

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. 10,958,840 B2

Inter Partes Review No. IPR2024-01165

**PETITION FOR *INTER PARTES* REVIEW
UNDER 35 U.S.C. §§ 311-319 AND 37 C.F.R. § 42.100 *et seq.***

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Petitioner Arashi Vision (U.S.) LLC (d/b/a Insta360) (“Petitioner” or “Insta360”) respectfully petition for *inter partes* review of claims 1-21 of U.S. Patent No. 10,958,840 B2 (“the ’840 patent” (EX1001)) in accordance with 35 U.S.C. §§ 311-319 and 37 C.F.R. § 42.100 *et seq.*

I. INTRODUCTION

The ’840 patent relates to stabilizing video content captured by an image capture device. (EX1001, Abstract.) The ’840 patent does so by generating a smoothed trajectory, which has smoother changes (*e.g.*, in rotational positions or translational positions) than the actual trajectory of device. (*Id.*, 2:56-58.) The smoothed trajectory is generated by using a look-ahead, or later portion, of the trajectory of the device. (*Id.*, 8:43-46.)

Stabilized visual content is then generated by relying on the smoothed trajectory. (EX1001, Abstract.) Specifically, the smoothed trajectory is used to determine the placement of a viewing window, which is smaller than the captured image frame, within the frame. (*Id.*, 1:40-44.) Visual content within the viewing window is then cropped and used to generate the stabilized video. (*Id.*, 25:4-9.)

Determining a smoothed trajectory by using a look-ahead of the trajectory was not new at the time of the ’840 patent in 2018. The prior art commonly looked into the future, *i.e.*, considered the motion data corresponding to future video frames, when determining the smoothed trajectory.

For example, Zhou discloses that “for each current frame, video stabilization operation [] determines the smoothed motion sample based on [] future motion data, and determines the correction (difference) that needs to be applied to the motion data to make it equal the smoothed trajectory.” (EX1006, 7:47-51.)

Similarly, generating stabilized video content by using a smaller portion of the captured video was well-known in 2018. Zhou discloses calculating the amount of movement for “visible frame 300 within captured frame 305,” visible frame 300 smaller the captured frame 305. (EX1006, 7:24-26; Figure 3.) Only the content within visible frame 300 is displayed to the user. (EX1006, 3:1-3.)

Petitioner submits that the challenged claims are unpatentable for the reasons set forth in this Petition, as supported by Dr. Katsaggelos. (EX1003.)

II. THE '840 PATENT

A. Summary

The independent claims of the '840 patent are directed to an image capture device and a method that stabilizes videos. (EX1001, Claims 1, 16.)

As shown in Figure 5C, a captured video is stabilized by determining a smoothed trajectory corresponding to the original trajectory of an image capture device. (EX1001, Abstract, 1:18-47.) The smoothed trajectory has less jitter or shake than the actual trajectory of device. (*Id.*, 2:56-58.) The smoothed trajectory is determined based on a look ahead of the trajectory, *i.e.*, subsequent portions of

the trajectory. (*Id.*, 8:41-46.)

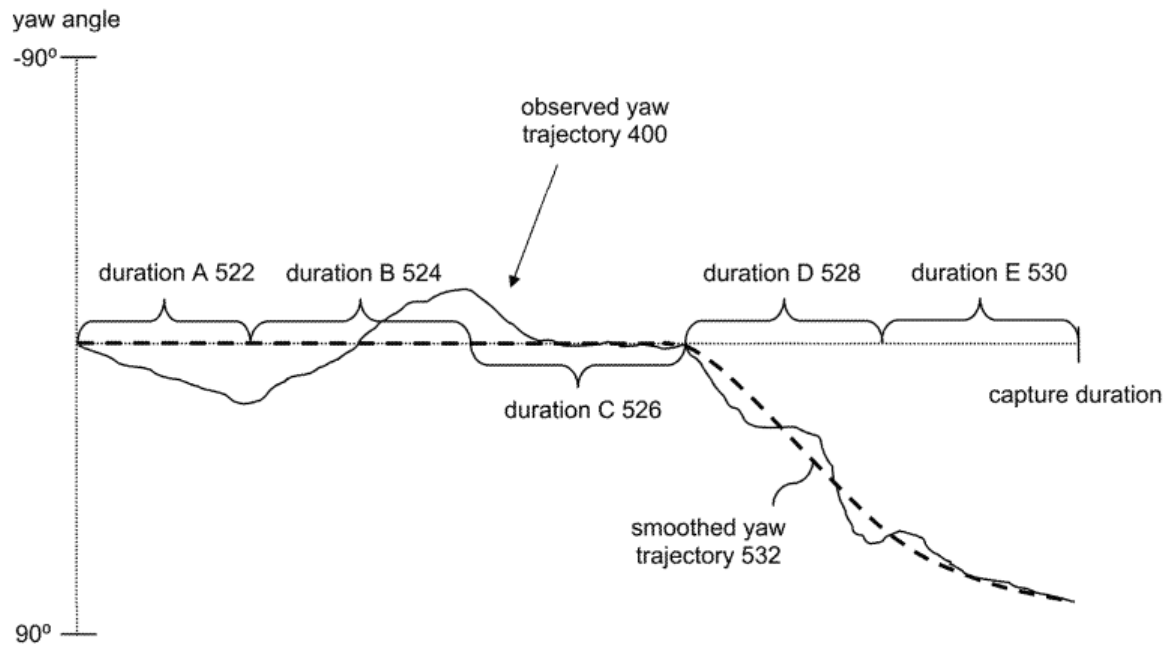


FIG. 5C

The generation of the stabilized video is based on the *viewing window*, which is smaller than the *field of view* of the captured frame, as shown in Figure 6A.¹ (*Id.*)

¹ All emphasis and annotations, such as color, highlighting, etc., added, unless otherwise noted.

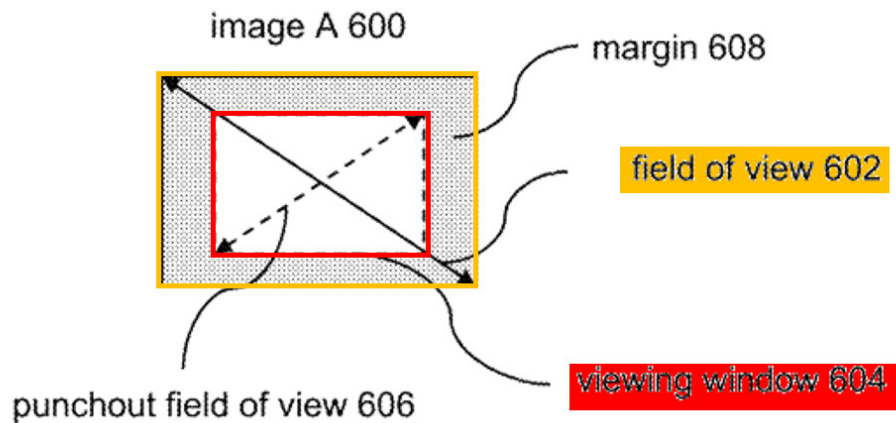
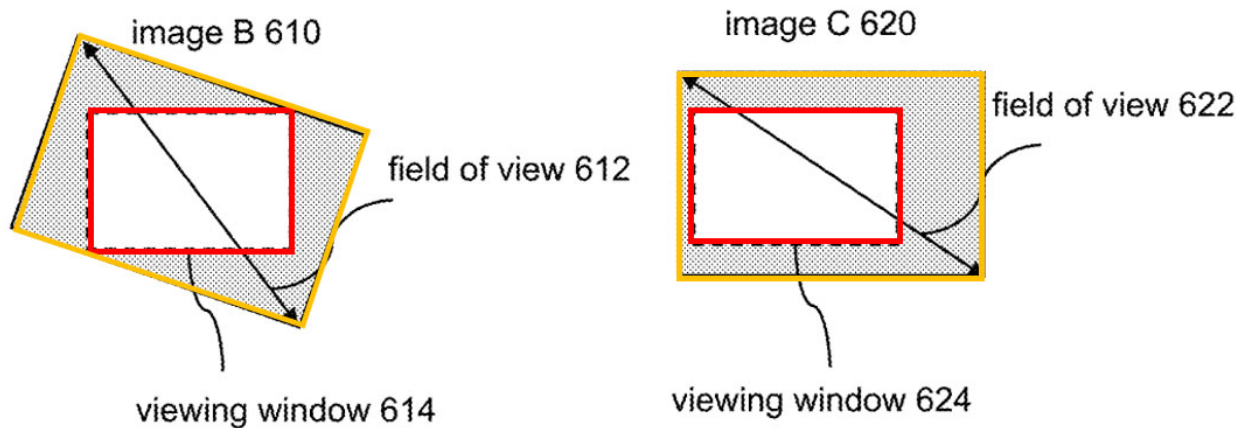


FIG. 6A

Placement of the **viewing window** with respect to the **field of view** is determined based on the smoothed trajectory. (*Id.*) For example, based on the smoothed trajectory, which represents the smoothed rotational positions of the device, the viewing window may be “rotated” or “laterally moved” with respect to the field of view, as shown in Figure 6B below. (*Id.*, 20:37-43.)



B. Effective Filing Date

The '840 patent was filed on December 13, 2019, issued on March 23, 2021, and claims priority to a provisional application filed on September 19, 2018.

(EX1001.) For purposes of this Petition only, Petitioner relies on September 19, 2018 as the earliest effective filing date. (EX1003, ¶9.)

C. Prosecution History of the '840 Patent

The Examiner issued one lone prior-art-based Office Action, which identified Beysserie (EX1007) and Guo (EX1008) as the closest art to the independent claims in the original patent application. (EX1002, 94-101.) The Examiner, however, stated that certain original dependent claims, including original claim 5, “would be allowable if rewritten in independent form.” (EX1002, 100.) Original claim 5, depends from original claim 1, with the following additional limitation:

wherein the determination of the smoothed trajectory based on the look-ahead of the trajectory includes use of a temporal horizon of motion experienced by the image capture device, the temporal horizon enabling approximation of intentional motion of the image capture device while causing a delay in the determination of the smoothed trajectory.

(*Id.*)

Applicant (1) amended original claim 5 in independent form to include all limitations in original claim 1, (2) cancelled original claim 1 and amended all claims dependent from it such that they depend from allowable claim 5, and (3) amended original claim 17 such that it parallels claim 5. (EX1002, 53-66.) The

Examiner then issued the Notice of Allowance. (EX1002, 32-38.)

D. Level of Ordinary Skill in the Art

A person of ordinary skill in the art (POSITA) in the field of the '840 patent would have a bachelor's degree in engineering or computer science, or equivalent field, and two years of experience working on image or video processing, or digital cameras. Alternatively, a POSITA would have four years of experience working on image or video processing, or digital cameras. An advanced graduate degree in the disciplines cited above may make up for the work experience indicated above. (EX1003, ¶32.)

III. CLAIM CONSTRUCTION

For purposes of this Petition only, Petitioner does not believe any terms require a formal construction.² Each of the terms carries its “ordinary and customary meaning,” which is “the meaning that the term would have to a person

² Petitioner interprets the challenged claims based on the breadth of GoPro's infringement allegations in the related International Trade Commission (ITC) proceeding. (EX1013; EX1014.) Petitioner reserves the right to argue in the ITC proceeding that GoPro's construction of the terms are incorrect and/or not supported by the specification of the '840 patent.

of ordinary skill in the art in question” at the time of the invention.³ *In re Translogic Tech., Inc.*, 504 F.3d 1249, 1257 (Fed. Cir. 2007) (citation omitted); EX1003, ¶35.)

IV. PRECISE REASONS FOR RELIEF REQUESTED

Pursuant to 37 C.F.R. § 42.104(b), Petitioner requests cancellation of the challenged claims based on the following references (EX1003, ¶¶36-41):

Prior Art Reference	Abbreviation (Exhibit No.)
U.S. Patent No. 9,674,438	“Zhou” (EX1006)
U.S. Patent No. 10,158,802	“Cai” (EX1009)
U.S. Patent No. 8,994,838	“Sokeila” (EX1011)
U.S. Patent No. 9,071,756	“Karpenko” (EX1010)
Steven Bell, Alejandro Troccoli, and Kari Pulli, “A Non-Linear Filter for Gyroscope-Based Video Stabilization,” <i>ECCV</i> (4), Vol. 8692 of <i>Lecture Notes in Computer Science</i> , pp. 294-308, Springer (2014).	“Bell Paper” (EX1004)

The statutory grounds for the challenge of each claim are set forth below.

All of the statutory citations are AIA.

³ An IPR petition may only rely on prior art patents or printed publications. 35

U.S.C. § 311(b). Petitioner reserves the right to raise other invalidity issues, such as invalidity under § 101 or § 112, in the related ITC proceeding.

Ground	35 U.S.C. §	Claims	Prior Art Reference
1	103	1-3, 5-11, 14-16, 18, 19, 21	Zhou, Cai
2	103	4, 20	Zhou, Cai, Karpenko
3	103	12	Zhou, Cai, Sokeila
4	103	13, 17	Zhou, Cai, Bell Paper

Below, Petitioner discusses why the challenged claims are unpatentable under the statutory grounds raised, including how and where the prior art satisfies each element of each challenged claim, as required by 37 C.F.R. § 42.104(b)(4). Petitioner’s showing establishes that there is a reasonable likelihood that it will prevail with respect to at least one of the claims challenged in the petition.

A. Ground 1: Zhou and Cai Render Obvious Claims 1-3, 5-11, 14-16, 18, 19, 21

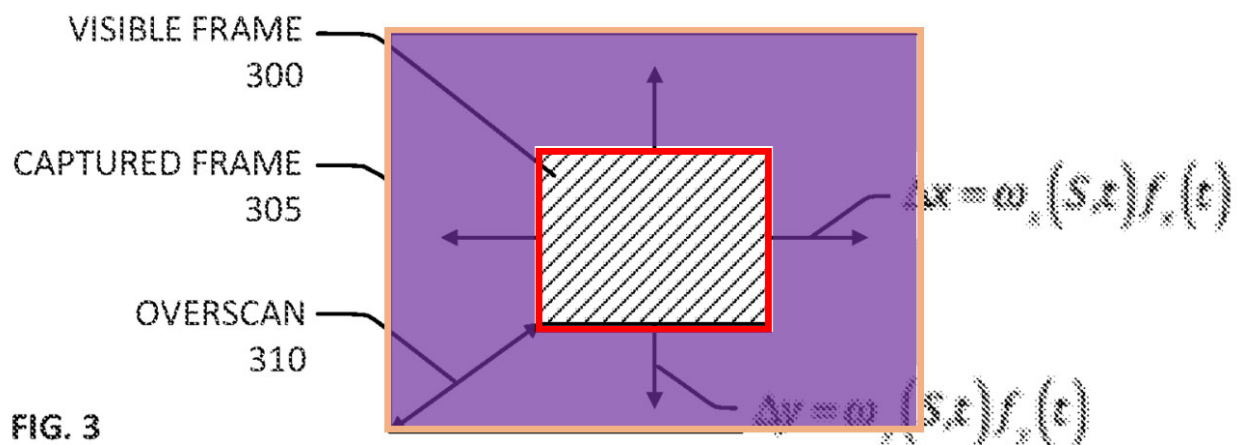
1. Summary of Zhou

Zhou was filed on August 25, 2014 and claims priority to a provisional application filed on July 6, 2014. It was published on January 7, 2016 and issued on June 6, 2017. It qualifies as prior art to the ’840 patent at least under §§ 102(a)(1) and 102(a)(2). The Examiner cited but never applied Zhou during prosecution.

Zhou discloses “[t]echniques to improve a digital image capture device’s ability to stabilize a video stream in low light capture conditions.”

(EX1006, Abstract.) To avoid “abrupt or jarring changes in the...stabilized video,” Zhou determines the smoothed trajectory “based on past/future motion data” of the digital image capture device. (EX1006, 8:50-51, 7:49.) Zhou discloses determining the “correction (difference) that needs to be applied to the motion data to make it equal the smoothed trajectory and, using this information” to apply the transformations needed to the image to generate stabilized video. (EX1006, 7:49-52.)

The videos as captured are comprised of *captured frames*. (EX1006, 2:1-3.) However, only the visual content within *visible frame* is displayed to the user. (EX1006, 3:1-3, 7:24-26.) Zhou’s video stabilization operation adjusts the smoothing of the trajectory and the resulting transformations applied to the image so that *visible frame* fits within its *overscan*, i.e., stays within the boundary of the *capture frame*. (EX1006, 7:47-51, Abstract.)



2. Summary of Cai

Cai was filed on September 19, 2014 and published on August 10, 2017. It was issued on December 18, 2018. It qualifies as prior art to the '840 patent at least under §§ 102(a)(1) and 102(a)(2). The Examiner never found, and Applicant never cited, Cai during prosecution.

Cai discloses “smooth[ing] a shaky camera trajectory in a captured video sequence so that the jitter motion in the input video can be effectively removed.” (EX1009, 2:17-19.) Specifically, Cai discloses distinguishing “zero motion videos . . . with intended motion” “using two or more successive frames” to “stabilize the video more accurately.” (EX1009, 3:58-64.)

3. Claim 1

a. Preamble: “An image capture system that stabilizes videos, the image capture system comprising:”

To the extent the preamble is limiting (which Petitioner does not concede), Zhou discloses the preamble of claim 1.

Zhou discloses “[t]echniques to improve a *digital image capture device*’s ability to *stabilize* a video stream.” (EX1006, Abstract.)

b. 1[a]: “a housing of an image capture device;”

Zhou discloses that the digital image capture device can be “a mobile telephone” or “portable camera.” (EX1006, 11:58-59.) Figure 7 shows “a simplified functional block diagram” of the device. (EX1006, 11:55-56.) A

POSITA would have understood that a mobile telephone or a portable camera has a *housing* that encloses the components shown in Figure 7. (EX1006, 11:60-67; EX1003, ¶51.)

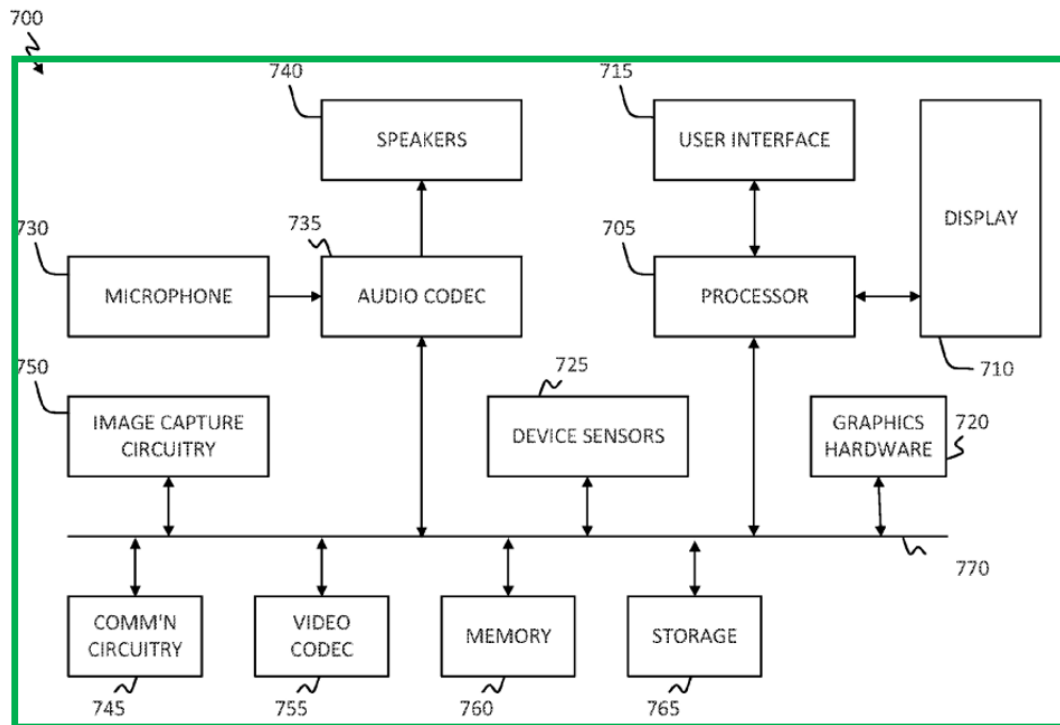


FIG. 7

- c. 1[b]: “an optical element carried by the housing and configured to guide light within a field of view to an image sensor;”

Per the '840 patent, “the optical element” may include “one or more of *lens*, mirror, prism, and/or other optical elements.” (EX1001, 6:32-34.) A POSITA would have understood that a digital image capture device such as a portable camera has *a lens*, which is “an optical element.” (EX1003, ¶52.) Zhou further discloses that the stabilization techniques use “known camera (e.g., focus) and *lens*

characteristics.” (EX1006, 7:52-53; EX1003, ¶52.) A POSITA would also have understood that the lens is carried by the *housing* of the device. (EX1003, ¶52.)

Zhou discloses that “[a] video image capture device” comprising “*an image sensor*.” (EX1006, claim 14.) Zhou discloses that “[i]mage capture circuitry 750 may capture video images.” (EX1006, 12:31.) A POSITA would have understood that the “image capture circuitry 750” in Figure 7 (reproduced below) encompasses *an image sensor*. (EX1006, 11:62-65, 12:31-37; EX1003, ¶¶53-54.)

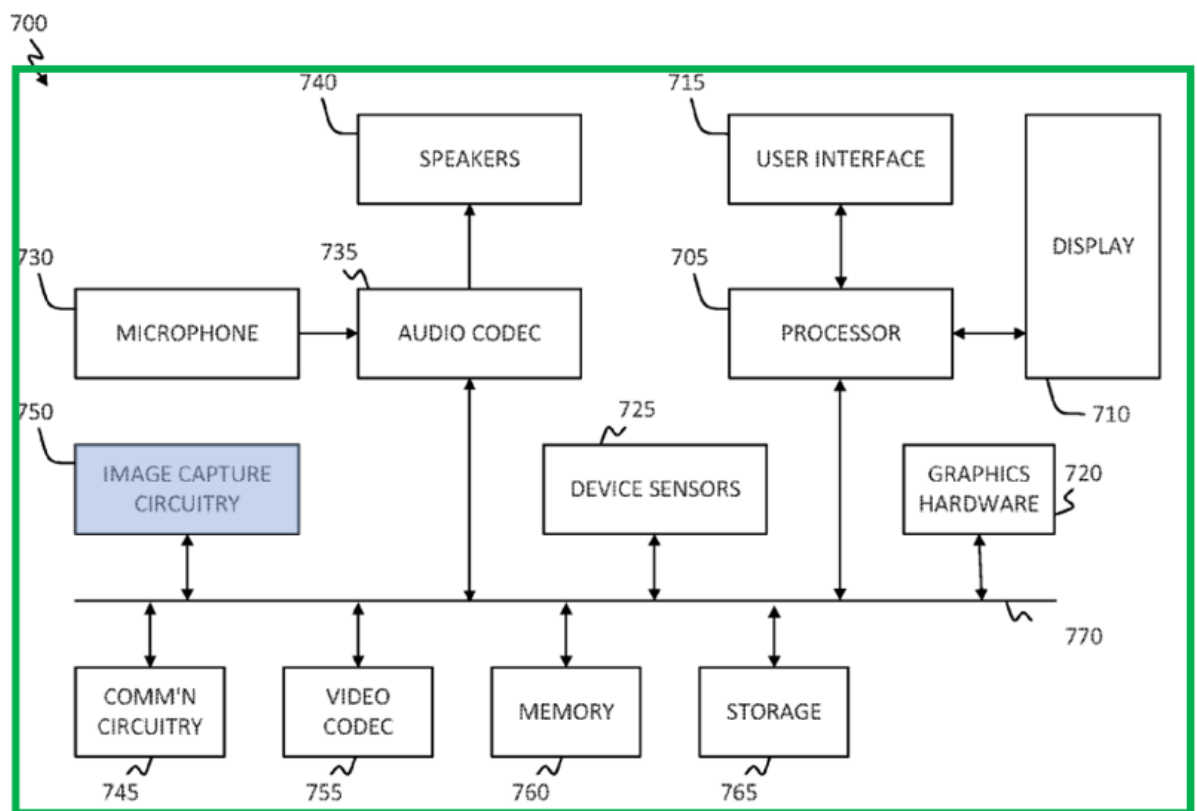


FIG. 7

A POSITA would have further understood that the *lens* is configured to

guide light within a field of view captured by the lens to *the image sensor*.

(EX1003, ¶55.)

- d. **1[c][i]: “the image sensor carried by the housing and configured to generate a visual output signal conveying visual information based on light that becomes incident thereon during a capture duration,”**

A POSITA would have understood that the image sensor is carried by the housing of the device. (EX1003, ¶56.) A POSITA would also have understood that an image sensor is configured to generate visual output signals based on light that strikes upon the image sensor. (EX1003, ¶56.)

Zhou discloses “capturing a first time-sequenced set of images (e.g., a video stream).” (EX1006, 2:12-13.) The time sequence of the captured video stream is the capture duration. (EX1003, ¶57.) Zhou discloses that from the video stream, “image data,” or “frame data . . . (e.g., R, G, and B values),” is placed into a buffer. (EX1006, 4:23-34, 8:62-63.) Image data constitutes “visual information.” (EX1003, ¶57.) A POSITA would have understood that the image data is conveyed by the visual output signals generated by the image sensor. (EX1003, ¶57.)

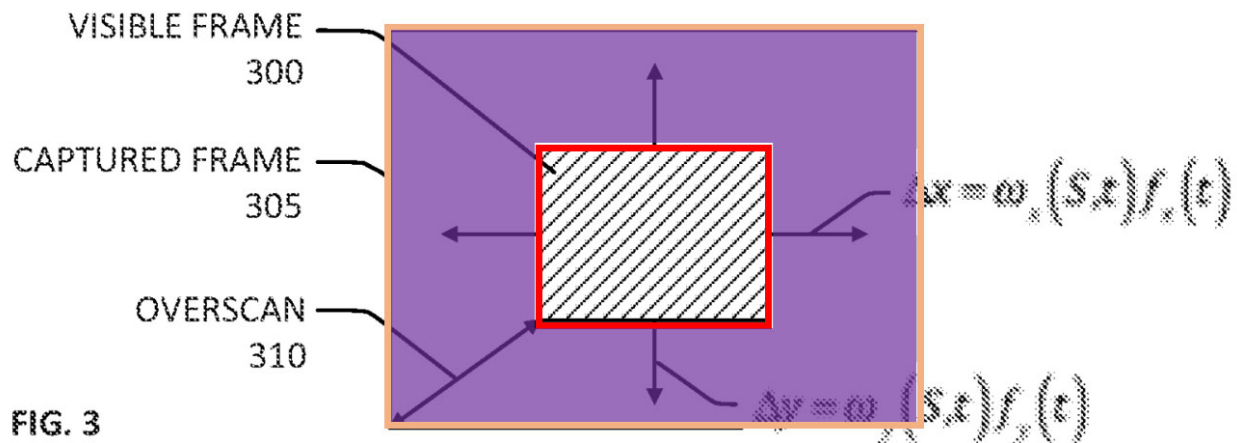
- e. **1[c][ii]: “the visual information defining visual content having the field of view,”**

The image data in Zhou is “visual information.” (*Supra* § IV.A.3.d.) Zhou discloses that the image data corresponds to the incoming video frames, or

“*captured frames*,” which are the “visual content.” (EX1006, 4:20-29, 7:24-25; EX1003, ¶58.) A POSITA would have understood that the entire field within the *captured frame 305* is the claimed “field of view.” (EX1003, ¶58.)

- f. 1[c][iii]: “the field of view being larger than a size of a viewing window for generating stabilized visual content;”

Zhou also discloses a “viewing window”: a “*visible frame 300* within *captured frame 305*,” as shown in annotated Figure 3 below. (EX1006, 4:20-29.) The field of view of *captured frame 305* is larger than the size of *visible frame 300*, with “the difference being *overscan 310*.” (EX1006, 7:25-26; EX1003, ¶59.) In other words, *overscan* = field of view of *captured frame 305* – size of *visible frame 300*. (EX1003, ¶59.)



Zhou further discloses that *visible frame 300* is for generating stabilized visual content. Zhou discloses that “‘*overscan*’ is the term given to the buffer of

pixels around the edges of an image that are captured but not displayed to the user.” (EX1006, 3:1-3.) In other words, only the image within **visible frame 300** (*i.e.*, “viewing window”) is displayed to the user. (EX1003, ¶61.) As Zhou also discloses that “a stabilized version of a captured video” is displayed to the user (EX1006, 12:16-18), a POSITA would have understood that **visible frame 300** is for generating stabilized video content. (EX1003, ¶61.)

- g. 1[d][i]: “a position sensor carried by the housing and configured to generate a position output signal based on positions of the housing during the capture duration,”**

The time duration of the captured video stream in Zhou is the “capture duration.” (*Supra* § IV.A.3.d.)

According to the ’840 patent, “the position sensor may include one or more of a gyroscope, an accelerometer, and/or an inertial measurement unit.” (EX1001, 2:20-22.) Zhou discloses that the image capture device includes “**device sensors 725** (e.g., **proximity sensor**/ambient light sensor, **accelerometer and/or gyroscope**),” as Figure 7 shows. (EX1006, 11:62-63.) Zhou further discloses that “**motion sensors such as gyroscopes or accelerometers**” provides “motion information.” (EX1006, 2:14-16.) The motion sensors in Zhou are therefore the claimed “position sensors.”

A POSITA would have understood that the **motion sensors** are carried by

the *housing* of the device. (EX1003, ¶64.)

Zhou also discloses that each image within the captured video stream has “motion information . . . provided by one or more motion sensors such as gyroscopes or accelerometers” and “motion data.” (EX1006, 2:13-16, 4:23-29.) The “motion information,” which can be “time stamped gyroscope data points,” reflects “the image capture device’s orientation” (*i.e.*, position). (EX1006, 5:20-24; EX1003, ¶65.) Because the image capture device includes the *housing*, the motion information (*i.e.*, position information) of the device reflects the position information of the *housing*. (EX1003, ¶65.)

A POSITA would have understood that the motion information is conveyed by motion signals generated by the *motion sensors*. (EX1003, ¶65.)

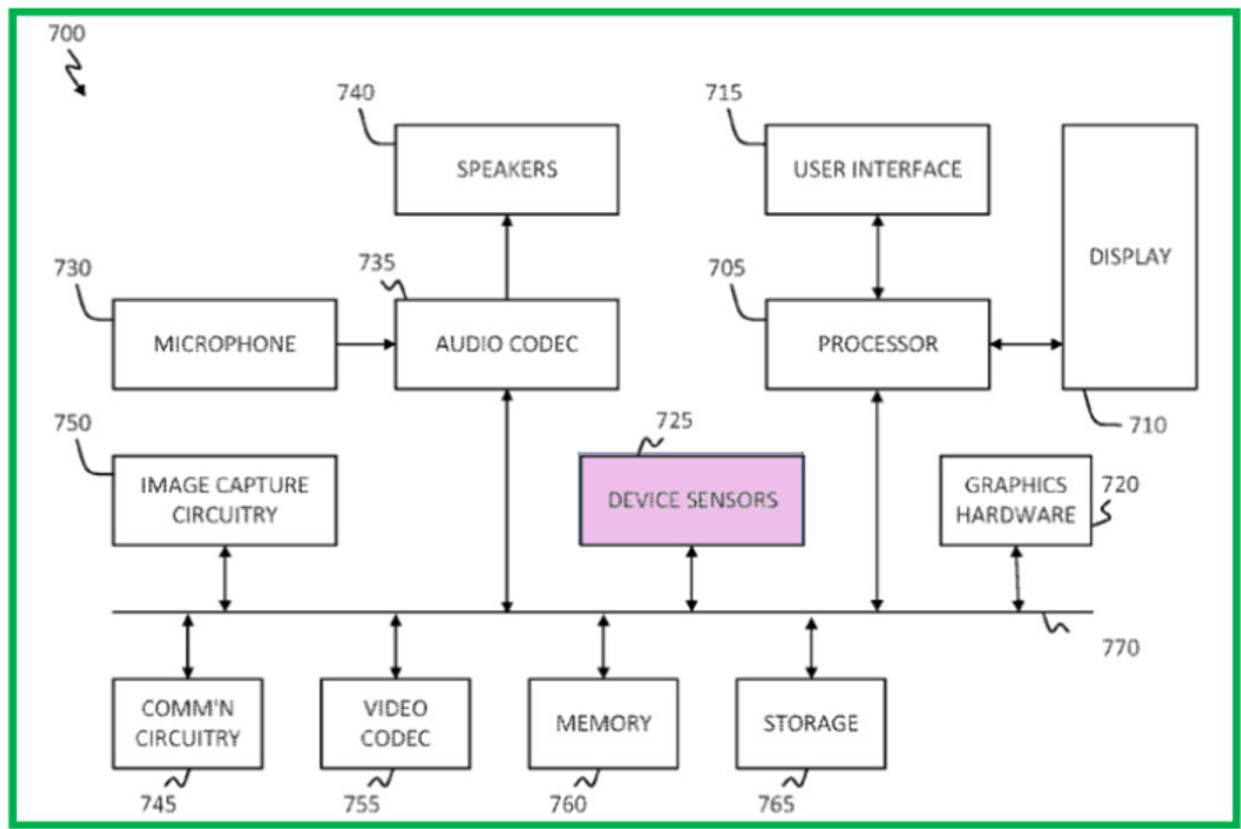


FIG. 7

- h. 1[d][ii]: “the position output signal conveying position information that characterizes rotational positions of the housing at different moments within the capture duration; and”**

The motion information may be “time stamped gyroscope data points” that “compute the image capture device’s orientation.” (EX1006, 5:21-22.) A POSITA would have understood that gyroscope data points characterize the rotational positions of the image capture device, and therefore, the housing. (EX1003, ¶67.) The gyroscope data points are conveyed by motion signals generated by the motion sensors. (EX1003, ¶68.)

Zhou discloses that the motion information from “gyroscopes and/or . . . accelerometers . . . is matched with, or synchronized to, the capture of video frames.” (EX1006, 4:36-38.) Zhou also discloses that each captured image “has a capture time and motion information.” (EX1006, 2:12-16.) Thus, the motion information corresponds to different moments within the duration of the captured video. (EX1003, ¶69.)

i. 1[e]: “one or more physical processors configured by machine-readable instructions to:”

Zhou discloses that “electronic device 700 may include *processor 705*,” as shown in Figure 7. (EX1006, 11:60-61.) “*Processor 705* may execute instructions necessary to carry out or control the operation of many functions performed by device 700.” (EX1006, 12:1-3.)

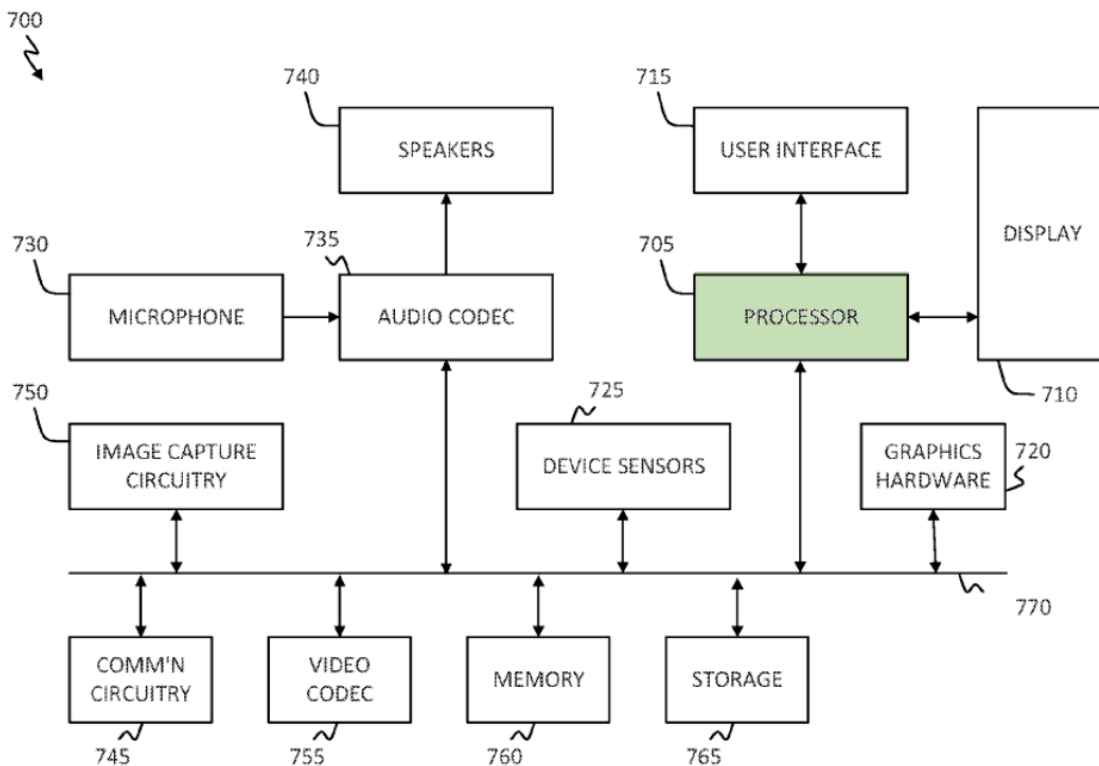


FIG. 7

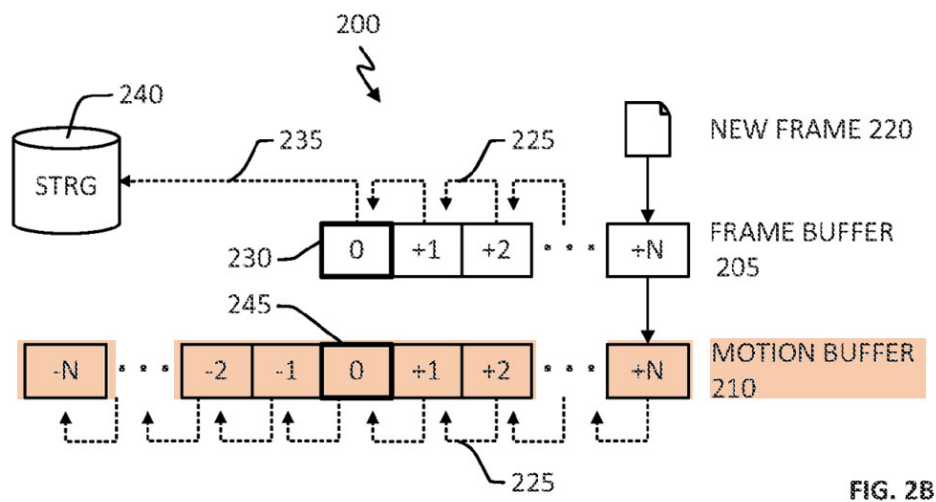
- j. **1[f][i]: “determine a trajectory of the housing during the capture duration based on the position information, the trajectory reflecting the rotational positions of the housing at the different moments within the capture duration,”**

The time duration of the captured video stream in Zhou is the “capture duration.” (*Supra* § IV.A.3.d.) The motion information provided by the motion sensors is the “position information,” which characterizes the rotational positions of the device at different moments within the duration of the captured video. (*Supra* § IV.A.3.h.)

Under GoPro’s infringement theory in the related ITC action, the accused

products “form[] a moment-by-moment listing of the camera position based on the six-axis gyroscope generated position output signals to create *an observed trajectory* of the housing during the capture duration.” (EX1014, at 13.)

Zhou discloses storing each frame of the video stream’s “corresponding *motion data* . . . into” a “motion buffer entry,” as Figure 2B shows. (EX1006, 4:33-34.) Zhou therefore discloses a moment-by moment listing of the image capture device’s motion information, and therefore determines a trajectory of the device. (EX1003, ¶72.)



Zhou also discloses an “*uncorrected trajectory 600*,” that “represents the change in stabilization strength value needed to stabilize a video stream,” as shown in Figure 6. (EX1006, 10:19-21.) Zhou further discloses that “the ‘trajectory’ of the strength parameter . . . is a stand-in for the . . . trajectory of the image capture device.” (EX1006, 9:63-65.) Therefore, a POSITA would have understood that a

trajectory of image capture device, including its housing, is determined. (EX1003, ¶73.)

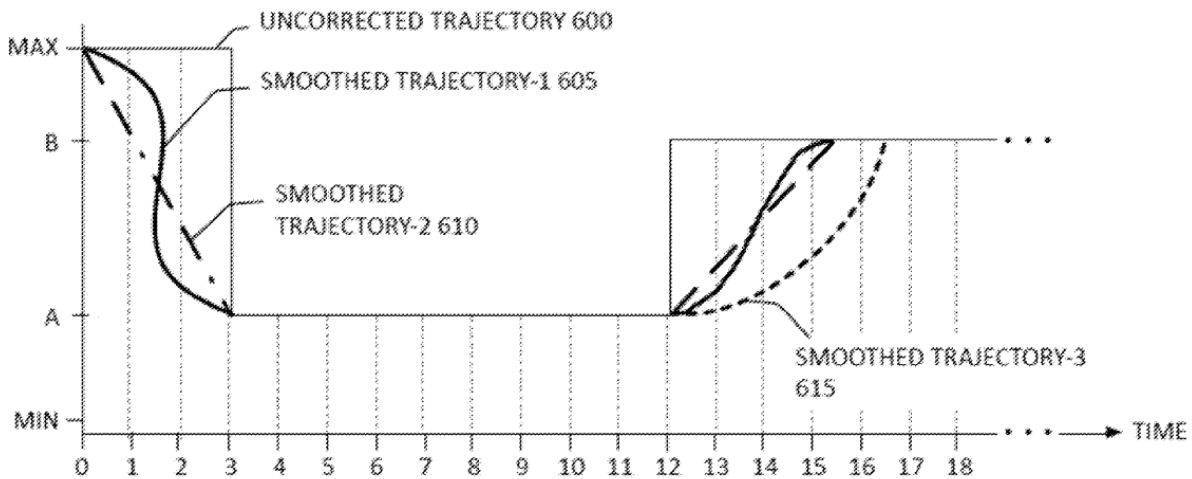


FIG. 6

- k. 1[f][ii]: “the trajectory including a first portion corresponding to a first moment within the capture duration and a second portion corresponding to a second moment subsequent to the first moment within the capture duration;”

Zhou discloses a “current frame” as the “frame in frame buffer entry 230,” with the corresponding “*motion data in motion buffer entry 245*.” (EX1006, 5:9-11.) It further discloses that in the “buffer system 200” shown in Figure 2B, the “entries having positive prefixes” correspond to “*frames captured after* frame and *motion entry 230 and 245* respectively.” (EX1006, 4:40, 51, 52.)

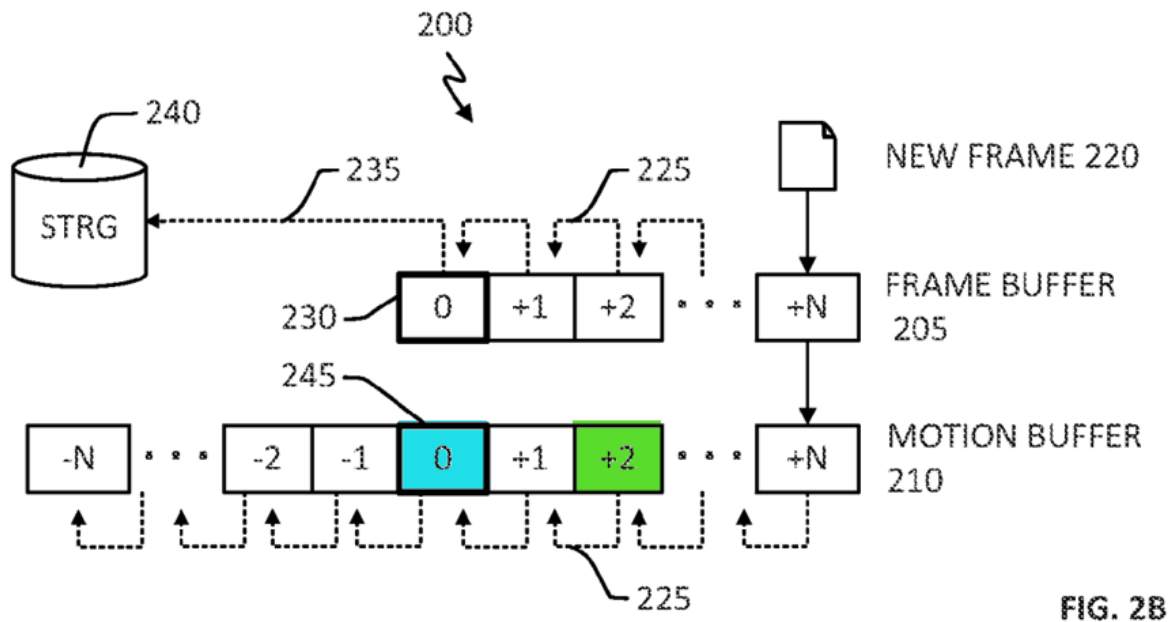


FIG. 2B

A POSITA would have understood that motion data in *motion entry 245* corresponds to a first moment within the captured video, and motion data in a motion entry after entry 245, such as *the “+2” entry*, corresponds to a second moment, subsequent to the first moment, within the captured video. (EX1003, ¶76.)

Because the trajectory reflects the motion data for all frames within the captured video, the trajectory includes (1) a point corresponding to motion data in *motion entry 245*, which corresponds to a first moment within the captured video, and (2) another point corresponding to motion data in later entry, such as *the “+2” motion entry*, which corresponds to a second moment subsequent to the first moment within the captured video. (EX1003, ¶77.)

- I. 1[g][i]: “determine a smoothed trajectory of the housing based on a look-ahead of the trajectory and one or more of a weight-balance parameter, a low-light high-pass parameter, and/or a stickiness parameter,”

Determine a smoothed trajectory based on a look-ahead of the trajectory.

According to the '840 patent, a “look-ahead of the trajectory may include use of a subsequent portion of the trajectory to determine a preceding portion of the smoothed trajectory.” (EX1001, 8:43-46.)

Zhou discloses “techniques . . . for stabilizing video images using . . . a *look-ahead* buffer comprising a number of video input frames.” (EX1006, 2:61-64.) Zhou discloses that its “ability to *look into the ‘future’* provides it a unique ability to anticipate abrupt movements in the future.” (EX1006, 10:01-02.) Zhou further discloses that “for each current frame, video stabilization operation 100 determines the smoothed motion sample based on past/*future motion data*, and determines the correction (difference) that needs to be applied to the motion data to make it equal the *smoothed trajectory*.” (EX1006, 7:47-51.) In other words, Zhou discloses determining the portion of the smoothed trajectory corresponding to the current frame based on future motion data, which corresponds to a later portion of the trajectory after the current frame. (*Supra* §§ IV.A.3.j - IV.A.3.k; EX1003, ¶¶79-82.) Zhou therefore discloses determining a smoothed trajectory based on a look-ahead of the trajectory. (EX1003, ¶82.)

Determine a smoothed trajectory based on a low-light high-pass parameter.⁴

According to the '840 patent, “smoothing the trajectory may result in the motion blur becoming more evident.” (EX1001, 18:39-41.) Therefore, a “low-light high-pass parameter” is used to control the balance between strength of smoothing and masking motion blur. (EX1001, claim 17, 33:18-22.)

Specifically, a “low-light high-pass parameter may range between 0 and 1, with 0 corresponding to no motion blur compensation and 1 corresponding to full motion blur compensation.” (EX1001, 22:8-10.)

Therefore, a value of 1 for the parameter “may result in the smoothed trajectory being same as the (observed) trajectory during the exposure periods.” (EX1001, 22:14-16.) This means there is no smoothing performed, which results in the resulting trajectory “include[ing] high frequencies that mask motion blur within the visual content.” (EX1001, 22:17-18.) Conversely, a value of 0 (no motion compensation) “may result in the observed motion being fully attenuated” and the motion blur is left unaddressed. (EX1001, 22:12-18.)

Zhou discloses ways to “more effectively stabilize *low light* video.” (EX1006, 2:60-61.) It does so by employing “techniques . . . for estimating the amount of *motion blur* in a ‘current’ frame . . . to adjust or modulate the strength

⁴ Claim 14 also is disclosed by Zhou. (*Infra* § IV.A.13.)

of a video stabilization metric value.” (EX1006, 3:3-8.)

Zhou discloses that “video stabilization operation [] determines . . . the correction (difference) that needs to be applied to the motion data to make it equal the smoothed trajectory” and that “strength parameter . . . is a stand-in for the smoothed/stabilized trajectory of the image capture device.” (EX1006, 7:47-51, 9:64-65; EX1003, ¶85.) Therefore, the stabilization strength parameter determines the amount of smoothing applied to generate the smoothed trajectory. (EX1003, ¶85.)

Zhou further discloses adjusting “the stabilization strength metric” based on “an estimated amount of motion blur.” (EX1006, Fig. 1D, 2:19-22, 5:20-6:38.) Zhou discloses using the estimated amount of motion blur to “calculate a target max stabilization strength value for the current image.” (EX1006, 6:39-41.) The target max stabilization strength value sets a limit on how much a current frame can be stabilized. (EX1006, 9:38-40, 10:43-45.) Zhou discloses that “if the amount of blur in the image is larger (typically found in *darker images* with longer integration times), smaller stabilization strengths may be employed.” (EX1006, 6:46-49.) A POSITA would have understood that darker images have low light. (EX1003, ¶87.) On the other hand, “if the amount of blur in the image is smaller . . . larger stabilization strengths may be employed.” (EX1006, 6:41-44.)

Therefore, the stabilization strength parameter controls (1) the amount of

smoothing applied to generate the smoothed trajectory and (2) the extent of motion blur compensation, and is a low-light high-pass parameter. (EX1003, 83-88.)

Determine a smoothed trajectory based on a stickiness parameter.⁵

According to the '840 patent, a “stickiness parameter may refer to a parameter that control the extent by which preceding portion(s) of the (observed) trajectory impacts determination of the smoothed trajectory.” (EX1001, 22:22-25.)

Zhou discloses that “the amount of motion . . . that the current frame should be moved in accordance with stabilization operation” can be determined based on a weighing functions “ $\omega_x()$ and $\omega_y()$.” (EX1006, 7:32-35.) The weighing functions can be represented by Gaussian weighting function 400, as expressed by a bell curve in Figure 4. (EX1006, 7:61-64.)

⁵ Claim 15 also is disclosed by Zhou. (*Infra* § IV.A.14.)

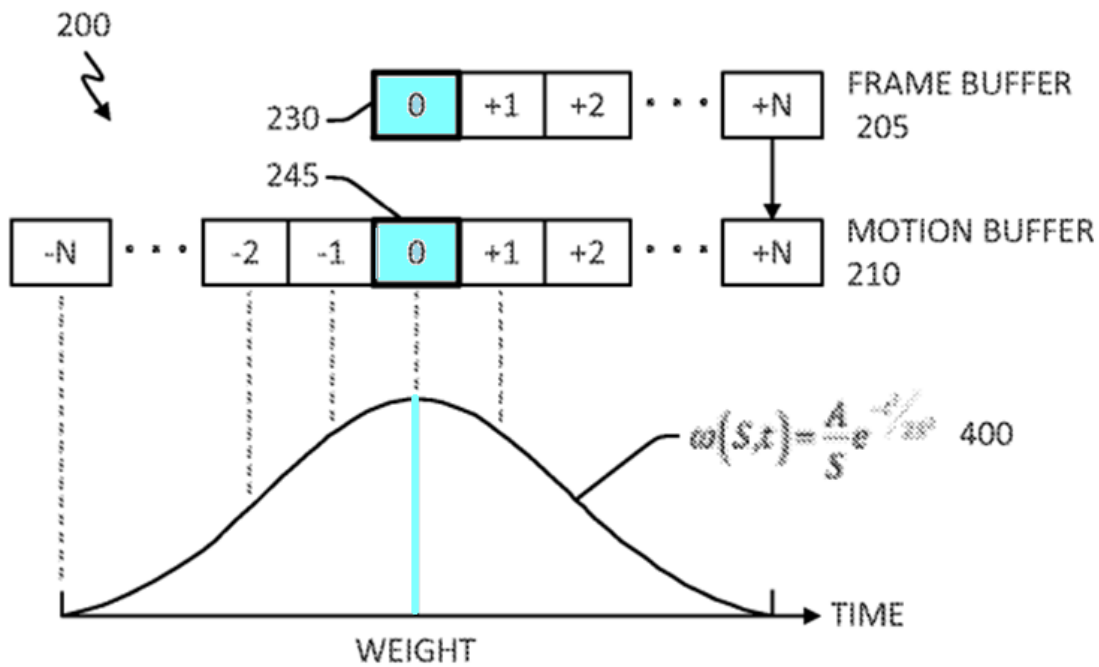


FIG. 4

A POSITA would have understood that the weighting function is expressed as weight versus time, with time corresponding to the frames of the captured video. (EX1003, ¶92.) Zhou discloses that “time may correspond to the buffered motion data’s index, [which can be] positive and negative”; “time=0” for the *current frame*, which corresponds to “*buffer entries 230 and 245.*” (EX1006, 7:65-8:1.)

Zhou further discloses that the weighting function determines that the “weight value assigned to the *current entry* (time=0, buffer entries 230 and 245) would be the maximum value of function.” (EX1006, 7:67-8:2.) Correspondingly, other frames, including frames before the current frame (*i.e.*, frames -N to -1), have smaller weight values and are weighed less. (EX1003, ¶93.) Frame -N can be “a

preceding portion of the trajectory.” (EX1003, ¶93.)

Zhou also discloses that “reducing the spread of the Gaussian weighting function . . . attributes more weight/significance to those entries closer to the current frame.” (EX1006, 9:15-18.) In other words, reducing the spread of the Gaussian weighting function decreases the impact of frames far from the current frame, such as frame -N. (EX1003, ¶¶95-99.)

Therefore, the weighting function, expressed by the parameter ω , controls the extent by which preceding portions of the trajectory (*e.g.*, frame -N) impacts the smoothing, and is therefore the stickiness parameter. (EX1003, ¶¶95-99.)

Thus, Zhou discloses determining a smoothed trajectory of the image capture device based on a low-light high-pass parameter and a stickiness parameter, which is “one or more of a weight-balance parameter, a low-light high-pass parameter, and/or a stickiness parameter.” (EX1003, ¶¶89-100.)

- m. **1[g][ii]: “the look-ahead of the trajectory including use of a subsequent portion of the trajectory to determine a preceding portion of the smoothed trajectory such that a portion of the smoothed trajectory corresponding to the first portion of the trajectory is determined based on the second portion of the trajectory,”**

The trajectory and its corresponding smoothed trajectory. As discussed for element 1[f][i], each point on the trajectory reflects the corresponding motion data of a particular frame. (*Supra* § IV.A.3.j.) The trajectory includes (1) a point

corresponding to motion data in *motion entry 245*, which corresponds to the current frame, and (2) another point corresponding to motion data in a later entry, such as *the “+2” motion entry*, which corresponds to a subsequent frame within the captured video. (*Supra* § IV.A.3.k.)

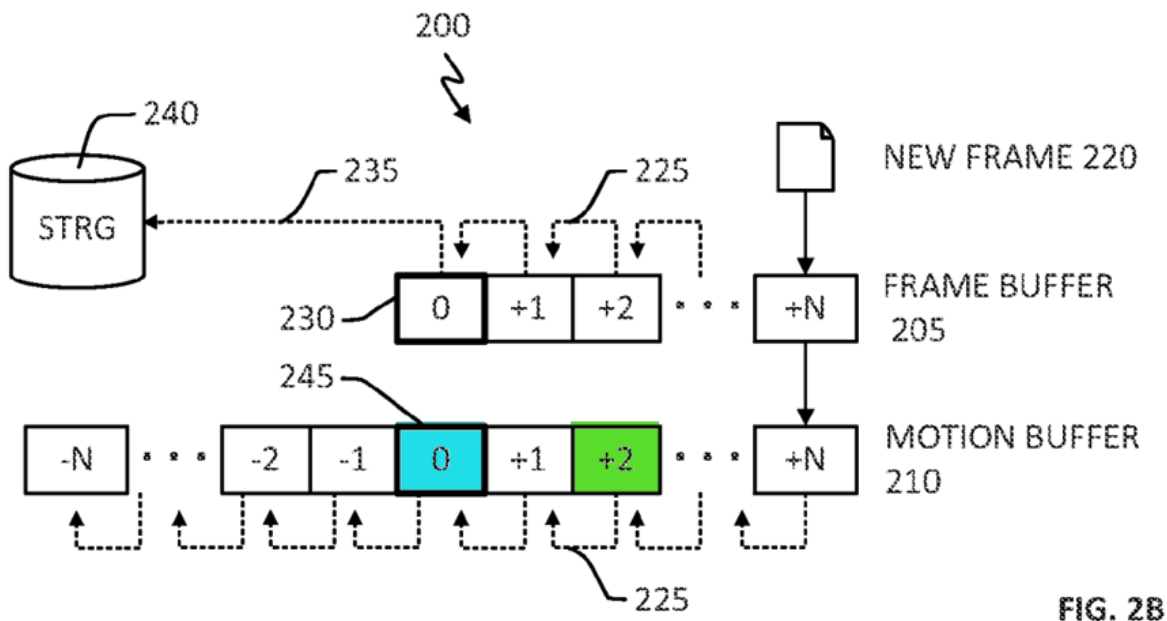


FIG. 2B

Zhou further discloses that the smoothed trajectory generated after video stabilization corresponds to the trajectory of the device. (EX1003, ¶102.) Zhou discloses that “for each current frame, video stabilization operation 100 . . . determines the correction (difference) that needs to be applied to the motion data to make it equal the smoothed trajectory.” (EX1006, 7:47-51.)

Use look-ahead of trajectory. Zhou discloses “techniques . . . for stabilizing video images using . . . a *look-ahead* buffer comprising a number of video input frames.” (EX1006, 2:61-64.) Zhou discloses “stabilization adjustments . . . of a

current frame in a way that prepares for, or anticipates, the motion in *future frames*.” (EX1006, 4:2-4.) The *current frame* corresponds to the first portion of the trajectory, and the *future frames* correspond to the second portion of the trajectory. (EX1003, ¶104; *supra* § IV.A.3.k.) Zhou further discloses that “for each *current frame*, video stabilization operation 100 determines the *smoothed motion sample* based on past/*future motion data*.” (EX1006, 7:47-49.) Therefore, Zhou discloses determining a first or preceding portion of the smoothed trajectory corresponding to the *current frame* based on a second, or subsequent portion of the trajectory, which corresponds to *subsequent, future frames*. (EX1003, ¶104.)

n. 1[g][iii]: “the smoothed trajectory having smoother changes in the rotational positions of the housing than the trajectory,”

Zhou discloses that “video may be stabilized using gyroscope output (represented as *quaternions*) *against rotation*.” (EX1006, 7:41-42.) Quaternion is a mathematical notation for rotational positions. (EX1003, ¶105.) Zhou further discloses that “video stabilization operation [] determines the smoothed motion sample . . . and determines . . . the smoothed trajectory.” (EX1006, 7:47-51.) Therefore, a POSITA would have understood that the smoothed trajectory generated after video stabilization has smoother changes in the rotational positions compared to the trajectory of the device, which is not stabilized. (EX1003, ¶106.)

- o. 1[g][iv]: “wherein the determination of the smoothed trajectory based on the look-ahead of the trajectory”**

Zhou discloses determining a smoothed trajectory based on future motion data, which corresponds to a look-ahead of the trajectory. (*Supra* §§ IV.A.3.l and § IV.A.3.m.) Specifically, Zhou discloses determining a first or preceding portion of the smoothed trajectory corresponding to the *current frame* based on a second, or subsequent portion of the trajectory, which corresponds to *subsequent, future frames*. (*Supra* § IV.A.3.m.)

- p. 1[g][v]: “includes use of a temporal horizon of motion experienced by the image capture device, the temporal horizon enabling approximation of intentional motion of the image capture device while causing a delay in the determination of the smoothed trajectory”;**

Use of a temporal horizon of motion experienced by the image capture device, the temporal horizon enabling approximation of intentional motion of the image capture device.

According to the '840 patent, “[i]ntentional motion may refer to the motion that was intended by the user of the image capture device,” such as “a forward motion to follow an object of interest, a panning motion to shoot a wide view of a scenery, and/or other motion.” (EX1001, 9:3-5, 9:8-10.) On the other hand, “[u]nintentional motion may be characterized by higher frequency motion (e.g., jitter, shake) than intentional motion.” (EX1001, 9:18-20.)

The '840 patent provides no definition of “temporal horizon.” (EX1003, ¶110.) The '840 patent, however, states that “[t]he positions/motions of the image capture device in the ‘future’ may be analyzed (look ahead) to determine whether particular position(s)/motion(s) of the image capture device at a moment is an *intended motion* or an unintended motion (e.g., shaking due to vibration, rotation due to bumping/mishandling the image capture device).” (EX1001, 15:1-6.) The '840 patent also states that “when determining the smoothed trajectory for a moment (e.g., corresponding to the 1000th video frame) within the capture duration, the position(s)/motion(s) of the image capture device for a duration subsequent to the moment (e.g., corresponding to the next 30 video frames, corresponding to next second of capture) may be analyzed to determine whether the position/motion of the image capture device at the moment was *intended* or not.” (EX1001, 15:6-15.) The '840 patent additionally states that “[u]sing the subsequent portion(s) of the (observed) trajectory may enable the smoothed trajectory component 104 to determine a smoothed trajectory that preserves a user’s *intended motion* for the image capture device.” (EX1001, 14:52-58.)

To the extent Zhou does not disclose this limitation, Cai discloses it.

Cai discloses that “[t]o stabilize the video more accurately, zero motion videos may be distinguished from videos with *intended motion*.” (EX1009, 3:58-59.) Cai also discloses that in “a zero motion scenario, small jitter movements can

easily be observed.” (EX1009, 2:30-31.) A POSITA would have understood that a non-zero, or intended, motion in Cai is “intentional motion.” (EX1003, ¶112.)

Cai discloses that “input frames are received from storage or from a video camera” and are buffered so that present and future frames are available.”

(EX1009, 8:65-8:67.) Cai also discloses that “the input trajectory is determined based on analyzing the received frames.” (EX1009, 9:1-3.) A POSITA would have understood that the input trajectory includes a path corresponding to the motion experienced by the device during future frames. (EX1003, ¶113.)

Cai also discloses applying a “Gaussian filter” to the input trajectory, and that “the smoothed trajectory . . . is projected into future frames, for example, the next five frames. This is compared to the Gaussian filtered next five frames to *characterize the video as zero motion* or not.” (EX1009, 9:14-18.)

A POSITA would have understood that “the smoothed trajectory . . . projected into . . . the next five frames” can be compared to the raw input trajectory of the next five frames, instead of the Gaussian filtered next five frames. (EX1003, ¶¶115-119.) Cai discloses the limitations of the low-pass filter or Gaussian filter, such that they “only reduce some jitter motions” and “do not compensate for all motions and are limited by the size of the missing areas that are required to correct for motion.” (EX1009, 2:19-25.)

Cai therefore discloses using motion experienced by the device in successive

future frames to characterize non-zero motion, which is approximating intentional motion. (EX1003, ¶119.) The motion experienced by the device during successive future frames, which is used to approximate intentional motion, is the “temporal horizon of motion experienced by the image capture device.” (EX1003, ¶119.)

Alternatively, under GoPro’s infringement theory, Cai also discloses this limitation. GoPro alleges that “[o]bservation of the X3, exemplary of the ’840 Accused Products, indicates the ability to approximate intentional motion of the image capture device causing a delay in the determination of the smoothed trajectory, which indicates the use of temporal horizon of motion experienced by the image capture device.” (EX1014, at 22.)

As discussed above, Cai discloses “intentional motion,” which is non-zero, or intended, motion. Additionally, Cai discloses that “input frames are received from storage or from a video camera” and are buffered so that present and future frames are available.” (EX1009, 8:65-8:67.) Cai also discloses that “the input trajectory is determined based on analyzing the received frames.” (EX1009, 9:1-3.) Cai further discloses applying a “Gaussian filter” to the input trajectory, and that “the smoothed trajectory . . . is projected into future frames, for example, the next five frames. This is compared to the Gaussian filtered next five frames to *characterize the video as zero motion or not.*” (EX1009, 9:14-18.)

Therefore, a POSITA would have understood that future frames are used to

characterize non-zero motion, or intentional motion. (EX1003, ¶¶120-123.) A POSITA would also have understood that considering future frames, which must be buffered, causes a delay in the determination of smoothed trajectory. (*Id.*) Therefore, Cai discloses that the ability to approximate intentional motion of the image capture device causes a delay in the determination of the smoothed trajectory.

As a result, under GoPro’s infringement theory, Cai discloses the use of temporal horizon of motion experienced by the image capture device.

Causing a delay in the determination of the smoothed trajectory. Cai discloses that “input frames . . . from a video camera are . . . buffered.” (EX1009, 8:65-67.) Zhou also discloses “buffer[ing] some number of incoming video frames.” (EX1006, 3:64-65.) As the determination of the smoothed trajectory requires future frames, or “incoming video frames,” which need to be “buffered,” the determination is delayed “by the time required to capture” these future frames. (EX1006, 3:63-66; EX1003, ¶¶124-125.) Zhou further discloses a “delay time that is acceptable between initiation of video capture operation 100 and generation of a first stabilized output frame” based on the size of frame buffer. (EX1006, 4:66–5:1.)

Combination. It would have been obvious to combine Cai and Zhou. Both Cai and Zhou are directed to the same goal of stabilizing videos. (EX1009,

Abstract; EX1006, Abstract.) Zhou discloses that one way to stabilize videos is to “minimize[]” “jitter caused by camera movement,” which “mak[es] it possible to transform shaky, handheld footage into steady, smooth shots.” (EX1006, 1:27-29.) Cai further discloses how to remove jitter by first distinguishing zero-motion from intended motion, then “estimate[ing] a smooth trajectory . . . for the zero-motion frames,” and finally removing jitter “from the zero-motion frames using the smooth trajectory.” (EX1009, 11:56-58.) To the extent that Zhou does not explicitly disclose approximating intentional motion, it discloses “analyzing the amount of movement in the ‘future frames.’” (EX1006, 7:5-6.) Therefore, it would have been obvious to use the known technique in Cai to improve the video stabilization technique in Zhou in the same way. (EX1003, ¶¶126-129.)

The Zhou-Cai combination results in an image capture system that approximates non-zero, or intended, motion using motion experienced by the device during successive future frames when determining a smoothed trajectory. (EX1003, ¶132.)

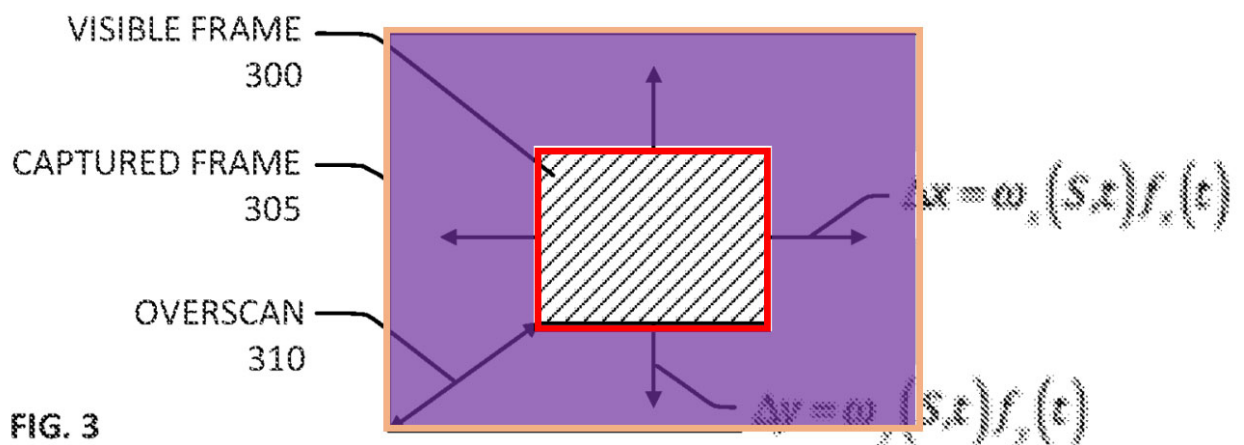
A POSITA would have been motivated to combine Cai’s approach to remove jitter with Zhou’s video stabilization techniques to “stabilize the video more accurately,” which can further benefit Zhou’s goal of “more effectively stabiliz[ing] low light video.” (EX1009, 3:58-59; EX1006, 2:60-61; EX1003, ¶¶126-133.) The ability to approximate intentional motion improves the video

stabilization capabilities of Zhou without requiring much effort and with a reasonable expectation of success. (EX1003, ¶¶126-133.)

- q. 1[h][i]: “determine placement of the viewing window for the visual content with respect to the field of view of the visual content based on the smoothed trajectory of the housing,”

The captured video frames are the “visual content.” (*Supra* § IV.A.3.e.)

The entire field within the *captured frame 305* is its field of view. (*Supra* § IV.A.3.e.) “*Visible frame 300* within *captured frame 305*” is the “viewing window.” (*Supra* § IV.A.3.f.) *Overscan* = field of view of *captured frame 305* – size of *visible frame 300*. (*Supra* § IV.A.3.f.)



Zhou discloses calculating the amount of movement for “*visible frame 300* within *captured frame 305* (the difference being overscan 310).” (EX1006, 7:24-26.) Zhou also discloses “keep[ing] the current frame within its *overscan*.” (EX1006, Abstract), which means keeping *visible frame 300* within the boundary

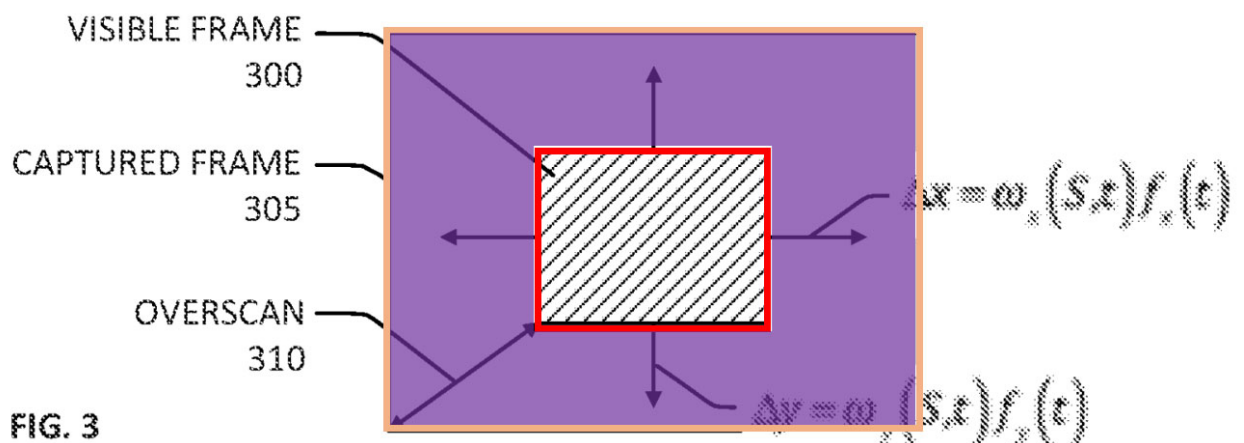
of *captured frame 305*. (EX1003, ¶136.) To determine how to move *visible frame 300* within *captured frame 305* is “determine[ing] placement of it.” (EX1003, ¶137.)

Zhou discloses that the amount of movement for *visible frame 300* within *captured frame 305* is determined by the “video stabilization operation 100 [which] determines *the smoothed motion sample* based on past/future motion data, and determines the correction (difference) that needs to be applied to the motion data to make it equal *the smoothed trajectory*.” (EX1006, 7:47-51.) Therefore, the placement of *visible frame 300* with respect to the field within *captured frame 305* is based on the smoothed trajectory. (EX1003, ¶¶138-142.)

- r. **1[h][ii]: “the viewing window defining one or more extents of the visual content to be included within a punchout of the visual content; and”**

According to the '840 patent, a “punchout of visual content may refer to using one or more portions of the visual content for presentation, such as a cut-out of the image or a cropped portion of the image.” (EX1001, 12:52-55.) The '840 patent additionally states that “[t]he size of the viewing window may refer to the field of view of the punchout for generating a video based on visual content.” (EX1001, 20:10-12.) In other words, the claimed “punchout of the visual content” defines the portion of the displayed video frames and is of the same size of the viewing window. (EX1003, ¶143.)

As discussed for element 1[c][ii], only the image within **visible frame 300** is displayed to the user. (*Supra* § IV.A.3.e.) A POSITA would have understood that the field of view of **visible frame 300** is the “punchout.” (EX1003, ¶144.) Therefore, **visible frame 300** defines the extents of the **captured frame 305** included within the field of view of **visible frame 300**. (EX1003, ¶144.)



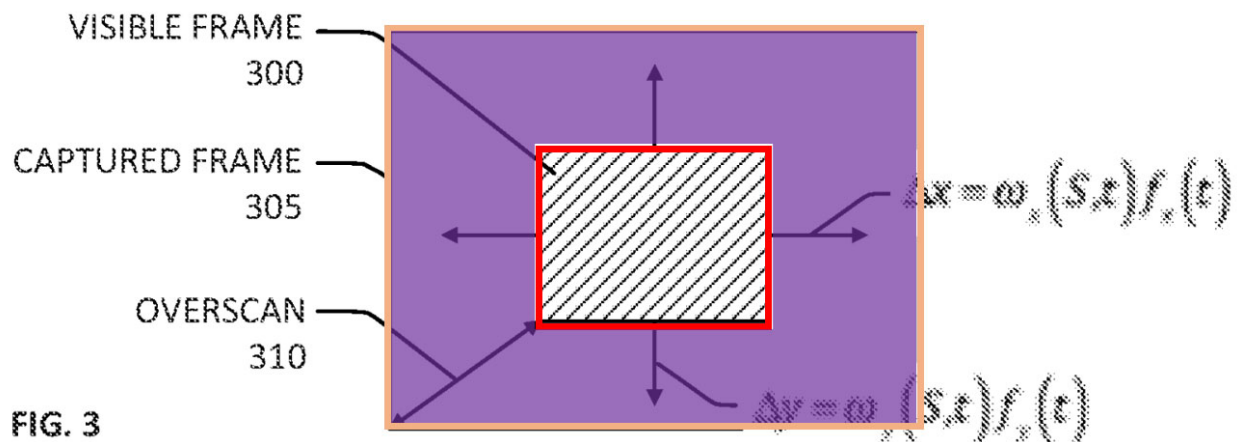
- s. 1[i][i]: “generate the stabilized visual content of a video based on the viewing window, the stabilized visual content including the punchout of the one or more extents of the visual content within the viewing window,”

Zhou discloses “generat[ing] a stabilized version of the captured video stream,” which may be displayed. (EX1006, 12:13-14.) As discussed for element 1[c][iii], only the image within **visible frame 300** is displayed to the user. (*Supra* § IV.A.3.f.) Thus, a POSITA would have understood that the generation of the stabilized video is based on **visible frame 300**, and that the stabilized video

includes the field of view within **visible frame 300**, which as discussed for element 1[h][ii], is the “punchout.” (*Supra* § IV.A.3.r; EX1003, ¶¶145-146.)

- t. **1[i][ii]: “wherein inclusion in the stabilized visual content of the one or more extents of the visual content within the viewing window effectuates stabilization of the visual content via selective cropping.”**

Zhou discloses “*stabilizing* video images using an *overscan* region.” (EX1006, Abstract.) Zhou also discloses that “[*o*]*verscan*’ is . . . the buffer of pixels around the edges of an image that are captured but not displayed to the user.” (EX1006, 3:1-3.) A POSITA would have understood that for the *overscan* to be within the *captured frame* but not eventually displayed to the user, the *overscan* must be selectively removed, or cropped, so that only the image within **visible frame 300** is left. (EX1003, ¶148.)

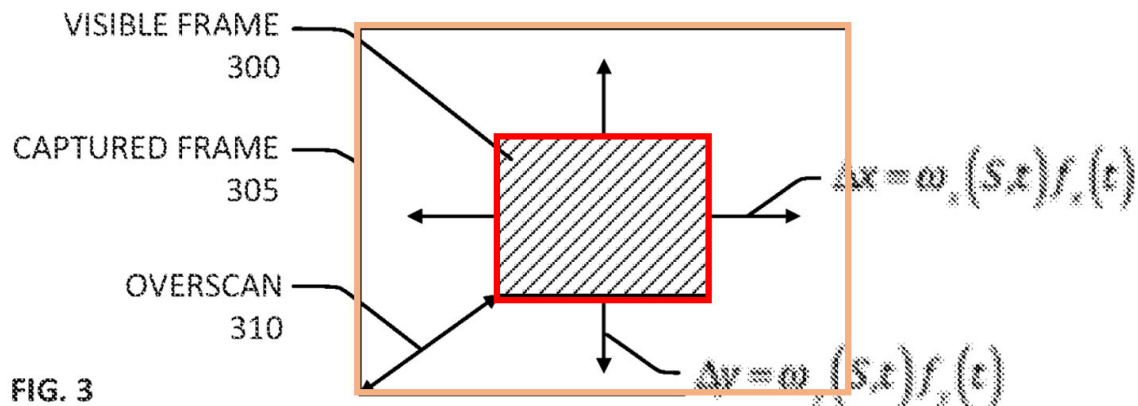


4. **Claim 2: “The image capture system of claim 1, wherein the position information further characterizes translational**

positions of the housing at the different moments within the capture duration, the trajectory further reflects the translational positions of the housing at the different moments within the capture duration, and the smoothed trajectory has smoother changes in the translational positions of the housing than the trajectory.”

Zhou’s motion data generated by the motion sensors is the “position information.” (*Supra* § IV.A.3.h.)

Translational positions. Figure 3 in Zhou “illustrates the movement that can be applied to **a visible region of a frame** within its overscan during stabilization operations.” (EX1006, 2:42-44.)



Specifically, the “motion of **visible frame 300** within **captured frame 305** (the difference being overscan 310)” can be shown as

$$\Delta x = \omega_x(S, t) f_x(t) \quad \text{EQ. 1A}$$

$$\text{and } \Delta y = \omega_y(S, t) f_y(t), \quad \text{EQ. 1B}$$

“where Δx and Δy represent the amount of **motion along x and y coordinate axes.**” (EX1006, 7:24-34.) Further, as discussed for element 1[h][i], the

movement applied to *visible frame 300* reflects the correction applied to the trajectory to make it equal to the smoothed trajectory. (*Supra* § IV.A.3.q.)

As the movement of *visible frame 300* is along x and y coordinate axes, *i.e.*, translational, a POSITA would have understood that the corresponding correction to the trajectory is also translational. (EX1003, ¶152.) Therefore, both the trajectory and the smoothed trajectory reflect translational positions of the device within the duration of the video. (EX1003, ¶¶153-154.) As the trajectory is comprised of the image capture device's motion information (*supra* § IV.A.3.h), the motion information must include translational positions of the device throughout the duration of the captured video. (EX1003, ¶¶153-154.)

Zhou further discloses that “video stabilization operation [] determines the smoothed motion sample . . . and determines . . . the smoothed trajectory.” (EX1006, 7:47-51.) A POSITA would have understood that the smoothed trajectory generated after video stabilization has smoother changes in motion, including translational positions, compared to the trajectory of the device, which is not stabilized. (EX1003, ¶155.)

Moreover, Zhou discloses that its video stabilization operation allows “visible jumps or glitches in the final video sequence [] be reduced or eliminated.” (EX1006, 10:4-5.) A jump is a translational movement. (EX1003, ¶157.)

5. Claim 3

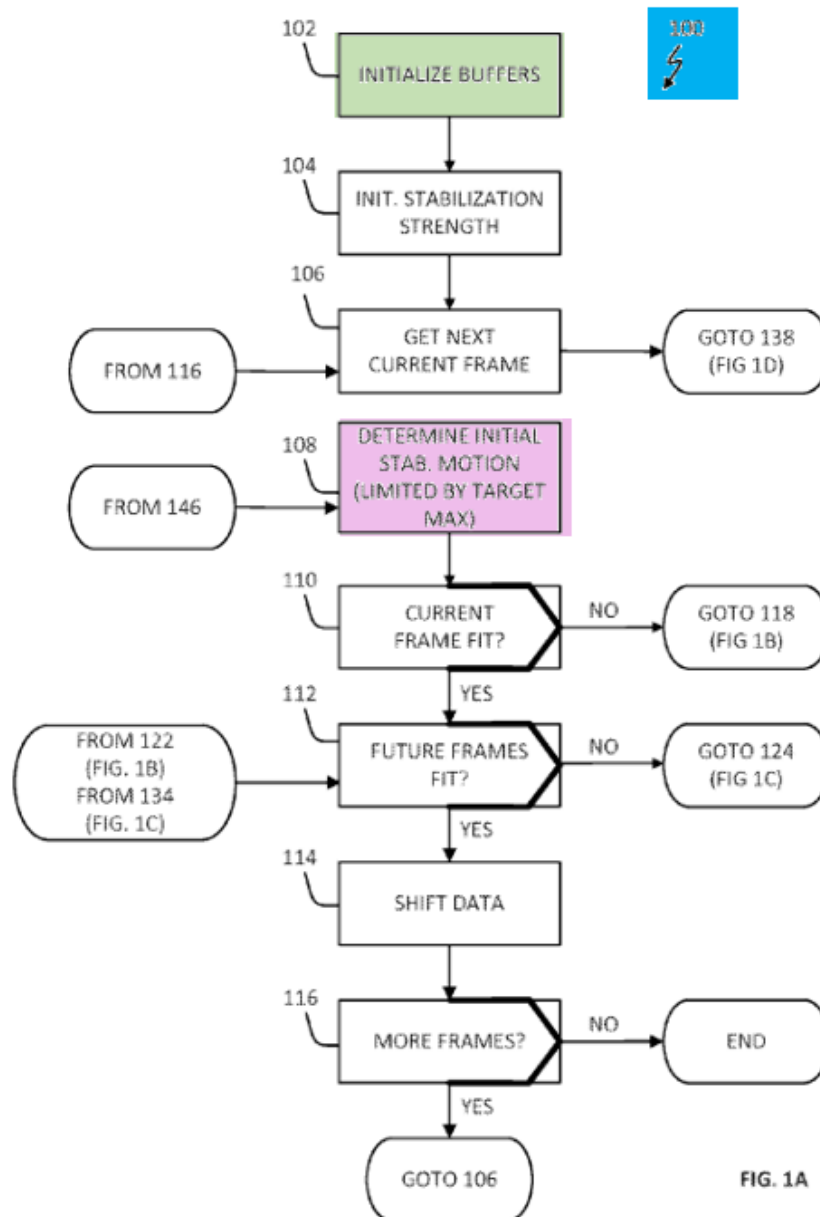
- a. **3[i]: “The image capture system of claim 1, wherein the smoothed trajectory is determined further based on a trajectory retrieval algorithm,”**

Zhou discloses that its Figures “1A-1D show flowcharts illustrating a *general video stabilization operation* in accordance with the disclosed embodiments.” (EX1006, 13:1-4.) As Zhou further discloses that “*video stabilization operation* . . . determines . . . the smoothed trajectory (EX1006, 7:47-51), a POSITA would have understood that the flowcharts in 1A-1D are the trajectory retrieval algorithm, based on which the smoothed trajectory is determined. (EX1003, ¶158.)

- b. **3[ii]: “input to the trajectory retrieval algorithm including the trajectory of the housing and a bootstrap trajectory, the bootstrap trajectory including a current or an initial guess of the smoothed trajectory.”**

Trajectory of the housing. Zhou discloses that “*video stabilization operation 100* . . . begins by *initializing a buffer system* with an incoming stream of video frames (block 102).” (EX1006, 4:20-23.) It also discloses that “[f]rom this stream, image data and *motion data (including, e.g., image capture device motion data . . .)* may be buffered for a specified number of frames.” (EX1006, 4:23-28.)

As discussed for element 1[f][i], motion data corresponding to all frames of the video stream constitutes the trajectory of the device. (*Supra* § IV.A.3.j.)



Bootstrap trajectory including a current or an initial guess of the smoothed trajectory. Zhou also discloses that *video stabilization operation 100* determines “the current frame’s *initial stabilization motion*” (block 108). (EX1006, 8:4-7.) According to this *initial stabilization motion*, the motion of the visible frame with

respect to the field of view for a given captured frame is “simply functions of time (e.g., motion buffer entry index).” (EX1006, 8:10-11.) Zhou further discloses determining “the current frame” and “if the current frame’s future frames will fit in their overscan.” (EX1006, 8:31-34.)

As discussed for element 1[h][i], the motion of the visible frame is based on the correction applied to the trajectory to make it equal to the smoothed trajectory. (*Supra* § IV.A.3.q.) Therefore, a POSITA would have understood that in order to determine the current and future frames’ movements, an estimate of the smooth trajectory must have been determined. (EX1003, ¶¶160-161.)

The estimate is an initial estimate because Zhou further discloses “adjust[ing] the stabilization strength value” and therefore changing the estimated smooth trajectory. (EX1006, 8:36-52; EX1003, ¶162.)

Input to the trajectory retrieval algorithm. Both *motion data in buffer system 102* and *initial stabilization motion 108* are utilized by *video stabilization operation 100*. (EX1003, ¶163.)

Additionally, both the *motion data in the buffer system* and the *initial stabilization motion* are used at block 110 to determine if the “the current frame’s calculated stabilization movements . . . do not permit the visible portion of the current frame to remain within its overscan.” (EX1006, 9:3-5.) Specifically, as discussed for element 1[h][i], the placement of the viewing window is dependent

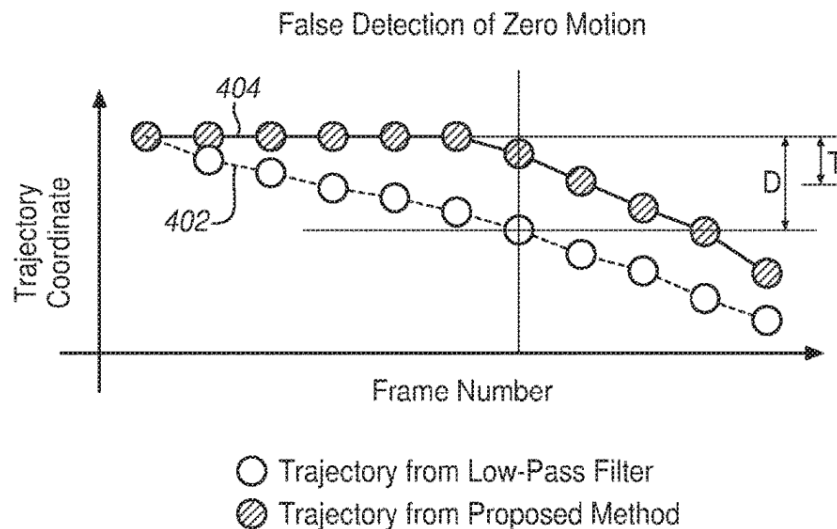
on the correction that needs to be applied to the motion data to make it equal the smoothed trajectory (*i.e.*, initial stabilized motion). (*Supra* § IV.A.3.q.) Therefore, both the trajectory of the housing and a bootstrap trajectory are used by block 110 of *video stabilization operation 100*. (EX1003, ¶¶163-164.)

6. Claim 5: “The image capture system of claim 1, wherein a longer interval of the temporal horizon enables better approximation of the intentional motion of the image capture device while causing a longer delay in the determination of the smoothed trajectory.”

As shown for element 1[g][v], Zhou and Cai disclose an image capture system that approximates non-zero, or intended, motion when determining a smoothed trajectory by using motion experienced by the device during successive future frames. (*Supra* § IV.A.3.p.)

Cai discloses that there are “true zero motion detection” and “false zero motion detection.” (EX1009, 3:62-64.) “FIG. 4 corresponds to a case in which a zero-motion detection is a false alarm.” (EX1009, 6:4-5.) Cai discloses that “[w]hen the camera is consistently taking small movements in the same direction . . . the system may interpret the sequence as zero motion video” when it is actually “an intentional slow movement of the camera.” (EX1009, 6:5-14.) False alarm for zero-motion detection is undesirable as it “will deteriorate the visual quality of the stabilized video if treated as zero-motion video.” (EX1009, 6:15-17.)

FIG. 4



It would have been obvious to try to better distinguish zero motion from non-zero motion by using motion experienced by more future frames, which corresponds to *a longer interval of the temporal horizon of motion experienced*. (EX1003, ¶¶168-169.) To distinguish zero from non-zero motion, a POSITA is faced with three, finite options: using motion experienced during more future frames, fewer future frames, or the same amount of future frames. (EX1003, ¶170.) “When there is a design need or market pressure to solve a problem and there are a finite number of identified, predictable solutions, a person of ordinary skill in the art has good reason to pursue the known options within his or her technical grasp.” *KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 402 (2007).

Further, a POSITA would have been motivated to use motion experienced

during more future frames to approximate zero motion. (EX1003, ¶171.) Cai discloses that “[t]o prevent a false zero motion detection, the gap between the mean value and the predicted trajectory may be checked for each frame.”

(EX1009, 6:30-32.) “When that gap (D) is larger than the threshold (T), the mean value for the planned trajectory 404 is updated” and “[t]he motion is not zero.”

(EX1009, 6:33-35.) Statistically speaking, the more frames that are considered, the less likely that a gap larger than the threshold will be missed. (EX1003, ¶171.) A POSITA therefore would have been motivated to consider more frames to distinguish zero from non-zero motion and would have had a reasonable expectation of success. (EX1003, ¶171.)

As discussed for element 1[g][v], the determination of the smoothed trajectory is delayed “by the time required to capture” the future frames. (*Supra* § IV.A.3.p.) A POSITA would have understood that considering more frames would cause a longer delay. (EX1003, ¶172.)

7. **Claim 6: “The image capture system of claim 1, wherein the smoothed trajectory is determined further based on minimization of a value, a score, or a metric that expresses an amount of high frequencies while respecting a crop constraint.”**

A value, a score, or a metric that expresses an amount of high frequencies.

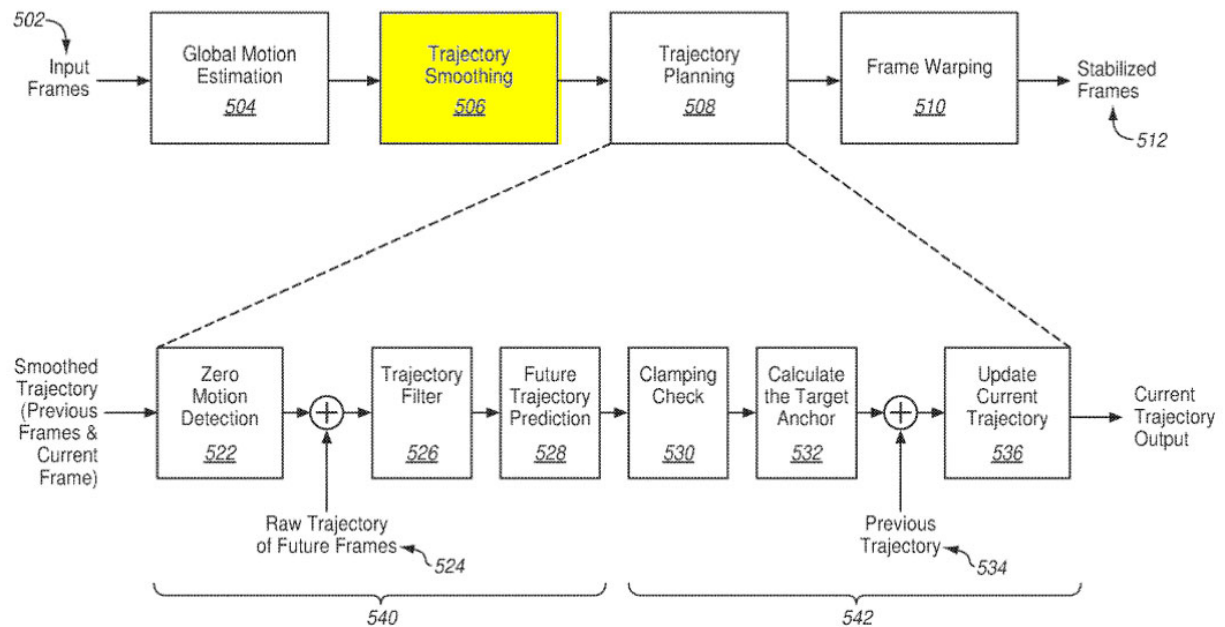
The ’840 patent describes that “jitters” can reflect “high frequencies” or “higher frequency motion.” (EX1001, 9:18-20; 17:61-62.) Cai discloses that a “trajectory

includes both high and low frequency motion,” and that “jitter” refers to “quick or shaky motions.” (EX1009, 2:38-40.)

Cai discloses that “the random jitters may be estimated.” (EX1009, 7:17-19.) It also discloses “calculated jitter values.” (EX1009, 7:23-25.) Cai therefore discloses a value that expresses an amount of high frequencies. (EX1003, ¶¶ 173-174.)

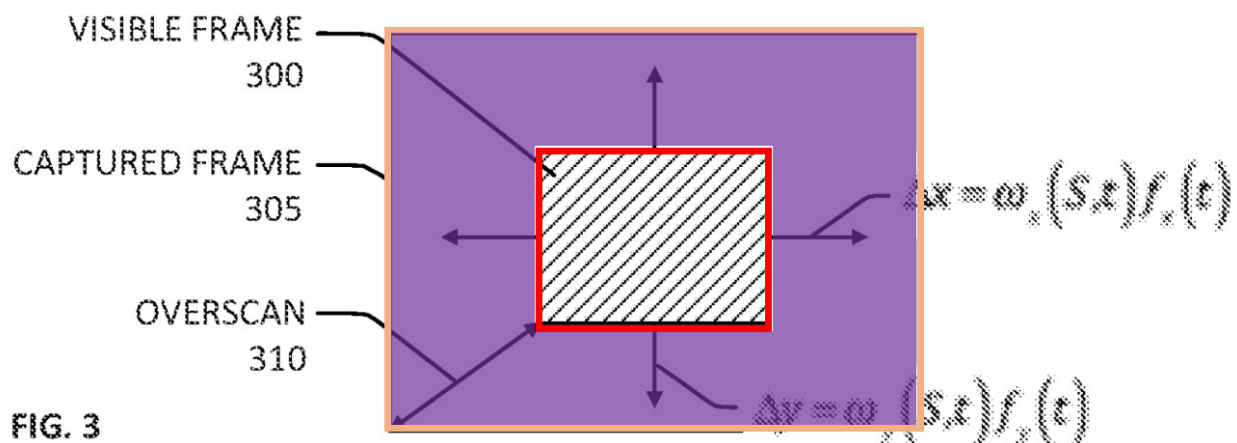
Smoothed trajectory determined based on minimization of the value. Cai discloses techniques that “smooth a shaky camera trajectory in a captured video sequence so that the jitter motion in the input video can be *effectively removed*.” (EX1009, 2:17-19.) A POSITA would have understood that means the jitter motion is minimized. (EX1003, ¶175 .) Specifically, Cai discloses “a block diagram of smoothing a video sequence” in Figure 5. (EX1009, 2:4-5.) The “perturbations caused by jitter and other noise are treated with *a trajectory smoothing block 506*.” (EX1009, 7:11-13.) Thus, Cai discloses that the smooth trajectory is determined based on the removal or treatment of jitter. (EX1003, ¶ 176.)

FIG. 5



Respect a crop constraint. Cai discloses that “video frames are usually ***cropped*** on all four sides leaving a transparent region that is the edge around the cropped video.” (EX1009, 2:66-3:1.) The transparent region is used to “fill in the missing areas when necessary to compensate for camera motion.” (EX1009, 3:1-4.) Cai also discloses that “[t]he maximum size of the missing area is normally predetermined [, which] limits the amount of jitter that can be compensated for each input video frame.” (EX1009, 3:17-19.) “The smoother the filtered trajectory, the larger the missing areas.” (EX1009, 3:5-6.) Cai therefore discloses that determining a smoothed trajectory while respecting the crop restraint. (EX1003, ¶¶177-178.)

Zhou also discloses determining a smoothed trajectory while respecting the crop constraint. (EX1003, ¶179.) Zhou discloses *a visible frame 300* within *captured frame 305* and “stabilizing video images using an ‘overscan’ region,” which is the area in the *captured frame 305* but not in the *visible frame 300*. (*Supra* § IV.A.3.f, IV.A.3.t.)



It would have been obvious to combine Cai and Zhou. (*Supra* § IV.A.3.p.)

The Zhou-Cai combination improves Zhou’s video stabilization abilities by incorporating Cai’s idea of removing jitter. (*Supra* § IV.A.3.p.)

8. **Claim 7: “The image capture system of claim 6, wherein the smoothed trajectory is determined further based on iterative minimization, the iterative minimization including iterations of steps that alter latest estimate, the steps including an update step that updates a current estimate to decrease a value of an objective function and a projection step that applies one or more constraints, the current estimate being re-projected based on the one or more constraints not being satisfied.”**

As discussed for claim 6, Cai discloses “calculated jitter values.” (*Supra* § IV.A.7.) As “the random jitters may be estimated,” the jitter values are values of an objective function. (EX1003, ¶181.)

The Zhou-Cai combination teaches generating a smoothed trajectory by reducing jitter. (*Supra* § IV.A.3.p.) As Zhou discloses that the stabilization strength parameter controls the amount of smoothing (*e.g.*, reducing jitter) applied to generate the smoothed trajectory (*supra* § IV.A.3.1), the stabilization strength parameter decreases the jitter value. (EX1003, ¶182.)

Zhou further discloses iterations of steps that alter the stabilization strength parameter, as shown below. (EX1003, ¶¶183-189.)

First step: update step that updates stabilization strength parameter. Zhou discloses that video stabilization operation determines “the current frame’s initial stabilization motion.” (EX1006, 8:4-7.) The initial stabilization motion is based on the current stabilization strength value. (EX1006, 9:19-21.)

Second step: projection step that applies one or more constraints the current estimate being re-projected based on the one or more constraints not being satisfied. Zhou discloses that after a frame’s initial stabilization motion is determined, “a test may be made to determine if the current frame remains within its overscan.” (EX1006, 8:26-28.) Zhou also discloses that “[i]f the current frame’s calculated stabilization movements Δx and Δy do not permit the visible

portion of the current frame to remain within its overscan,” the stabilization strength S may be recalculated and “changed by some amount,” such as “reduc[ing] in fixed steps of 0.1.” (EX1006, 9:3-5, 08, 11-12.)

Third step: update step that updates stabilization strength parameter. Zhou discloses that after “the current frame has been determined to fit within its overscan,” the operation considers the future frames. (EX1006, 8:31-32.) Zhou discloses “adjust[ing] the stabilization strength value” if a future frame is found that “necessitates a change in the stabilization strength value (e.g., due [] to motion blur).” (EX1006, 8:41-45.)

Fourth step: projection step that applies one or more constraints. Zhou discloses adjusting the stabilization value if “the current frame’s future frames are determined not to fit within their overscan.” (EX1006, 9:31-33.)

Fifth step: update step that updates stabilization strength parameter. Zhou discloses that “after having its stabilization strength value adjusted, a frame fits within its overscan . . . another check may be made to determine if its value is such that it may be beneficial to smooth the transition between itself and prior frames.” (EX1006, 9:43-48.)

Zhou therefore discloses iterative steps of updating the stabilization strength parameter, which updates the smoothed trajectory, and projecting it to see if the resulting moved frame fits within its overscan. (EX1003, ¶¶183-189.)

9. Claim 8: “The image capture system of claim 1, wherein the determination of the smoothed trajectory based on the look-ahead of the trajectory includes weighing past positions of the housing less than future positions of the housing.”

Zhou emphasizes the benefits of relying on the look-ahead, or future frames. (EX1003, ¶190.) Zhou discloses that its video stabilization operation’s “ability to look into the ‘future’ provides it a unique ability to anticipate abrupt movements in the future . . . so that visible jumps or glitches in the final video sequence may be reduced or eliminated.” (EX1006, 10:1-5.)

Zhou discloses “using motion data from *either* or both of ‘past’ and ‘*future*’ frames . . . to adjust or modulate the strength of a video stabilization metric value.” (EX1006, 3:5-8.) In other words, Zhou discloses that determining video stabilization, and in turn, the smoothed trajectory, may use only future frames. (EX1003, ¶191.) A POSITA would have understood that if motion data of past frames is not considered at all, then it is certainly weighed less compared to motion data of future frames. (EX1003, ¶¶191-192.)

Zhou also discloses that “stabilization strength S may be the standard deviation of Gaussian weighting function 400” as shown in Figure 4. (EX1006, 7:61-63.) Zhou further discloses that “[a]s shown in illustrative weighting function 400, time may correspond to the buffered motion data’s index, positive and negative.” (EX1006, 7:64-66.) A POSITA would have understood that a Gaussian

distribution is a distribution that is symmetric about *the median*, which is the current entry corresponding to “*time=0, buffer entries 230 and 245.*” (EX1003, ¶193.) In other words, the Gaussian weighting function 400 weighs past and future frames equally. (EX1003, ¶191.)

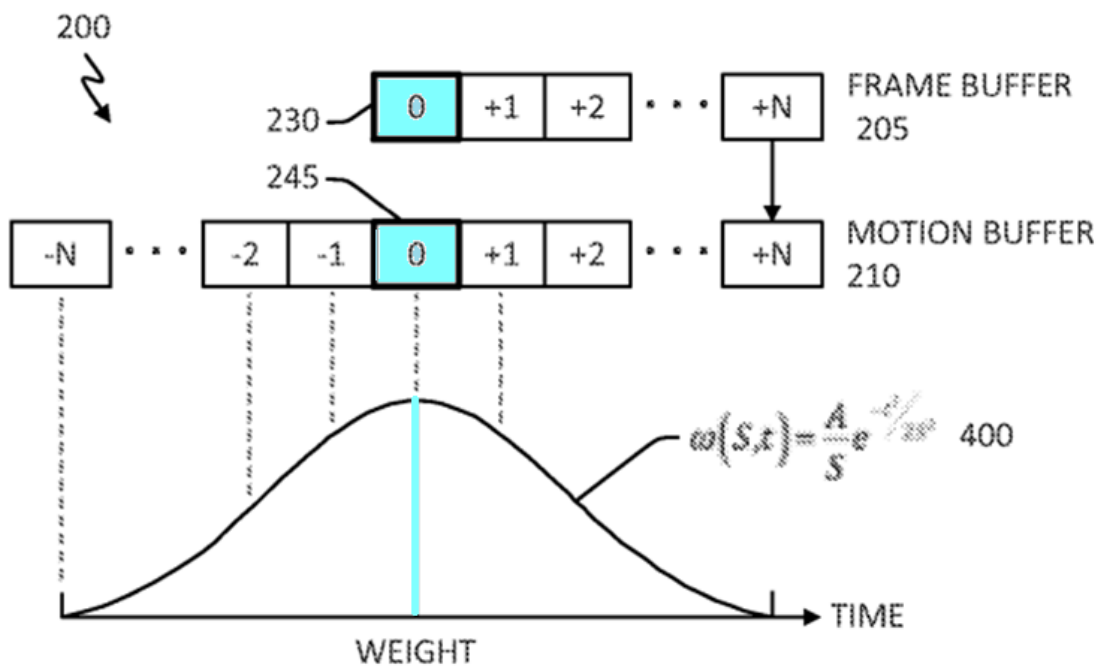


FIG. 4

It would have been obvious to try to weigh past positions of the device (and its housing) less than future positions. (EX1003, ¶194.) In determining the stabilization strength and therefore the stabilized trajectory, a POSITA is faced with three finite options: weigh past and future positions equally, weigh past positions less than future positions, and weigh past positions more than future positions. (EX1003, ¶196.) Given Zhou’s emphasis on the unique advantages of

future frames, a POSITA would be motivated to try weighing past positions less than future positions with reasonable expectation of success. (EX1003, ¶197.) A POSITA would have known that the stabilization strength *S* can be expressed as a non-symmetric weighting function that skews more towards the future frames. (EX1003, ¶¶195, 198.) Doing so means that the motion data of past frames (*i.e.*, past positions) is weighed less than that of future frames (*i.e.*, future positions). (EX1003, ¶198.)

10. **Claim 9: “The image capture system of claim 1, wherein the determination of the smoothed trajectory based on the look-ahead of the trajectory includes a prior portion of the trajectory having less impact on the determination of the smoothed trajectory than a future portion of the trajectory.”**

As discussed for claim 8, Zhou discloses or makes obvious weighing the motion data of past frames less than that of future frames when determining the smoothed trajectory. (*Supra* § IV.A.9.) A POSITA would have understood that means past frames (*i.e.*, a prior portion) have less impact on the determination of the smoothed trajectory than future frames (*i.e.*, a future portion). (EX1003, ¶199.)

11. **Claim 10: “The image capture system of claim 1, wherein the determination of the smoothed trajectory based on the look-ahead of the trajectory includes using a first amount of a prior portion of the trajectory and a second amount of a future portion of the trajectory, the first amount being smaller than the second amount.”**

As discussed for claim 8, Zhou discloses using only future frames and no

past frames when determining video stabilization. (*Supra* § IV.A.9.) A POSITA would have understood that means Zhou discloses using a zero amount of past frames, which is less than the amount of future frames used for determining the smoothed trajectory. (EX1003, ¶200.)

Moreover, it would have been obvious to try to use fewer past frames than future frames when determining the smoothed trajectory. (EX1003, ¶¶201-202.) In determining the smoothed trajectory, a POSITA is faced with three finite options: considering (1) an equal amount of past and future frames, (2) fewer past frames than future frames, and (3) more past frames than future frames. (EX1003, ¶201.) Given Zhou's emphasis on the unique advantages of future frames, a POSITA would be motivated to try considering fewer past frames than future frames when determining the smoothed trajectory. (EX1003, ¶¶201-202.)

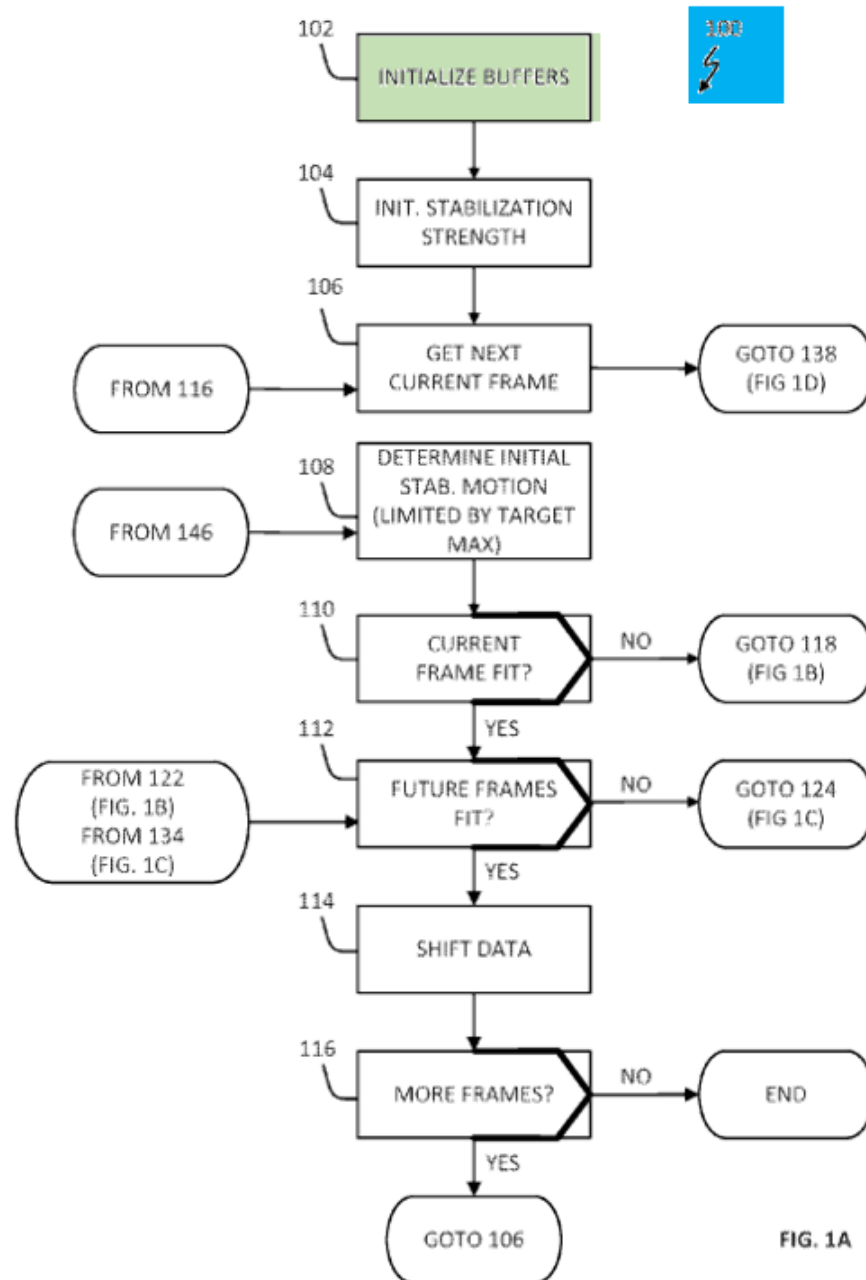
12. **Claim 11: “The image capture system of claim 1, wherein the visual content are stored in a buffer during smoothed trajectory generation such that the visual content corresponding to the portion of the smoothed trajectory are stored in the buffer during the determination of the portion of the smoothed trajectory using the look-ahead of the trajectory, and the visual content stored in the buffer are used after the determination of the portion of the capture trajectory to generate the stabilized visual content.”**

Visual content are stored in a buffer during smoothed trajectory generation.⁶

Incoming video frames, or “captured frames,” are the “visual content.” (*Supra* § IV.A.3.e.)

As discussed for claim 3, Zhou discloses that “*video stabilization operation 100* . . . begins by *initializing a buffer system* with an incoming stream of video frames (block 102).” (EX1006, 4:20-23.)

⁶ This limitation is not grammatically correct. It should be “visual content[s] are stored” or “visual content [is] stored.”



Zhou discloses that as shown in Figure 2A, “buffer system 200 . . . includes (N+1) *entry frame buffer 205*.” (EX1006, 4:30-31.) Zhou discloses that “[a]s each frame 215 arrives, it is placed into the *+Nth frame buffer entry*.” (EX1006, 4:32-34.) Therefore, Zhou discloses storing incoming frames, *i.e.*, visual content,

in a buffer during *video stabilization operation 100*, which “determines . . . the smoothed trajectory.” (EX1006, 7:49-51)

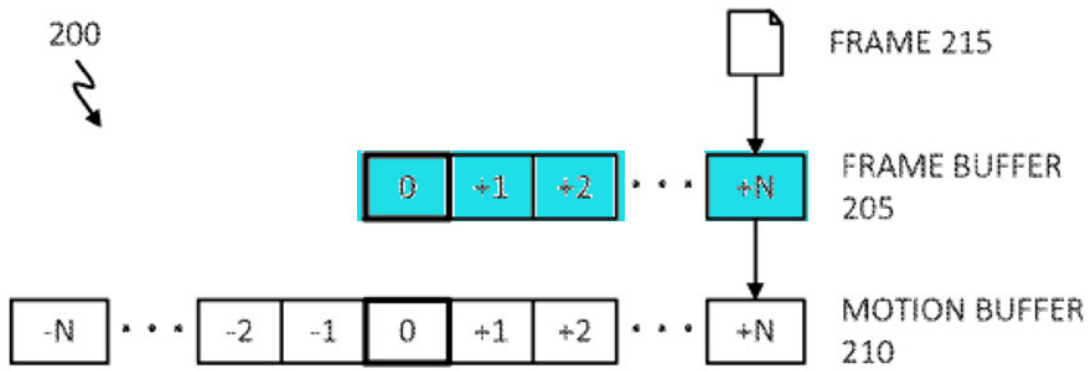


FIG. 2A

Visual content corresponding to the portion of the smoothed trajectory are stored in the buffer during the determination of the portion of the smoothed trajectory using the look-ahead of the trajectory.⁷ “The portion of the smoothed trajectory” refers to “a portion of the smoothed trajectory corresponding to the first portion of the trajectory” in claim 1. (EX1003, ¶206.) The claimed “the portion of the smoothed trajectory” therefore is a point on the smoothed trajectory that corresponds to *motion data in motion entry 245*. (*Supra* § IV.A.3.k.) The claimed “visual content corresponding to the portion of the smoothed trajectory” is the *current frame in frame buffer entry 230*.

⁷ Similarly, this limitation is not grammatically correct.

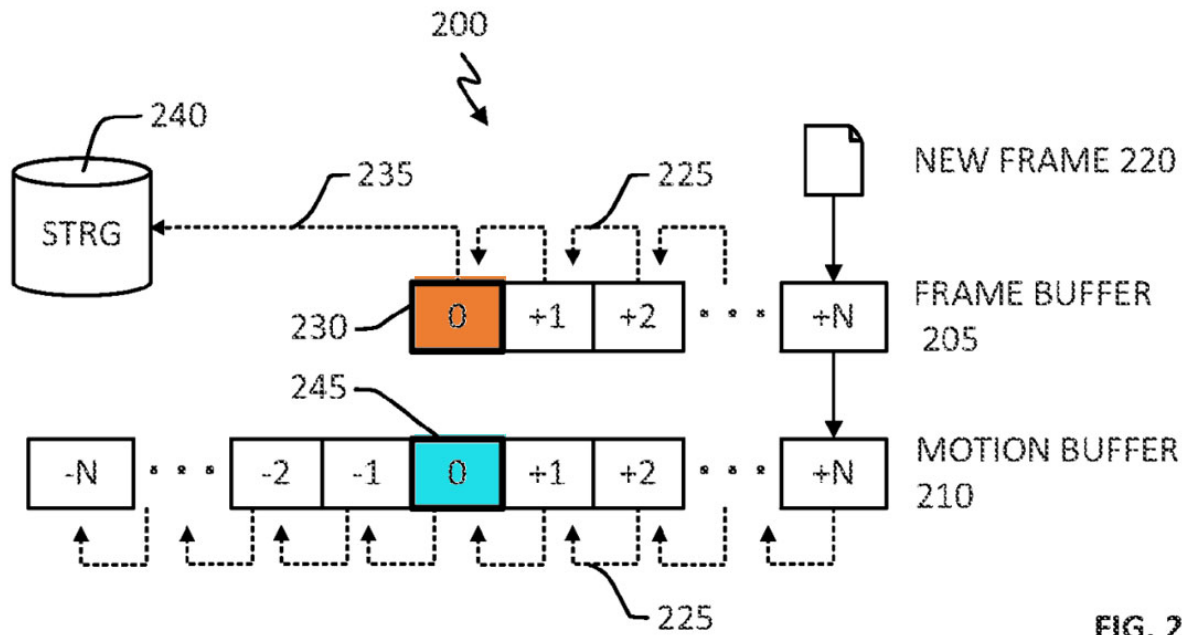


FIG. 2B

As discussed for element 1[g][i], Zhou discloses determining a smoothed trajectory based on a look-ahead of the trajectory. (*Supra* § IV.A.3.1.)

Zhou discloses that “after a *current frame* . . . and its future frames . . . have been evaluated and its stabilization strength modified as necessary . . . the *current frame* may be shifted out of the *buffer system* (e.g., buffer system 200).”

(EX1006, 11:39-46.) Zhou therefore discloses that the current frame is stored in the buffer during stabilization of that frame. (EX1003, ¶209.)

As discussed for element 1[g][i], “for each current frame, video stabilization operation 100 determines . . . the smoothed trajectory.” (EX1006, 7:47-51.) Zhou therefore discloses that the current frame is stored in the buffer during the determination of the point corresponding to that current frame on the smoothed

trajectory. (EX1003, ¶¶210-211.)

The visual content stored in the buffer are used after the determination of the portion of the capture trajectory⁸ to generate the stabilized visual content. Zhou discloses that “after a current frame . . . and its future frames . . . have been evaluated and its stabilization strength modified as necessary, *the current frame’s image data* (or metadata) may be updated . . . to reflect the determined stabilization motions.” (EX1006, 11:39-45.)

- 13. Claim 14: “The image capture system of claim 1, wherein the low-light high-pass parameter controls amount or strength of smoothing performed in smoothed trajectory generation and an extent of motion blur compensation applied in determination of the smoothed trajectory.”**

As shown in claim element 1[g][i], Zhou discloses a low-light high-pass parameter that controls (1) the amount of smoothing applied to generate the smoothed trajectory and (2) the extent of motion blur compensation. (*Supra* § IV.A.3.1.)

- 14. Claim 15: “The image capture system of claim 1, wherein the stickiness parameter controls an extent by which a**

⁸ “The capture trajectory” has no antecedent basis. Claim 1, from which claim 11 depends, does not recite a “capture trajectory.” For purposes of this proceeding only, Petitioner interprets “the capture trajectory” to refer to the smoothed trajectory.

preceding portion of the trajectory impacts determination of the smoothed trajectory.”

As shown in claim element 1[g][i], Zhou discloses a stickiness parameter that control the extent by which preceding portions of the trajectory impacts the determination of the smoothed trajectory. (*Supra* § IV.A.3.1.)

15. Claim 16

- a. Preamble: “A method for stabilizing videos, the method performed by an image capture system including one or more processors, an optical element, an image sensor, and a position sensor, the optical element carried by an image capture device and configured to guide light within a field of view to the image sensor, the method comprising:”**

To the extent the preamble is limiting (which Petitioner does not concede), Zhou discloses the preamble of claim 16.

As shown for the preamble of claim 1, Zhou discloses “[t]echniques to improve a *digital image capture device*’s ability to *stabilize a video stream*.” (*Supra* § IV.A.3.a.) Zhou further discloses or renders obvious the components included in the “image capture system,” as shown in elements 1[b]-1[e]. (*Supra* §§ IV.A.3.c - IV.A.3.i.)

- b. 16[a]: “generating, by the image sensor, a visual output signal conveying visual information based on light that becomes incident thereon during a capture duration, the visual information defining visual content having the field of view, the field of view being larger than a size of a viewing window for generating stabilized visual content”;**

Element 16[a] recites limitations similar to 1[c][i], 1[c][ii], and 1[c][iii], except that it requires that the image sensor generate a visual output signal.

(EX1003, ¶218.) Image sensors generate a visual output signal. (EX1003, ¶219.)

- c. **16[b]: “generating, by the position sensor, a position output signal based on positions of the image capture device during the capture duration, the position output signal conveying position information that characterizes rotational positions of the image capture device at different moments within the capture duration”;**

Element 16[b] recites limitations similar to 1[d][i] and 1[d][ii], except that it requires that the position sensor generate a position output signal and that the position information characterizes rotational positions of the image capture device.

(EX1003, ¶220.) Motion sensors generate a position output signal. (EX1003, ¶221.)

- d. **16[c] – 16[f]**

Elements 16[c]-16[f] mirror elements 1[f]-1[i], respectively, except that they recite trajectories and positions of the image capture device, instead of the housing. (EX1003, ¶¶222-223.)

16. Claim 18

Claim 18 mirrors claim 3, except that it requires the trajectory of the image capture device, instead of the housing. (EX1003, ¶224.)

17. Claim 19

- a. **Preamble: “The method of claim 16, wherein the determination of the smoothed trajectory based on the look-ahead of the trajectory includes:”**

To the extent the preamble is limiting (which Petitioner does not concede), Zhou and Cai disclose the preamble of claim 19. (*Supra* § IV.A.15.)

- b. **19[a]: “weighing past positions of the image capture device less than future positions of the image capture device;”**

Element 19[a] mirrors a subset of claim 8, except that it recites positions of the image capture device, instead of the housing. (EX1003, ¶226.)

- c. **19[b]: “a prior portion of the trajectory having less impact on the determination of the smoothed trajectory than a future portion of the trajectory; or”**

Element 19[b] mirrors a subset of claim 9. (EX1003, ¶227.)

- d. **19[c]: “using a first amount of the prior portion of the trajectory and a second amount of the future portion of the trajectory, the first amount being smaller than the second amount.”**

Element 19[c] mirrors a subset of claim 10. (EX1003, ¶228.)

18. Claim 21

Claim 21 mirrors claim 7. (EX1003, ¶229.)

B. Ground 2: Zhou, Cai, and Karpenko Render Obvious Claims 4 and 20

1. Summary of Karpenko

Karpenko was filed on December 9, 2013 and issued on June 30, 2015, qualifying as prior art to the '840 patent at least under §§ 102(a)(1) and

102(a)(2). The Examiner cited Karpenko's related publication but never applied it during prosecution.

Karpenko discloses "[s]ystems and methods for digital video stabilization via constraint-based rotation smoothing." (EX1010, Abstract.) Specifically, Karpenko discloses an algorithm that performs a "sufficiently high" number of "iterations" that "result in smooth rotations." (EX1010, 13:32-34.)

Karpenko additionally discloses a way to "improve the efficiency" of the algorithm by "running it in coarse to fine mode." (EX1010, 16:59-60.) This allows the algorithm "to be run for significantly fewer iterations at each step." (EX1010, 17:1-2.)

2. **Claim 4: "The image capture system of claim 3, wherein the smoothed trajectory is determined further based on iterations of smoothing including a fine scale approach to smooth on a small scale and a coarse approach to smooth on a large scale, the iterations of smoothing resulting in convergence of the smoothed trajectory."**

Smoothed trajectory is determined further based on iterations of smoothing.

Karpenko discloses that a constraint-based rotation smoothing algorithm, algorithm 1, that uses "sufficiently high" "number of *iterations*" to "result in smooth rotations." (EX1010, 13:32-33.) Karpenko discloses that after the iterations of smoothing, the resulting ϕ_i , "new smoothed camera orientations ϕ_i ," are used to "produce a stabilized output video." (EX1010, 10:16-25; EX1003, ¶¶234-238.)

A fine scale approach to smooth on a small scale and a coarse approach to smooth on a large scale. Karpenko discloses that that the efficiency of the smoothing algorithm can be improved by “running it in *coarse to fine* mode.” (EX1010, 16:57-60.) Specifically, Karpenko discloses that algorithm 1 may be “initialized by supplying and solving for every 16th orientation ϕ_i .” (EX1010, 16:30-61.) Karpenko further discloses that the algorithm “may be run again, but now optimizing every 8th orientation for smoothness and constraints.” (EX1010, 16:64-67.) According to Karpenko, “[r]unning coarse to fine may permit algorithm 1 to be run for significantly fewer iterations at each step. The overall camera motion may be smoothed out and then the orientations may be refined to meet constraints at increasingly smaller frame intervals while still remaining smooth.” (EX1010, 17:1-5.)

The iterations of smoothing resulting in convergence of the smoothed trajectory. Karpenko discloses that the coarse to fine mode can “improv[e] the rate of *convergence* of algorithm 1.” (EX1010, 16:57-60.) As a result, “a smoothed orientation has been computed for all frames.” (EX1010, 17:9-11.) A POSITA would have understood that Karpenko’s algorithm 1’s iterations of the coarse to fine smoothing result in convergence of the smoothed trajectory. (EX1003, ¶243.)

Combination. It would have been obvious to combine Karpenko with the Zhou-Cai combination. (EX1003, ¶¶244-247.) For example, Zhou makes clear its

preference for techniques that are “power efficient and computationally efficient.” (EX1006, 2:05-06.) A POSITA would have been motivated to turn to a prior art reference that discloses the details of improving the efficiency of video stabilization. (EX1003, ¶¶244-245.) Given that Karpenko’s coarse to fine smoothing approach improves the efficiency of calculating the smoothed trajectory by allowing “significantly fewer iterations at each step” to be run, a POSITA therefore would have been motivated to adopt Karpenko’s efficient approach to smooth the trajectory. (EX1003, ¶246.) The combination would have a reasonable expectation of success because the iterative smoothing disclosed by Karpenok is constraint-based like Zhou. (EX1003, ¶247.)

3. Claim 20

Claim 20 mirrors claim 4. (EX1003, ¶248.)

C. Ground 3: Zhou, Cai, and Sokeila Render Obvious Claim 12

1. Summary of Sokeila

Sokeila was filed on April 16, 2013 and issued on March 31, 2015, qualifying as prior art to the ’840 patent at least under §§ 102(a)(1) and 102(a)(2). The Examiner never found, and Applicant never cited, Sokeila during prosecution.

Sokeila discloses “methods, apparatuses, and software related products” for “video stabilization using motion adaptive cropping.” (EX1011, 2:41-45.) The cropping is “based at least on a future prediction of motion in a frame” to “make

the cropping factor change smoothly over time.” (EX1011, 2:48-56.)

2. Claim 12: “The image capture system of claim 11, wherein the buffer includes a circular buffer, and the visual content are stored in the circular buffer as video frames to be stabilized.”

As discussed for claim 11, Zhou discloses storing incoming frames, *i.e.*, visual content, in a buffer during the video stabilization operation. (*Supra* § IV.A.12.) A POSITA would have known that there are multiple widely known types of buffer, including linear buffer and ring buffer (also known as circular buffer). (EX1003, ¶251.) Given there are finite types of buffers, it would have been obvious to try to use a known option, such as a ring buffer, with a reasonable expectation of success. (EX1003, ¶¶251-252.) Additionally, it would have been obvious to apply a known type of buffer, a ring buffer, to a known image capture device to yield predictable results. (*Id.*)

Further, as Zhou does not discuss what type of buffer to use, a POSITA would have been motivated to turn to a prior art reference that discloses the specific type of buffer to use for storing video frames. (EX1003, ¶252.)

Sokeila, like Zhou, relates to video stabilization using cropping and “future prediction.” (EX1011, 2:50.) Sokeila discloses a “*ring buffer 14* [] configured to hold a certain number of frames and may be continuously or periodically or repeatedly updated with new frames.” (EX1011, 4:20-22.) It would have been

obvious to combine Zhou's video stabilization techniques with the known ring buffer disclosed in Sokeila. (EX1003, ¶¶253-255.)

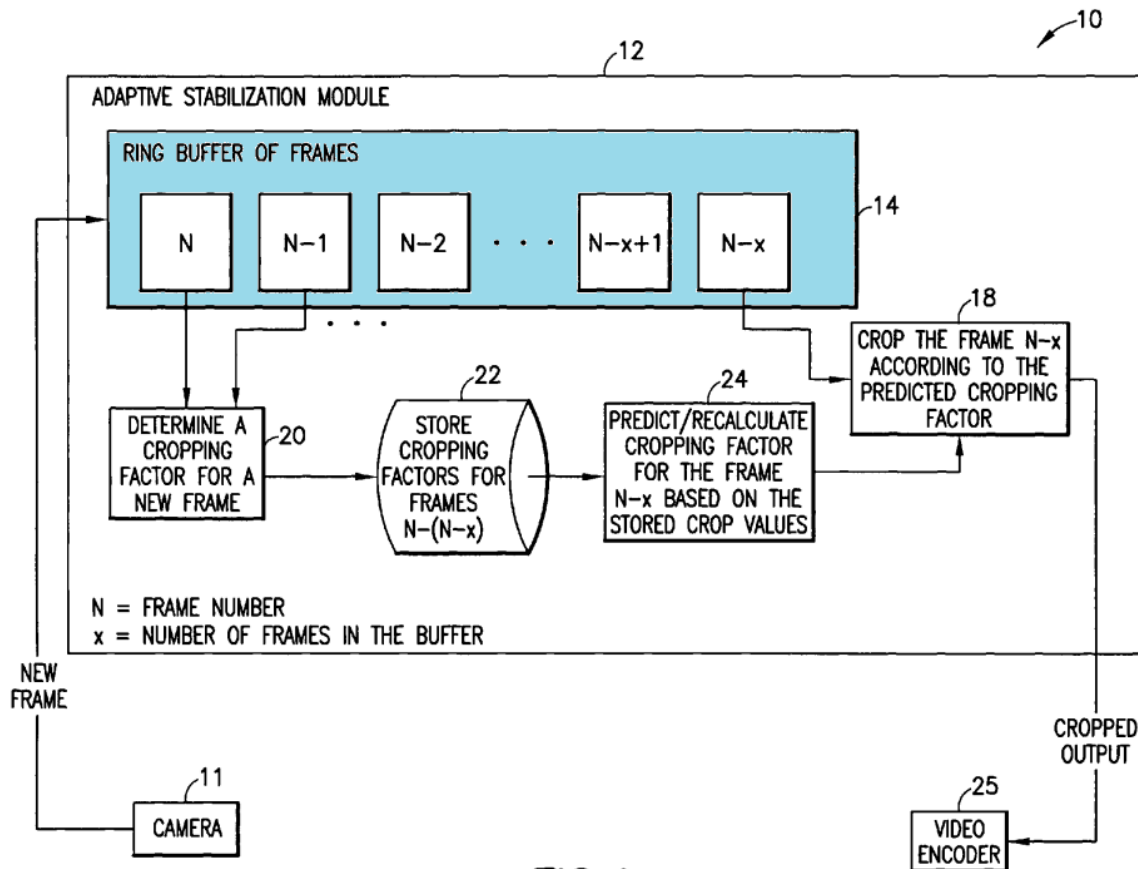


FIG. 1

D. Ground 4: Zhou, Cai, and Bell Paper Render Obvious Claims 13 and 17

1. Summary of Bell Paper

Bell Paper was published in *ECCV* (4), Volume 8692 of *Lecture Notes in Computer Science* in 2014 and made publicly available in 2015, qualifying as prior art to the '840 patent at least under § 102(a)(1). (EX1004, EX1005, EX1012.) The

Examiner never found, and Applicant never cited, Bell Paper during prosecution.

Bell Paper discloses “a method for video stabilization . . . for videos captured on mobile devices.” (EX1004, 294.) Bell Paper discloses “us[ing] the gyroscope to track the camera motion” and “model[ing] the camera motion as a rotation in a global coordinate frame.” (EX1004, 297.) Bell Paper discloses that the stabilized video produced with its method is based on a smoothed camera path, which “is nearly free of rotational motions.” (EX1004, 304.)

2. Claim 13: “The image capture system of claim 1, wherein the weight-balance parameter controls types of motion that are minimized in smoothed trajectory generation, the types of motion including rotational velocity and rotational acceleration.”

The Zhou, Cai, and Bell Paper combination disclose this claim under GoPro’s infringement theory. GoPro alleges that the accused products include the “weight-balance parameter” because “angular velocity and angular acceleration are considered as part of the process for smoothing videos.” (EX1014, at 14.)

As discussed for claim element 1[g][i], Zhou discloses that the stabilization strength parameter controls the amount of smoothing applied to generate the smoothed trajectory. (*Supra* § IV.A.3.1.)

Zhou also discloses that “video may be stabilized . . . against rotation,” but does not specify the types of rotational motion minimized. (EX1006, 7:41-42.)

Hence, a POSITA would have been motivated to turn to a prior art reference that

discloses the details of types of motion minimized. (EX1003, ¶260.)

Bell Paper discloses that “[w]hen the camera is nearly still, [its] virtual camera is fixed, removing all jitter.” (EX1004, 296.) A POSITA would have understood that removing all jitter when the camera is still means that the rotational velocity is minimized. (EX1003, ¶261.)

Bell Paper discloses a “method for video stabilization” that “dramatically reduces the jitter in *angular velocity*, and even removes it when possible, thus producing smoother results.” (EX1004, 304.) A POSITA would understand that reducing jitter in angular velocity is minimizing rotational acceleration. (EX1003, ¶262.) Bell Paper further discloses that its method “removes most of the *angular acceleration*, producing an output video which is pleasing to view.” (EX1004, 304.)

The Zhou, Cai, and Bell Paper combination teach that the video stabilization operation can use the stabilization strength parameter to minimize angular velocity and angular acceleration. (EX1003, ¶¶263-265.)

It would have been obvious to minimize rotation in terms of rotational velocity and rotational acceleration. (*Id.*) Rotational velocity and acceleration are one of a “finite number of identified, predictable solutions” for defining rotational motion. *KSR*, 550 U.S. at 402. A POSITA would have reasonably expected the Zhou, Cai, and Bell Paper combination to succeed. (EX1003, ¶265.)

3. Claim 17

a. Preamble: “The method of claim 16, wherein:”

To the extent the preamble is limiting (which Petitioner does not concede), Zhou and Cai disclose the preamble of claim 17. (*Supra* § IV.A.15.)

b. 17[a]: “the weight-balance parameter controls types of motion that are minimized in smoothed trajectory generation, the types of motion including rotational velocity and rotational acceleration”;

Element 17[a] mirrors claim 13. (EX1003, ¶267.)

c. 17[b]: “the low-light high-pass parameter controls amount or strength of smoothing performed in smoothed trajectory generation and an extent of motion blur compensation applied in determination of the smoothed trajectory; and”

Element 17[b] mirrors claim 14. (EX1003, ¶268.)

d. 17[c]: “the stickiness parameter controls an extent by which a preceding portion of the trajectory impacts determination of the smoothed trajectory.”

Element 17[c] mirrors claim 15. (EX1003, ¶269.)

V. THE BOARD SHOULD NOT DENY INSTITUTION UNDER *FINTIV*

As the USPTO Interim Procedure for Discretionary Denials stated, “[t]he plain language of the *Fintiv* factors is directed to district court litigation and does not apply to parallel U.S. International Trade Commission (ITC) proceedings, as the ITC lacks authority to invalidate a patent and the ITC’s invalidity rulings are not binding on the Office or on the district courts.” (USPTO Interim Procedure for

Discretionary Denials, 2-3.) Accordingly, the Board should not exercise its discretion to deny institution.

VI. THE BOARD SHOULD NOT DENY INSTITUTION UNDER § 325(D)

The Board should not deny institution under § 325(d) on the basis of the prosecution of the '840 patent. Section 325(d) is inapplicable to this proceeding, because the Petition does not raise substantially the same art or arguments in the same way as the examination of the '840 Patent; to the extent the Petition does, the Office erred in a material manner. *Advanced Bionics, LLC v. MED-EL Elektromedizinische Geräte GmbH*, IPR2019-01469, Paper 6 at 8 (Feb. 13, 2020) (designated precedential on March 24, 2020).

The Board applies a two-part framework for determining whether to deny institution under § 325(d) in view of prosecution of the original patent application and any subsequent reexamination: “(1) whether the same or substantially the same art previously was presented to the Office or whether the same or substantially the same arguments previously were presented to the Office; and (2) if either condition of first part of the framework is satisfied, whether the petitioner has demonstrated that the Office erred in a manner material to the patentability of challenged claims.” *Advanced Bionics*, IPR2019-01469, Paper 6 at 8.

Here, the Board need not reach the second part of the test, because the first part fails: neither the same (or substantially the same) art or arguments were

previously presented to the Office.

Three of the five references presented in this Petition—Cai, Sokeila, and Bell Paper—were not considered during prosecution of the '840 patent. And while Zhou and Karpenko's related publication were cited during prosecution, the Examiner never substantively discussed or applied them against the claims. The Examiner instead applied two prior art references, Beysserie and Guo, against the claims. *See Amazon Inc. v. M2M Sols. LLC*, IPR2019-01204, Paper 14 at 16 (P.T.A.B. Jan. 23, 2020) (“reference that was neither applied against the claims nor discussed by the Examiner” weighs against denying institution under section 325(d)).

Zhou also is not cumulative of Beysserie. The Examiner found that Beysserie did not disclose the “determine placement of the viewing window for the visual content with respect to the field of view . . .” and “generate the stabilized visual content of a video based on the viewing window” limitations. (EX1002, 96) Zhou, however, as discussed, discloses those limitations. Moreover, Zhou in combination with Cai teach the “use of a temporal horizon” limitation in elements 1[g][iv] and 1[g][v] and claim 16 that the Examiner found was missing from both Beysserie and the other applied art Guo. (*Supra* § II.C.)

Moreover, the Examiner also never considered the combination of Zhou with Cai. That “one piece of art” in a combination “was previously presented

and/or argued” is “insufficient to satisfy the first prong of *Advanced Bionics*.”

Thorne Rsch., Inc. v. Trs. of Dartmouth Coll., No. IPR2021-00491, Paper 18, 8 (PTAB Aug. 12, 2021) (no denial where other reference in combination was not before the examiner); *Samsung Elecs. Co. v. Headwater Rsch. LLC*, No. IPR2023-01226, Paper 9, 6-7 (PTAB Feb. 8, 2024) (same); *BMW of N. Am., Inc. v. Mich. Motor Techs., LLC*, No. IPR2023-01031, Paper 12, 13 (PTAB Jan. 23, 2024) (same). Thus, the inquiry should end there.

To the extent the same art or arguments were previously presented to the Office, the second step of the *Advanced Bionics* inquiry—whether the examiner erred in a manner material to patentability—would still preclude discretionary denial. This is because the Office erred to the extent it failed to fully consider the significance of the art or arguments as set forth in this Petition. Accordingly, even if the first part of the test is satisfied, the Board further should not deny institution based on the second part of the test.

Thus, the Board should not exercise its discretion to deny institution under § 325(d).

VII. NOTICES AND STATEMENTS

Pursuant to 37 C.F.R. § 42.8(b)(1), Arashi Vision Inc. (d/b/a Insta360) is the real party-in-interest for Petitioner.

Pursuant to 37 C.F.R. § 42.8(b)(2), Petitioner identifies the following related

matters:

- *In the Matter of Certain Cameras, Camera Systems, and Accessories Used Therewith*, Inv. No. 337-TA-1400 (USITC).
- *GoPro, Inc. v. Arashi Vision Inc. et al.*, No. 8:24-cv-00681-HDE-JCV (C.D. Cal.).⁹

Pursuant to 37 C.F.R. § 42.8(b)(3), Petitioner identifies the following counsel (and a power of attorney accompanies this Petition).

Lead Counsel	First Backup Counsel
Alex S. Yap Registration No.: 60,609 MORRISON & FOERSTER LLP 707 Wilshire Blvd., Suite 6000 Los Angeles, CA 90017 Email: AYap@mofo.com Tel: 213-892-5200 Fax: 213-892-5454	Mehran Arjomand Registration No.: 48,231 MORRISON & FOERSTER LLP 707 Wilshire Blvd., Suite 6000 Los Angeles, CA 90017 Email: MArjomand@mofo.com Tel: 213-892-5200 Fax: 213-892-5454
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⁹ IPR2024-00984 and IPR2024-01052 also are related to the ITC and C.D. Cal.

litigations.

Pursuant to 37 C.F.R. § 42.8(b)(4), service information for lead and back-up counsel is provided above. Petitioner consents to electronic service by email to MoFo_Insta360-IPRs@mofo.com.

Pursuant to 37 C.F.R. § 42.104(a), Petitioner certifies that the '840 patent is available for *inter partes* review and that Petitioner is not barred or estopped from requesting an *inter partes* review challenging the patent claims on the grounds identified in this Petition.

The USPTO is authorized to charge any required fees, including the fee as set forth in 37 C.F.R. § 42.15(a) and any excess claim fees, to Deposit Account No. **03-1952** referencing Docket No. **33316-00000.02**.

Dated: July 12, 2024

Respectfully submitted,

By /s/ Alex S. Yap
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Counsel for Petitioner

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

I hereby certify that this Petition for *Inter Partes* Review has 13,324 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, mandatory notices under § 42.8, a certificate of service or word count, or appendix of exhibits or claim listing.”

Dated: July 12, 2024

By /s/ Alex S. Yap
Alex S. Yap

IPR2024-01165
Patent 10,958,840 B2

Certificate of Service (37 C.F.R. § 42.6(e)(4) and 42.205(a))

I hereby certify that the attached Petition for *Inter Partes* Review and supporting materials were served as of the below date by UPS, which is a means at least as fast and reliable as U.S. Express Mail, on the Patent Owner at the correspondence address indicated for U.S. Patent No. 10,958,840:

GoPro Issuance
3025 Clearview Way
San Mateo, CA 94402

Dated: July 12, 2024

/s/ Alex S. Yap
Alex S. Yap