

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

SAMSUNG ELECTRONICS CO. LTD.,
SAMSUNG ELECTRONICS AMERICA, INC. and
GOOGLE LLC
Petitioners

v.

EYESMATCH LTD.,
Patent Owner

Case No. IPR2024-00810
U.S. Patent No. 8,982,110

**DECLARATION OF DR. DAVID FORSYTH IN SUPPORT OF PATENT
OWNER EYESMATCH LTD.'S RESPONSE TO PETITION FOR *INTER*
PARTES REVIEW OF U.S. PATENT NO. 8,982,110**

TABLE OF CONTENTS

I.	INTRODUCTION	1
A.	Education and Professional Experience.....	1
B.	Compensation	6
C.	Materials Reviewed and Relied Upon	6
D.	Legal Principles	6
1.	Claim Construction.....	7
a.	“mirror tracking mode”/ “it appears to mimic a reflection of a mirror”	10
b.	“adaptive transformation mapping”/ “transformation mapping”	10
2.	Pre-America Invents Act	11
3.	Presumption of Validity and Burden of Proof.....	11
4.	Invalidity: Anticipation	12
5.	Invalidity: Obviousness	12
6.	Invalidity: Objective Indicia of Non-Obviousness.....	18
E.	Level of Ordinary Skill in the Art.....	20
II.	BACKGROUND	20
A.	The 110 Patent	20
B.	General Optical Properties of a Conventional Mirror	21
C.	Overview of the References.....	28
1.	Haan.....	28
2.	Francois	29

3.	Rosenberg	30
4.	Park.....	30
5.	Geisner.....	30
6.	Lizee	31
III.	PETITION GROUNDS	31
A.	Ground 1: Petitioners Fail to Show Unpatentability of Claims 1-6, 10-12, and 16-17 in View of Haan and Francois.....	31
1.	Neither Haan Nor Francois, Alone Or In Combination, Disclose Limitation 1(f)	31
2.	Petitioners Fails to Show Motivation to Combine Haan and Francois for Limitation 1(f).....	38
3.	Francois Does Not Disclose Limitations 1(c) and 1(e)	39
4.	Petitioners Fail to Show Motivation to Combine Haan and Francois for Limitations 1(c) and 1(e).....	40
B.	Ground 2: Petitioners Fail to Show Invalidity of Claims 1-6 and 10-12 in View of Rosenberg and Park.....	43
1.	Neither Rosenberg Nor Park, Alone Or In Combination, Disclose Limitation 1(f)	43
2.	Petitioners Fail to Show Motivation to Combine Rosenberg and Park as to Limitation 1(f).....	49
3.	Rosenberg Does Not Disclose Limitations 1(c) and 1(e).....	50
4.	Petitioners Fail to Show Motivation to Combine Rosenberg and Park as to Limitation 1(c) and 1(e).....	56
C.	Ground 3: Petitioners Fail to Show Invalidity of Claims 1-18 in View of Geisner and Lizee	75
1.	Neither Geisner Nor Lizee Disclose Limitation 1(f).....	75

2.	Petitioners Fail to Show Motivation to Combine Geisner and Lizee for Limitation 1(f).....	85
3.	Geisner Does Not Disclose Limitations 1(c) and 1(e).....	86
4.	Petitioners Fail to Show Motivation to Combine Geisner and Lizee for Limitations 1(c) and 1(e)	89
D.	Ground 4	90
E.	Ground 5	92

I, Dr. David Forsyth, hereby declare as follows:

I. INTRODUCTION

1. Counsel for EyesMatch Ltd. (“Patent Owner”) has retained me as an expert in this matter to provide my independent opinion in regard to the matters at issue in *inter partes* review of U.S. Patent No. 8,982,110 (the “110 Patent”) in IPR2024-00810.

2. I submit my opinions in this declaration based on my study of the evidence; my education, training, research, knowledge, and personal and professional experience; and my understanding as an expert in the field.

3. This declaration contains statements of my opinion formed to date and the bases and reasons for those opinions. I may offer additional opinions based on further review of materials in this case, to rebut opinions offered by any of Petitioners’ experts, and to address issues raised by Petitioners in their briefing to the extent permitted by the Patent and Trademark Appeal Board.

A. Education and Professional Experience

4. My qualifications and credentials are fully set forth in my *curriculum vitae*, attached as Attachment 1.

5. I am currently the Fulton-Watson-Copp Chair in Computer Science at the University of Illinois at Urbana-Champaign. I believe that my background and expertise qualify me as an expert in the technical issues in this matter. My full

Curriculum Vitae is attached to this Opinion as Attachment 1. A summary of my qualifications is included below.

6. My education began in Cape Town, South Africa. I was an undergraduate at the University of the Witwatersrand, Johannesburg, and I hold a Bachelor of Science (1984) and Master of Science in Electrical Engineering from that University. I was awarded the Diocesan College Rhodes Scholarship in 1984 to attend Oxford University. I hold a Master of Arts by special election from Oxford University and a Doctorate of Philosophy in Engineering Science from Balliol College, Oxford. I was appointed Fellow by Examination of Magdalen College, Oxford in 1989. I was then appointed Assistant Professor of Computer Science at the University of Iowa in 1991; in 1994, I was promoted to Associate Professor of Computer Science, and went on leave of absence to take up an appointment as Assistant Professor of Computer Science at U.C. Berkeley. I was promoted to Associate Professor of Computer Science at U.C. Berkeley in 1996, and to Professor of Computer Science in 2002. I went on leave of absence from U.C. Berkeley to take up an appointment as Professor of Computer Science at the University of Illinois at Urbana-Champaign in 2004. I am currently the Fulton-Watson-Copp Chair in Computer Science at the University of Illinois at Urbana-Champaign.

7. I have studied Computer Vision since my final year as an undergraduate in 1984, when I engaged in an undergraduate project on the topic. My Ph.D. thesis

treats a traditional problem in computer vision, known as “color constancy,” and the paper that resulted from this work is still quite regularly cited. As a Fellow by Examination, I studied illumination and shading effects in vision, and geometric methods to recognize objects. I have published papers on a wide range of topics in computer vision, computer graphics, machine learning and human-computer interfaces. I have published about 220 refereed papers and 10 book chapters. I have published one textbook on computer vision in two editions and four languages, one research monograph, and two recent textbooks on machine learning. I have edited six volumes of collected papers. A reasonably complete list of my publications is contained in my curriculum vitae in Attachment 1.

8. In addition, I have occupied various leadership posts within my discipline. I was (or will be) program co-chair for the Institute of Electrical and Electronics Engineers (“IEEE”) Conference on Computer Vision and Pattern Recognition (“CVPR”) in 2000, 2011, 2018 and 2021, and for the European Conference on Computer Vision (“ECCV”) in 2008. I was general co-chair for CVPR in 2006 and again held the position for CVPR 2015. I was general co-chair for the IEEE International Conference on Computer Vision in 2019. I am an Associate Editor of the International Journal of Computer Vision; of the Association for Computing Machinery (“ACM”) Transactions on Graphics; and of the Journal of the ACM. I was the Editor in Chief of the IEEE Transactions on Pattern Analysis

and Machine Intelligence (“TPAMI”) for four years. TPAMI is a journal which receives approximately 1000 submissions per year, and which is usually seen as the leading journal in the discipline. I also served for three years on a committee of the National Research Council, convened to study methods to protect children from pornography and other inappropriate material on the internet.

9. Throughout my career I have received a variety of awards. In 1993, the Marr prize for Best Paper at the International Conference on Computer Vision was awarded to “Extracting Projective Structure from Single Perspective Views of 3D Point Sets,” a paper I wrote with Charles A. Rothwell, Andrew Zisserman, and Joseph L. Mundy. In 2002, the award for Best Paper in Cognitive Computer Vision at the European Conference in Computer Vision was awarded to “Object recognition as machine translation: Learning a lexicon for a fixed image vocabulary,” a paper I wrote with P. Duygulu, K. Barnard, and J.F.G. de Freitas. I was awarded an IEEE Technical Achievement Award in 2005 for my work on Computer Vision. I became an IEEE Fellow in 2009, and an ACM Fellow in 2014. In 2024, I received the Mark Everingham Prize at the European Conference in Computer Vision.

10. My work is extensively cited in computer vision literature, with 45,185 citations recorded by Google scholar in Jan, 2025.

11. My appended CV lists all publications authored in the past 10 years, with perhaps a few exceptions that I have forgotten.

12. I have made extensive contributions to computer vision education. I am lead co-author of a widely used textbook in the discipline, “Computer Vision - A Modern Approach”, which has appeared in two editions and four languages. I have written two other textbooks, and am the lead co-author of the computer vision chapter in the leading Artificial Intelligence textbook. I have trained 35 Ph.D. students. I have trained people who are very well known academics in computer vision. Tamara Berg was associate professor of computer science at the University of North Carolina at Chapel Hill and is now an entrepreneur. Ali Farhadi is professor of computer science at the University of Washington and CEO of the Allen Institute for Artificial Intelligence. Deva Ramanan is a tenured professor of computer science at Carnegie Mellon University. Gang Wang was assistant professor of computer science at Nanyang Technological University in Singapore, and moved to become the senior lead in AI research at Alibaba. Zicheng Liao is a professor of computer science at Zhejiang University. Kobus Barnard is professor of computer science at University of Arizona. Each is seen as a young leader in the field.

13. Based on my above-described 35 years of experience in the field of computer vision and the acceptance of my publications and professional recognition by societies in my field, I believe that I am considered to be an expert in the field of computer vision (including image analysis).

B. Compensation

14. I am being compensated for my time in connection with this case at my standard legal consulting rate, which is \$450 per hour. I have no personal or financial interest in the outcome of this proceeding.

C. Materials Reviewed and Relied Upon

15. In formulating my opinions, I have considered: U.S. Patent Nos. 8,982,109 and 8,982,110 and their corresponding file histories; Patent Owner's Response filed concurrently herewith including all documents cited therein; all documents cited in this declaration; the Petition in IPR2024-00810 (Paper 1) and all Exhibits thereto including the Expert Declaration of Dr. Lina Karam; the Patent Owner's Preliminary Response (Paper 17) and all Exhibits thereto; the Institution Decision (Paper 20), the claim construction briefing and Claim Construction Order in *EyesMatch Ltd. v. Samsung Electronics Co., Ltd., et al.*, No. 2:23-cv-363 (E.D. Tex.) ("the District Court Litigation"), and the deposition of Dr. Lina Karam taken on February 26, 2025 in connection with this IPR. If Petitioners' expert submits an additional declaration, I may submit a supplemental declaration addressing any new opinions or additional explanations, as appropriate and if permitted.

D. Legal Principles

16. I am not a lawyer. I have been provided with an understanding of the legal principles that govern claim construction and patent validity. I have conducted

my analysis in conformance with these principles. I set forth those understandings below.

1. Claim Construction

17. I understand that in assessing the patentability of a claim, the Patent Office generally construes claim terms in accordance with their ordinary and customary meaning as understood by a person of skill in the art (“POSITA”) at the time of the invention in view of the claim language in light of the specification and file history.

18. I understand that various sources are available that may help show what a claim term should mean. These sources include the text of the claims themselves, the patent’s specification, the prosecution history of the patent, and the prior art cited in a patent or in the prosecution history. Together, I understand that these sources are called “intrinsic” evidence. I also understand that other sources for example concerning relevant scientific principles, dictionaries or technical dictionaries, and other information concerning the state of the art is called “extrinsic” evidence. I understand that extrinsic evidence may not be used to contradict the claim language.

19. I understand that claim terms should generally be given their ordinary meaning, which is the meaning that the term would have to a person of ordinary skill in the art in question at the time of the invention

20. I understand that the context in which a claim term is used can be highly instructive. Other claims of the patent in question, both asserted and not asserted, can also be valuable sources as to the meaning of a claim term. Because claim terms are normally used consistently throughout the patent, the usage of a term in one claim can often illuminate the meaning of the same term in other claims. Differences among claims can also be a useful guide in understanding the meaning of particular claim terms.

21. I understand that a person of ordinary skill in the art is deemed to read a claim term not only in the context of the particular claim in which the disputed term appears, but also in the context of the entire patent, including the specification. The specification is the primary basis for construing the claims and is considered the single best guide to the meaning of a disputed term. For this reason, the words of the claim must be interpreted in view of the specification. The interpretation of a term can only be determined and confirmed with a full understanding of what the inventors actually invented and intended to cover within the claim.

22. A claim term should not be interpreted to exclude embodiments disclosed in the specification absent probative evidence to the contrary. I further understand that, in general, the claimed invention is not limited to a preferred embodiment, even if the specification does not describe any other embodiment.

23. In addition to consulting the specification, one should also consider the patent's prosecution history, if it is available. The prosecution history consists of the complete record of the proceedings before the Patent Office and includes cited prior art. The prosecution history can inform the meaning of the claim language by demonstrating how the inventor understood the invention. I understand that the prior art cited in a patent, or the prosecution history of the patent, also constitutes intrinsic evidence.

24. I have been asked to offer my opinion regarding the level of ordinary skill in the art at the time of the invention or the effective filing date, which I understand to be December 2012 for the 110 Patent. I have considered the types of problems encountered in the art, the prior solutions to those problems found in prior art references, the rapidity with which innovations are made, the sophistication of the technology, the level of education of active workers in the field and my own experience working with those of skill in the art at the time of inventions.

25. I understand that Petitioner Samsung is a Defendant in *EyesMatch Ltd. v. Samsung Electronics Co., Ltd., et al.*, No. 2:23-cv-363 (E.D. Tex.) ("the District Court Litigation") in which the 110 Patent is also asserted. I understand that the District Court issued a claim construction order in the District Court Litigation. Ex. 2008. I further understand that the PTAB will consider this claim construction order and may find the District Court's reasoning to be persuasive. In reviewing

Petitioners’ asserted prior art and forming my opinions in this Declaration, I have applied the constructions from the District Court Litigation Claim Construction Order.

a. “mirror tracking mode”/ “it appears to mimic a reflection of a mirror”

26. With respect to the 110 Patent, I understand that the claim construction order in the District Court Litigation construed the following terms that are relevant to the 110 Patent, limitation 1(f). The term “mirror tracking mode” was construed as “a mode of operation in which the user sees their reversed reflection appearing at roughly double the distance from the camera and the reflection maintains roughly the same size regardless of the user movement”. Ex. 2008 at 41. The term “it appears to mimic a reflection of a mirror” was construed as “an image where the user sees their reversed reflection appearing at roughly double the distance from the camera and the reflection maintains roughly the same size regardless of the user movement.” Ex. 2008 at 19.

b. “adaptive transformation mapping”/ “transformation mapping”

27. With respect to the 110 Patent, I understand that the claim construction order in the District Court Litigation construed the following terms that are relevant to the 110 Patent, limitation 1(c). The term “adaptive transformation mapping” was construed as “continuously variable transformation mapping”. Ex. 2008 at 37. The

term “transformation mapping” was construed as a “selected set of image transformations”. Ex. 2008 at 14.

2. Pre-America Invents Act

28. I understand Petitioners seek cancellation of Claims 1-18 of the 110 Patent under pre-AIA 35 U.S.C. § 103.

29. I understand that the pre-AIA patent statute applies to the 110 Patent because, although it was filed after March 16, 2013 (filed April 15, 2014), the challenged claims claim priority to a provisional application that was filed before March 16, 2013 (Provisional Application No. 61/738,957, filed December 18, 2012).

30. I understand effective filing date to mean either: (1) the actual date on which the patent application containing the claimed invention was filed; or (2) the filing date of an earlier patent application (*e.g.*, provisional and non-provisional applications, domestic and foreign) upon which patent application containing the claimed invention relies for priority.

31. I understand the date of the claimed invention to be either: (1) the effective filing date of the patent; or (2) when the claimed invention was conceived or reduced to practice.

3. Presumption of Validity and Burden of Proof

32. I have been informed that an issued patent is presumed valid, and a party seeking to challenge the validity of a claim of an issued patent must submit

proof that each claim is invalid. I understand that in this IPR, Samsung bears the burden of proving invalidity by a preponderance of the evidence.

4. Invalidity: Anticipation

33. I understand that Petitioners do not contend that any prior art reference anticipates the Asserted Claims of the 110 Patent.

5. Invalidity: Obviousness

34. I have been informed that if a single reference does not contain every limitation of a patent claim, it can only invalidate that claim if it would be obvious when considered in light of other prior art references or devices without viewing the combination with hindsight bias. The claim is invalid only if the differences between the claimed invention and the prior art are such that the claimed invention, as a whole, would have been obvious to a person having ordinary skill in the art at the time the invention was made (without the benefit of hindsight bias).

35. I have been informed that prior art references can be combined to show a patent is invalid as obvious under 35 U.S.C. § 103.

36. I understand that an obviousness evaluation can be made on a single reference or a combination of several prior art references. For example, a single reference, when considered in view of the knowledge of a person of ordinary skill in the art, could render a claim obvious.

37. I have been informed that the analysis of obviousness involves several factual inquiries including: (1) level of ordinary skill in the pertinent art; (2) the scope and content of the prior art; (3) the differences between the prior art as a whole and the claim at issue; and (4) objective indicia of non-obviousness (also known as secondary considerations of non-obviousness). I understand that the patentee has the burden of production on any objective indicia of non-obviousness.

38. I have been informed that the test for analogous art is very specific. I have been informed that art is non-analogous unless it is: (1) from the same field of endeavor as the claimed invention; or (2) reasonably pertinent to the particular problem faced by the inventor. I have been informed that an art citation that is not from the same field of endeavor as a claimed invention must be “reasonably pertinent” to the problem addressed by the inventor. I have been informed that art is “reasonably pertinent” when it would “logically commend itself” to an inventor’s attention in considering his problem. Conversely, I have been informed that when art is directed to a different purpose than a claimed invention, an inventor would have less motivation or occasion to consider it.

39. I have been informed that the fact that prior art references all concern the same field of endeavor is not in itself sufficient rationale for making the combination. Many types of techniques and systems exist in the same field of endeavor. That fact alone would not make it obvious to combine their features. I

have been informed that a proper obviousness determination must show the reason why a person of ordinary skill in the art would have thought to combine particular available elements of knowledge, as evidenced by the prior art, to reach the claimed invention.

40. I have been informed that a party seeking to invalidate a patent on obviousness grounds must demonstrate that a skilled artisan would have been motivated to combine the teachings of the prior art references to achieve the claimed invention and that the skilled artisan would have had a reasonable expectation of success in doing so.

41. I understand for a claim to be obvious where not every element of a claim is taught by the prior art, a party trying to show obviousness must show why it would have been obvious to a person of ordinary skill in the art to both combine the prior art references and overcome the differences and make modifications between the claimed invention and the prior art. I also understand that the existence of every element of the claimed invention in the prior art does not necessarily mean a skilled artisan would have been motivated to combine those references. I also understand that a skilled artisan must have had a reason to combine the elements in the same way as the claimed invention. Conclusory statements that a skilled artisan would have been motivated to combine the prior art or would have thought it obvious to modify the prior art are insufficient to show obviousness.

42. I have been informed that, when assessing if there was motivation to combine the prior art references, important factors include: (1) whether the claimed invention was merely the predictable result of using prior art elements according to their known functions; (2) whether the claimed invention provides an obvious solution to a known problem in the relevant field; (3) whether the prior art teaches or suggests the desirability of combining elements in the invention; (4) whether the prior art teaches away from combining elements in the claimed inventions; and (5) whether it would have been obvious to try the combinations of elements, such as when there is a design incentive or market pressure to solve a problem and there are a finite number of identified, predictable solutions.

43. I have been informed that to establish *prima facie* obviousness of a claimed invention, all the claim limitations must be taught or suggested by the prior art.

44. I understand that Petitioners, as the challengers asserting obviousness based on a combination of prior-art references, must demonstrate that a POSITA would have been motivated to combine the teachings of the prior art references to achieve the claimed invention and that the skilled artisan would have had a reasonable expectation of successfully achieving the claimed invention from the combination.

45. I understand that a showing that a prior art reference teaches away from a given combination is evidence that one of skill in the art would not have been motivated to make that combination to arrive at the claimed invention. A reference may be said to teach away when a POSITA, 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. If the proposed invention would defeat the purpose of a reference, for example, that reference teaches away from the invention. To teach away, the reference must criticize, discredit, or otherwise discourage the solution reached by the proposed invention. I also understand that the absence of a formal teaching away in one reference does not automatically establish a motivation to combine it with another reference in the same field.

46. I have been informed that if the proposed modification or combination of the prior art would change the principle of operation of the prior art invention being modified, then the teachings of the references are not sufficient to render the claims *prima facie* obvious.

47. I have been informed that to determine whether a combination of known elements would have been obvious to a person of ordinary skill in the art at the time of the invention, one must consider the references in their entirety to

ascertain whether the disclosures in those references render the combination obvious to such a person.

48. I have been informed that the combination of familiar elements according to known methods may be obvious when it does no more than yield predictable results. Additionally, I understand that a patent may be invalid for obviousness if a POSITA can implement a predictable variation or if there existed at the time of the invention a known problem for which there was an obvious solution encompassed by the patent's claims. I understand that the obvious solution only needs to be a known solution for solving the problem, and not an improvement over other solutions. A combination is not obvious, however, where the combination cannot be implemented without undue experimentation or when the motivation to create the combination comes from hindsight.

49. I have been informed that when there is a design need or market pressure to solve a problem and there are a finite number of identified, predictable solutions, a POSITA has good reason to pursue the known options within his or her technical grasp. I understand that, if this leads to anticipated success, it may be the product not of innovation, but rather of ordinary skill and common sense. I have been informed that the fact that a combination was obvious to try might show that the patent claim was obvious.

50. I have been informed that, even when all claim limitations can be found in a combination of prior art references, the fact-finder must consider as part of the obviousness determination not only what the prior art teaches, but whether the prior art teaches away from the claimed invention and whether there is a motivation to combine teachings from separate references in the manner claimed.

6. Invalidity: Objective Indicia of Non-Obviousness

51. I have been informed that, in assessing whether a claimed invention is obvious, objective indicia of non-obviousness (sometimes referred to as “secondary considerations”) should be considered. I understand that the weight accorded to objective indicia evidence depends on that evidence being reasonably commensurate with the scope of the claims and the existence of a nexus between the merits of the claimed invention and the evidence of objective indicia. I have been informed that objective indicia that may weigh towards the non-obviousness of the invention include the following:

- Whether the claimed invention satisfied a long-felt need;
- Whether the claimed invention was preceded by a history of failures by others to solve a problem or problems solved by such invention;
- Whether the claimed invention achieved a surprising or unexpected result;
- Whether the claimed invention exhibited performance superior to prior art devices and/or methods;

- Whether the claimed invention has achieved commercial success;
- Evidence of industry acquiescence;
- Licenses;
- Whether the claimed invention has been copied;
- Whether the particular claimed invention was the subject of skepticism by the industry; and
- Whether the prior art taught away from the claimed invention.

52. I have been informed that evidence of a long felt but unresolved need tends to show non-obviousness because it is reasonable to infer that the need would have not persisted had the solution been obvious. I understand that objective considerations such as failures by others to solve the problem and copying may often be the most probative and cogent evidence of non-obviousness. I understand that the significance of licensing a patent as an objective indicium in enhancing the non-obviousness of an invention is that an independent third party with an interest in being free of the patent has chosen to respect it and pay a royalty under it rather than litigate and invalidate it. I understand that there is a nexus between the patent and the licensing activity when the factfinder can infer that the licensing arose out of recognition and acceptance of the subject matter claimed in the patent. I understand that the commercial response to an invention is significant to determinations of non-obviousness.

E. Level of Ordinary Skill in the Art

53. Based upon my experience in this area, a person of ordinary skill in the art (“POSITA”) in this field at the relevant time frame would have been familiar with the design of, theory behind, principles of operation of, intended use of, and the underlying technology used in computer vision. This typically would consist of a minimum of a bachelor in science in Computer Science or Electrical Engineering (or related engineering field) plus either a year of graduate training or 2-4 years of relevant experience, with the graduate training or relevant experience including experience in computer vision techniques and principles.

54. I would qualify as a POSITA as of the priority date of the 110 Patent, and have applied the understanding of such a POSITA in forming my opinions.

II. BACKGROUND

A. The 110 Patent

55. U.S. Patent No. 8,982,110 (the “110 Patent”) issued on March 17, 2015, and is entitled “Method for Image Transformation, Augmented Reality, and Telep[re]sence”. It lists Ofer Saban and Nissi Vilcovsky as inventors. Ex. 1001 (“110 Patent”).

56. The 110 Patent is directed to methods of modifying a stream of images of a user with adaptive transformation mapping so that the images appear to be captured from a different point of view than that of the camera’s actual point of view,

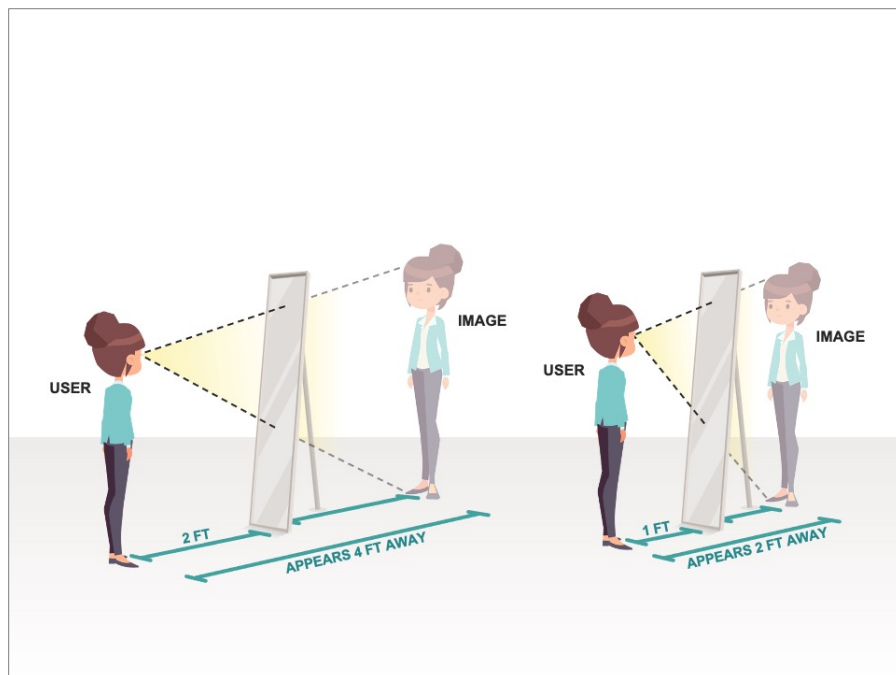
including by, for example, rotating, resizing, or varying image magnitude. *See, e.g.*, 110 Patent at Claim 1.

57. As of the December 2012 priority date, the 110 Patent claims and teaches an unconventional way to use cameras, computers, and display devices to modify a stream of images of the user such that the displayed image appears to be from a different point of view than that of the actual camera.

B. General Optical Properties of a Conventional Mirror

58. With a conventional mirror, the image of the person looking into the mirror appears left-right reversed.

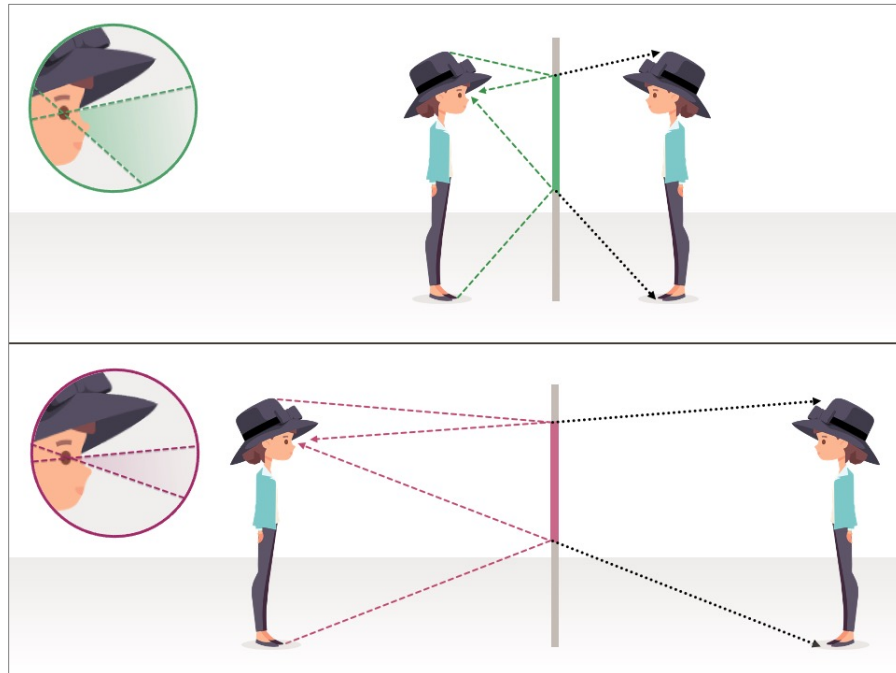
59. With a conventional mirror, the image of the person looking into the mirror appears at approximately double the distance that the person is standing from the mirror.



60. With a conventional mirror, the image of the person looking into the mirror is always approximately the same size regardless of the person's movement toward or away from the mirror.

61. The property of a conventional mirror by which the person looking into the mirror appears at approximately the same size regardless of the person's movement toward or away from the mirror may lead one to ask why people move very close to a mirror when they want to see something small on their face, like their iris for example. The actual size of the iris reflected in the mirror does not change as the person moves physically closer to the mirror. However, what does change is the visual angle subtended by their reflected iris. In particular, the iris in the mirror occupies a larger fraction of the viewer's retina. The change in this angle means that as the person gets closer to the mirror the portion of the retina occupied by the iris is greater even though the actual size of the displayed iris has not itself increased. This can be seen in the image below. On the top, an observer wearing a hat stands close to a mirror (green, left). The observer sees their mirror image (green, right) at an equal distance on the other side of the mirror. The rays from the observer's feet and hat to the mirror (green, dotted) are reflected into the observer's eye along the line of the rays from the observer's feet and hat to the observer's eye (green, dashed). The observer then moves to the red position, but the section of mirror occupied by the observer does not change (compare red dashed to green dashed). However, an

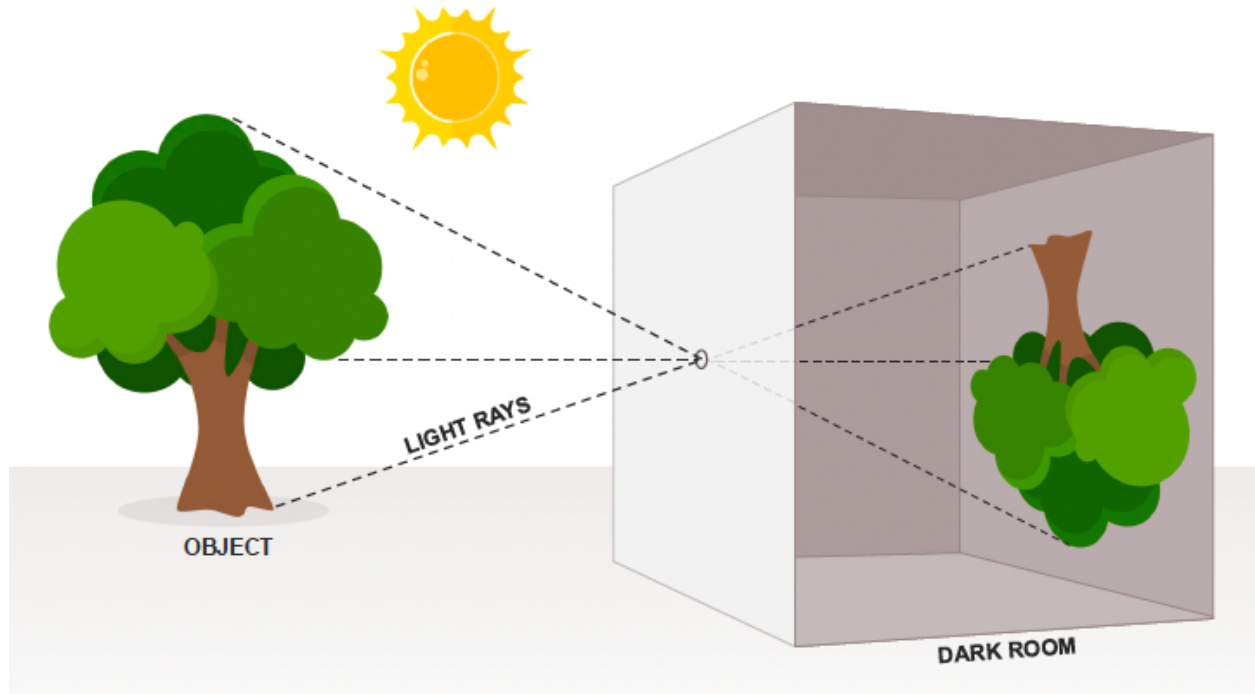
observer wanting to look at a facial detail will move closer to a mirror. This is because, although the size of the observer's reflection in the mirror does not change, the visual angle subtended by the reflection at the eye changes sharply. A relatively small range of rays arriving at the red observer's eye comes from the reflection (the red angle), but a much larger range of rays arriving at the green observer's eye comes from the reflection. The difference between the angles of the observer's eyes (red vs green, below) show how substantial this effect is.



62. Unlike a mirror, which inverts the viewer's image, a camera captures the subject person's image as if another person would see the subject person.

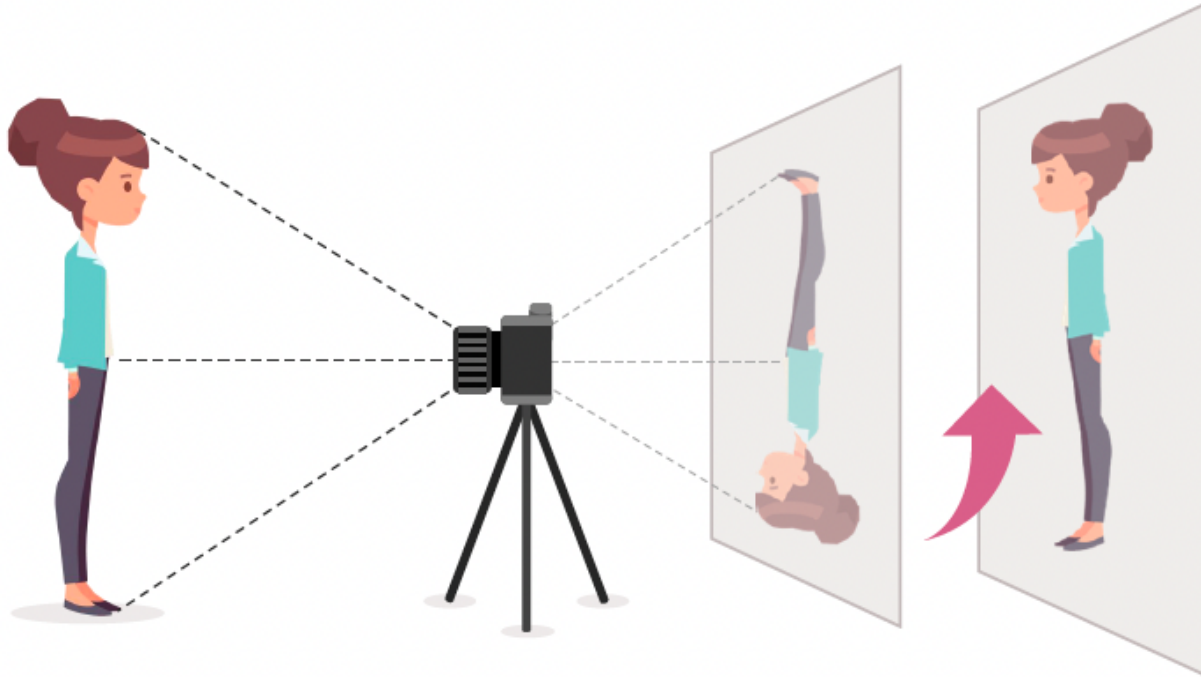
63. The forerunner to the modern camera was the camera obscura based on pinhole projection. If a person entered a completely dark room and light entered only through a very small hole, e.g., a pinhole, the outside scenery would be projected

onto the opposite wall. However, the image would be upside-down and left-right reversed.



64. The camera obscura produces dark images because the hole is small and so collects relatively little light. Furthermore, the camera obscura has no method to capture the image on the wall. Modern cameras have lens systems, designed to collect larger amounts of light and ensure that the light remains focused, as well as an image capture system. For a wide range of purposes, the geometric properties of almost all cameras are accurately modelled by the camera obscura. Exceptions include very large field of view lenses and some other lenses that distort images and chromatic aberration in lens systems. Image capture systems used to involve

chemical effects in film, but are now almost always solid state sensors. The image collected by the capture system can be rotated by 180 degrees before being displayed.



65. The key geometric feature of a camera is the focal point, corresponding to the hole in the camera obscura model. Light leaving a point in space passes through this focal point, and is then collected by the sensor. If the sensor is sufficiently large, rotating a camera about its focal point will change the image in a way that can be corrected using a form of transformation known as a homography. However, any movement of the camera in the scene that results in the focal point moving will produce a change in the image that cannot usually be corrected without detailed knowledge of the 3D geometry of the scene (exceptions include a plane scene). There is no pure transformation of an image that can reproduce the effect of

moving a camera focal point toward or away from a scene, absent detailed 3D geometric information. In particular, moving a camera toward or away from a scene is not equivalent to making an image larger or smaller, because occlusion effects between objects in the scene change. Magnifying or zooming an image is not the same as changing the point of view or changing the perspective, as the example in the figures below illustrates. This can be seen in the images below. In the first image, the coffee shop will appear to be about 6 inches high (because this is where the blue ray that just touches the top of the coffee shop strikes the ruler), and the top feature on the coffee shop is visible to the camera (red ray). When the camera moves closer to the coffee shop (second image), the front of the coffee shop occludes the top feature, and the coffee shop appears to be about 9 inches high. This means that there are regions of the first image that cannot be seen in the second image (the top feature on the coffee shop; the section of the ruler from 6 inches to 9 inches), meaning that reconstructing the second image from the first requires information that is not present in the first image. Therefore, magnification is **not** the equivalent to a change in camera position.



Image 1

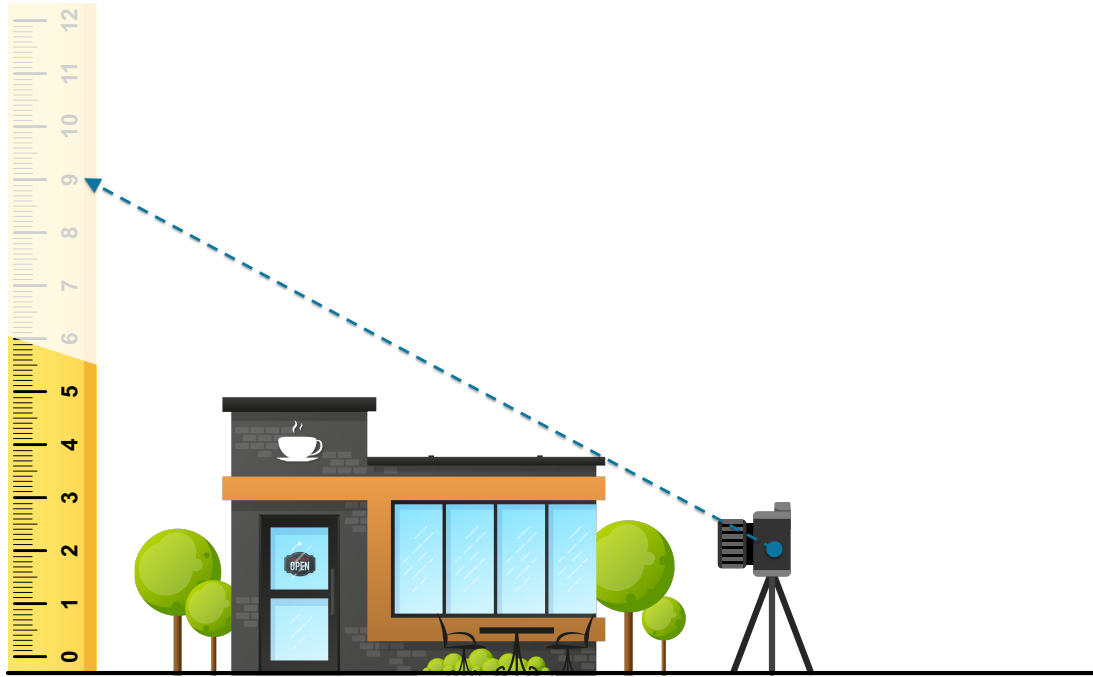


Image 2

C. Overview of the References

1. Haan

66. Haan is directed to a “mirror device” that determines the position of a body part and based on this position, the viewpoint from which the displayed image is recorded is changed. [Ex. 1005, Abstract]. Haan’s preferred embodiment is a reflective physical mirror with semi-transparent surface that can switch between both states. Ex. 1005, ¶ 0029.

67. Haan discloses both a single and a multiple camera embodiment. In the single camera embodiment, the camera is physically moved to change the point of

view. Ex. 1005, ¶ 0026. The multiple camera embodiment synthesizes the images obtained from the several cameras to “construct a virtual camera position and/or magnification” Ex. 1005, ¶ 0058. “The position of the virtual viewpoint is dependent on the determined face orientation”. Ex. 1005, ¶ 0058.

2. Francois

68. Francois is a paper discussing the development and application in demonstration projects of Software Architecture for Immersipresence (“SAI”). Ex. 1009, §§ 1.2-1.3.

69. One of the demonstration projects disclosed in Francois is a virtual handheld mirror simulation comprised of an “LCD screen manipulated by the user, a single camera fixed on the screen, and a tracking device.” Ex. 1009, § 4.3. The image displayed on the screen is described as a “close approximation of what the user would see on the screen surface if it were a real mirror.” Ex. 1009, § 4.3, Figure 12. In my opinion, Francois does not disclose modifying the image such that it appears to be captured from a different point of view than the camera’s actual point of view as required by Claim 1 of the 110 Patent. The mirror simulation detects the user’s face based on the magnetic trackers. Ex.1009, § 4.3. A POSITA would not regard this as a disclosure of detecting the user in the captured image as required by Claim 1 of the 110 Patent. It is also my opinion that none of Francois’ other

demonstration projects disclose utilizing the angle of the images and modifying the image to change the apparent perspective or point of view as required by Claim 1.

3. Rosenberg

70. Rosenberg discloses a “digital mirror system” which “emulates a traditional mirror by displaying real-time video imagery of a user who stands before it.” Ex. 1006 at Abstract. Rosenberg’s mirror system is also “adapted to provide real-time captured images that approximate what a user would see when viewing an ordinary mirror, with the addition of various other image processing features.” Ex. 1006, ¶¶ 0006, 0050, 0075, 0077. *See also, id.*, ¶ 0028.

4. Park

71. Park is directed to an image capturing apparatus and image capturing method to compensate for 3D distortion which occurs when the user’s image is captured while looking down towards a camera, such as a phone camera, based on the determined tilt of the device capturing the image. Ex. 1011, ¶¶ 0009, 0010.

5. Geisner

72. Geisner is directed to a shopping application of a virtual system with display interface on which a representation of a user is displayed, the user’s motions are tracked, and an interface is provided allowing the user to interact with virtual articles. Ex. 1007, Abstract, ¶¶ 003, 0024.

6. Lizee

73. Lizee is directed to a virtual presence system. [Ex. 1008, Abstract]. Lizee discloses an image capture device to capture a user's image "from which a virtual representation of the user may be generated and displayed" "by applying a mirrored silhouette transformation to the user image" Ex. 1008, Abstract, ¶¶ 0012, 0014.

III. PETITION GROUNDS

A. Ground 1: Petitioners Fail to Show Unpatentability of Claims 1-6, 10-12, and 16-17 in View of Haan and Francois

1. Neither Haan Nor Francois, Alone Or In Combination, Disclose Limitation 1(f)

74. Limitation 1(f) requires: "wherein during mirror tracking mode the processor utilizes the angle of the images captured by the camera and applies parametric input for a mapping transformation that changes imaging perspective of the images captured by the camera." In the District Court Litigation, the term "mirror tracking mode" was construed as "a mode of operation in which the user sees their reversed reflection appearing at roughly double the distance from the camera and the reflection maintains roughly the same size regardless of the user movement." Ex. 2008 at 41.

75. It is my opinion that Haan does not disclose limitation 1(f) of the 110 Patent under the construction of "mirror tracking mode" in the District Court

Litigation. Nor does Francois, or the combination of these references, disclose limitation 1(f).

76. In paragraphs 72 through 76 and Figures 7 and 8 of Haan, Haan discloses changing the magnification of the user's image as the user's distance from the camera changes. This disclosure is contrary to how a conventional mirror operates. With a conventional mirror, the image of the person looking into the mirror will stay the same size regardless of the person's movement toward or away from the mirror. A POSITA would have known these disclosures in Haan to be contrary to a conventional mirror and would have regarded them to mean that Haan expressly chose to depart from implementing the optical property of a conventional mirror, whereby the size of the user is approximately the same regardless of movement toward or away from the camera. For example, as discussed above in Section II.B. under the general optical properties of conventional mirrors, I explained why a person looking into a mirror may want to get closer to the mirror to inspect something small on their face like the iris even though the size of the iris in the mirror image does **not** get bigger as the user gets closer. If this example of a person looking at their iris were put in the context of Haan's invention, the image of the user would be magnified and the reflected image of the iris would change size, i.e., the size would increase. This subtle, but important, difference between the 110 Patent and Haan is one that a POSITA would have been aware of and, thus, would

not have regarded Haan as disclosing this optical property of conventional mirrors and the 110 Patent invention. In other words, a POSITA would not have regarded Haan as disclosing a reflection that “maintains roughly the same size regardless of user movement.”

77. A POSITA would also have regarded the disclosures in Haan at paragraphs 72 through 76 and Figures 7 and 8 to be contrary to the operation of the 110 Patent invention in light of the District Court Litigation claim construction of “mirror tracking mode” / “it appears to mimic a reflection of a mirror”. Ex. 2008 at 19, 41. This is because these disclosures establish that in Haan’s invention the user’s image would not appear “roughly the same size regardless of user movement.” Ex. 2008 at 19, 41.

78. Based on paragraphs 72-73 and 75-76 and Figures 7 and 8 in Haan, a POSITA would understand that the size of the user’s image in Haan’s system would *not* appear roughly the same size as the user moved toward or away from the camera. Rather, a POSITA would understand that the user image would be magnified at different amounts based on the user’s distance from the camera. A POSITA would have regarded Haan as teaching away from implementing this optical property of a conventional mirror.

[0072] FIG. 7 illustrates a further embodiment of the invention. When one looks into a flat mirror the perceived distance at which the image is formed is the same as the distance between the

object and the mirror. It is possible to use a convex mirror which allows magnification of the object. However this is a fixed magnification. Within embodiments of the invention the **displayed image is magnified as a function of the distance to the mirror device**. Typically, a viewer holds and maintains a certain distance to a mirror. When he/she wants to take a better look at a detail he/she reduces the distance to the mirror. FIG. 7 illustrates an embodiment of the invention.

Ex. 1005, ¶ 0072.

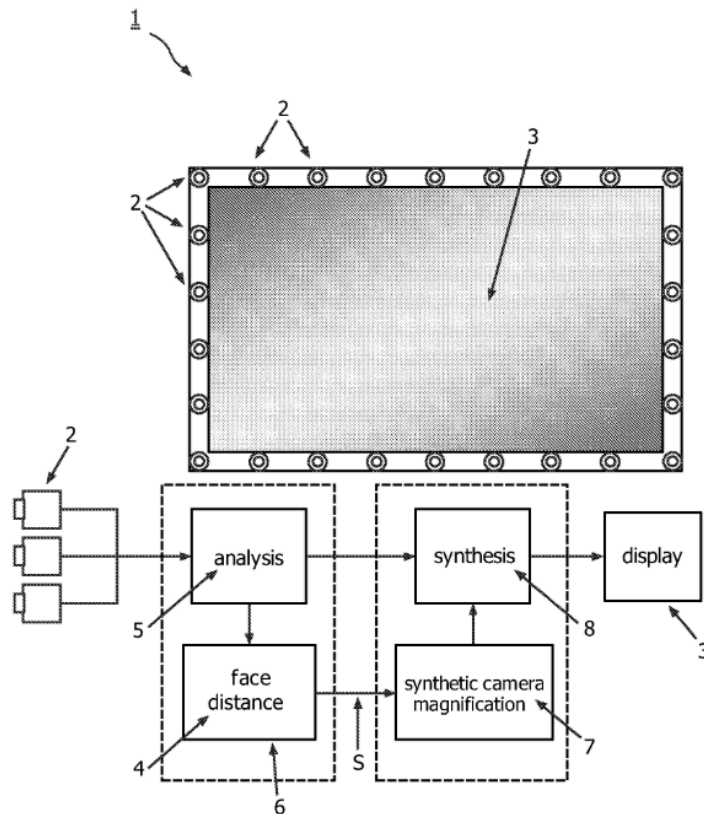


FIG. 7

Ex. 1005, Fig. 7.

[0073] In FIG. 7 **face distance determining** means determine the distance of the face in respect of the mirror device. This determination **determines the magnification of the displayed image**. It is remarked that magnification is in fact equivalent to moving a camera with fixed magnification closer to the object, so all applications can be seen, in fact as changing the point of view, or in other words the position of the camera, be it a real camera or a virtual camera. Exaggerating the angle of rotation means in fact that one shifts the point of view from which the image is recorded further to the left or to the right then one would do for a mirror, amplification equals a shift of the point of view towards the object.

Ex. 1005, ¶ 0073.

[0075] FIG. 8 illustrates an exemplary relation between the magnification M of the image and the distance d in centimeter to the mirror.

Ex. 1005, ¶ 0075.

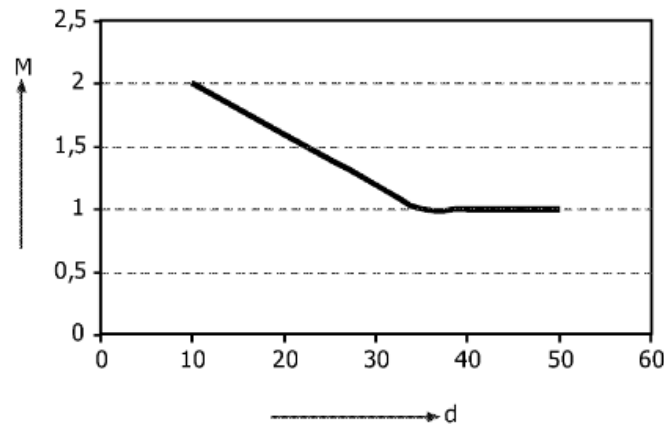


FIG. 8

Ex. 1005, Fig. 8.

[0076] For distances d larger than a threshold value, for instance in this example 35 cm distance, the magnification is kept at a fixed value of, in this example 1. This can be done for instance by using the device as a simple mirror, i.e. not displaying an image on the display device, but using the device in the reflective mode. For smaller distances, as the viewer moves his head or torso closer to the display screen, an enlarged image is displayed, i.e. with a magnification larger than 1. To avoid a sudden jump in the image there is a smooth transition between the two regions.

In embodiment there can be a range of distances for which the magnification factor is less than 1. This can be for instance useful when a hat is tried on, a normal mirror would show the face, but only part of the hat. By using a magnification smaller than 1, it does become possible to see the hat even at relatively small distances from the mirror. This would also be useful in small size changing cubicles.

Ex. 1005, ¶ 0076.

79. It is also my opinion that Haan contains a gross error in describing camera properties such that a POSITA would be disinclined to rely on Haan alone or in combination to meet limitation 1(f). In paragraph 73, Haan states: “It is remarked that magnification is in fact equivalent to moving a camera with fixed magnification closer to the object, so all applications can be seen, in fact as changing the point of view, or in other words the position of the camera, be it a real camera or a virtual camera.” Ex.1005, ¶0073. A POSITA would immediately realize this is description is entirely inaccurate. Changing the position of a camera does change the point of view, but magnifying or zooming in on an image does ***not*** change point of view. *See above*, ¶¶ 62-65.

[0073] In FIG. 7 face distance determining means determine the distance of the face in respect of the mirror device. This determination determines the magnification of the displayed image. **It is remarked that magnification is in fact equivalent to moving a camera with fixed magnification closer to the object, so all applications can be seen, in fact as changing the point of view, or in other words the position of the camera, be it a real camera or a virtual camera.** Exaggerating the angle of rotation means in fact that one shifts the point of view from which the image is recorded further to the left or to the right then one would do for a mirror, amplification equals a shift of the point of view towards the object.

Ex. 1005, ¶ 0073.

80. It is my opinion that Francois does not disclose limitation 1(f) of the 110 Patent under the construction of “mirror tracking mode” in the District Court Litigation. Nor does Haan, or the combination of these references, disclose limitation 1(f).

81. A POSITA would recognize that Francois only discloses simple inversion of the user’s image. Ex.1009, Fig. 13; *see also* Ex.1009, Fig. 12.

82. Francois is silent with respect to whether a user’s image appears at roughly double the distance from the mirror. Francois is also silent with respect to whether a user’s image would appear roughly the same size regardless of user movement. A POSITA would have regarded Francois’ silence on these optical properties of a conventional mirror as not disclosing either.

2. Petitioners Fails to Show Motivation to Combine Haan and Francois for Limitation 1(f)

83. It is my opinion that a POSITA would not have been motivated to combine Haan and Francois to meet limitation 1(f) of the 110 Patent.

84. A POSITA would not have been motivated to combine Haan and Francois to meet limitation 1(f) of the 110 Patent because, as discussed above, a POSITA would not have regarded either reference as disclosing this limitation.

85. Additionally, a POSITA would not have been motivated to combine Haan and Francois because Haan teaches away from having a user’s image appear

at roughly the same size regardless of the user's distance to the camera and because Francois only discloses basic image inversion and does not disclose the user appearing at roughly double the distance to the camera nor appearing at roughly the same size regardless of user movement.

86. It is my opinion that any assertion that a POSITA reading Haan and Francois would have automatically been able to easily and without undue experimentation implement the known optical properties of a conventional mirror that the user's image appears roughly double the distance to the mirror and roughly the same size regardless of user movement, relies on hindsight bias. Although these optical properties of conventional mirrors likely have been known for millennia, it is my opinion that a POSITA reading Haan and Francois would not have considered the relative importance of including these optical properties beyond simple inversion. This is because Haan teaches away from incorporating the optical property of having a user's image appear at roughly the same size regardless of the user's distance to the camera and Francois does not disclose it at all. Therefore, in my opinion a purported combination of Haan and Francois would not have suggested inclusion of these optical properties to a POSITA.

3. Francois Does Not Disclose Limitations 1(c) and 1(e)

87. Limitation 1(c) of the 110 Patent requires: "operating the processor to apply adaptive transformation mapping to the stream of images captured by the

camera to generate modified images that appear to be captured from a different point of view of the camera's actual point of view”.

88. Limitation 1(e) of the 110 Patent requires: “wherein the different point of view corresponds to an image taken from a different angle and a different distance than the actual images captured by the camera”.

89. It is my opinion that Francois does not disclose limitations 1(c) and 1(e) of the 110 Patent because Francois does not disclose modifying the user’s image to appear to be captured from a different point of view of the camera’s actual point of view. Nor does Francois disclose modifying the image’s point of view such that it corresponds to an image taken from a different angle and a different distance than the actual images captured by the camera.

90. Francois discloses only basic image inversion, i.e., a left-right flip. Aside from this basic reversing of the user’s image, Francois does not disclose further transformation of the user’s image.

4. Petitioners Fail to Show Motivation to Combine Haan and Francois for Limitations 1(c) and 1(e)

91. It is my opinion that a POSITA would not have been motivated to combine Haan and Francois to meet limitations 1(c) and 1(e) of the 110 Patent.

92. A POSITA would regard Francois as disclosing, at most, basic mirroring functionality with inversion of the user’s image as the only modification of the user’s image.

93. A POSITA would regard Francois' primary concern to be not with transforming the image of the user, but rather with the accomplishment of synchronizing input streams and image rendering with low latency. For example, Francois states:

The two major difficulties in this application are (1) synchronizing the various input streams (video and tracking data) to compute a consistent result; and (2) displaying the result with a low enough latency and a high enough throughput to produce a convincing simulation.

Ex. 1009, § 4.3.

94. In contrast, Haan is directed to manipulating physical camera positioning and stitching images together to modify the captured images.

95. It is my opinion that a POSITA would not regard a combination with Haan as improving Francois. Francois discloses a handheld mirror. A POSITA would understand that a handheld device has many practical and commercial advantages including portability, convenience, and cost effectiveness. It is my opinion that a POSITA would regard the physical manipulations of a camera(s) and/or stitching together images from multiple cameras disclosed in Haan (*see, e.g.* Ex. 1005, ¶¶ 0026-0027) as cumbersome, impractical, and beyond a POSITA's skill to implement in the handheld mirror of Francois.

96. As a POSITA would have seen in Figure 12 of Francois, the device described in that paper is large and at the outer range of what can be held in the hand. For example, the view of the user's grip of the device in the user's right hand (the left hand is obscured) suggests the device requires two hands to hold. A POSITA would have recognized that the camera displayed there is a substantial component of the device's bulk. In my opinion, a POSITA would have realized that adding cameras to the top or side of the device would have made it difficult or impossible to manipulate.

97. It is my opinion that as of December 2012, it would have been impractical and likely outside of a POSITA's skill set to implement Haan's elaborate system in a handheld device like that disclosed in Francois. For example, in my opinion, a POSITA would have regarded Francois' description of the device in Figure 12 as handheld is ambitious; the device is tethered by a variety of communication cables, strongly suggesting that the video processing was not on the device. I am not aware of any computing system that, at the time of Francois, could have performed the processing required on a handheld device.

98. Additionally, it is my opinion that a POSITA would have regarded Francois as discouraging any such combination with Haan because Francois affirmatively states that simulating a real mirror experience on a computer screen is "geometrically impossible". Ex. 1009, § 4.3. Specifically, Francois states:

In order to simulate a real mirror on a computer screen, images of the observed world, consistent with the viewer's position, must be synthesized and displayed in real-time. This is of course geometrically impossible, but with a few simplifying assumptions (e.g. planar world), the image transform required was made simple yet convincing enough to consider building an actual device.

Ex. 1009, § 4.3. It is my opinion that a POSITA reading this statement in Francois would regard Francois as teaching away from further attempts to simulate a real mirror because Francois regarded its invention as “convincing enough” and “geometrically impossible” to do better.

B. Ground 2: Petitioners Fail to Show Invalidity of Claims 1-6 and 10-12 in View of Rosenberg and Park

1. Neither Rosenberg Nor Park, Alone Or In Combination, Disclose Limitation 1(f)

99. It is my opinion that Rosenberg does not disclose limitation 1(f) of the 110 Patent under the construction of “mirror tracking mode” in the District Court Litigation.

100. Rosenberg discloses two primary inventive methods: (1) mirror image-freeze and (2) mirror image-buffering. Ex. 1006, ¶ 0037. In mirror image-freeze the user can selectively freeze a current mirror image of the user which is then statically displayed on the device. Ex. 1006, ¶ 0039. The displayed image will not change in size regardless of user movement. In mirror image-buffering, a certain number of

real-time images of the user are stored which the user can play back. Ex. 1006, ¶ 0044. The played-back buffered images will not change even if the user's distance to the camera changes.

101. Rosenberg also discloses multi-view mirroring, in which a composite of the user is created based on frozen or buffered images. Ex. 1006, ¶ 0048. Those composite images will not change regardless of the user's distance to the camera.

102. Rosenberg also discloses zoom-in and/or zoom-out functionality based on the user's affirmative commands, not based on the user's distance to the camera. Ex. 1006, ¶ 0050. This functionality may render an image that appears to be much greater or much less than roughly double the user's distance to the camera.

103. It is my opinion that a POSITA would have understood Rosenberg as not disclosing optical property of a conventional mirror whereby the image of the person looking into the mirror appears at approximately double the distance to the mirror. A POSITA would also have understood that Rosenberg chose to exclude this property because it does not permit the benefits (such as closer inspection of the user's own image) that Rosenberg is trying to achieve. Paragraph 39 of Rosenberg states in part:

[0039] When employing the mirror image-freeze feature, the user is given the ability to selectively freeze the image displayed upon the screen such that it ceases being updated for a period of time with new video imagery from the camera. Instead a previous

image that was captured at the time (or nearly at the time) that the image-freeze feature was engaged is displayed for that period of time. When in a traditional mirror emulation mode, the frozen image is a left-right inverted image of the user. When in a third person mirror mode, the frozen image is a non-inverted image of the user. Thus a user may be looking in the mirror, **engage the mirror image-freeze feature**, and have the then current (or substantially current) image that was displayed upon engaging the feature, freeze upon the screen for an extended period. **This will allow the user, for example, to examine the frozen image in detail. This is particularly useful for a user who wishes to change his or her distance and/or location with respect to the mirror to get a better view of his or her image, but NOT have the image change as the user moves.** For example, a user may wish to step closer to the mirror and view a portion of his or her face from only a few inches away. **With a traditional optical mirror, such an act would cause the reflected image to change such that the user who is just a few inches away ends up staring into his or her own eyes. In reality he may wish to freeze the image, step close, and then view some other portion of the face. The mirror image-freeze feature of the present invention enables this enhanced mirroring operation.** It works by saving a current frame (i.e., a frame that was captured at or substantially at the time the user engaged the image freeze feature) in memory and using the stored image to update the graphical display such that the user views the frozen image over an extended period. When the user wishes to end the image-

freeze function he or she may selectively end the feature and return to the real-time mirroring mode that was in operation prior to the freeze feature. In this way a real-time mirror mode will resume in which the image is continuously updated.

Ex. 1006, ¶ 0039 (emphasis added, capitalization in original).

104. It is my opinion that a POSITA would understand Rosenberg to find the optical property of a conventional mirror whereby the person looking into the mirror appears at double the distance from the mirror to be suboptimal. A POSITA would also understand that Rosenberg did not disclose this optical property in his invention. And a POSITA would have also understood that this property was excluded because it does not permit the benefits (such as closer inspection of the user's own image) that Rosenberg is trying to achieve.

105. Rosenberg discloses basic image inversion. *See, e.g.*, Ex. 1006, ¶ 0026 (“This left-right inversion process is performed to present the user with a traditional mirror image view of himself or herself, inverted in a similar was [sic] as would be seen in a traditional optical mirror.”). Consequently, it is my opinion that a POSITA would not have understood Rosenberg to address what is the difficult and more complex technical issue of having the inverted image appear at roughly double the distance of the user to the camera. This failure to address more complex mirror mimicking techniques in combination with Rosenberg's disclosure in paragraph 39, stating that it is undesirable to have the user's image appear at approximately double

the distance to the camera, would cause a POSITA to: (1) regard Rosenberg's invention as not including this optical property of a conventional mirror; and (2) be discouraged from attempting to implement this optical property of a conventional mirror because it does not permit the benefits (such as closer inspection of the user's own image) that Rosenberg is trying to achieve.

106. In my opinion, a POSITA would not have understood the use of the phrase “with a displayed size and scaling such that it appears like a traditional life-size mirror image” in paragraph 77 of Rosenberg to mean that the image appears at roughly double the distance from the camera and/or roughly the same size regardless of user distance to the camera. A POSITA would not have understood this to be what paragraph 77 discloses. A POSITA would have understood that paragraph 77 makes clear just what Rosenberg regards as constituting a “traditional mirror emulation” – simple left-right inversion, nothing more. Given that Rosenberg's “traditional mirror mode” discloses only flipping an image, it would be apparent to a POSITA that Rosenberg did not consider the importance of addressing these optical properties, or implement them.

[0077] FIG. 5 illustrates a computer rendering of a human user 501 standing in front of a wall-mounted embodiment of the advanced digital mirror system 502 according to at least one embodiment of the present invention. The user's image is captured as a real-time video image by a camera upon or within

the digital mirror 502 as described previously. A representation of that real-time video image is then displayed upon the wall mounted screen of the digital mirror 502 **with a displayed size and scaling such that it appears like a traditional life-size mirror image 503.** **In a traditional mirror emulation mode, the real-time video image is left-right inverted prior to display upon the screen.** Thus the user 501 standing before the digital display is given the visual impression that he or she is standing before a traditional wall mirror, viewing a traditional mirror image of himself or herself.

Ex. 1006, ¶ 0077.

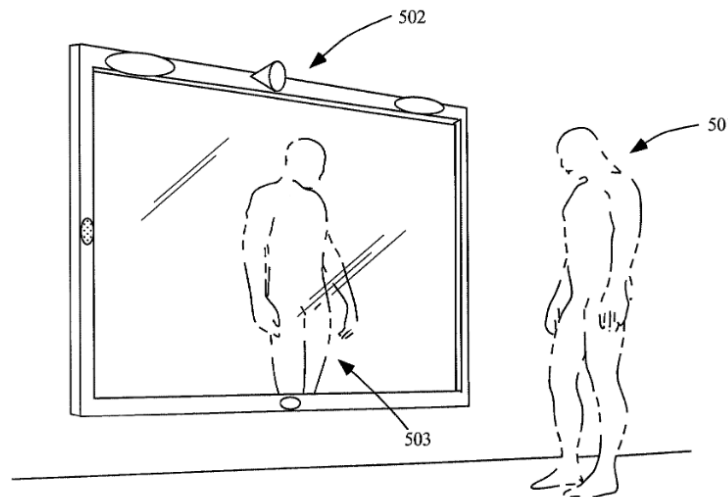


Fig. 5

Ex. 1006, Fig. 5.

107. It is my opinion that Park does not disclose limitation 1(f) of the 110 Patent under the construction of “mirror tracking mode” in the District Court

Litigation. Nor does Rosenberg, or the combination of these references, disclose limitation 1(f).

108. Park is directed to tilt correction in a mobile device. At most, a POSITA would have understood Park to disclose basic image inversion. A POSITA would not have understood Park to disclose other optical properties of a conventional mirror. It is my opinion that a POSITA would have regarded Park as only disclosing at most, basic image inversion, and consequently, a POSITA would not have understood Park to disclose the more difficult technical issue of having the inverted image appear at roughly double the distance of the user to the camera.

2. Petitioners Fail to Show Motivation to Combine Rosenberg and Park as to Limitation 1(f)

109. It is my opinion that a POSITA would not have been motivated to combine Rosenberg and Park to meet limitation 1(f) of the 110 Patent.

110. A POSITA would not have been motivated to combine Rosenberg and Park to meet limitation 1(f) of the 110 Patent because, as discussed above, a POSITA would not have regarded either reference as disclosing this limitation.

111. Additionally, a POSITA would not have been motivated to combine Rosenberg and Park because Rosenberg teaches away from having a user's image appear at roughly the same size regardless of the user's distance to the camera (Ex. 1006, ¶ 0039) and because Park, at most, only discloses basic image inversion and

does not disclose the user appearing at roughly double the distance to the camera nor appearing at roughly the same size regardless of user movement.

112. It is my opinion that any assertion that a POSITA reading Rosenberg and Park would have automatically thought to implement the known optical properties of a conventional mirror that the user's image appears roughly double the distance to the mirror and roughly the same size regardless of user movement, relies on hindsight bias. Although these optical properties of conventional mirrors likely have been known for millennia, it is my opinion that a POSITA reading Rosenberg and Park would not have considered the relative importance of including these optical properties beyond simple inversion. This is because Rosenberg teaches away from incorporating the optical property of having a user's image appear at roughly the same size regardless of the user's distance to the camera (Ex. 1006, ¶ 0039) and Park does not disclose it at all. Therefore, in my opinion a purported combination of Rosenberg and Park would not have suggested inclusion of these optical properties to a POSITA.

3. Rosenberg Does Not Disclose Limitations 1(c) and 1(e)

113. Limitation 1(c) of the 110 Patent requires: "operating the processor to apply adaptive transformation mapping to the stream of images captured by the camera to generate modified images that appear to be captured from a different point of view of the camera's actual point of view".

114. Limitation 1(e) of the 110 Patent requires: “wherein the different point of view corresponds to an image taken from a different angle and a different distance than the actual images captured by the camera”.

115. Rosenberg discloses two primary inventive methods: (1) mirror image-freeze and (2) mirror image-buffering. Ex. 1006, ¶ 0037. In mirror image-freeze the user can selectively freeze a current mirror image of the user which is then statically displayed on the device. Ex. 1006, ¶ 0039. In mirror image-buffering, a certain number of real-time images of the user are stored which the user can play back. Ex. 1006, ¶ 0044. A POSITA would understand that simply viewing previously captured images also does not change the apparent point of view from which those previously captured images were taken.

116. Rosenberg also discloses in multi-view mirroring, in which a composite of the user is created based on frozen or buffered images. Ex. 1006, ¶ 0048. Rosenberg makes no disclosure of manipulating the images to create a composite that appears to be from a different point of view than that of the camera nor change the angle or distance than that of the actual images captured by the camera. A POSITA would understand such a manipulation to be a complex technical process and therefore would regard Rosenberg’s silence on such a manipulation to constitute lack of disclosure.

117. Rosenberg discloses a zoom-in and/or zoom-out functionality based on a user's affirmative commands. Ex. 1006, ¶ 0050. A POSITA would understand that zooming in or out on an image does not change the apparent point of view of the camera. In my opinion, a POSITA would know that there is a subtle but important difference between changing point of view and zooming in or out. A POSITA would know they are not the same thing and do not render the same results. A POSITA would know that when a camera physically moves closer to the object it is photographing the angle changes such that more of the background is occluded by the object. Conversely, a zoom-in or zoom-out of a captured image does not change the angle as demonstrated by the fact that the background in a zoom-in or zoom-out does not change. This can be seen in the images below. The key geometric feature of a camera is the focal point, corresponding to the hole in the camera obscura model. Light leaving a point in space passes through this focal point, and is then collected by the sensor. If the sensor is sufficiently large, rotating a camera about its focal point will change the image in a way that can be corrected using a form of transformation known as a homography. However, any movement of the camera in the scene that results in the focal point moving will produce a change in the image that cannot usually be corrected without detailed knowledge of the 3D geometry of the scene (exceptions include a plane scene). There is no pure transformation of an image that can reproduce the effect of moving a camera focal point toward or away

from a scene, absent detailed 3D geometric information. In particular, moving a camera toward or away from a scene is not equivalent to making an image larger or smaller, because occlusion effects between objects in the scene change. Magnifying or zooming an image is not the same as changing the point of view or changing the perspective, as the example in the figures below illustrates. This can be seen in the images below. In the first image, the coffee shop will appear to be about 6 inches high (because this is where the green ray that just touches the top of the coffee shop strikes the ruler), and the top feature on the coffee shop is visible to the camera (red ray). When the camera moves closer to the coffee shop (second image), the front of the coffee shop occludes the top feature, and the coffee shop appears to be about 9 inches high. This means that there are regions of the first image that cannot be seen in the second image (the top feature on the coffee shop; the section of the ruler from 6 inches to 9 inches), meaning that reconstructing the second image from the first requires information that is not present in the first image. Therefore, magnification is **not** the equivalent to a change in camera position.



Image 1

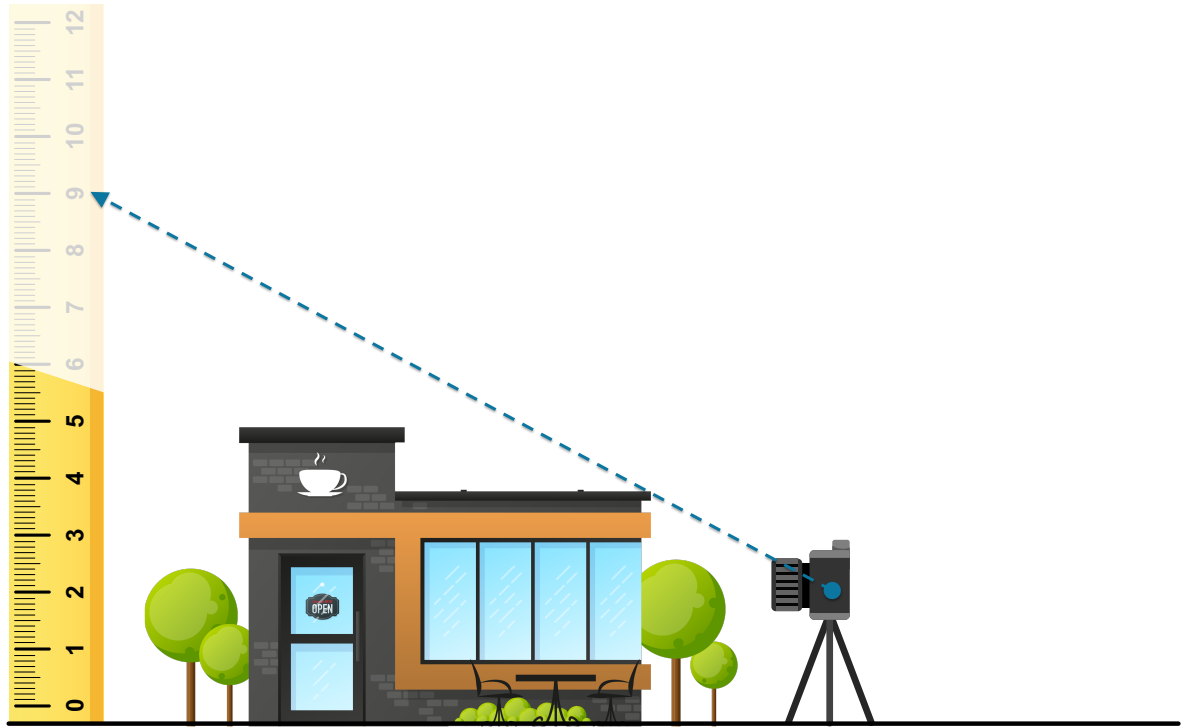


Image 2

118. Rosenberg does disclose basic inversion of the image, i.e., a left-right flip. In my opinion, a POSITA would regard only the inversion of the image as a transformation because the other techniques Rosenberg discloses — freezing the image, playback of images, composite image, or zoom in on the image — do not change what the camera captured. Ex. 1006, ¶¶ 0026-0027, 0039, 0045-0046, 0048, 0050.

119. Additionally, it is my opinion that a POSITA would not regard inverting the image, freezing the image, playback of images, composite image, or

zoom in on the image to be modifying images such that they “appear to be captured from a different point of view of the camera's actual point of view” as required by limitation 1(c) or appear to be “from a different angle and a different distance” as required by limitation 1(e).

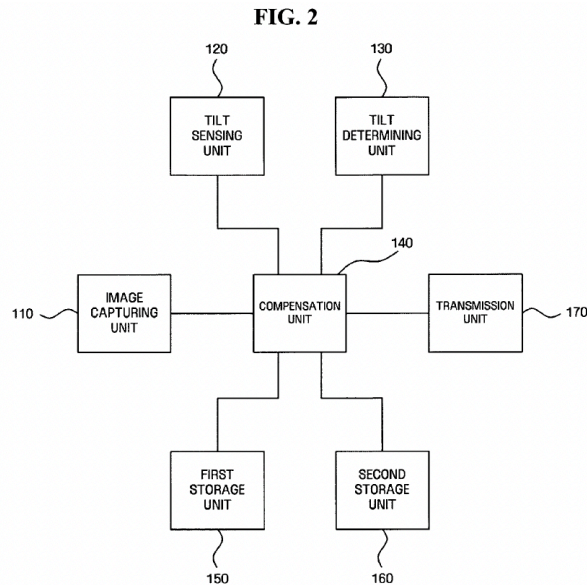
4. Petitioners Fail to Show Motivation to Combine Rosenberg and Park as to Limitation 1(c) and 1(e)

120. It is my opinion that a POSITA would not have been motivated to combine Rosenberg and Park to meet limitations 1(c) and 1(e) of the 110 Patent.

121. A POSITA would regard Park as presenting a wholly computer processing based solution to changing image perspective and angle. A POSITA would understand that the compensation unit disclosed in Park operates via computer processing. Park states:

[0036] As illustrated in **FIG. 2**, the image capturing apparatus 100 with image compensation, according to an embodiment of the present invention, includes an image capturing unit 110 capturing the image of a specified object, a tilt sensing unit 120 sensing a tilt of a device in which the image capturing unit 110 is installed, a tilt determining unit 130 determining the tilt of the image capturing unit 110 in accordance with the sensed tilt, and **a compensation unit 140 performing compensation of the captured image in accordance with the determined tilt.**

Ex. 1011, ¶ 0036 (emphasis added).



Ex. 1011, Fig. 2.

[0059] **The compensation unit 140 can perform the image compensation using a geometric transform technique and a perspective transform technique that is a kind of geometric transform technique.** However, it is to be understood that these are merely non-limiting examples to facilitate the understanding of the present embodiment, and other diverse techniques can be used for the image compensation.

Ex. 1011, ¶ 0059 (emphasis added).

In the foregoing descriptions of embodiments of the present invention, reference was made to accompanying drawings illustrating block diagrams and flowcharts. **It is to be understood that each block of the flowchart illustrations, and combinations of blocks in the flowchart illustrations, can be implemented by computer program instructions. These computer program instructions can be provided to a**

processor of a general purpose computer, special purpose computer, or other programmable data processing apparatus to produce a machine, such that the instructions, which execute via the processor of the computer or other programmable data processing apparatus, create means for implementing the functions specified in the flowchart block or blocks.

Ex. 1011, ¶ 0088 (emphasis added).

122. A POSITA would understand Rosenberg's inventive concept to be ideal physical placement of a camera to replicate a traditional mirror. Rosenberg's repeated emphasis on physical placement of the camera would cause a POSITA to find Rosenberg as disclosing physical camera placement as the solution replicating a mirror. For example Rosenberg states:

[0027] In this way the user can view his or her own image quickly and conveniently by simply stepping before the display portion of the digital mirror. In addition, embodiments of the present invention may be configured to provide a plurality of digital mirror display modes that may be selectively engaged by the user through hands-free user interactions. In a basic mode of operation, referred to herein a traditional mirror emulation mode, the digital mirror is operative to replicate the performance of a standard household mirror, providing the user with a left-right reversed frontal image of himself or herself when standing before the display. This is achieved by streaming a left-right inverted representation of the real-time video imagery from a camera

aimed at the user to a screen portion of the display, the camera being mounted and aimed such that it points back at the user from a position on or near the display. In a preferred embodiment, the camera is positioned such that it is centered with respect to the screen area of the display. In basic embodiments the *camera is mounted directly above the screen* area of the display, generally near the center. *This is non-ideal* because it provides the user with a view of himself or herself from a somewhat unnatural perspective as compared to a traditional mirror. In more advanced embodiments the camera is mounted within the screen area of the display itself, approximately at eye-level of typical users, for example, positioned behind the display surface and aimed through a transparent portion of the display. Such embedded-camera embodiments provide a superior arrangement because they provide the user with a natural and accurate visual perspective of himself or herself as compared to a traditional mirror. In many such embedded-camera embodiments the camera imaging frame rate is interlaced with the display imagery frame rate such that camera images are captured during off times between the image display. Thus by mounting the camera at such a location and in such a manner, the user will get the most closely approximated mirror image captured by the camera and projected upon the display. However, embodiments which have a *camera mounted above the screen area may still be configured to provide an effective image*, but the vantage point will simply be slightly higher than the eye-level vantage point with which users are familiar. *This raised*

vantage point is sometimes advantageous, giving users an increased view of the top of their head, an area that is often the focus of hair brushing.

Ex. 1006, ¶ 0027 (emphasis added).

[0028] It is often **preferred to incorporate the camera within or behind the display** screen because it yields a more realistic replication of a true mirror image (i.e., an image that is from a vantage point perfectly straight ahead). **Such embodiments of the present invention often strive to achieve placement of the camera such that the image captured by the camera is taken from a vantage point that is centered horizontally with respect to the display screen and at an elevation vertically that generally corresponds with a user's typical eye level.** In this way the user is looking straight at the camera when standing centered before the digital mirror display screen. A number of different methods and/or technologies may be employed **to achieve placement of a camera** such that the image captured is from this centrally located area upon the display screen. In some embodiments a small region of active screen area is removed to allow the camera to capture an image through the screen surface. This region of removed screen will generally appear as a blacked-out portion of the mirror image as if a small black dot was cut into a real mirror to allow light to pass through it. With proper optics, this dead region of the mirror display surface can be very small—for example a circular region of less than 1 millimeter in diameter. Various configurations of lenses, mirrors,

and/or fiber optics can be used to enable flexibility in **camera hardware positioning** with respect to the small non-active portion of the screen.

Ex. 1006, ¶ 0028 (emphasis added).

[0075] FIG. 4 illustrates a digital mirror 405 according to at least one embodiment of the invention. Unlike the embodiment shown in FIG. 3 where the camera is mounted above the display screen, the embodiment shown in FIG. 4 has **a camera 402 mounted within the screen area. Such embodiments may be preferred because they yield more realistic replications of traditional mirrors** because the displayed image that is from a vantage that is straight ahead. **Such embodiments of the present invention often strive to achieve placement of the camera 402 such that the image captured by the camera 402 is taken from a vantage point that is centered horizontally with respect to the display screen and at an elevation vertically that generally corresponds with a user's typical eye level.** In this way the user is looking straight at the camera 402 when standing centered before the digital mirror display screen. A number of different methods and/or technologies may be employed **to achieve placement of a camera** 402 such that the image captured is from this centrally located area upon the display screen. In some embodiments a small region of active screen area is removed to allow the camera 402 to capture an image through the screen surface. This region of removed screen will generally appear as a blacked-out portion of the mirror image as if a small black dot

was cut into a real mirror to allow light to pass through it. With proper optics, this dead region of the mirror display surface can be very small—such as for example, a circular region of less than 1 millimeter in diameter. Various configurations of lenses, mirrors, and/or fiber optics can be used to enable flexibility in **camera hardware positioning** with respect to the small non-active portion of the screen.

Ex. 1006, ¶ 0075 (emphasis added).

123. A POSITA would recognize that Rosenberg’s disclosures for both basic and advanced embodiments emphasize physical arrangement of the camera to achieve a digital mirror experience. A POSITA would further recognize that for both basic and advanced embodiments Rosenberg discloses the advantages of the physical arrangement of the camera. Consequently, in my opinion a POSITA would regard Rosenberg as disclosing a physical arrangement to achieve a digital mirror experience.

124. A POSITA would further recognize that with respect to changes in perspective or angle, Rosenberg discloses only physical manipulation of the camera or the user. For example:

[0061] In a basic mode of operation the digital mirror is operative to replicate the performance of a standard household mirror, providing the user with a left-right reversed frontal image of himself or herself when standing before the display 200. This is achieved by feeding a left-right inverted representation of the

real-time video image from a camera aimed at the user to a screen portion of the display, the camera being mounted and aimed such that it points back at the user from a position on or near the display 200. In a preferred embodiment, the camera is positioned such that it is horizontally centered with respect to the screen area of the display 200. In basic embodiments the camera is mounted directly above the screen area of the display 200, generally near the horizontal center. In more advanced embodiments the camera is mounted within the screen area of the display 200 itself, approximately at eye-level of typical users, positioned behind the display surface and aimed through a transparent portion of the display 200. In many such embodiments the camera imaging frame rate is interlaced with the display imagery frame rate such that camera images are captured during off times between the image display 200. By mounting the camera at such a location and in such a manner, the user will get the most closely approximated mirror image captured by the camera and projected upon the display 200. By mounting the camera above the display 200, the user can capture an image from slightly above, thereby providing some view of the top of his or head. This is sometimes desirable. A camera may also be mounted at multiple elevations with respect to the display screen and can be selected between to provide for a variety of viewing angles—for example, an eye-level viewing angle that provides a highly realistic mirror replication image and a higher viewing angle that provides some view of the top of the head.

Ex. 1006, ¶ 0061 (emphasis added).

[0042] As described above, the image freeze feature may be employed by a user of the digital mirror to enable this user to view himself or herself from orientations not provided by standard wall-mirrors. **For example, the user may wish to view himself from behind, view himself from left profile, or view himself from right profile.** When using a typical mirror, a user may turn sidewise thereby presenting his or her profile image to the mirror, but can no longer see the image because he or she is turned sideways. The same is true of the standard mirroring mode of the present invention. Thus to enable a user to view alternate angles upon himself or herself, **the image freeze feature is used.** The user interface of the present invention makes this a very simple operation of the user. **To view himself from behind, the user simply turns around such that he or she is now facing away from the digital mirror display screen. The user then engages the image freeze feature** by, for example, uttering the word “freeze,” the user then turns back around to view the mirror in a normal manner. **Upon the display is a view of his or her backside.** In this way a user can easily view how he or she looks from behind, examining the back of his or her head or body. To end the mode, the user may issue a command such as uttering “end freeze” and then resume viewing himself in a standard mirroring manner. **To view a left profile view of himself or herself, the user can turn and face to his right such that the front plane of his body is approximately orthogonal to the**

mirror display screen he is standing before. He or she may engage the image freeze feature by uttering the word “freeze” or some other defined command utterance. The user then turns back toward the mirror and views it in a normal manner. Upon the display will be the user's left profile view. To end the mode, the user may issue a command such as uttering “end freeze” and then resume viewing himself in a standard mirroring manner.

Ex. 1006, ¶ 0042 (emphasis added).

[0043] To view a right profile view of himself or herself, the user can turn and face to his left such that the front plane of his body is approximately orthogonal to the mirror display screen he is standing before. He or she then engages the image freeze feature by uttering the word “freeze” or some other defined command utterance. The user then turns back toward the mirror and views it in a normal manner. Upon the display will be the user's right profile view. To end the mode, the user may issue a command such as uttering “end freeze” and then resume viewing himself in a standard mirroring manner. In addition to viewing himself or herself from behind, left profile, and right profile, other orientations may be viewed in this manner. For example, if the user wishes to view the top of his or her head—he or she can tilt over such that the top of his or her head is angled towards the display screen, engage the freeze feature, and then tilt back and look at the image from a normal viewing orientation.

Ex. 1006, ¶ 0043 (emphasis added).

[0046] As described previously, the **mirror image buffering feature** may be employed by a user to enable himself or herself to view himself or herself from orientations not provided by standard wall-mirrors. For example, a user may slowly turn himself around in front of a traditional mirror but will not be able to see himself during times he is not facing the mirror. **Using the digital mirror with the mirror image buffering feature, however, a user can slowly turn around in front of the mirror, exposing a range of angles of his or her body to the mirror surface, and then view the stream of captured imagery right afterwards while looking directly at the screen.** The user interface makes this a very simple operation of the user. **To view himself while turning around in front of the mirror, the user simply turns around, for example, in a slow 360 degree spin, directly in front of the digital mirror display screen. The user then engages the mirror image buffering display feature,** by for example uttering the word “replay” while looking at the screen. In response to this identified command, or other command configured to trigger the feature, **the imagery displayed upon the screen is routed from the buffer and not from the live camera feed.** As described previously the buffer may, for example, store the previous 10 seconds worth of video footage captured by the camera. Thus in response to the “replay” command, **the previous 10 seconds of mirror display imagery is displayed to the user, showing what it looked like when he**

turned around in front of the mirror. The system is generally configured to continue replaying the 10 second buffer video clip, again and again, until the user explicitly ends the feature. Thus the user can watch that particular 10 second clip again and again until he or she ends the replay feature. To end the replay image buffering mode, the user may issue a command such as uttering “end replay” and then resume viewing himself in a standard mirroring manner. In some embodiments the user may just utter “end.” In some embodiments, the buffer may store some other duration than 10 seconds of previous video frames.

Ex. 1006, ¶ 0046 (emphasis added).

125. A POSITA would recognize that all these disclosures in Rosenberg are physical solutions — positioning the camera or requiring the user to move (Ex. 1006, ¶¶ 61, 42-43, 46) — to allow users to see angles and perspectives of themselves not possible with a conventional mirror. A POSITA would further realize that Rosenberg makes no suggestion that computer-processing based adjustment of the camera angle or apparent perspective is needed or even desirable. Consequently, it is my opinion that a POSITA would regard Rosenberg’s disclosure as discouraging a computer-processing based solution because a POSITA would have regarded Rosenberg as teaching that a physical solution was wholly adequate. A POSITA would have recognized that Rosenberg does have computer-processing based components to the system, such as, for example, speech recognition and image-freeze software, but

does not disclose such solutions for perspective and distortion issues. This would further support a POSITA's impression that Rosenberg regards physically based solutions as the preferable solution with respect to changes in perspective or angle.

126. A POSITA recognize that although Rosenberg discloses rudimentary image processing for other modes, like left-right flip about a vertical axis, Rosenberg never suggests or discloses using more advanced image processing techniques to accomplish a perspective change. Rosenberg states that in basic embodiments physical placement of the camera on the top of the display screen will result in a vantage point higher than eye-level. *See, e.g.,* Ex. 1006, ¶¶ 0027, 0061. This contrasts with more advanced or preferred embodiments in which the camera is mounted within the display to provide a vantage point that more closely approximates eye-level. *See, e.g.,* Ex. 1006, ¶¶ 0027, 0061. Rosenberg explicitly discloses that although the camera is mounted on top of the display it will still produce an “effective image, *but the vantage point will simply [be] slightly higher* than the eye-level vantage point with which users are familiar.” Ex. 1006, ¶ 0027. This disclosure would lead a POSITA to conclude that no additional digital image transformations were being performed to “fix” this vantage point that is “slightly higher” than what Rosenberg regards as ideal.

[0027] In this way the user can view his or her own image quickly and conveniently by simply stepping before the display portion of the digital mirror. In addition, embodiments of the present

invention may be configured to provide a plurality of digital mirror display modes that may be selectively engaged by the user through hands-free user interactions. In a basic mode of operation, referred to herein a traditional mirror emulation mode, the digital mirror is operative to replicate the performance of a standard household mirror, providing the user with a left-right reversed frontal image of himself or herself when standing before the display. This is achieved by streaming a left-right inverted representation of the real-time video imagery from a camera aimed at the user to a screen portion of the display, the camera being mounted and aimed such that it points back at the user from a position on or near the display. In a preferred embodiment, the camera is positioned such that it is centered with respect to the screen area of the display. In basic embodiments the camera is mounted directly above the screen area of the display, generally near the center. This is non-ideal because it provides the user with a view of himself or herself from a somewhat unnatural perspective as compared to a traditional mirror. In more advanced embodiments the camera is mounted within the screen area of the display itself, approximately at eye-level of typical users, for example, positioned behind the display surface and aimed through a transparent portion of the display. Such embedded-camera embodiments provide a superior arrangement because they provide the user with a natural and accurate visual perspective of himself or herself as compared to a traditional mirror. In many such embedded-camera embodiments the camera imaging frame rate is interlaced with the display imagery

frame rate such that camera images are captured during off times between the image display. Thus by mounting the camera at such a location and in such a manner, the user will get the most closely approximated mirror image captured by the camera and projected upon the display. **However, embodiments which have a camera mounted above the screen area may still be configured to provide an effective image, but the vantage point will simply being slightly higher than the eye-level vantage point with which users are familiar.** This raised vantage point is sometimes advantageous, giving users an increased view of the top of their head, an area that is often the focus of hair brushing.

Ex. 1006, ¶ 0027.

[0061] In a basic mode of operation the digital mirror is operative to replicate the performance of a standard household mirror, providing the user with a left-right reversed frontal image of himself or herself when standing before the display 200. This is achieved by feeding a left-right inverted representation of the real-time video image from a camera aimed at the user to a screen portion of the display, the camera being mounted and aimed such that it points back at the user from a position on or near the display 200. In a preferred embodiment, the camera is positioned such that it is horizontally centered with respect to the screen area of the display 200. In basic embodiments the camera is mounted directly above the screen area of the display 200, generally near the horizontal center. In more advanced embodiments the camera

is mounted within the screen area of the display 200 itself, approximately at eye-level of typical users, positioned behind the display surface and aimed through a transparent portion of the display 200. In many such embodiments the camera imaging frame rate is interlaced with the display imagery frame rate such that camera images are captured during off times between the image display 200. By mounting the camera at such a location and in such a manner, the user will get the most closely approximated mirror image captured by the camera and projected upon the display 200. **By mounting the camera above the display 200, the user can capture an image from slightly above, thereby providing some view of the top of his or head. This is sometimes desirable. A camera may also be mounted at multiple elevations with respect to the display screen and can be selected between to provide for a variety of viewing angles—for example, an eye-level viewing angle that provides a highly realistic mirror replication image and a higher viewing angle that provides some view of the top of the head.**

Ex. 1006, ¶ 0061.

127. In her deposition, Dr. Karam asserted that because more of the figures in Rosenberg show the basic embodiment, there must be additional digital image transformations taking place. Ex. 2012, 69:14-70:18. I disagree with Dr. Karam's conclusion (as would a POSITA reading Rosenberg). Rather, the fact that more of the figures in Rosenberg show the basic embodiment would lead a POSITA to

conclude that Rosenberg discloses no such digital transformations. A POSITA would realize that Rosenberg repeatedly discusses the slightly elevated vantage point of the basic embodiment and never once discloses a process to digitally transform that vantage point (*see, e.g.*, Ex. 1006, ¶¶ 0027, 0061, – offering as the only disclosed alternative to physically place the camera within the screen – the fact that more of Rosenberg’s figures depict that embodiment would lead a POSITA to conclude that Rosenberg regards physical placement of the camera with basic inversion as sufficient to emulate a traditional mirror. Even Dr. Karam admitted in her deposition testimony that Rosenberg does not explicitly disclose any such digital transformation. Ex. 2012, 58:2-12 (“Q. So Rosenberg does not disclose trying to adjust the vantage point of this basic embodiment, the basic embodiment being the one where the camera is mounted above the display, above the screen? He does not disclose trying to adjust that vantage point by computer processing means, correct? A. You know, it does not explicitly disclose.”).

[0027] In this way the user can view his or her own image quickly and conveniently by simply stepping before the display portion of the digital mirror. In addition, embodiments of the present invention may be configured to provide a plurality of digital mirror display modes that may be selectively engaged by the user through hands-free user interactions. In a basic mode of operation, referred to herein a traditional mirror emulation mode, the digital mirror is operative to replicate the performance of a

standard household mirror, providing the user with a left-right reversed frontal image of himself or herself when standing before the display. This is achieved by streaming a left-right inverted representation of the real-time video imagery from a camera aimed at the user to a screen portion of the display, the camera being mounted and aimed such that it points back at the user from a position on or near the display. In a preferred embodiment, the camera is positioned such that it is centered with respect to the screen area of the display. In basic embodiments the camera is mounted directly above the screen area of the display, generally near the center. This is non-ideal because it provides the user with a view of himself or herself from a somewhat unnatural perspective as compared to a traditional mirror. In more advanced embodiments the camera is mounted within the screen area of the display itself, approximately at eye-level of typical users, for example, positioned behind the display surface and aimed through a transparent portion of the display. Such embedded-camera embodiments provide a superior arrangement because they provide the user with a natural and accurate visual perspective of himself or herself as compared to a traditional mirror. In many such embedded-camera embodiments the camera imaging frame rate is interlaced with the display imagery frame rate such that camera images are captured during off times between the image display. Thus by mounting the camera at such a location and in such a manner, the user will get the most closely approximated mirror image captured by the camera and projected upon the display. **However, embodiments which have a**

camera mounted above the screen area may still be configured to provide an effective image, but the vantage point will simply being slightly higher than the eye-level vantage point with which users are familiar. This raised vantage point is sometimes advantageous, giving users an increased view of the top of their head, an area that is often the focus of hair brushing.

Ex. 1006, ¶ 0027.

[0061] In a basic mode of operation the digital mirror is operative to replicate the performance of a standard household mirror, providing the user with a left-right reversed frontal image of himself or herself when standing before the display 200. This is achieved by feeding a left-right inverted representation of the real-time video image from a camera aimed at the user to a screen portion of the display, the camera being mounted and aimed such that it points back at the user from a position on or near the display 200. In a preferred embodiment, the camera is positioned such that it is horizontally centered with respect to the screen area of the display 200. In basic embodiments the camera is mounted directly above the screen area of the display 200, generally near the horizontal center. In more advanced embodiments the camera is mounted within the screen area of the display 200 itself, approximately at eye-level of typical users, positioned behind the display surface and aimed through a transparent portion of the display 200. In many such embodiments the camera imaging frame rate is interlaced with the display imagery frame rate such

that camera images are captured during off times between the image display 200. By mounting the camera at such a location and in such a manner, the user will get the most closely approximated mirror image captured by the camera and projected upon the display 200. **By mounting the camera above the display 200, the user can capture an image from slightly above, thereby providing some view of the top of his or head. This is sometimes desirable. A camera may also be mounted at multiple elevations with respect to the display screen and can be selected between to provide for a variety of viewing angles—for example, an eye-level viewing angle that provides a highly realistic mirror replication image and a higher viewing angle that provides some view of the top of the head.**

Ex. 1006, ¶ 0061.

128. It is my opinion that because Rosenberg’s disclosures with respect to changes in image perspective and angle are all physically based, despite the presence of computer-processing aspects to the invention, a POSITA would not be motivated to combine Rosenberg with the computer processing based solution of Park with respect to limitations 1(c) and 1(e).

C. Ground 3: Petitioners Fail to Show Invalidity of Claims 1-18 in View of Geisner and Lizée

1. Neither Geisner Nor Lizée Disclose Limitation 1(f)

129. It is my opinion that Geisner does not disclose limitation 1(f) of the 110 Patent under the construction of “mirror tracking mode” in the District Court

Litigation. Nor does Lizee, or the combination of these references, disclose limitation 1(f).

130. Limitation 1(f) requires: “wherein during mirror tracking mode the processor utilizes the angle of the images captured by the camera and applies parametric input for a mapping transformation that changes imaging perspective of the images captured by the camera.” In the District Court Litigation, the term “mirror tracking mode” was construed as “a mode of operation in which the user sees their reversed reflection appearing at roughly double the distance from the camera and the reflection maintains roughly the same size regardless of the user movement.” Ex. 2008 at 41.

131. A POSITA would regard Geisner as disclosing the generation of an on-screen representation or avatar of a user. Ex. 1007, Abstract, ¶¶ 0103, 0105, 0030.

132. It is my opinion that a POSITA would not regard the on-screen representation or avatar of a user disclosed in Geisner to appear as the user does in the mirror. A POSITA would understand that such an avatar is a representation or caricature of the user, it is not a mirror reflection of the user’s real-life appearance.

133. A POSITA would regard it as irrelevant that the avatar tracks the user’s movements in real-life because avatar does not constitute a reflection of the user’s real-life appearance. A POSITA would not consider the avatar or it’s movements to

be a “reversed reflection” within the meaning of the 110 Patent, as construed in the District Court Litigation.

134. Additionally, Geisner does not disclose that the user’s avatar appear at “roughly double the distance from the camera” as required by limitation 1(f) as construed in the District Court Litigation. A POSITA would regard Geisner’s silence with respect to this optical property of a conventional mirror as a lack of disclosure.

135. It is my opinion that Lizee does not disclose limitation 1(f) of the 110 Patent under the construction of “mirror tracking mode” in the District Court Litigation. Nor does Geisner, or the combination of these references, disclose limitation 1(f).

136. Lizee discloses generating a representation of a user for placement in a virtual world. Ex. 1008, Abstract. ¶¶ 0012, 0013, 0029, 0088, Fig. 7.

137. In paragraph 73 Lizee discloses using a user’s silhouette to generate the user’s virtual representation. Lizee states:

[0073] Also, the use of a silhouette image 20 provides for the easy harmonization of the projected image 26 in a stylized virtual environment 22. For instance, **it would be harder to respect the artistic direction of the virtual environment 22 if an actual image was used to overlay the virtual environment graphics.** Furthermore, while true image overlays may be intimidating for some users, **the use of silhouettes**, while still providing an **adequate identification** of the user on the screen 18, **provides a**

less threatening experience accessible to all.

Ex. 1008, ¶ 0073.

138. This disclosure in paragraph 73 would have led a POSITA to conclude that Lizee was teaching away from the use of the user's actual image at all, let alone to provide a "reversed reflection" as required by the construction of "mirror tracking mode" in the District Court Litigation. This is because Lizee highlights the difficulty of using an actual image, notes that use of an actual image may be threatening to some users, and importantly, that "adequate identification of the user on the screen" was all that was required. Therefore, a POSITA reading Lizee would conclude that unlike the 110 Patent, Lizee does not seek to replicate a user's true appearance as would be seen in a conventional mirror.

139. Lizee discloses that the user's silhouette is inverted, i.e., a left-right flip. Lizee states:

[0034] With particular reference now to Figures 1 C and 1 D, the image 20 projected on the screen 18 is illustratively **represented by a translucent mirrored silhouette transformation** (hereinafter referred to as a silhouette image 20) of the captured image 14. In other words, the captured image 14 is isolated by the computing device 19, **inverted from left to right about a vertical axis, and transformed into a translucent silhouette image 20** (Figure 1 B) for display on the screen 18 (Figure 1C).

Ex. 1008, ¶ 0034.

140. A POSITA would regard the fact that the silhouette in Lizee is inverted as irrelevant because the user is not seeing their “reversed reflection” as though it were in a mirror. A POSITA would not consider this to be a “reversed reflection” within the meaning of the 110 Patent, as construed in the District Court Litigation, because the user is not seeing their “reversed reflection” as part of “mirror tracking mode” because the silhouette is not the user’s reflection as it would appear in a conventional mirror.

141. Additionally, a POSITA would have regarded Lizee as teaching away from mimicking a mirror. In discussing a prior art system developed by Sony, Lizee states:

[0008] In addition, the Sony application **discloses the use of a mirror captured image to create a representation of the player in the game. As a result, the player sees a mirror representation of him/herself that feels unnatural and requires significant adaptation from the player** since the character on screen and the player share a same left and right side but not a same orientation. Ultimately, the character on the screen is looking at the player, like in a mirror, but not where the player is looking.

Ex. 1008, ¶ 0008.

142. Despite the implementation in the Sony prior art system, Lizée states that it was well known in the art that having the virtual camera placed behind the player's representation is more intuitive.

[0009] As it is known in the art, the player controlled character in a third-person 3D game (or an avatar in a virtual environment) is more intuitive to the player when the virtual camera used to generate the display is behind the controlled character because the controlled character and the player perception of the display share the same direction, i.e. left is left, right is right, forward is forward and backward is backward, both on screen and using the controls. Yet, since conventional capture systems involve a front facing capture camera, conventional techniques using captured images from these systems can't be implemented without first simulating the skeleton of the controlled character, as with the Antigrav game published by Sony on the EyeToy.

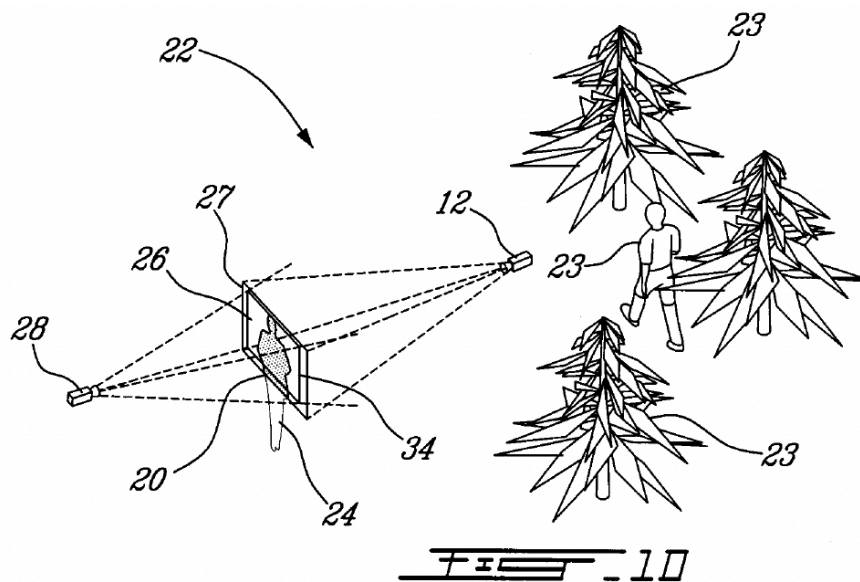
Ex. 1008, ¶ 0009.

143. Unlike the Sony prior art, Lizée makes clear that the virtual camera in Lizée's invention is positioned *behind* the virtual representation of the user. Even though the physical, real-world camera capturing the user is in front of the user, the user sees their representation via the virtual camera, from behind.

[0039] With reference now to Figure 1 D, the silhouette model 24, possibly representing a virtual character in a video game or a video entertainment system, is conceptually defined by the

projection 26 of the silhouette image 20 (Figure 1B) on a virtual panel 27 in the virtual environment 22, the back of the silhouette model 24 referring to the side on which the silhouette image 20 is projected. Figuratively, the projected image 26 is viewed by a virtual camera 28 positioned behind the silhouette model 24 and providing a rear view thereof such that the user and the silhouette model 24 share a substantially same orientation.

Ex. 1008, ¶ 0039.



Ex. 1008, Fig. 1D

[0071] The system 10 thus **provides the user with the illusion that his/her silhouette has been captured from behind** and projected inside the virtual environment 22 and, through this silhouette image 20, he/she can interact in the virtual environment 22 in a natural way. Namely, since the user and the user's visual representation, illustratively provided by the user's silhouette model 24, share a same general orientation, the user is

provided with a better sense of direction and can thus better interact within the virtual environment 22. **This provides a very intuitive control of the virtual silhouette 24 as the user is provided with the illusion that his/her shadow is cast on the display screen 18 and can directly interact in the virtual environment 22.**

Ex. 1008, ¶ 0071.

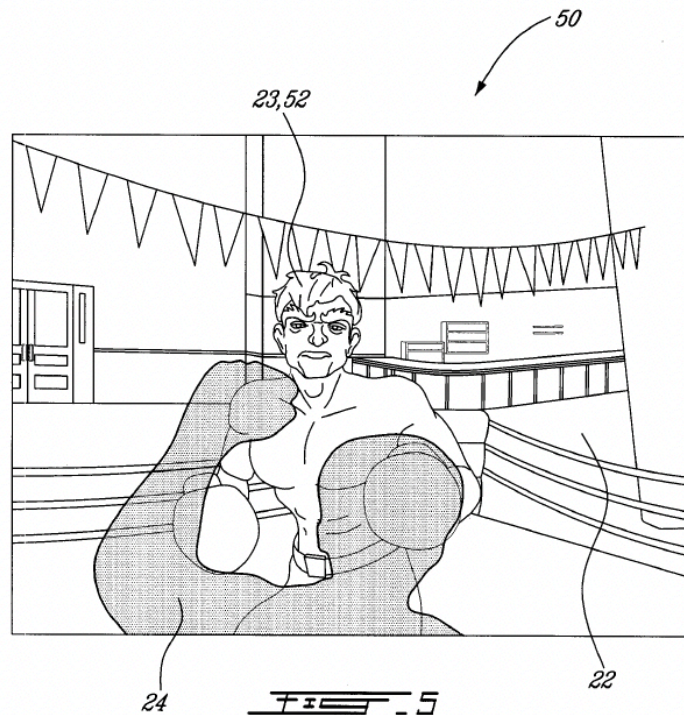
[0072] In addition, the system 10 **provides the user silhouette, as it would be observed from behind, while capturing the image for the generation thereof from the front of the user.** This permits the system 10 to be installed conventionally, such that the user faces both the display 16 and the video capture device 12. Moreover, by positioning the image capture device 12 in front of the user, a frontal image of the user is obtained that provides greater visual cues usable in the implementation of the system 10, such as the position of the hands of the user and any object carried thereby. As will be apparent to a person of ordinary skill in the art, various visual cues such as tags, interactive pointers and the like may be used to enhance the visualization effect and facilitate interaction within the virtual environment 22.

Ex. 1008, ¶ 0072.

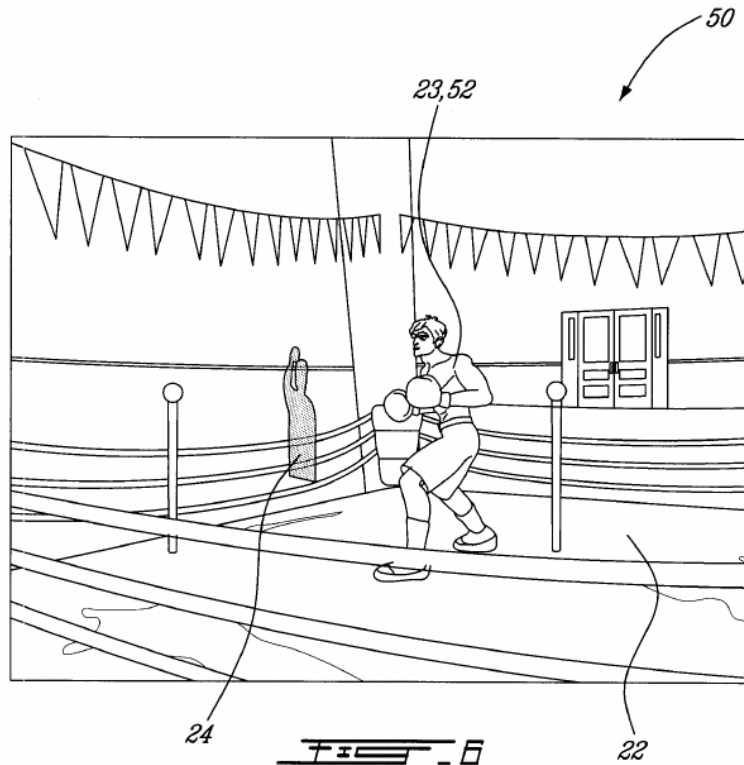
[0083] Yet, though the player interacts with the game in a 3D environment, the projected image 26 remains as a 2D representation of the user. As seen in Figure 6, which provides an exemplary screen display of the same setting as Figure 5 but from the vantage point of an additional virtual camera, the **virtual camera projecting the silhouette image 20 remains behind the**

virtual user and need only project a 2D image thereof. When the player and the silhouette model 24 share a same orientation, the illusion of 3D virtual presence is obtained nonetheless, avoiding the heavy implementation of a full 3D virtual image.

Ex. 1008, ¶ 0083.



Ex. 1008, Fig. 5.



Ex. 1008, Fig. 6.

144. It is my opinion that a POSITA would not regard the virtual camera positioned behind the user’s representation to disclose rendering an image that mimics a mirror as construed in the District Court Litigation.

145. In my opinion, because both both Geisner and Lizee are silent as to implementation of the optical property of a conventional mirror “in which the user sees their reversed reflection appearing at roughly double the distance from the camera” (Ex.2008 at 41), a POSITA would not have understood them to disclose implementation of this property.

146. It is my opinion that neither Geisner nor Lizee, either alone or in combination, disclose limitation 1(f) of the 110 Patent as construed in the District Court Litigation.

2. Petitioners Fail to Show Motivation to Combine Geisner and Lizee for Limitation 1(f)

147. It is my opinion that a POSITA would not have been motivated to combine Geisner and Lizee to meet limitation 1(f) of the 110 Patent.

148. A POSITA would not have been motivated to combine Geisner and Lizee to meet limitation 1(f) of the 110 Patent because, as discussed above, a POSITA would not have regarded either reference as disclosing this limitation.

149. A POSITA would understand that Geisner and Lizee are directed to the generation of virtual rather than real-life representations of a user. Unlike the 110 Patent, neither Geisner nor Lizee are directed to replicating a conventional mirror nor are they directed to even rendering an actual likeness of the user. A POSITA would understand Lizee as explicitly teaching away from using the actual image of a user to generate the virtual representation of the user in favor of using the user's silhouette. Ex. 1007, ¶ 0073.

150. Moreover, a POSITA would not have been motivated to combine Geisner and Lizee to meet limitation 1(f) of the 110 Patent because a POSITA would understand that the rendering of a user avatar in a virtual environment would not be the same as rendering a user's image to appear as if it were in a conventional mirror;

it would be substantially different. An avatar of a user does not appear as the user does in the mirror, an avatar is a representation or caricature of the user, it is not a mirror reflection of the user's real-life appearance. A POSITA would know that the skills and techniques used to create the virtual avatars in Geisner and Lizee would be substantially different from those needed to render a user's image as it would be reflected in a conventional mirror as in the 110 Patent. Consequently, it is my opinion that a POSITA would not be motivated to combine these two references to meet limitation 1(f) of the 110 Patent.

151. It is my opinion that because both Geisner and Lizee are silent as to implementation of the optical property of a conventional mirror "in which the user sees their reversed reflection appearing at roughly double the distance from the camera", a POSITA would not have understood them to disclose implementation of this property and would not have been motivated to combine these two references to meet limitation 1(f) of the 110 Patent.

152. It is my opinion that neither Geisner nor Lizee, either alone or in combination, disclose limitation 1(f) of the 110 Patent as construed in the District Court Litigation.

3. Geisner Does Not Disclose Limitations 1(c) and 1(e)

153. Limitation 1(c) of the 110 Patent requires: "operating the processor to apply adaptive transformation mapping to the stream of images captured by the

camera to generate modified images that appear to be captured from a different point of view of the camera's actual point of view”.

154. Limitation 1(e) of the 110 Patent requires: “wherein the different point of view corresponds to an image taken from a different angle and a different distance than the actual images captured by the camera”.

155. It is my opinion that Geisner does not disclose “adaptive transformation mapping” as construed in the District Court Litigation.

156. A POSITA would recognize that Geisner does not disclose modifying the user’s image to appear to have been captured from a different point of view than the camera’s actual point of view. A POSITA would recognize that Geisner discloses physical positioning of multiple cameras to capture different angles or having the user physically turn and move while the camera(s) captures the user’s image from multiple angles. Ex.1007, ¶¶0039, 0103. In my opinion, there is no disclosure that these images are that these images are modified to change point of view as required by limitation 1(c) or are modified to appear to be “from a different angle and a different distance” as required by limitation 1(e). A POSITA would regard Geisner’s silence as to such modifications to constitute nondisclosure.

[0039] According to another embodiment, the capture device 20 may include **two or more physically separated cameras that may view a scene from different angles**, to obtain visual stereo data that may be resolved to generate depth information.

Ex. 1007, ¶0039.

[0103] In one embodiment, in order for a user's motion to be used to control an application the user must first be enrolled or bound to the application. In one embodiment, each user will be asked to identify himself or herself by standing in front of the system so that depth images and/or visual images can be obtained from multiple angles for that user. **For example, the user may be asked to stand in front of the camera, turn around, and make various poses while depth images and visual images are obtained. After the system obtains enough depth and/or visual images, the system will create a set of identifying data from the images that uniquely identifies the user.** The system will create a unique identification and associate that unique identification with on-screen representation (e.g., avatar) or other object in the game/application. After a user is enrolled in (or bound to) the application, the system will track the motion of that user while the user is actively engaged with the application (e.g., playing the game or using the application). However, in the past, other people in the room who are not actively engaged with the application, (e.g., not bound to application, bound to application but not playing current game, or bound to application but currently not having a turn to play) do not have a way to interact with the application.

Ex. 1007, ¶0103.

4. Petitioners Fail to Show Motivation to Combine Geisner and Lizee for Limitations 1(c) and 1(e)

157. It is my opinion that a POSITA would not have been motivated to combine Geisner and Lizee to meet limitations 1(c) and 1(e) of the 110 Patent.

158. A POSITA would recognize that unlike the 110 Patent, which aims to provide a real-life representation of the user as if the user was looking into a mirror, Geisner and Lizee are not directed to that goal at all. A POSITA would realize that Geisner discloses rendering an avatar of a user (*see, e.g.*, Ex.1007, ¶0072 (“may be displayed as an avatar or other on screen representation of the user”) which does not appear as the user does in the mirror – an avatar is a representation or caricature of the user, it is not a mirror reflection of the user’s real-life appearance. And, a POSITA would regard Lizee as explicitly teaching away from using the user’s actual image to create the representation of the user. Ex.1008, ¶0073. A POSITA would understand that the rendering of a user avatar in a virtual environment would not be the same as rendering a user’s image to appear as if it were in a conventional mirror; it would be substantially different. In my opinion, a POSITA would not be motivated to combine these two references to meet limitations 1(c) and 1(e) of the 110 Patent.

159. It is also my opinion that a POSITA would understand Geisner and Lizee to disclose opposing ways of depicting a user in a virtual environment such that a POSITA would not be motivated to combine these references at all, let alone with respect to limitations 1(c) and 1(e).

160. For example, a POSITA would recognize that Geisner is directed to creating a model of the user and using a camera to track a user's movements to interact with virtual articles. Ex.1007, ¶¶0024. The focus of Geisner is on user movement for virtual interaction and control of an avatar in a virtual experience. *See, e.g.,* Ex.1007, ¶¶0030-0033, 0037, 0045. Conversely, a POSITA would recognize that Lizee discloses the capture of a user's image only for purposes of generating a silhouette that can then be used to control a wholly virtual and derived user representation in an entirely virtual world. *See, e.g.,* Ex.1008, Abstract, ¶¶0012, 0014, 0039, 0060. A POSITA would understand Lizee to explicitly teach away from using the actual image of the user to create the representation of the user (as in Geisner) in favor of a silhouette, stating that "it would be harder to respect the artistic direction of the virtual environment 22 if an *actual image* was used to overlay the virtual environment graphics". Ex.1008, ¶¶0073. A POSITA would regard Lizee as further explicitly teaching away from Geisner by asserting that the silhouette model "avoids the complex analysis of the captured image 14 to infer the posture of the user" thereby reducing "computational load" and increasing "system responsiveness." Ex.1008, ¶¶0076.

D. Ground 4

161. My opinions in Sections III.A (Ground 1) and III.C (Ground 3) are incorporated herein by reference.

162. A POSITA would not have been motivated to combine Haan and Francois with Geisner to meet limitation 1(f) of the 110 Patent because, as discussed above, a POSITA would not have regarded any of these references as disclosing this limitation.

163. A POSITA would not be motivated to combine Haan and Francois with Geisner with respect to limitation 1(f) of the 110 Patent because both Haan and Francois are directed to digital mirror devices whereas Geisner is directed to a tracking a user's movement to control a virtual on-screen representation of the user (*see, e.g.*, Ex. 1007, ¶ 0024). A POSITA would understand that the rendering of a user avatar in a virtual environment would not be the same as rendering a user's image to appear as if it were in a conventional mirror; it would be substantially different. A POSITA would know that the skills and techniques used to create the virtual avatar in Geisner would be substantially different from those needed to render a user's image as it would be reflected in a conventional mirror as in the 110 Patent or in Haan or Francois. Therefore, it is my opinion that a POSITA would not be motivated to combine these references to meet limitation 1(f) of the 110 Patent.

164. A POSITA would not have been motivated to combine Haan and Francois with Geisner to meet limitations 1(c) and 1(e) of the 110 Patent.

165. A POSITA would not be motivated to combine Haan and Francois with Geisner to meet limitations 1(c) and 1(e) of the 110 Patent because unlike the 110

Patent, Haan and Francois (which are directed to depicting a user in a digital mirror), Geisner is directed to tracking a user's movement to control a virtual on-screen representation of the user.

166. A POSITA would understand that the rendering of a user avatar in a virtual environment (Geisner) would not be the same as rendering a user's image to appear as if it were in a mirror (110 Patent; Francois; Haan), it would be substantially different. A POSITA would understand that meeting the requirements of modifying the images such that they "appear to be captured from a different point of view than the camera's actual point of view" (limitation 1(c)) "wherein the different point of view corresponds to an image taken from a different angle and a difference distance than the actual images captured by the camera" (limitation 1(e)) would also require substantially different techniques. Consequently, it is my opinion that a POSITA would not be motivated to combine these three references to meet limitations 1(c) and 1(e) of the 110 Patent.

E. Ground 5

167. My opinions in Sections III. B (Ground 2) and III.C (Ground 3) are incorporated herein by reference.

168. A POSITA would not be motivated to combine Rosenberg and Park with Geisner with respect to limitation 1(f) because both Rosenberg and Park are directed to digital devices that display a user's real-life image whereas Geisner is

directed to a tracking a user's movement to control a virtual on-screen representation of the user (*see, e.g.*, Ex. 1007, ¶ 0024). A POSITA would not have been motivated to combine Rosenberg and Park with Geisner because a POSITA would understand that the rendering of a user avatar in a virtual environment would not be the same as rendering a user's real life image on a digital display; it would be substantially different. A POSITA would know that the skills and techniques used to create the virtual avatar in Geisner would be substantially different from those needed to render a user's image on a digital display as in the 110 Patent or in Rosenberg or Park. Therefore, it is my opinion that a POSITA would not be motivated to combine these references to meet limitation 1(f) of the 110 Patent.

169. It is also my opinion that a POSITA would not be motivated to combine Rosenberg and Park with Geisner for limitations 1(c) and 1(e) of the 110 Patent. A POSITA would understand that the rendering of a user avatar in a virtual environment (Geisner) would not be the same as rendering a user's image to appear as if it were in a mirror (110 Patent; Rosenberg) or as the user appears in real-life (Park), it would be substantially different. A POSITA would understand that meeting the requirements of modifying the images such that they “appear to be captured from a different point of view than the camera's actual point of view” (limitation 1(c)) “wherein the different point of view corresponds to an image taken from a different angle and a difference distance than the actual images captured by the camera”

(limitation 1(e)) would also require substantially different techniques. Consequently, it is my opinion that a POSITA would not be motivated to combine these three references to meet limitations 1(c) and 1(e) of the 110 Patent.

I declare under penalty of perjury under the laws of the United States of America that the foregoing is true and correct to the best of my knowledge based on the information available to me at this time, and that this declaration was executed on March 6, 2025, in Urbana, Illinois.

A handwritten signature in red ink, consisting of a series of loops and a final cross-like stroke.

Dr. David Forsyth

Attachment 1

Curriculum Vitae:

D.A. Forsyth

Birth

2 May, 1963, Cape Town, South Africa.

Degrees

1. B.Sc., Electrical Engineering, U. of the Witwatersrand, Johannesburg, 1984
2. B.Sc., Electrical Engineering, U. of the Witwatersrand, Johannesburg, 1986
3. M.A., (procedural degree), Oxford University, 1989
4. D.Phil., Oxford University, 1989

Appointments

1. Fellow, Magdalen College, Oxford, Jan. 1989-Jan. 1992
2. Assistant Professor, Dept. of Computer Science, U. of Iowa, Sept. 1991-Jul. 1994
3. Associate Professor, Dept. of Computer Science, U. of Iowa, July 1994-Jul. 1996
4. Assistant Professor, Dept. of Computer Science, U. of California, Berkeley, Jul. 1994-Jun. 1996
5. Associate Professor, Dept. of Computer Science, U. of California, Berkeley, Jul. 1996-Jun. 2002
6. Full Professor, Dept. of Computer Science, U. of California, Berkeley, Jul. 2002-Jun 2006
7. Full Professor, Dept. of Computer Science, U. of Illinois, Aug. 2004-Present
8. Fulton Watson Copp Chair in Computer Science, U. of Illinois, May 2014-Present

Honors and Awards

1. Diocesan College Rhodes Scholar, 1985
2. National Science Foundation Research Initiation Award, 1992
3. National Science Foundation Young Investigator Award, 1992
4. Marr Prize, Best Paper at 1993 ICCV, 1993
5. Best Paper in Cognitive Computer Vision, ECCV, 2002
6. Okawa Foundation Fellowship, 2003
7. IEEE Technical Achievement Award, 2006
8. IEEE Fellow, 2009
9. ACM Fellow, 2014

Consulting Activities

1. Consultant, intellectual property law firm, 65 hours billed, 1998-99
2. Consultant on retainer, FujiFilm Software CA, 2001-2006
3. Consultant, venture capital firm, 3 hours billed, 2002
4. Consultant, intellectual property law firm, 13 hours billed, 2003
5. Consultant, State's attorney's general, 1 hour, 2006
6. Technical Advisor, Euclid Media, 2007-2008
7. Technical Advisor, Animate-me, 2007-2008, helped them get NSF SBIR award, EyesMatch Ex2013

Samsung et al. v. EyesMatch, IPR2024-00810

8. Technical Advisor, Snap-and-buy, 2007-2008
9. Technical Advisor, Lumenous, 2015-present, helped them get NSF SBIR award.
10. Technical Advisor, Depix, 2020-present
11. Technical Advisor, Revery.ai, 2020-present
12. Consultant, Foley+Lardner, 2009-2010
including reading and report preparation, 10 hours deposition, attendance at trial, about 4 hours direct examination at trial, about 2 hours cross examination at trial. Matter was 337-TA-680 in the ITC
13. Consultant, Sheridan and Ross (IP law firm), 2012-2013;
including reading, search and report preparation; district court case number 6:11-cv-00494
14. Consultant, Fish and Richardson, 2014-2015
including reading and report preparation, deposition in IPR invalidity, deposition on non-infringement, presenting to district court judge on technical tutorial. Matter was IpLearn-Focus, LLC vs Microsoft Corp, district court case number 3:14-cv-00151-JD. IPR's were IPR2015-00095; IPR2015-00096; IPR2015-00097.
15. Consultant, Irell and Manella, 2016-2018
including reading, search and report preparation; 3 full day depositions; IPR petitions; *Legend3D, Inc. v. Prime Focus Creative Services Canada Inc.*, IPR2016-00806; *Prime Focus Creative Services Canada Inc. v. Legend3D, Inc.*, IPR2016-01243; and *Prime Focus Creative Services Canada Inc. v. Legend3D, Inc.*, IPR2016-01491. Parties were: Legend 3D and Prime Focus Creative Services Canada
16. Consultant, Klarquist Sparkman, 2019-current
Including reading, search and report preparation for invalidity and non-infringement, for district court matter. 1 full day deposition. *Kewazinga Corp. v. Microsoft Corporation*, Southern District of New York, 1:2018-cv-04500 (SDNY)
Parties were: Microsoft Inc. and Kewazinga Corp.
17. Consultant, Scientific Advice to Apple, 2021
18. Consultant, Kerr, Russell and Weber,
2020-2022, Parties were Innovision and Autis: engaged, but only 1 hr work done.,
19. Consultant, Oblon, 2021,
Parties were: Eagle View Technologies Inc.; Pictometry International Corp; Nearmap US Inc; Nearmap Australia, Pty, Ltd and Nearmap Ltd)
21. Consultant, Tensegrity Law group, 2021
Parties were: Facebook, Inc.; MTA Platforms, Inc; Instagram LLC; Whatsapp, Inc; Eyesmatch, Ltd; Memomi Labs, Inc. The activities involved preparing materials for IPRs involving U.S. Patent Nos. 7,948,481, and 8,624,883
22. Consultant, Quinn Emmanuel, 2021
The matter was: Certain Barcode Scanners, Mobile Computers with Barcode Scanning Capabilities, Scan Engines, and Components Thereof (Inv. No. 337-TA-1285); Honeywell Int'l Inc., Hand Held Products, Inc., and Metrologic Instruments, Inc. v. Zebra Techs. Corp., Civil Action No. 6:21-cv-01008-ADA; Honeywell Int'l Inc., Hand Held Products, Inc., and Metrologic Instruments, Inc. v. Zebra Techs. Corp., Civil Action No. 6:21-cv-01010-ADA;
23. Consultant, Fish and Richardson, 2022-present
Including reading, search, report preparation and deposition for five IPR's:
IPR2022-00733, IPR2022-00734, IPR2022-00735, IPR2022-01090, IPR2022-01009
Parties are: Eagle View Technologies Inc.; Pictometry International Corp; Nearmap US Inc; Nearmap Australia, Pty, Ltd and Nearmap Ltd)
24. Consultant, Groombridge Wu, present
Parties are: Eagle View Technologies Inc.; Pictometry International Corp; Nearmap US Inc; Nearmap Australia, Pty, Ltd and Nearmap Ltd)
25. Consultant, Tensegrity, present
Parties are: Eyesmatch Ltd; Samsung Electronics, Ltd
Samsung et al. v. EyesMatch, IPR2024-00810

Graduated PhD Students

1. C.A. Rothwell (co advised with A. Zisserman)
2. J.Haddon
3. F.S.Cho
4. S.J. Chenney
5. S.Ioffe
6. P.Duygulu (co-advised)
7. O.Arikan
8. D.Ramanan
9. T.Berg (nee Miller)
10. J.Edwards
11. R.White
12. L.Ikemoto
13. N.Loeff
14. A.Farhadi
15. D.Tran
16. A.Sorokin
17. G.Wang
18. V.Hedau (joint with D. Hoiem)
19. B.Jones (joint with B. Bailey)
20. R.Sodhi (joint with B. Bailey)
21. K.Karsch
22. A.Sadeghi
23. Z.Liao
24. S. Singh
25. D. Tsatsoulis
26. J. Lu
27. J. Rock
28. A. Deshpande
29. M. Vasileva
30. D. Roberts (joint with M. Golparvar Fard)
31. T. Issaranon
32. M-J. Chong
33. Anand Bhattad
34. Kedan Li

Editorial Boards

1. Associate Editor, IEEE Trans. Multimedia
2. Editorial Board, Int. J. Computer Vision
3. Associate Editor, IEEE Trans Pattern Analysis and Machine Intelligence, 2 terms
4. Associate Editor, J. ACM, since 2011
5. Associate Editor, ACM Transactions on Graphics, since 2011
6. Editor in Chief, IEEE Trans. Pattern Analysis and Machine Intelligence, 2013-2017

Service and Administration

1. Committee member, U.C. Berkeley Committee on Admissions, Enrollment and Preparatory Education, 1995-2001 (Dealt with the University's response to the UC Regents order on affirmative action; established now well-known new admission policy for UC Berkeley, currently being taken up by other UC campuses).
2. Committee member, U.C. Berkeley Rhodes and Marshall Scholarship Committee, 1999-2003.
3. Member, National Research Council Committee on Tools and Strategies for Protecting Kids from Pornography and Their Applicability to Other Inappropriate Internet Content. (3 years of hearings, both closed and public, and an extensive report that was very well received by the popular press)
4. Founder and Member, Executive Committee of the Board, Berkeley Foundation for Opportunity in Information Technology. (Foundation seeks to ensure that Demographics of California University Computer Science Departments reflects that of the state, by helping targeted schoolchildren improve their understanding of science and their college application packets; by offering scholarships; and by various other means.)
5. Program Co-Chair: ECCV2008, CVPR 2000, CVPR2011, CVPR2018, CVPR2021, ICCV2025
(Note: For vision conferences, program chairs cannot submit papers; PC is a major administrative task; CVPR2018 had approx. 5000 submissions and CVPR 2021 had approx. 7000 submissions)
6. General Co-Chair: CVPR2006, CVPR2015, ICCV2019
7. Senior Advisor to Program Chairs: CVPR2024
8. Associate Department Chair, UIUC CS Department, 2011-2015
9. Adjunct Professor, TTIC, 2015-ongoing
10. Scientific Advisory Board, Allen Institute for Artificial Intelligence, 2015-to date
11. Scientific Advisory Board, KAUST Visual Computing Institute, 2016-ongoing
12. Scientific Advisory Board, Baidu Research, 2017-ongoing
13. Editor in Chief, IEEE Trans. Pattern Analysis and Machine Intelligence, 2013-2017
14. Committee member, UIUC Senate Committee on Student Discipline, 2017-present
15. Ombud, CVPR, 2018-present
16. Member, 8'th Senate review commission, UIUC 2018-2019
17. Chair, UIUC Senate committee for Academic Freedom and Tenure, 2020-present
Duties included: Significant Article X Hearing (40 hours of testimony) and managing difficult academic freedom disputes
18. Technical Advisory board, Depix, 2019-present
19. Scientific advisor, Revery.ai, 2020-present
20. Moderator for Computer Vision, ArXiv, 2017(?) -present
21. Chair, search committee for EIC IEEE TPAMI, 2021

US Patents

1. US 9330500 B2 Inserting objects into content, Kevin Karsch, Varsha Chandrashekhara Hedau, David A. Forsyth, Derek Hoiem
2. US 8842118 B1 Automated image replacement using deformation and illumination estimation, Ryan White, David Forsyth
3. US 9,471,967, Relighting Fragments For Insertion Into Content, Kevin Karsch, Zicheng Liao, David Forsyth,

Publications

Authored books

1. Forsyth, D.A. and Ponce, J., *Computer Vision: A Modern Approach*, Prentice-Hall, 2002.
2. Forsyth, D.A. and Ponce, J., *Computer Vision: A Modern Approach*, 2002. Chinese Language Edition
3. Forsyth, D.A. and Ponce, J., *Computer Vision: A Modern Approach*, 2002. Russian Language Edition
4. Forsyth, D.A. and Ponce, J., *Computer Vision: A Modern Approach*, 2002. Japanese Language Edition
5. Forsyth, D.A., Arikan, O., Ikemoto, L., O'Brien, J., and Ramanan, D., *Computational Studies of Human Motion: Part 1, Tracking and Motion Synthesis*, ISBN: 1-933019-30-1 178pp July 2006 (also available as *Foundations and Trends in Computer Graphics and Vision Volume 1 Issue 2/3* (255pp), 2006)
6. Forsyth, D.A. and Ponce, J., *Computer Vision: A Modern Approach* (2e), Prentice Hall, 2011 (heavily revised edition, about 50% new material)
7. Forsyth, D.A., *Probability and Statistics for Computer Science*, Springer Verlag, 2018
8. Forsyth, D.A., *Applied Machine Learning*, Springer Verlag, 2019

Edited books

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