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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

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

v.

GOPRO, INC.,
Patent Owner

Case IPR2024-01164
U.S. Patent No. 10,958,840

**DECLARATION OF HASSAN FOROOSH PH.D.
IN SUPPORT OF PATENT OWNER'S PRELIMINARY RESPONSE**

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1. I have been retained on behalf of GoPro, Inc. (“Patent Owner”) in connection with the above-captioned *inter partes* review (IPR). I have been retained to provide my opinions in support of Patent Owner’s Preliminary Response. I am being compensated for my time at my standard rate of \$650 per hour. I have no interest in the outcome of this proceeding.

2. In preparing this declaration, I have reviewed and am familiar with the Petition for IPR2024-01164, U.S. Patent No. 10,958,840 (“the ’840 patent”) and its file history, and all other materials cited and discussed in the Petition (including the declaration of Petitioner’s expert Dr. Aggelos Katsaggelos), and cited and discussed in this Declaration.

3. The statements made herein are based upon my own knowledge and opinion. This Declaration represents only the opinions I have formed to date. I may consider additional documents as they become available or other documents that are necessary to form my opinions. I reserve the right to revise, supplement, or amend my opinions based on new information and on my continuing analysis.

I. QUALIFICATIONS

4. I have been retained to serve as a technical expert in this matter based upon my educational and research experience, and specifically my work in the fields of computer vision, image processing, and optics. My curriculum vitae

PUBLIC VERSION

(“CV”) submitted as Exhibit 2002, which contains details about my education, experience, publications, and other qualifications to render an expert opinion in this matter.

5. I am a Professor of Computer Science at the University of Central Florida. My primary research interests include computer vision, image/video processing, and machine learning, including deep learning and large language models.

6. I received my Ph.D. in Computer Science from INRIA (French National Institute for Research on Informatics and Control), University of Nice Sophia Antipolis in 1996. I also earned a Master of Science in Computer Science from the University of Nice Sophia Antipolis in 1993, a Master of Science in Electrical Engineering from Kingston University, U.K., in 1990, and a Bachelor of Science in Electrical Engineering from Kingston University, U.K., in 1989.

7. Prior to research and teaching, I worked as an R&D Engineer at Innovative Engineering Solutions Ltd. in London from 1990 to 1992. Between 1993 and 1996, I served as a Research Assistant in the Scene Analysis and Symbolic Image Processing Group of INRIA, where I performed research in areas such as 3D super-resolution, sub-pixel image registration, and image-based depth and shape recovery and analysis. From 1997 to 2000, I served as an Assistant Research

PUBLIC VERSION

Scientist at the University of Maryland, College Park, where I investigated topics such as image registration (2D and 3D), super-resolution of video data for unmanned aerial vehicles, super-resolution of Synthetic Aperture Radar (SAR) and Foliage Penetrating SAR (FOPEN-SAR), and Automatic Target Detection, Tracking, and Recognition (ATD/R). During this time, I authored one of the most cited works on sub-pixel registration and alignment based on phase correlation: (Hassan Foroosh (Shekarforoush), Josiane Zerubia and Marc Berthod, Extension of Phase Correlation to Sub-pixel Registration, IEEE Transactions on Image Processing, vol. 11, Issue 3, pp. 188-200, 2002). Between 2000 to 2002, I served as Senior Research Scientist at the University of California, Berkeley where I also served as the Technical Coordinator and Principal Research Scientist of a Multi-University Research Initiative (MURI) funded by the Office of Naval Research. As part of the project, I conducted research on multi-sensor acquisition of 3D data for autonomous 3D modeling and visualization of urban environments.

8. I joined the Department of Computer Science at the University of Central Florida (UCF) as an Assistant Professor in 2002. Since then, I have served as an Associate Professor, Professor, and CAE Link Professor of Computer Science in the same department. I also served in various other capacities within the department, such as the Graduate Program Coordinator, chair of various leadership

PUBLIC VERSION

committees, and most recently in the Faculty Senate Strategic Planning Council for UCF.

9. I have taught a number of courses directed to computer vision and 3D modeling, including 3D Computer Vision, Image Processing, Special Topics in 3D Computer Vision, and Visual Simulation. Since joining UCF, I have also advised and chaired the dissertation of over 30 doctoral students, 28 of whom have already successfully defended their doctoral dissertation, and secured academic positions or industry jobs with major high-tech corporations. As one example, I served as the advisor for a dissertation directed to *“Improving Matching and Classification Through Deep Learning of Structure and Varying Illumination”*. This dissertation involved also working with GoPro camera systems for mobile aerial platforms.

10. I have been the principal investigator or co-principal investigator of numerous research projects funded by the National Science Foundation (NSF), NASA, DoD, and industry partners, with total funding exceeding \$14M since joining UCF, and ongoing funded projects for an additional \$3M. As one related example, I recently served as the principal investigator in two projects funded by the National Science Foundation (NSF) on 3D modeling and camera systems, and the role of 3D information in machine understanding of digitized 3D world.

PUBLIC VERSION

11. I have also conducted extensive research in partnership with industry in the field of computer vision, in particular 3D computer vision and camera systems, including body-worn cameras and cameras on agile mobile platforms, or cameras operating in various different modalities (EO, FLIR, polarized, etc.). Below, I highlight some of the projects that were funded by industry and state-sponsored technology transfer initiatives that specifically involved using GoPro camera systems or similar platforms. For example, from 2012 to 2018, I received funding from Jackson Technologies related to Airborne Multisensor Visual Data Processing, which studied automated methods of reconstructing 3D panoramic models around a flying aircraft that used the GoPro camera system and software tools extensively; From 2013 to 2018, I received related funding from the Florida High Tech Corridor (“FHTC”) for Rapid Automated 3D Terrain Modeling from Airborne Data, which similarly studied automated methods of reconstructing 3D models of a terrain from a flying aircraft, again using extensively the GoPro cameras and software tools; From 2008 to 2009, I received funding from Electronic Arts – Tiburon related to Modeling and Tracking Human Activities in Sport Events. The goal of this project was to develop algorithms for tracking and recognition of human activities in sport events, using body-worn cameras similar to GoPro systems, as well as surrounding cameras, network of cell phone cameras, and other sensors.

PUBLIC VERSION

12. I have authored or co-authored over 200 articles in peer reviewed journals or conference proceedings, relating to the areas of Computer Vision (CVPR, ICCV, ECCV, etc.), Machine Learning (ICLR, AAAI, ACL, EMNLP, etc.), and Image Processing and Pattern Recognition (ICIP, ICPR). Some related example publications include: Yang Zhang, Zixiang Zhou, Philip David, Xiangyu Yue, Zerong Xi, Boqing Gong, Hassan Foroosh, *PolarNet: An Improved Grid Representation for Online LiDAR Point Clouds Semantic Segmentation*, Proceedings of IEEE Conference on Computer Vision and Pattern Recognition (CVPR), 2020; Chuan Sun, Imran Junejo, Marshall Tappen, Hassan Foroosh, *Exploring Sparseness and Self-Similarity for Action Recognition*, IEEE Transactions on Image Processing, vol. 24, issue 8, pp. 2488-2501, 2015; Chen Shu, Luming Liang, Wenzhang Liang, Hassan Foroosh, *3D Pose Tracking with Multi-Templates Warping and SIFT Correspondences*, IEEE Trans. on Circuits and Systems for Video Technology, 2015; Nazim Ashraf, Chuan Sun, and Hassan Foroosh, *View-Invariant Action Recognition Using Projective Depth*, Journal of Computer Vision and Image Understanding (CVIU), vol. 123, pp. 41-52, 2014; Yuping Shen and Hassan Foroosh, *View-invariant Action Recognition from Point Triplets*, IEEE Transactions on Pattern Analysis and Machine Intelligence (PAMI), vol. 31, no. 10, pp. 1898-1905, 2009; Nazim Ashraf, Yuping Shen, Xiaochun Cao, and Hassan

PUBLIC VERSION

Foroosh, *View-Invariant Action recognition using Weighted Fundamental Ratios*, Journal of Computer Vision and Image Understanding (CVIU), vol. 117, pp. 587-602, 2013.

13. Based on my work, I have also applied for and received several patents in the field of image processing, including U.S. Pat. No. 8,755,569 entitled Methods for Recognizing Pose and Action of Articulated Objects with Collection of Planes and Motion, which was issued in 2014.

14. I have served as the editor and/or committee member on numerous professional organizations. For instance, I have been on the editorial board of the IEEE Transactions on Image Processing (Associate Editor, 2003-2008, 2011-2016); IEEE Conference on Computer Vision and Pattern Recognition (CVPR) serving as area chairs, session chairs and Technical Committee member over many years (2004-2012, 2015-2016, 2019-2023); Organizing Committee and sponsorship chair of ACM Multimedia Conference in 2014; and frequent reviewer on various IEEE transactions, including the IEEE Transactions on Pattern Analysis and Machine Intelligence.

15. For my work, I have been honored with numerous awards, including the *Piero Zamperoni Award*, International Association for Pattern Recognition (IAPR) (2004). I have also received several Best Paper awards, including “*The Best*

PUBLIC VERSION

Scientific Paper Award” in the IAPR International Conference on Pattern Recognition in 2008, “*The Best Paper Award*” in the IEEE International Conference on Image Processing (ICIP) in 2018, and the *Distinguished Researcher*, UCF College of Engineering and Computer Science (2004-2005, 2005-2006).

16. In sum, I have studied, taught, practiced, and conducted research in the areas of computer vision, image processing, machine learning (deep learning and large language models), and optics.

II. LEGAL UNDERSTANDING**A. The Person of Ordinary Skill in the Art (“POSITA”)**

17. I understand that a person of ordinary skill in the relevant art at the time of the invention (also referred to herein as “ordinary artisan”) is presumed to be aware of all pertinent art, thinks along conventional wisdom in the art, and is a person of ordinary creativity—not an automaton.

18. I have been asked to consider the level of ordinary skill in the field that someone would have had at the time the claimed invention was made. In deciding the level of ordinary skill, I considered the following:

- the levels of education and experience of persons working in the field;
- the types of problems encountered in the field; and
- the sophistication of the technology.

PUBLIC VERSION

19. I have reviewed the declaration of Dr. Katsaggelos, including his opinions regarding the Person of Ordinary Skill in the Art, which is a person with “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” or alternatively “four years of experience working on image or video processing or digital cameras.” Ex. 1003, ¶¶20-21.

20. My opinions set forth in this Declaration apply Dr. Katsaggelos’s definition of a POSITA.

21. I am well-qualified to determine the level of ordinary skill in the art. I was a person of at least ordinary skill in the art at the time of the September 2018 provisional application priority date of the ’840 patent under Dr. Katsaggelos’s definition of a POSITA. If I do not explicitly state that my statements below are based on this timeframe, all of my statements are to be understood as an ordinary artisan would have understood something as of the priority date of the ’840 patent.

B. Legal Principles

22. I am not a lawyer and will not provide any legal opinions. Though I am not a lawyer, I have been advised that certain legal standards are to be applied by technical experts in forming opinions regarding the meaning and validity of patent claims.

PUBLIC VERSION1. Anticipation

23. I understand that to obtain a patent, a claimed invention must have, as of the priority date, been novel. I understand that to prove that a prior art reference anticipates a patent, the four corners of the prior art reference must describe element of the claimed invention, either expressly or inherently. I also understand that the prior art reference must describe the elements arranged as in the claim and that it is improper to combine disparate embodiments to establish anticipation unless a POSITA when reading the reference could at once envisage such a combination.

2. Obviousness

24. I understand that to obtain a patent, a claimed invention must also have, as of the priority date, been nonobvious in view of prior art in the field. I understand that an invention is obvious when the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art.

25. I understand that to prove that prior art, or a combination of prior art, renders a patent obvious, it is necessary to: (1) identify the particular references that singly, or in combination, make the patent obvious; (2) specifically identify which elements of the patent claim appear in each of the asserted references; and (3) explain how the prior art references could have been combined to create the inventions

PUBLIC VERSION

claimed in the asserted claim, including how there would have been a reasonable expectation of success.

26. I understand that a patent composed of several elements is not proved obvious merely by demonstrating that each of its elements was, independently, known in the prior art, and that obviousness cannot be based on the hindsight combination of components selectively culled from the prior art to fit the parameters of the patented invention.

27. I also understand that a reference may be said to teach away when a person of ordinary skill, upon reading the reference, would be discouraged from following the path set out in the reference, or would be led in a direction divergent from the path that was taken by the applicant. Even if a reference is not found to teach away, I understand its statements regarding preferences are relevant to a finding regarding whether a skilled artisan would be motivated to combine that reference with another reference.

3. *My Understanding of Claim Construction Law*

28. I have been informed that patent claims are construed from the viewpoint of a person of an ordinary artisan and that patent claims generally should be understood consistent with their ordinary and customary meaning at the time of the invention. A review of the patent claim language, the patent specification, and

PUBLIC VERSION

its prosecution history are also necessary to determine the proper meaning and scope of the term at issue.

29. I have further been informed that in the specification and prosecution history the patentee may define a claim term in a way that differs from the ordinary and customary meaning. I understand that during prosecution of the patent before the U.S. Patent and Trademark Office, the Applicant may make representations or provide definitions of terms that may affect the scope of the patent claims. In particular, the Applicant may, during the course of prosecution, limit the scope of the claims to overcome prior art and/or disavow claim coverage by making clear and unambiguous statements to that effect.

30. I have been informed that an ordinary artisan may, among other things, consider dictionaries, publications, other patents, and treatises (*i.e.*, “extrinsic evidence”). I understand that extrinsic evidence may generally not be relied on if it contradicts the meaning of claim language provided by the intrinsic evidence, such as express definitions given for terms in the specification.

4. *Secondary Considerations of Non-Obviousness*

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

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“objective indicia of non-obviousness.” I understand that such evidence can often be probative of the issues of obviousness.

32. I understand that examples of objective evidence include (1) commercial success, (2) copying, (3) industry praise, (4) skepticism, (5) long-felt but unsolved need, and (6) failure of others.

33. I understand that there must be a nexus between the patented invention and the evidence of secondary considerations. I further understand that there is a presumption of such a nexus if the claims of the patent are coextensive with a product or products that are the subject of the secondary considerations evidence. I further understand that in order for a claim to be coextensive with a product, one must look at the claims at the whole and not just the new claimed feature. In addition, the claimed invention should not be merely a subcomponent of the products sold but should encompass the entire apparatus.

III. CLAIM CONSTRUCTION

34. In my opinion, all claim terms should be given their ordinary and customary meaning in light of the specification.

IV. OVERVIEW OF THE '840 PATENT

35. The '840 Patent, titled “Systems and Methods for Stabilizing Videos,” discloses an advanced system designed to stabilize video content in diverse circumstances and conditions. The system operates by analyzing position

PUBLIC VERSION

information including characterizing the rotational positions of the image capture device during the capture duration. This position information allows the system to generate a “trajectory of the image capture device during the capture duration,” which “reflect[s] the rotational positions of the image capture device at different moments within the capture duration.” Ex. 1001, 1:18-29; 30:18-23 (claim 1); 32:28-33 (claim 16).

36. One of the key aspects of the '840 Patent is the use of specific parameters that influence how stabilization is achieved. *Id.*, 21:17-25. These include the “weight-balance parameter” (*id.*, 17:32-60, 21:17-58), “low-light high-pass parameter” (*id.*, 21:59-22:21), and “stickiness parameter” (*id.*, 22:22-41), which enable fine tuning of the stabilization process under diverse circumstances and conditions. *Id.*, 30:35-38 (claim 1), 32:44-48 (claim 16).

37. The weight-balance parameter determines the degree to which the system minimizes rotational velocity or rotational acceleration and their tradeoff to achieve stabilization, allowing flexibility in the system’s response to a wide variety of different types of motion. *Id.*, 17:32-60, 21:17-58. The low-light high-pass parameter addresses the challenge of stabilizing videos captured in low-light environments by controlling the extent to which the system compensates for motion blur that occurs during frame exposure. *Id.*, 21:59-22:21. The stickiness

PUBLIC VERSION

parameter ensures the smoothed trajectory retains some influence from past movements to provide continuity in rapid or erratic camera motions. *Id.*, 22:22-41.

38. These innovations are integral to GoPro’s HyperSmooth technology, which has played a significant role in the commercial success and industry recognition of GoPro’s cameras.

I. OVERVIEW OF CERTAIN CITED ART

39. The petition challenges the ’840 Patent’s claims 1 to 21 on seven grounds. Ground 1 asserts that the combination of Bell and Shi renders the independent claims 1 and 16, along with certain dependent claims, obvious. Grounds 2 through 7 address the remaining dependent claims by asserting the combination of Bell and Shi, along with one or two other references.

40. Below are short summaries of the primary references relied on for the independent claims.

B. Ground 1 Cited Art**1. Bell (Ex. 1006)**

41. Bell discloses a system for real-time video stabilization that relies on on-board motion sensing technology, such as gyroscopes, to measure the movement of cell phones and mobile devices during recording casual video. Ex. 1006, Abstract, 1:15-29; 6:9-18. A central feature of Bell’s system is the creation of a “virtual camera” that simulates a smoothed camera trajectory to reduce

PUBLIC VERSION

unwanted shake. *Id.*, 8:51-56. Bell explains that this virtual camera remains static when the motion of the physical camera is below a certain movement threshold, allowing the stabilization system to ignore insignificant movements. *Id.* The system uses angular velocity data from sensors to calculate and adjust the virtual camera's orientation, resulting in a smoother video output. *Id.* Specifically, Bell describes a method where “a crop polygon around scene content common to the first image frame and the second image frame is identified” and then “warped to remove motion distortions” using the measured movement data. *Id.*, Abstract. And Bell describes “us[ing] data from a look-ahead buffer to calculate a smoother path.” Ex. 1006, 10:10-16.

42. However, while Bell's system focuses on smoothing the virtual camera's trajectory based on physical parameters such as angular velocity, it does not disclose key features present in the '840 Patent. Specifically, Bell does not disclose the use of parameters like the low-light high-pass parameter, which addresses the challenge of motion blur in low-light environments by controlling stabilization in such conditions, or the weight-balance parameter, which fine-tunes stabilization by considering both rotational velocity and rotational acceleration, or possibly higher order rotational derivatives. Ex. 1001, 17:40-53, 21:17-58. Additionally, Bell does not describe a mechanism similar to the “stickiness

PUBLIC VERSION

parameter” found in the ’840 Patent, which ensures that the virtual camera trajectory retains influence from past movements to ensure smoother transitions in rapid or erratic motion scenarios. *Id.*, 22:22-41. These distinctions make Bell’s system materially different from the system disclosed in the ’840 Patent, particularly in its capacity to handle a wide variety of recording situations including low-lighting conditions and/or when both angular and linear velocities may change rapidly over time, i.e. in the presence of angular and linear accelerations, or even changing acceleration. Bell teaches filtering discrete angular velocities for determining the smooth path of a virtual camera, but does not discuss or take into account angular acceleration or changing angular acceleration, and as for linear acceleration measurements using an accelerometer, it discourages its use even for estimating translational displacement. In contrast, the ’840 patent teaches minimizing a weighted balance objective function that trades off between linear and angular velocities and acceleration and possibly other video parameters. Ex. 1001, 9: 29-41, 21: 26-43.

2. Shi (Ex. 1007)

43. Shi focuses on trajectory estimation and correction to stabilize videos through a series of transformations that adjust the camera’s position and rotation based on motion data. The system applies a first transformation using optical

PUBLIC VERSION

image stabilization (OIS) data and then calculates a second transformation based on additional positional data collected after the capture of the frame. Ex. 1007, 3:52-4:11. This second transformation refines the stabilization by incorporating further motion data captured post-frame, complementing the initial OIS-based transformation.

44. While Shi introduces a coefficient to adjust for motion blur by interpolating between the real and virtual camera positions based on detected and estimated blur (a *reactive approach* that responds to blur after it occurs), it does not disclose or suggest the low-light high-pass parameter of the '840 Patent. The '840 Patent takes a *proactive approach*, dynamically adjusting smoothing in anticipation of motion blur caused by increased exposure times in low-light conditions. Specifically, the low-light high-pass parameter is triggered by detecting conditions—such as low-light environments—that are likely to result in motion blur, and it fine-tunes the stabilization to prevent the effect of blur before it manifests.

45. Fig. 7 of the '840 Patent illustrates this proactive approach, where the amount of smoothing is adjusted based on factors such as exposure time, motion of the image capture device, and other conditions. The system uses smoothing strengths (Ex. 1001, 22:2-7) and smoothing directions (Ex. 1001, 22:2-7) that are

PUBLIC VERSION

optimized according to the environment, with the application of constraints like the low-light high-pass parameter, which is tailored for scenarios where longer exposure times increase the likelihood of motion blur. Shi, by contrast, makes *no mention of low-light conditions*, nor does it suggest any adaptation to account for such conditions, leaving its approach reactive rather than proactive.

II. GROUND 1: PETITIONER FAILS TO ESTABLISH THAT BELL AND SHI RENDER CLAIMS 1-21 OBVIOUS

A. Claims 1 and 16: Bell in View of Shi Does Not Render Obvious the Limitation “determine a smoothed trajectory and one or more of a weight-balance parameter, a low-light high pass parameter, and/or a stickiness parameter”

46. Claims 1 and 16 require the stabilization system to “determine a smoothed trajectory and one or more of a weight-balance parameter, a low-light high pass parameter, and/or a stickiness parameter.”

47. While Bell discloses a look-ahead buffer for calculating a smoother virtual camera path, the Petition concedes that Bell does not specify the parameters—such as a low-light high pass parameter—necessary for determining the smoothed trajectory as required by the challenged claims. Instead, the Petition relies on Shi, claiming it discloses the low-light high-pass parameter. In my opinion, this is incorrect.

48. Shi’s system, while *reactively* adjusting for motion blur when detected and estimated, does not disclose nor suggest the *proactive* low-light high-pass

PUBLIC VERSION

parameter of the '840 Patent. In fact, Shi makes no mention of low-light conditions, much less the specific adjustments required to handle such conditions during stabilization.

49. The '840 Patent's low-light high-pass parameter dynamically adjusts the smoothing strength in response to low-light conditions, balancing motion blur compensation and stabilization by accounting for the increased exposure times that often lead to motion blur. This parameter operates along a well-defined range from 0 to 1, where 1 provides full motion blur compensation and 0 applies full smoothing without blur compensation. Ex. 1001, 22:8-21. These values are determined based on the capture conditions, including low-light and longer exposure times. Shi does not disclose any environment-specific light-based controls.

50. Furthermore, the Petition's motivation to combine Bell's video stabilization technique with Shi's motion blur compensation is based on conclusory statements. Petitioner relies solely on the presence of blur in Shi without addressing the significant differences between the proactive, light-condition-based control of the '840 Patent and Shi's reactive, frame-by-frame compensation method based on first estimating the motion blur in each frame.

PUBLIC VERSION

51. Additionally, in my opinion, modifying Bell with Shi's reactive approach would lead to a technically incompatible system. Shi's blur compensation reacts only after blur is detected, while Bell's system relies on forward-looking stabilization. The combination of these two would disrupt Bell's look-ahead mechanism, making it impractical for pre-emptively adjusting the trajectory. Such a modification would not yield predictable results and would undermine the operation of Bell's system, rendering it inoperable for its intended purpose.

52. Furthermore, the Petition's reliance on Shi to modify Bell's stabilization involves impermissible hindsight. In my opinion, the Petition engages in hindsight-driven reasoning by selectively incorporating Shi's reactive blur handling into Bell's system, without any real motivation or teaching in the prior art suggesting this combination.

53. The '840 Patent's proactive stabilization solution is illustrated in Fig. 7, where smoothing values and smoothing directions (Ex. 1001, 22:2-7) adjust according to factors like exposure time and motion of the image capture device, accounting for varying light conditions.

PUBLIC VERSION

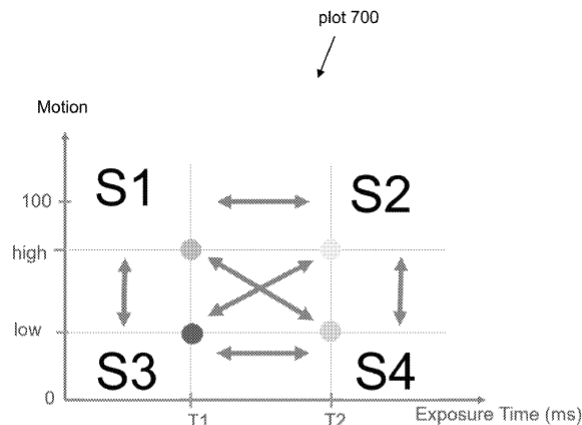


FIG. 7

54. The '840 Patent explains, “[i]n some implementations, the exposure time of the image capture device may be automatically adjusted based on *light conditions*.” Ex. 1001, 19:15-18 (emphasis added). “For instance, referring to FIG. 7, exposure time of less than T1 may be used in *high light* conditions, exposure time between T1 and T2 may be used in *mid light* conditions, and exposure time greater than T2 may be used in *low light* conditions. Higher exposure time may result in a greater amount of motion blur within the captured visual content.” *Id.* 19:20-26 (emphasis added), Fig. 7.

55. In addition to proactive adjustments to exposure time, the '840 Patent uses smoothing values and smoothing directions (Ex. 1001, 22:2-7), a set of constraints, and optimization parameters to smooth the trajectory depending upon the recording conditions. For example, “[i]n some implementations, a set of

PUBLIC VERSION

parameters... may control the generation of the smoothed trajectory” and may include the *low-light* high-pass parameter. Ex. 1001, 22:22-35.

56. This low-light high-pass parameter is part of a sophisticated system designed to proactively modify smoothing based on environmental factors—unlike Shi’s reactive approach based on first estimating the motion blur. Specifically, Fig. 7 demonstrates how the system adapts smoothing based on lighting conditions and hence the exposure time, with different values used for short or long exposure times, depending on whether the environment is well-lit or in low light.

57. In contrast, Shi’s discussion of a coefficient to handle motion blur is a reactive approach. Shi’s system adjusts based on estimating the motion blur first in the captured frames, and interpolating between real and virtual camera positions based on the estimated blur. Ex. 1007, 17:59-66, 18:1-10. This coefficient is applied generally to reduce the perception of unnatural motion blur, without addressing specific conditions like low-light environments. Shi’s coefficient does not contemplate a dynamic, proactive response to anticipated blur caused by low-light conditions, nor does it offer a mechanism for adjusting smoothing based on such anticipation.

58. By contrast, the low-light high-pass parameter in the ’840 Patent is proactively triggered by detecting low-light conditions that would lead to increased

PUBLIC VERSION

exposure times and, consequently, greater potential for motion blur. It optimizes stabilization by anticipating such conditions and adjusting stabilization to compensate for motion blur based on factors like lighting and exposure. This nuanced control mechanism enables the system to balance the need for stabilization with the need to mask or compensate for motion blur. Ex. 1001, 18:37-42. In particular, the ‘840 patent also teaches that when motion blur is anticipated by low light environment, its effect may be compensated by having the smoothed trajectory in stabilization follow the (observed) trajectory during the exposure periods under low light conditions. Ex. 1001, 22:2-7. The ‘840 patent thus teaches also that the alignment of stabilized trajectory with the anticipated direction of motion blur (i.e. the observed trajectory) can avoid “poor visual impressions” known as “motion blur pulsation” in video stabilization. Ex. 1001, 22:2-7. This teaching of using the anticipated direction of blur in addition to the anticipated blur strength is not disclosed anywhere in Shi for video stabilization.

59. Furthermore, Shi’s coefficient operates in a binary fashion—adjusting only when motion blur exceeds a certain threshold. Ex. 1007, 18:34-37. It lacks the granular control over smoothing strength and blur compensation that the low-light high-pass parameter in the ‘840 Patent provides. In contrast, the ‘840 Patent’s parameter offers dynamic adjustments, allowing for fine-tuning based on exposure

PUBLIC VERSION

time and other environmental factors, as explained in connection with Fig. 7. This level of control is critical when stabilizing video in low-light scenarios, where the trade-off between blur compensation and maintaining stability is more pronounced.

60. In summary, Shi's coefficient is a general-purpose, reactive blur compensation mechanism, whereas the low-light high-pass parameter in the '840 Patent is a proactive, finely-tuned control mechanism designed to anticipate and manage motion blur strength and its direction in low-light scenarios. The '840 Patent goes beyond simply reacting to blur; it adjusts smoothing dynamically based on environmental inputs, ensuring optimal stabilization under varying conditions, particularly in low light.

B. A POSITA Would Not Have Been Motivated to Combine Bell and Shi

61. The Petition argues that the combination of Bell and Shi would have been obvious because both are aimed at stabilizing videos and addressing issues like motion blur. It suggests that a person skilled in the art would have been motivated to combine Shi's motion blur compensation technique with Bell's video stabilization technique. But, in my opinion, a POSITA would not have been motivated to combine Bell and Shi to create a stabilization system as claimed to "determine a smoothed trajectory of the housing based on a look-ahead of the

PUBLIC VERSION

trajectory and one or more of a weight-balance parameter, a low-light high-pass parameter, and/or a stickiness parameter.”

62. In my opinion, Bell and the '840 patent are targeting fundamentally different applications and markets. Bell clearly discloses that their target application is narrow and is for “cell phones and other mobile devices” for “recording casual video” (Ex. 1006, 1:15-29), whereas the '840 patent is not so limited and applies to casual as well as specialized video, e.g. bodycams in fast sports, or mobile agile platforms, etc. That is why Bell does not incorporate accelerations (linear or angular) or higher order derivatives, whereas the '840 patent does, and teaches a weighted balanced objective function depending on various input video characteristics (linear/angular velocity/acceleration or higher order derivatives), so a wide range of applications can be covered.

63. Bell focuses on real-time video stabilization for cell phones and other mobile devices while recording casual video using a look-ahead buffer but does not address low-light conditions or motion blur. Shi discusses handling blur, but primarily in the context of adjusting the virtual camera position based on frame blur detected and estimated after the fact. In my opinion, there is no clear teaching or suggestion in the references that would motivate a skilled artisan to combine Bell’s smoothing technique with Shi’s *reactive*, blur-handling method to arrive at a

PUBLIC VERSION

system incorporating the *proactive low-light* high-pass parameter as defined in the '840 Patent.

64. Furthermore, in my opinion, Petitioner's reliance on the alleged combination of Bell and Shi reflects improper hindsight reasoning. Petitioner fails to offer any reasoned motivation based on the prior art to combine Bell's look-ahead smoothing with Shi's reactive blur compensation. In my opinion, a POSITA, without hindsight, would not have been motivated to combine two fundamentally different systems—Bell's forward-looking approach and Shi's reactionary method.

65. Moreover, in my opinion, the combination of Shi's reactive blur detection and estimation with Bell's anticipatory stabilization would undermine Bell's look-ahead functionality. Such a combination would lead to incompatible techniques, as Bell is focused on pre-emptively adjusting for future motion, while Shi reacts only after blur is detected. Combining these systems would thus render Bell's system inoperable for its intended purpose, leading to technical incompatibility. The Petition fails to address these fundamental differences, further weakening the rationale for combining these systems.

66. In sum, in my opinion, Petitioner has not articulated a rationale supported by the evidence that would motivate a POSITA to combine Bell's and Shi's systems in a way that would result in the claimed invention.

PUBLIC VERSION**III. GROUND 2 THROUGH 7 FAIL ON THE MERITS**

67. Petitioner asserts that the combination of Bell and Shi in combination with various other references render the remaining dependent claims of the '840 Patent obvious. However, these combinations fail for the same reason as Ground 1, as all dependent claims require one or more of the low-light high pass, weight-balance and stickiness parameters of the independent claims.

IV. PETITIONER FAILS TO PROVIDE A REASONABLE EXPECTATION OF SUCCESS OR ADEQUATE MOTIVATION TO COMBINE

68. In my opinion, none of Petitioner's grounds of challenge have adequately explained why a POSITA would combine the references or reasonably expect the combination to succeed. It is my understanding that it is Petitioner's burden to provide a non-conclusory, articulate explanation as to why a Petitioner would combine references, and how they would reasonably expect success.

69. For Ground 1, while Petitioner's expert attempts to explain a reasonable expectation of success by noting the shared video stabilization goals of Bell and Shi (Ex. 1003, ¶124), in my opinion, this analysis is both superficial and conclusory and fails to address the fact that Bell and Shi are both aimed at "casual video" stabilization for mobile devices (Ex. 1006, Intro) lacking the rigorous stabilization needed for more specialized applications.

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70. Bell’s system, designed for casual video capture by cell phones and other mobile devices, does not address the complex rotational dynamics or proactive approach to low-light conditions by the ’840 Patent. And, in my opinion, Shi does not remedy this deficiency. Therefore, while Petitioner argues that a combination of these references would succeed, the focus on casual image capture and mobile devices in both references makes it unlikely that such a combination would lead to the claimed invention of the ’840 Patent, which is designed for a wider range of applications, including more demanding applications (e.g., bodycams in sports or agile platforms with fast-changing motion characteristics). Petitioner has not explained nor demonstrated why a POSITA would have expected success in extending Bell’s and Shi’s mobile-specific methods to the more specialized environments addressed by the ’840 Patent.

V. SECONDARY CONSIDERATIONS CONFIRM THE NON-OBVIOUSNESS OF THE ’840 PATENT

71. In my opinion, there is strong, objective evidence that the ’840 Patent is not obvious. Patent Owner GoPro, Inc. (“GoPro”) successfully manufactured and sold wearable action cameras that include GoPro’s novel HyperSmooth technology, which I understand GoPro asserts is an embodiment of the ’840 Patent. Ex. 2006 (Complaint), ¶22.

PUBLIC VERSION

72. I have reviewed GoPro documents [REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

73. I have seen evidence of commercial success, specifically a press release indicating GoPro has sold over 50 million action cameras since 2009, with its HERO series cameras, featuring HyperSmooth stabilization, at the forefront of this success. *See* Ex. 2003 (“GoPro Celebrates Surpassing 50 Million Cameras Sold”). For example, the HERO7, which introduced HyperSmooth as a flagship feature, [REDACTED]

[REDACTED]

PUBLIC VERSION

[REDACTED]

[REDACTED]

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

75. This success is closely linked to specific features of GoPro’s patented technologies, such as its innovative use of specific stabilization parameters,

PUBLIC VERSION

including the weight-balance parameter, low-light high-pass parameter, and stickiness parameter. These parameters work together to ensure precise control over the stabilization process, allowing the system to adapt to various recording conditions, as described and claimed in the '840 Patent.

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

77. Third-party reviews consistently highlight HyperSmooth as a groundbreaking feature that sets GoPro apart from competitors, with praise for its

PUBLIC VERSION

ability to deliver stable, smooth video footage in challenging conditions. Ex. 2013 (analysts at JP Morgan stating GoPro’s “gimbal like hypersmooth stabilization (developed in-house software and hardware)” was “a significant upgrade” when introduced and was the “key selling point” in the HERO7 camera); Ex. 2014 at 5 (“GoPro’s HyperSmooth image stabilization is the best we’ve seen on any action camera”).

78. I have seen evidence of long-felt, but unmet need. For example, before the introduction of HyperSmooth, users of action cameras faced persistent challenges in capturing stable footage during high-vibration activities like mountain biking, hiking, or surfing. Mechanical gimbals, while used for stabilization, were bulky, fragile, and unsuitable for dynamic environments of such applications.

79. [REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

PUBLIC VERSION

[REDACTED]

[REDACTED]

80. I have seen evidence of unexpected results. For example, GoPro's system consistently outperformed traditional stabilization techniques, which often failed to maintain stabilization under rapidly changing motion characteristics, showcasing the unexpected success of the HyperSmooth system over prior technologies. Ex. 2014 ("GoPro's HyperSmooth image stabilization is the best we've seen on any action camera"); [REDACTED]

[REDACTED]

81. I have seen evidence of possible copying, as I understand in an ITC investigation, Insta360, a direct competitor, is accused of copying GoPro's HyperSmooth technology.

V. CONCLUSION

82. In signing this declaration, I recognize that the declaration will be filed as evidence in a contested case before the Patent Trial and Appeal Board of the United States Patent and Trademark Office. I also recognize that I may be subject to cross-examination in the case and that cross-examination will take place within the United States. If cross-examination is required of me, I will appear for cross-examination within the United States during the time allotted for cross-examination.

PUBLIC VERSION

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

Executed: October 28, 2024

/s/ Hassan Foroosh

Hassan Foroosh, Ph.D.