, 228.) It also discloses that “for video stabilization extreme choices for scale and rotation might minimize the residual better but discard a lot of information.” (*Id.*)

71. GoPro’s internal documentation describes that Kwatra paper discloses rotational movement. (It refers to Kwatra paper as Grundmann.)

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.

(EX1022, 18.)

72. This suggests that GoPro itself understood that Kwatra discloses rotational velocity and rotational acceleration. Angular velocity simply means rotational velocity. And angular acceleration means rotational acceleration.

73. Contrary to Dr. Foroosh’s arguments, GoPro itself understood that even though Kwatra paper employs linear programming, it is still capable of

characterizing rotational movement. Similarly, even though Kwatra paper discusses 2D linear motion model, GoPro itself understood that Kwatra paper characterizes rotational velocity and rotational acceleration.

74. Critically, GoPro itself understood that the objective function in Kwatra paper, which as discussed is the same as Equation 7 in Kwatra, is expressed as a combination of the camera's rotational velocity and rotational acceleration.

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

75. I also disagree with Dr. Foroosh's opinion that Insta360's petition fails to show “the position information is determined independent of the image information” in claim 5.

76. Dr. Foroosh contends that “Kwatra's ‘determination of position information’ is entirely dependent on, not independent of, image information as claimed.” (EX2018, ¶87.) But as I discuss earlier, Kwatra is not limited to an image-based motion estimation approach.

77. Dr. Foroosh also makes the fundamental mistake of ignoring that Insta360's petition relies on Zhou, not Kwatra, for the additional limitation in claim 5. I first explain the basic concepts of video stabilization.

78. There are three basic steps of video stabilization.

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

80. The second step is to create smoothed camera motion. After the actual camera trajectory is estimated, the second step can use different motion smoothing approaches to smooth the camera trajectory.

81. Finally, the last step uses the smoothed camera motion to generate a stable video. Since one cannot go back and re-shoot the video, stabilization reframes each original frame to make it look as if it were captured from the smoothed trajectory. This is typically done using an output frame that is smaller than the original input frame. Each original frame is like a large canvas. The stabilization algorithm picks a smaller window inside that canvas — the cropped window — and shifts it around to match the smooth trajectory. As a result, the viewer sees only the part of the frame that follows the smoothed motion.

82. Claim 5 of the '894 patent recites: “The system of claim 1, wherein 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.” A POSITA would have clearly understood that the additional limitation in claim 5 refers to the first step of video stabilization, namely the motion estimation step. It requires using a position sensor to determine the

position information and that the position information is determined independent of the image information.

83. The additional limitation in claim 5 has nothing to do with step 2, motion smoothing. Insta360's petition relies on Zhou for the motion estimation step. Dr. Foroosh does not dispute that Zhou discloses "a position sensor" that conveys "position information." (Petition, 16-18.) The position information is determined independent of the image information, but instead by the position sensor in Zhou.

84. Dr. Foroosh instead argues that Insta360 cherry picks disclosures and that the "minimization disclosures" in Kwatra "are inextricably intertwined with how Kwatra estimates the camera path using two-dimensional linear motion models." (EX2018, 42.) I disagree. Dr. Foroosh provides no explanation as to why the minimization disclosures in Kwatra must be tied to a specific way to estimate motion. As I explained, motion estimation is the first step of video stabilization. Insta360's petition relies on Kwatra for the second step of video stabilization, motion smoothing. Motion smoothing is performed on an estimated camera trajectory, regardless of whether it is a result of an image-based or sensor-based motion estimation approach.

85. As I explain further below, a POSITA would have been motivated to combine Zhou's video stabilization approach with Kwatra's disclosure of

performing smoothing by minimizing rotational velocity and rotational acceleration.

86. Dr. Foroosh also contends that “[o]ne cannot simply replace P with theta in Kwatra’s optimization equation (7) and assume that the rest of Kwatra’s teaching would hold.” (EX2018, 43.) But I am not proposing that for the combination, one would need to replace P with theta. P in Kwatra represents the original camera trajectory or path. When combining Kwatra with Zhou, a POSITA would have understood to perform Equation 7 using P, camera trajectory estimated using position information generated by the position sensor in Zhou.

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

Equation (7)

87. Equation 7 is a straightforward equation, and does not require linear or non-linear, two-dimensional or three-dimensional motion models.

C. A POSITA Would Have Been Motivated to Combine Zhou (and/or Shi) with Kwatra

88. I disagree with GoPro and Dr. Foroosh’s contention that “there is no persuasive motivation or reasonable expectation of success for a POSITA to combine Zhou and Shi with Kwatra.” (EX2018, ¶¶89-94.)

89. Dr. Foroosh criticizes that Insta360’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.” (EX2018, ¶93.) Dr. Foroosh’s sole argument regarding the lack of motivation to combine is the purported “computational and functional disparities between the references.” (*Id.*, ¶93.) There are multiple issues with Dr. Foroosh’s argument.

90. **First**, Dr. Foroosh mischaracterizes the prior art references. 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 (*id.*, ¶89).

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

92. Similarly, Shi discloses “[m]ethods, systems, and apparatus, including computer programs stored on a computer-readable storage medium, for video stabilization.” (EX1006, Abstract.) It 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.).” (*Id.*, 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 (“In some implementations, the system **can** provide real-time or substantially real-time processing while video is captured. . . . Further, the techniques discussed **can** be performed in a manner that is computationally feasible and power efficient on a battery-powered mobile electronic device, such as a mobile phone.”) (emphasis added).)

93. **Second**, Dr. Foroosh also is wrong that “Kwatra teaches a post-processing, server-based approach that estimates motion through feature tracking within the image data.” (EX2018, ¶89.) As he concedes, Kwatra in fact discloses that “[i]n **one example**, a video may be stabilized by performing post-processing techniques.” (*Id.* (citing Ex. 1005 at 3:47).)

94. Dr. Foroosh also acknowledges that Kwatra discloses:

FIG. 13 is a functional block diagram illustrating an example computing device 1300 used in a computing system that is arranged in accordance with at least some embodiments described herein. The computing device may be a personal computer, **mobile device, cellular phone**, video game system, or global positioning system, 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.

(EX1005, 26:12-21 (emphasis added).) This demonstrates that Kwatra’s video stabilization technique is not limited to implementation on a server. To the contrary, like Zhou and Shi, it discloses that its stabilization technique can be broadly implemented in a generic device, which can be a mobile device.

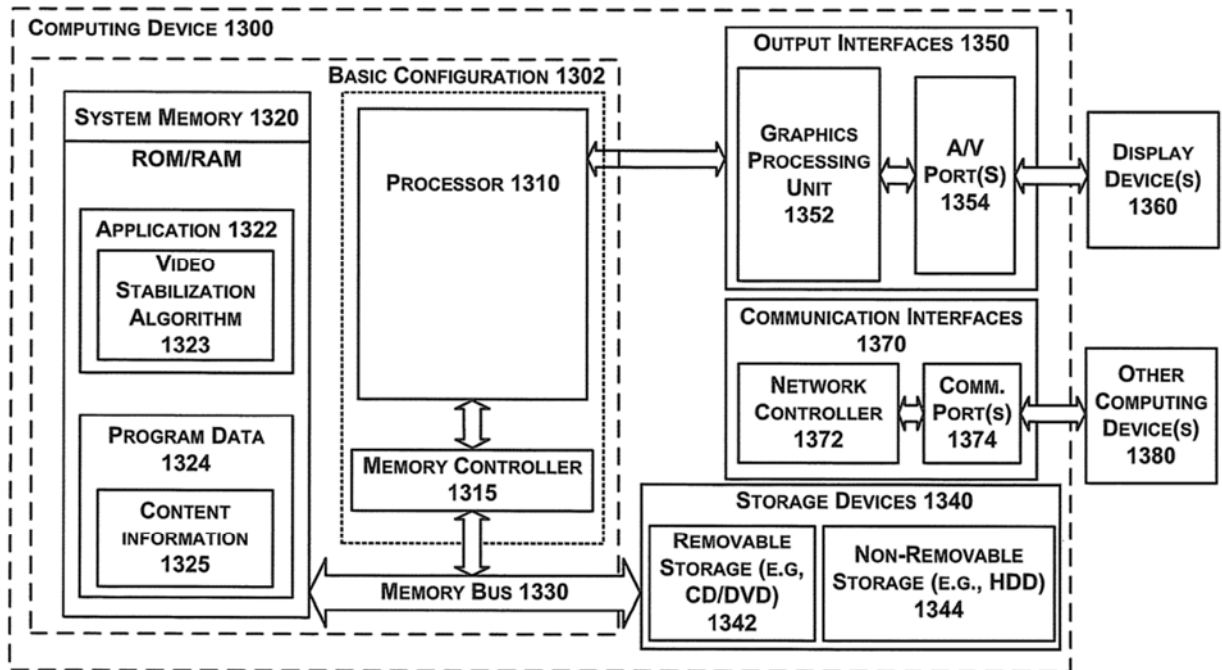


FIGURE 13

95. Kwatra also 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.) These all demonstrate that Kwatra’s stabilization technique is not limited to implementation on a server.

96. Dr. Foroosh misrepresents Kwatra’s disclosure about Figure 13. He concedes that Kwatra discloses that its stabilization technique can be implemented

on a generic “computing device 1300,” which “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.” (EX2018, ¶¶90; EX1005 at 26:11-21.) This disclosure alone shows that Kwatra’s technique can be implemented on a mobile device.

97. Dr. Foroosh, however, argues that Kwatra’s technique is limited to the specific architecture of Figures 1 and 2, which are server-based systems. This is wrong.

98. Dr. Foroosh ignores that the “components described in FIGS. 1-2” is an exemplary implementation; Kwatra teaches that besides that, its technique can be implemented in other configurations, including a client device, etc.

99. Moreover, Figures 1 and 2 are not limited to server-based systems.

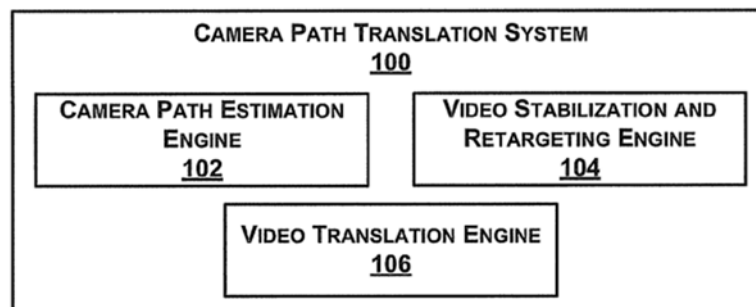


FIGURE 1

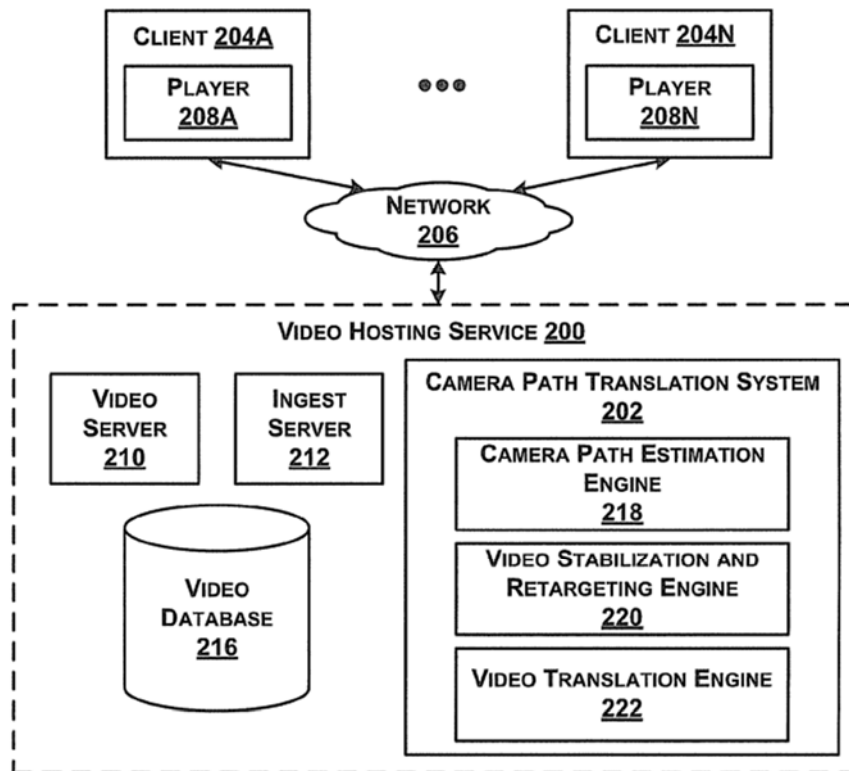


FIGURE 2

100. Figure 1 does not mention server at all. Dr. Foroosh provides no explanation for why a camera path translation system, which encompasses a camera path estimation engine, a video stabilization and retargeting engine, and a video translation engine, cannot be a mobile device. Those three engines are merely representations of the three basic steps of video stabilization.

101. Nor does Figure 2's camera path translation system mention server. Per Kwatra, the camera path translation system is the component that “perform[s] video stabilization of the videos.” (EX1005, 5:37-39.) 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.

102. **Third**, Dr. Foroosh is wrong 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.” (EX2018, ¶91.) He provides no explanation for how purported complex the optimization problem is or how purportedly resource-constrained a mobile device is. At the time of Kwatra (around 2013), mobile devices were capable of performing many computations. Nor is the computation required for Kwatra’s video stabilization technique a “computationally intensive process.” For example, Equation 7 is a simple equation that does not require complex computation.

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

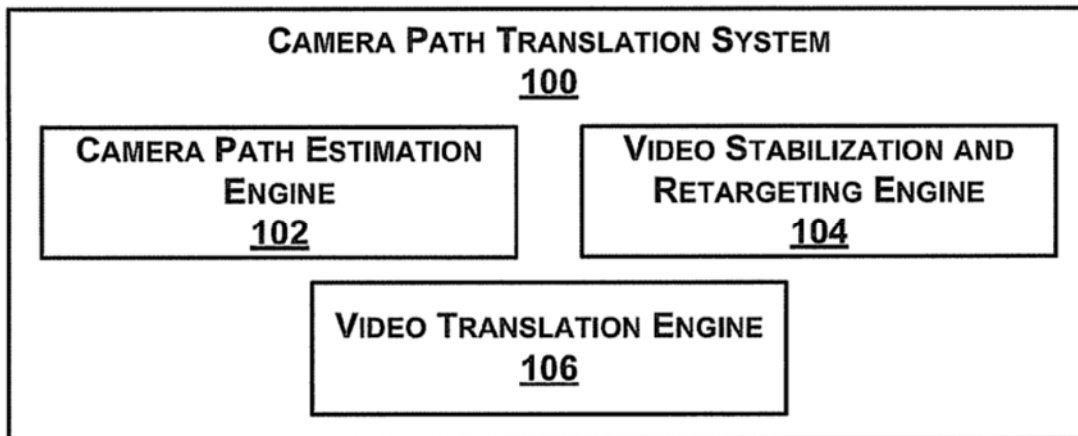
Consistent with the disclosures in Kwatra, a POSITA would have understood that the computation involved in Kwatra’s video stabilization can be performed on a mobile device.

103. **Fourth**, Dr. Foroosh’s argument about “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” (EX2018, ¶92) is without merit. As an initial matter, as I explained, Kwatra is not limited to an image-based motion estimation approach. Furthermore, as I explained earlier, this only addresses the first step in the video stabilization process.

104. Moreover, the combination of Kwatra and Shi and Zhou concerns only the limitation about “minimize[ing] a combination of rotational velocity and rotational acceleration of the housing.” This concerns the second step of video stabilization, the motion smoothing step. As discussed, Kwatra discloses that “[a] smooth camera path can be estimated using minimization of derivatives of the original camera path.” (EX1005, 5:64-66.)

105. The motion smoothing step is a distinct step from the first step, motion estimation. Kwatra confirms this. Its video stabilization system includes three components.



(EX1005, Fig. 1.)

The component corresponding to motion estimation — camera path estimation engine 102 — is a component distinct from the one corresponding to motion smoothing — video stabilization and retargeting engine.

106. Thus, the use of Kwatra has no bearing on the motion estimation step. As discussed, either the image-based or gyroscope-based motion estimation method determines the original trajectory. That is independent of the use of Kwatra, which is for the smoothing step. The combination uses Kwatra only for its Equation 7, which is agnostic as to how the motion estimation is performed.

107. Further, even assuming Kwatra is limited to image-based motion estimation, a POSITA would have still been motivated to combine Kwatra's minimization approach with Zhou and Shi's look-ahead approach. 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 is typically agnostic to the source of that estimated trajectory.

108. Furthermore, hybrid stabilization techniques — combining sensor and image data — were increasingly discussed in the literature and industry, reflecting a general motivation to integrate the best features of both. Thus, a POSITA would have had both the knowledge and the incentive to apply the smoothing technique discussed in a reference that uses an image-based motion estimation technique to a camera trajectory estimated using sensor data. This integration would have

involved only the predictable use of prior art elements according to their established functions, and would not have required undue experimentation or invention.

109. ***Fifth***, GoPro's own development documentation contradicts 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 a variety of 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.)

110. GoPro considered an image-based technique using features tracking (reference #1). It considered a sensor-based technique using gyroscopes (reference #2). It considered a mobile-device-based technique based on a mobile phone, the Pixel 2. It also considered Kwatra paper (Grundmann), whose technique according to GoPro, is too complex for a mobile device.

111. Contrary to GoPro's contention that Kwatra's technique is too complex and thus can only be implemented in servers, GoPro itself "[REDACTED]

[REDACTED]
[REDACTED] (EX1022, 18.)

112. GoPro's own development history is consistent with my understanding of how a POSITA approached prior art in the video stabilization space. Contrary to GoPro's contention now, a POSITA, when developing a video stabilization technique, is not limited to reviewing references in one specific, narrow approach. A POSITA 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.

VI. GROUND 2 DOES NOT FAIL ON THE MERITS

113. Dr. Foroosh does not provide any independent reasons for why ground 2 fails. His entire argument relies on the same arguments for ground 1 and thus also fails.

VII. THE OBJECTIVE EVIDENCE DOES NOT SUPPORT NON-OBVIOUSNESS

114. I understand that one of the factual inquiries when determining the obviousness of a patent is to consider objective evidence related to the issue of obviousness, sometimes called “secondary considerations of non-obviousness” or “objective indicia of non-obviousness.”

115. I understand objective indicia include: (i) commercial success of a product due to the merits of the claimed invention; (ii) long-felt need for the solution provided by the claimed invention; (iii) unsuccessful attempts by others to find the solution provided by the claimed invention; (iv) copying of the claimed invention by others; (v) unexpected and superior results from the claimed invention; (vi) praise of the claimed invention by others in the art; (vii) independent invention of the claimed invention by others before or at about the same time as it was conceived by the named inventors; (viii) whether others expressed surprise or disbelief regarding the invention; (ix) whether others sought or obtained rights to the claimed invention from the patentee; and (x) whether the inventor proceeded contrary to accepted wisdom in the art.

116. I understand that objective indicia are only relevant to the obviousness inquiry if there is a nexus between the claimed invention and the objective indicia of non-obviousness. I also understand that a rebuttable presumption of nexus applies only when a patent owner shows that the purported objective indicia

evidence is tied to a specific product and that product embodies the claimed invention, and is coextensive with the claims. On the other hand, a patent owner is not entitled to a presumption of nexus if the patented invention is only a component of a commercially successful machine or process. I further understand that to show nexus, any purported objective indicia must be the direct result of the unique characteristics of the claimed invention.

117. I understand that the Board previously found that GoPro failed to show objective indicia of non-obviousness. Based on what GoPro has submitted in its Patent Owner Response and Dr. Foroosh's declarations, I agree with the Board's conclusion.

A. HERO7 does not practice the '894 patent

118. Dr. Foroosh contends that GoPro's HERO7 Black camera's HyperSmooth functionality practices claims 1 and 5 the '894 patent. He does not contend that HERO7 practices other claims of the '894 patent. (EX2018, ¶97.) I disagree that he has shown that HERO7 practices claims 1 and 5 the '894 patent.

119. For example, he has failed to show that HERO7 practice limitation 1[g(iii)], the disputed claim limitation concerning "minimizes a combination of rotational velocity and rotational acceleration of the housing."

120. His entire analysis is two paragraphs long, and the only substantive discussion is in a single paragraph, paragraph 116. (*Id.*, ¶116.) In that paragraph,

Dr. Foroosh 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]

[REDACTED] (*Id.*)

121. I have reviewed both files cited by Dr. Foroosh. Neither EX2029 nor EX2036 mentions rotation. They also do not mention rotational velocity or rotational acceleration. Dr. Foroosh thus has failed to show that HERO7 meets the claim limitation “minimizes a combination of rotational velocity and rotational acceleration of the housing.” GoPro also claims that Dr. Foroosh reviewed the HyperSmooth “White Paper.” (POR, 37.) But GoPro does not show that the HyperSmooth technology described in that document is implemented in HERO7; nor does it link the description to Dr. Foroosh’s cited code.

122. In my opinion, Dr. Foroosh’s reliance on two .hpp files is insufficient to demonstrate that the HERO7 camera implements the claimed minimization feature. A .hpp file, also known as a header file, typically contains only declarations—such as function prototypes, class definitions, and macros—or, in some cases, inline definitions. However, header files do not themselves implement the runtime behavior of a program. They do not contain the underlying algorithms or logic that execute the claimed functionality. Instead, the actual executable code that carries out a program’s operations is generally found in implementation files,

such as .cpp files in C++ projects. Because Dr. Foroosh has not cited to any implementation files, in my view, he has not provided evidence that the HERO7 contains code that implements any feature, including the claimed minimization feature.

123. Dr. Foroosh similarly relies on only header files for other limitations (e.g., 1[g(ii)], 1[i]). (EX2018, ¶¶113-114, 119-120.) He thus cannot show that HERO7 meets those limitations.

B. No novel features

124. Dr. Foroosh claims:

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).

(EX2018, ¶125.) I disagree that these two are novel features.

125. In my opinion, neither of the features that GoPro characterizes as novel (POR, 36) was new or unknown in the prior art. Kwatra and the related Kwatra paper both disclosed techniques for minimizing rotational velocity and rotational acceleration. Based on GoPro's own development documents, I understand that GoPro's development of its video stabilization technologies relied on the Kwatra paper. (EX1022, 7, 18.) Additionally, GoPro did not originate the

use of gyroscope and accelerometer data to obtain position information. For example, Zhou reference disclosed that same approach. GoPro's development documentation also acknowledged that modern cameras [REDACTED]

[REDACTED]

[REDACTED]

[REDACTED] In my view, these facts show that the features GoPro identifies were already known in the prior art.

C. No nexus to the purported novel features

126. GoPro does not argue any presumption of nexus. I understand that a patent owner is not entitled to a presumption of nexus between the evidence and the claimed invention if the patented invention is only a component of a commercially successful product.

127. GoPro makes no attempt to show how the purported practicing product are coextensive with the challenged claims. I understand that the coextensive requirement requires the patent owner to show the product is essentially the claimed invention, but perfect overlap is not necessary. GoPro, however, has failed to do this. There are features in HERO7 other than stabilization, and GoPro has failed to explain the significance of those features and how they impact HERO7.

128. GoPro also does not show that any purported objective indicia is the direct result of the unique characteristics of the claimed invention. GoPro fails to identify any secondary consideration attributable to the purported novel features of the '894 patent.

129. **No commercial success or industry praise.** In my opinion, there is no evidence that the claimed features of the '894 patent have driven commercial success or industry praise. At most, GoPro has shown that its stabilization technology, HyperSmooth in general, has allegedly contributed to commercial success and garnered positive industry recognition. However, it is my opinion that other features—not the purported novel features of the '894 patent—are responsible for these outcomes.

130. The lead inventor of the '894 patent, Mr. Derbanne, acknowledged that the innovation in HyperSmooth [REDACTED]

[REDACTED] He explained that [REDACTED]
[REDACTED]

(EX1019, 243:2-16, 143:11-13, 242:16-19, 336:11-14.)

131. Furthermore, GoPro itself concedes that “patented technologies” in other patents, including the '840, '832, and '413 patents, “were directly responsible for GoPro’s sustained commercial success.” (EX2018, ¶134.)

132. In addition, the materials GoPro relies on do not establish industry praise attributable to the '894 patent. For example, EX2010 concerns an award for "EIS technology in 2015," which predates the priority date of the '894 patent, May 18, 2018. Exhibits EX2011 and EX2012 are GoPro's own press releases. EX2011 does not identify any specific award or accolade. EX2012 relates to the HERO10, not the HERO7, which GoPro alleges practices the claims. In my opinion, 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.

133. **No long-felt but unmet need.** I have seen no evidence that the claimed features of the '894 patent addressed any long-felt but unmet need. GoPro has not identified such a need, nor has it presented evidence that the claimed features solved one. Indeed, GoPro's own witnesses, including Mr. Derbanne, testified that [REDACTED] (EX1019, 83:16-21; EX1020, 150:20-151:2.) A POSITA would know that digital stabilization techniques were widely used well before the '894 patent.

134. **No unexpected results / failure of others.** It is also my opinion that the claimed inventions did not yield unexpected results. GoPro relies on two documents to argue otherwise. One is an internal study (EX2043), but in my opinion, GoPro engineers' belief that their developed technology outperformed other solutions does not establish that the results were unexpected in the technical

sense relevant for nonobviousness analysis. GoPro also cites a public document reviewing its products, but that document concerns HERO9 and HERO8—not the HERO7, which is the allegedly practicing product. (EX2014.) Moreover, Mr. Derbanne testified that he was unaware of any failure by others to achieve the claimed results. (EX1019, 83:16-21.)

135. **No copying.** Finally, I have seen no evidence that supports a finding of copying. GoPro points to certain Insta360 engineering documents comparing Insta360's product performance to GoPro's. (EX2018, ¶¶146-148.) However, none of those documents mention the specific purported novel features of the '894 patent. In my professional opinion, these documents reflect routine benchmarking against competitors, not copying. [REDACTED]

[REDACTED]

[REDACTED] (EX1020, 160:5-161:6.)

I declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and that these statements were made with knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code.

Dated: July 18, 2025


Dr. Aggelos Katsaggelos