

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

MICROSOFT CORPORATION,

Petitioners,

v.

EYESMATCH LTD.,
Patent Owner.

Declaration of Dr. Lina J. Karam, Ph.D.

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I. Introduction

1. I, Lina J. Karam, submit this declaration to state my opinions on the matters described below.

2. I have been retained as an independent expert in this proceeding before the United States Patent and Trademark Office.

3. I understand this proceeding involves U.S. Patent No. 8,982,109 (“the ’109 Patent”), and I have been asked to provide my opinions as to the unpatentability of the claims of the ’109 Patent.

4. This declaration sets forth my opinions, which I have formed 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.

5. I am being compensated for my time at my usual and customary rate. This compensation is not contingent upon the nature of my findings, the presentation of my findings in testimony, or the outcome of this proceeding.

II. Experience and Qualifications

6. I believe I am well qualified to serve as a technical expert in this matter based on my educational and work experience.

7. In formulating my opinions, I have relied upon my knowledge, training, and experience in the relevant art. I believe that I am well qualified to serve as a technical expert in this matter based upon my educational and work experience in

image and video processing, computer vision, and multidimensional signal processing, including but not limited to transformations, 3D data processing and visualization, camera calibration and modeling, single-view and multi-view geometry, appearance modification and adjustments, as well as augmented reality.

8. My qualifications are stated more fully in my curriculum vitae (CV), which has been provided as Ex. 1003 in this proceeding. My CV (Ex. 1003) also lists publications on which I am a named author and patents on which I am a named inventor. Here, I provide a brief summary of my qualifications.

9. I received a Bachelor of Engineering (B.E.) from the American University of Beirut in Computer and Communications Engineering in 1989, and a M.S. and a Ph.D. from the Georgia Institute of Technology in Electrical Engineering in 1992 and 1995, respectively.

10. I am currently an Emerita Professor in the School of Electrical, Computer, and Energy Engineering at Arizona State University (ASU) and the Director of the R&D Image, Video, and Usability (IVU) Laboratory at ASU. Prior to becoming Emerita Professor, I was a tenured Full Professor, Computer Engineering Program Chair and Computer Engineering Director for Industry Engagement at ASU. From 2020 to 2022, I served as Dean of the School of Engineering at the Lebanese American University. From 2019 to 2021, I served as the Editor-In-Chief of the high-impact IEEE Journal of Special Topics in Signal

Processing. I am also the President of PICARIS, LLC, a consulting company that provides expertise on media processing, compression, computer vision, and machine learning. I am also Chief Technical Advisor at AIAEC, LLC.

11. My research includes topics such as Signal, Image, and Video Processing, Compression, and Transmission; Computer Vision; Machine Learning; Perceptual-based Processing; Visual Attention Models; Automated Quality Assessment and Monitoring; Multidimensional Signal Processing; and Digital Filter Design. I have various awards in recognition of my research, including U.S. National Science Foundation CAREER Award, Intel Outstanding Researcher Award, U.S. National Aeronautics and Space Administration (NASA) Technical Innovation Award, the IEEE Signal Processing Society (SPS) Best Journal Paper Award, IEEE Phoenix Section Outstanding Faculty Award, and IEEE Region 6 Award. I am featured in the 8th, 9th, and 10th editions of Research.com (2022, 2023, and 2024) among World Top Computer Science Scientists.

12. In addition, I am an Institute of Electrical and Electronics Engineers (IEEE) Fellow, which is the highest grade level conferred by IEEE each year to no more than one-tenth of 1% of all IEEE voting members, for my contributions in the areas of image and video processing, visual media compression and transmission, and digital filtering. In addition to serving as Editor-In-Chief of a prestigious IEEE journal, I have also served on several IEEE Boards and chaired multiple IEEE

committees. For example, I served on the IEEE Signal Processing Society (SPS) Board of Governors (2016-2018), IEEE SPS Publications Board (2019-2021), IEEE SPS Award Board (2019-2020), IEEE SPS Conference Board (2003-2005 & 2017-2018), IEEE Publication Services and Products Board (PSPB) Strategic Planning Committee (2014-2016), IEEE Technical Activities Board (TAB)/PSPB Product and Services Committee, IEEE Educational Activities Board (EAB) Faculty Resources Committee, and IEEE TechRxiv Advisory and Editorial Boards. I am also an expert delegate of the ISO/IEC JTC1/SC29 Committee (Coding of audio, picture, multimedia, and hypermedia information) and participating in JPEG/MPEG standardization activities.

13. As part of my various roles at ASU, PICARIS, AIAEC, ISO and IEEE, I am actively involved in industry. For example, as an intern I contributed to the development of image and video processing and compression at AT&T Bell Labs (Murray Hill), and multi-dimensional data processing and visualization at Schlumberger. Later in my career I collaborated in the research and development of computer vision, machine learning, image/video processing, compression, and transmission projects with various industry leaders, including Intel, Qualcomm, Google, NTT, Motorola, Freescale, NXP, General Dynamics, and NASA. More recently, I took on the role of Chief Technical Advisor at AIAEC, LLC, supervising work and product development in the field of AI and machine learning.

14. In addition, I directed the development of image/video processing, compression, computer vision and machine learning technologies. The developed image/video processing, computer vision and machine learning systems for automated defect detection, 3D characterization, camera calibration and distortion correction, gender/age prediction, and autonomous vehicles were adopted at Intel. The developed image-based non-wet solder joints detection system was granted a Divisional Recognition Award by Intel. More details can be found in Said, Bennett, Karam, and Pettinato, "Automated Detection and Classification of Non-Wet Solder Joints," IEEE Transactions on Automation Science and Engineering, Jan 2011. The developed image-based automated void detection system helped in enabling two industry standards, JEDEC JC 14-1 void guideline and IPC-7095C. More details can be found in Said, Bennett, Karam, Siah, Goodman, and Pettinato, "Automated Void Detection in Solder Balls in the Presence of Vias and Other Artifacts," IEEE Transactions on Electronics Packaging Manufacturing, November 2012. More details about the developed 3D characterization system including image-based solder ball height and warpage measurements can be found in Li, Bennett, Karam, and Pettinato, "Stereo Vision Based Automated Solder Ball Height and Substrate Coplanarity Inspection," IEEE Transactions on Automation Science and Engineering, April 2016, and in Karam and Li, "Stereo Vision Measurement System and Method," US Patent 9,704,232 B2, issued July 2017. The developed object

identification and recognition system was granted a US patent, “Systems, Methods, and Media for Identifying Object Characteristics Based on Fixation Points,” US Patent 9,501,710, issued November 22, 2016.

15. I directed the development of camera calibration and distortion correction systems. The developed Fisheye Calibration and Distortion-Correction (FisheyeCDC) Toolbox (<https://ivulab.asu.edu/software/fisheycdc-toolbox/>) has been adopted by industry as well as academia. Details about the developed camera calibration, camera modeling, and distortion correction systems can be found in Prakash and Karam, “Camera Calibration using Adaptive Segmentation and Ellipse Fitting for Localizing Control Points,” IEEE International Conference on Image Processing (ICIP), September 2012, and in Li and Karam, “Depth Estimation from Multi-View Images,” IEEE International Conference on Emerging Signal Processing Applications, January 2012, and in Andrade and Karam, “Robust Radial Distortion Correction Based on Alternate Optimization,” IEEE International Conference on Image Processing, September 2016.

16. The developed machine learning and computer vision systems for autonomous vehicles include Advanced Driver Assist Systems (ADAS) technologies. The developed real-time forward collision warning system prototype included 3D geometry and camera modeling and was demonstrated by our Intel industry collaborators at the 2015 Consumer Electronics Show (CES) in Las Vegas.

More details can be found in Prakash, Li, Akhbari, and Karam, “Sparse Depth Calculation using Real-time Key-point Detection and Structure from Motion for Advanced Driver Assist Systems,” Springer Lecture Notes, ISVC, December 2014, and in Prakash, Akhbari, and Karam, “Robust Obstacle Detection for Advanced Driver Assistance Systems using Distortions of Inverse Perspective Mapping of a Monocular Camera,” Robotics and Autonomous Systems Journal, 2019.

17. I directed the development of scalable visual compression technologies. The developed codecs, utilizing the scalable visual compression technologies, were commercialized by General Dynamics. More details can be found in Chien, Sadaka, Abousleman, and Karam, “Region-of-Interest-Based Ultra Low-Bit-Rate Video Coding,” SPIE Symposium on Defense & Security, March 2008. I also directed the development of perceptual-based visual compression methods and algorithms. The work on JPEG2000 Encoding with Perceptual Distortion Control enabled the integration of adaptive perceptual-based visual processing and compression in the JPEG 2000 image coding standard and demonstrated improved performance in terms of visual quality and compression, while maintaining full compatibility with the JPEG 2000 standard. For this perceptual-based image compression work, I received a Technical Innovation Award from NASA.

18. In addition, I directed the development of automated biomedical image processing and computer vision technologies that enable high-throughput cancer

diagnostics and drug discovery. The developed automated image analysis technologies were licensed for cancer research at different industries and institutions, including the Translational Genomics Institute (TGEN) and the New York School of Medicine. More details can be found in Karam and Said, “Automatic Cell Migration and Proliferation Analysis,” US Patent 9,082,164, issued July 2015.

19. My work has been published numerous times in prestigious journals, including the IEEE Transactions on Signal Processing, IEEE Transactions on Image Processing, IEEE Transactions on Pattern Analysis and Machine Intelligence (PAMI), IEEE Transactions on Broadcasting, and IEEE/CVF Computer Vision and Pattern Recognition (CVPR) Conference. Some selected publications include “Morphological Reversible Contour Representation,” IEEE Transactions on Pattern Analysis and Machine Intelligence, March 2000, “Morphological Text Extraction from Images,” IEEE Transactions on Image Processing,” Nov. 2000, “A No-Reference Objective Image Sharpness Metric Based on the Notion of Just Noticeable Blur (JNB),” IEEE Transactions on Image Processing, April 2009, “Automated Detection and Classification of Non-Wet Solder Joints,” IEEE Transactions on Automation Science and Engineering, Jan. 2011, “Objective Video Quality Assessment Methods: A Classification, Review, and Performance Comparison,” IEEE Transactions on Broadcasting, June 2011, “An Efficient Selective Perceptual-Based Super-Resolution Estimator,” IEEE Transactions on Image Processing, Dec.

2011, “Select Trends in Image, Video, and Multidimensional Signal Processing,” IEEE Signal Processing Magazine, Jan. 2012, “A Distributed Canny Edge Detector: Algorithm and FPGA Implementation,” IEEE Transactions on Image Processing, July 2014, “3D Blur Discrimination,” ACM Transactions on Applied Perception, May 2016, “Spatially-Varying Blur Detection Based on Multiscale Fused and Sorted Transform Coefficients of Gradient Magnitudes,” IEEE Conference on Computer Vision and Pattern Recognition (CVPR), July 2017, “Unconstrained Ear Recognition using Deep Neural Networks,” IET Biometrics, January 2018, “Visual Saliency Prediction Using a Mixture of Deep Neural Networks,” IEEE Transactions on Image Processing, August 2018, “Quality Robust Mixtures of Deep Neural Networks,” IEEE Transactions on Image Processing, November 2018, “Augmented Sparse Representation Classifier (ASRC) for Face Recognition under Quality Distortions,” IET Biometrics Journal, November 2019, “DeepCorrect: Correcting DNN Models against Image Distortions,” IEEE Transactions on Image Processing, December 2019, “It GAN DO Better: GAN-based Detection of Objects on Images with Varying Quality,” IEEE Transactions on Image Processing, November 2021.

20. I am an inventor, and I have been awarded eight patents in the field of image and video processing, compression, and transmission: U.S. Patent Nos. 6,154,493 (“The Compression of Color Images Based on a 2-Dimensional Discrete Wavelet Transform Yielding a Perceptually Lossless Image”), 6,124,811 (“Realtime

Algorithms and Architectures for Coding Images Compressed by DWT-Based Techniques”), 6,717,990 (“Communication System and Method for Multi-Rate, Channel-Optimized Trellis-Coded Quantization”), 7,551,671 (“System and Method for Transmission of Video Signals using Multiple Channels”), 9,082,164 (“Automatic Cell Migration and Proliferation Analysis”), 9,501,710 (“Systems, Methods, and Media for Identifying Object Characteristics Based on Fixation Points”), 9,704,232 (“Stereo Vision Measurement System and Method”), and 11,0304,85 (“Systems and Methods for Feature Corrections and Regeneration for Robust Sensing, Computer Vision, and Classification,”). I am also a named inventor on an additional patent application, published as U.S. 2008/0259796 (“Method and Apparatus for Network-Adaptive Video Coding”).

21. Additional information regarding my background, qualifications, publications, and presentations is provided in my CV, which is provided as Ex. 1004.

III. Summary of Opinions

22. I have been asked to provide my opinion on whether the claims of the ’109 Patent are unpatentable over certain prior art references. It is my opinion that each of claims 1-18 of the ’109 Patent is unpatentable because each would have been obvious to a person of ordinary skill in view of the prior art.

IV. The '109 Patent

A. Overview of the '109 Patent

23. The '109 Patent relates to “[s]ystems, devices and methods enabling appearance comparison” using “a mirror-display device 140,” an “imaging device 130,” and an “image control unit 120.” '109 Patent (Ex. 1001), Abstract, 5:20-60, Figs. 1, 2A-2B, 3A-3B, 8, 13. The '109 Patent explains that the imaging device may be “a still or video camera.” '109 Patent (Ex. 1001), 5:40, 7:32-43, 18:27-32, 23:11-14. The '109 Patent explains that the mirror-display device may be “a flat panel display,” such as a liquid crystal display (LCD) device. '109 Patent (Ex. 1001), 5:41, 6:33-57. And the '109 Patent explains that the “[i]mage control unit 120 may include a controller 121, a network interface 122, a storage device 123, an input device 124.” '109 Patent (Ex. 1001), 5:41-44. These components are shown below in Figure 1 from the '109 Patent:

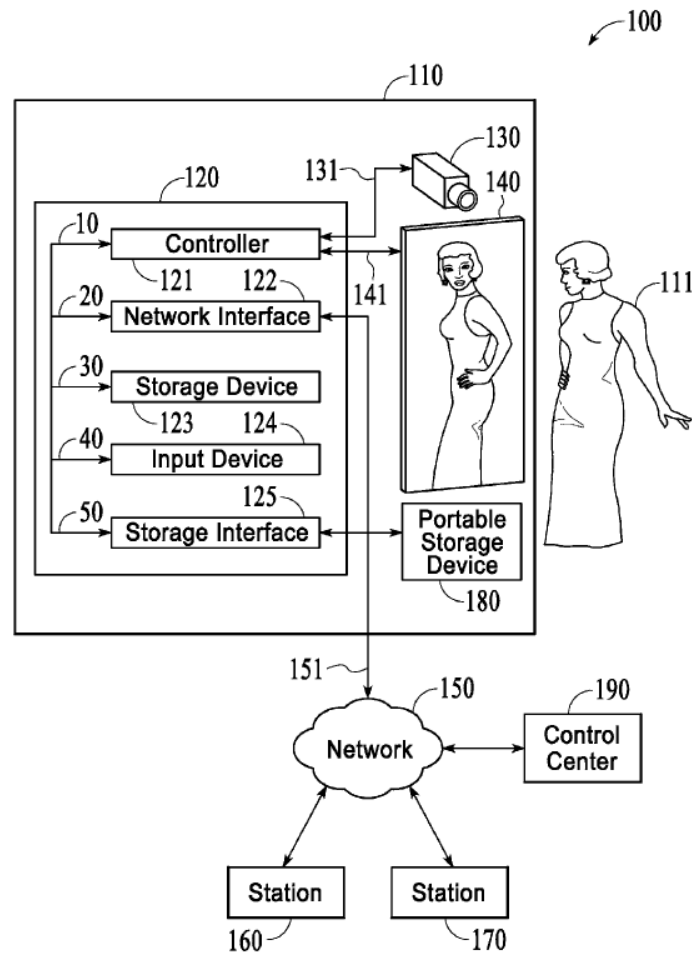


FIG. 1

'109 Patent (Ex. 1001), Fig. 1. As shown above, the '109 Patent explains that the camera ("imaging device 130") can be positioned above the display ("mirror-display device 140") and tilted downwards "to allow [for a] maximum dynamic range of the user's movement in front of the screen." '109 Patent (Ex. 1001), 15:26-31, 17:1-10, 21:19-22, 23:32-34, 24:25-30, 24:37-39, 26:18-20, Figs. 1, 2A-2B, 3A-3B, 8, 13. This is also shown below in Figure 8 of the '109 Patent:

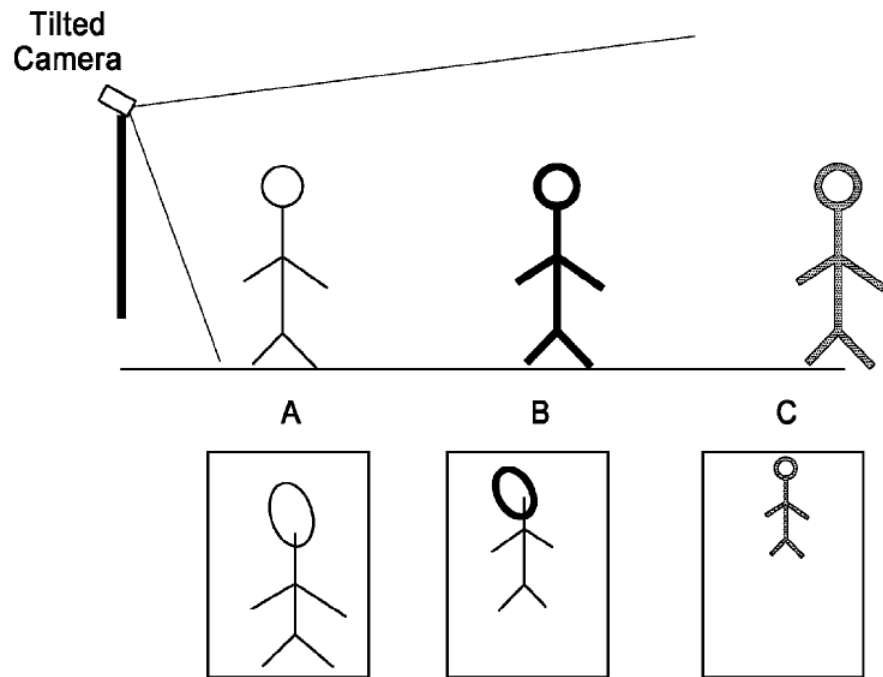


FIG. 8

'109 Patent (Ex. 1001), Fig. 8.

24. To achieve the '109 Patent's stated goal of "appearance comparison," the '109 Patent explains that the mirror-display device may "operate selectably in two modes of operation": (i) a "mirror mode," where the mirror-display device displays an image of the user's appearance "in real time"; or (ii) a "display mode," where the mirror-display device displays one or more previously captured images.

'109 Patent (Ex. 1001), 3:38-57; 5:61-6:32, 9:33-63, 12:62-14:5, 28:5-37, Fig. 4.

25. The '109 Patent describes performing what it calls "transformation mapping" to images captured by the camera to mimic what would appear to a user

as a reflection in a mirror (“mirror-mimicking image”). ’109 Patent (Ex. 1001), claim 1, 3:39-47, 5:26-29, 14:6-11, 18:19-21, 27:3-6, 28:5-15, 28:49-29:42, 30:52-67. The ’109 Patent explains that the transformation mapping include left-right flipping, geometric transformations (e.g., tilt/projection), translations (elevation or horizontal offset), scaling, resizing for zoom in/out, barrel-effect transformations, and fish-eye transformations. ’109 Patent (Ex. 1001), 16:46-17:28, 21:61-22:13, 23:41-24:9, 24:51-53, 25:48-51, 29:22-58. According to the ’109 Patent, these transformations “essentially reassign[] new addresses to each pixel of the original image.” ’109 Patent (Ex. 1001), 29:28-32, 14:40-43. They can be triggered by the mirror-display device whenever a user is detected in front of the camera/screen (e.g., ’109 Patent (Ex. 1001), 18:40-57; 23:18-23, Figs. 9, 12), and they can be performed according to the user’s distance from the camera/screen (’109 Patent (Ex. 1001), claim 1, 27:41-28:4).

B. Prosecution History

26. I understand that the application that matured into the ’109 Patent was filed on March 15, 2013. I also understand that the application that matured into the ’109 Patent claims priority to a Provisional Application No. 61/738,957 (’957 Provisional Application) that was filed on December 18, 2012. *See* ’109 Patent (Ex. 1001), Related U.S. Application Data; ’109 Patent Prosecution History (Ex. 1002), 83; ’957 Provisional Application (Ex. 1030).

27. I understand the Examiner did not issue any office actions addressing the claims of the '109 Patent, but rather allowed the claims in view of an Examiner's Amendment that added the limitation: "wherein the non-ordered steps are performed on a series of images of a live video feed from the camera; determining distance to a user appearing in the live video feed; and, varying rate at which the non-ordered steps are performed on the series of images according to the distance" to independent claim 1. '109 Patent Prosecution History (Ex. 1002), 352-55.

C. Priority Date

28. I understand that the '109 Patent, on its face, claims priority to the '957 Provisional Application, filed December 18, 2012 and is a continuation-in-part of U.S. Application No. 13/088,369, filed April 17, 2011, which claims priority, through a chain of continuation and continuation-in-part applications, to U.S. Provisional Application Nos. 60/656,884 and 60/656,885, both filed on March 1, 2005. *See, e.g.*, '109 Patent (Ex. 1001), Related U.S. Application Data.

29. I understand for a non-provisional application to receive the benefit of an earlier-filed patent application's filing date, the specification of that earlier-filed patent application must contain a written description of the invention claimed in the non-provisional application, and must include details of the manner and process of making and using the invention claimed in the non-provisional application, in full,

clear, concise, and exact terms to enable a person of ordinary skill in the art to practice the invention.

30. It is my opinion that the '109 claims are not entitled to claim priority to any provisional applications other than Provisional Application No. 61/738,957 (Ex. 1030), which was filed on December 18, 2012. This is because none of the nonprovisional applications other than the '957 Provisional Application (Ex 1030) discloses or suggests at least the limitations: “applying a transformation mapping to the image to modify the image such that it appears to mimic a reflection of a mirror,” “determining distance to a user appearing in the live video feed,” and “varying rate at which the non-ordered steps are performed on the series of images according to the distance,” as set forth in every claim of the '109 Patent. '109 Patent (Ex. 1001), 30:57-59, 30:64-67.

31. The first provisional application, Application No. 60/656,884 ('884 Provisional Application), discloses a “[m]emorable [i]nteractive [m]irror.” '884 Provisional Application (Ex. 1028), Title. While Figure 1 of this provisional application shows a mirror image of a user, it fails to disclose or suggest “a transformation mapping,” much less “applying” such mapping “to the image to modify the image such that it appears to mimic a reflection of a mirror,” as required by the '109 claims. Furthermore, this provisional application fails to disclose “determining distance to a user appearing in the live video feed” and “varying rate

at which the non-ordered steps are performed on the series of images according to the distance,” as required by the ’109 claims.

32. The second provisional, Application No. 60/656,885 (’885 Provisional Application), also discloses a “[f]itting [s]ystem [u]sing [m]emorable [i]nteractive [m]irror.” ’885 Provisional Application (Ex. 1029), Title. But like the ’884 Provisional Application discussed in the paragraph above, although Figure 1 of the ’885 Provisional Application shows a mirror image of a user, it fails to disclose or suggest “a transformation mapping,” much less “applying” any such mapping “to the image to modify the image such that it appears to mimic a reflection of a mirror,” as required by the ’109 claims. Furthermore, the ’885 Provisional Application fails to disclose “determining distance to a user appearing in the live video feed” and “varying rate at which the non-ordered steps are performed on the series of images according to the distance,” as required by the ’109 claims.

33. In my opinion, because these provisional applications lack a written description (disclosure) for the claimed features, they cannot offer a priority date to claims 1-18 of the ’109 Patent.

34. Additionally, I understand that EyesMatch (Patent Owner) previously explained “[t]he claims of the ’109 and ’110 Patents were conceived and constructively reduced to practice by December 18, 2012, with the filing of U.S. Provisional Application No. 61/738,957” in a prior district court litigation. Ex. 1026,

3. I understand that Patent Owner has also “applie[d] proposed level of skill” of “a POSA as of December 2012” for the ’109 Patent in a previous *inter partes* review case. Ex. 1027, 13. These statements by Patent Owner further attest that the earliest priority date for the ’109 Patent is December 18, 2012, the filing date of the ’957 provisional application (Ex. 1030).

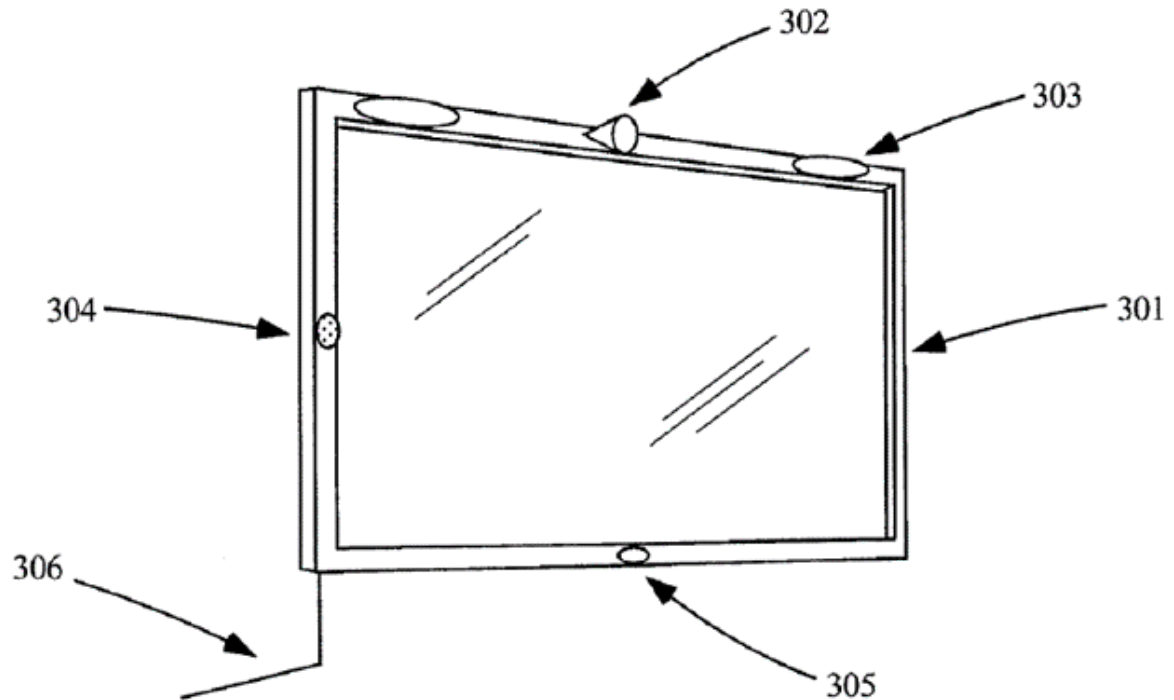
35. Thus, it is my opinion that claims 1-18 of the ’109 Patent cannot claim priority earlier than December 18, 2012, the filing date of the ’957 provisional (Ex. 1030).

V. Technology Background

A. Digital Mirrors Were Well Known

36. Long before the December 2012 priority date for the ’109 Patent, digital cameras and displays were increasingly being used as digital mirrors to mimic mirror reflections, with associated processors being able to combine images and handle image transformations and modifications. *See, e.g., Iwai* (Ex. 1010), 1:21-33. Various digital mirror systems that capture a user’s image using a digital camera and display the captured image to the user on a screen were developed. For example, *Rosenberg* (Ex. 1005) discloses a digital mirror system that emulates a traditional mirror by displaying real-time video imagery of a user. *See, e.g., Rosenberg* (Ex. 1005), Abstract, claims 1, 19, 23. As shown below, *Rosenberg*’s system

includes a display and digital video camera mounted above the screen. *Rosenberg* (Ex. 1005), [0062].



Rosenberg (Ex. 1005), Fig. 3. The camera is centered horizontally and aimed downward so that it points at a typical user in front of the display. *Rosenberg* (Ex. 1005), [0062], Fig. 3.

37. *Haan* (Ex. 1022) similarly discloses a mirror device that includes one or more cameras, a display, and an image analysis means and synthesis means. *Haan* (Ex. 1022), Abstract, Figs. 1-2, [0057]-[0059], [0064], [0087]. The image analysis means is used to analyze the images from the one or more cameras for determining the position of a user's body part. Based on the determined position, the image

synthesis means uses the images from the one or more cameras to form a single image from a virtual view point. *Haan* (Ex. 1022), [0027], [0058]. These components are shown in *Haan*'s Figure 2 below:

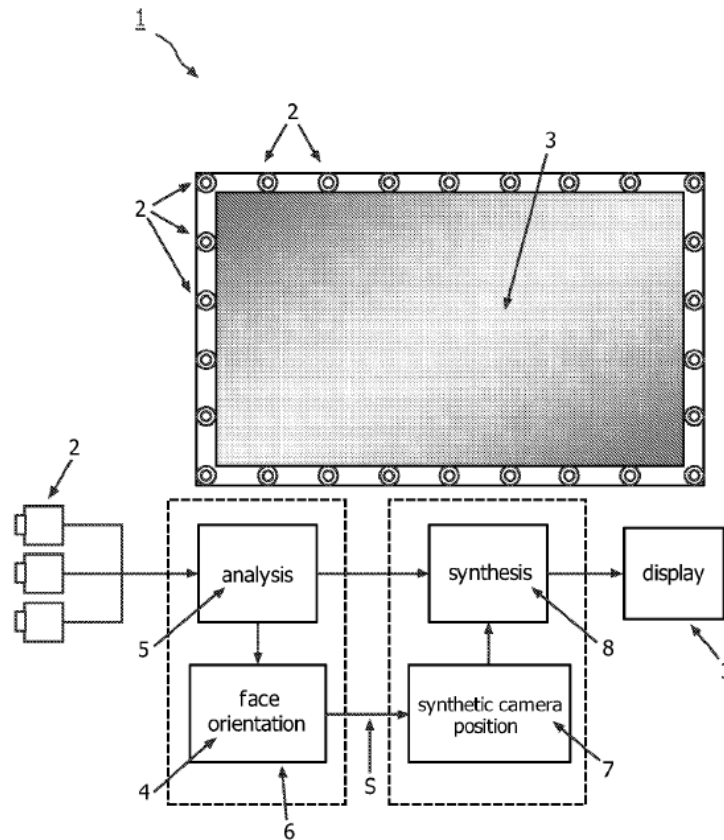


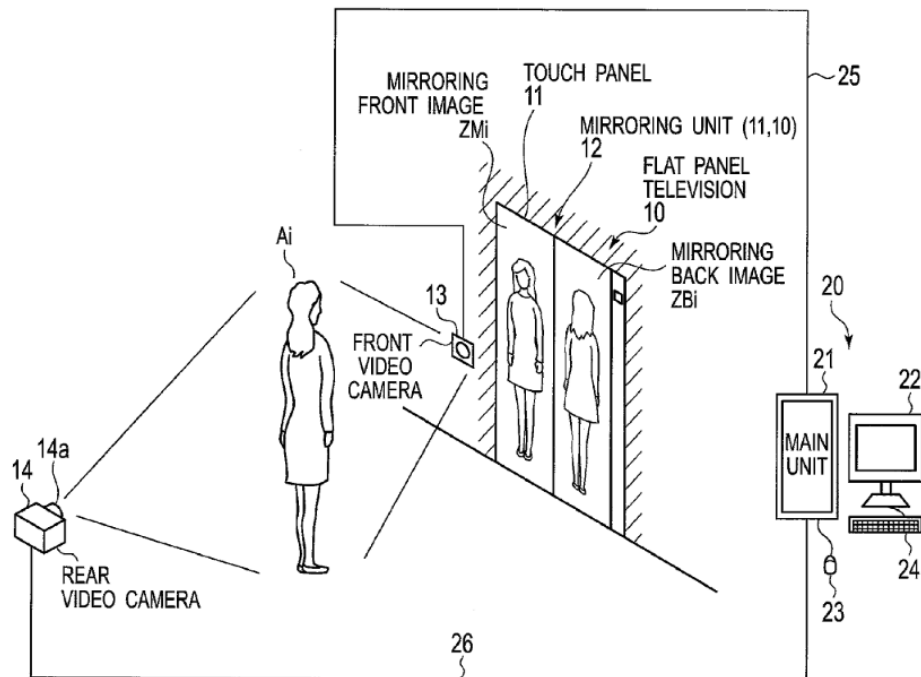
FIG. 2

Haan (Ex. 1022), Fig. 2.

38. *Koike* (Ex. 1031) similarly discloses an electronic mirroring system that includes a front video camera, a rear video camera, and a mirroring unit (or display). *Koike* (Ex. 1031), Abstract, [0001], [0013], [0072], [0074]. As shown below, *Koike* discloses front and back images of a user, captured by cameras, can be displayed to

the user on the display simultaneously. *Koike* (Ex. 1031), [0074]-[0075], [0119], [0180]. *Koike* discloses that its system can be used in various environments, such as a clothing store, a photo studio, a lobby, a hotel, a house, etc. *Koike* (Ex. 1031), [0071]. Figure 1 of *Koike* is shown below:

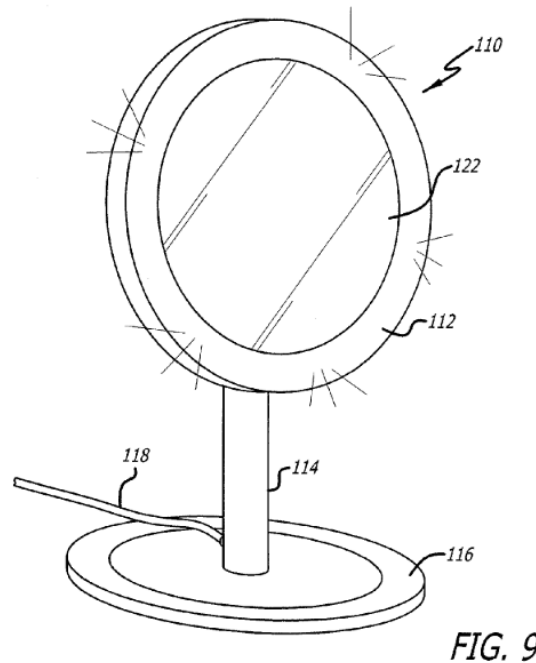
FIG. 1



Koike (Ex. 1031), Fig. 1.

39. It was also well known that, as compared to traditional mirrors, digital mirrors allowed for displaying modified images to the user using image processing techniques. For example, *Rolston* (Ex. 1032) discloses a video camera mirror system that includes a processor. *Rolston* (Ex. 1032), Abstract, [0004]-[0006], [0097]-[0098]. *Rolston* explains that its processor controls one or more video cameras for

capturing images, modifies the captured images in real time, and then presents the modified images as a mirror reflection on a display. *Rolston* (Ex. 1032), Abstract, [0004]-[0006], [0097]-[0098].



Rolston (Ex. 1032), Fig. 9. *Rolston*'s video camera mirror system can be used at a cosmetic counter (*Rolston* (Ex. 1032), [0113]-[0116], Figs. 12-13), on a wall in a room (*Rolston* (Ex. 1032), [0165]-[0170], Fig. 26), or on a mobile device (*Rolston* (Ex. 1032), [0184]-[0186], Figs. 32-33).

40. *Iwabuchi* (Ex. 1033) also discloses a "Smart Makeup Mirror" device. As shown below, *Iwabuchi*'s system includes a camera on top of a computer display. *Iwabuchi* (Ex. 1033), Abstract, Fig. 1.

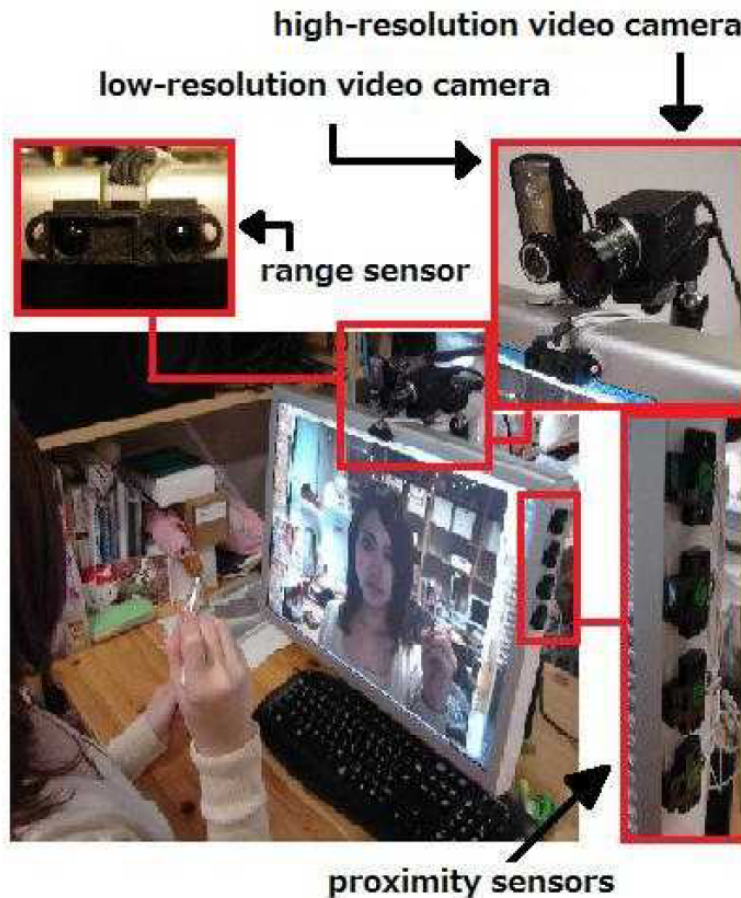


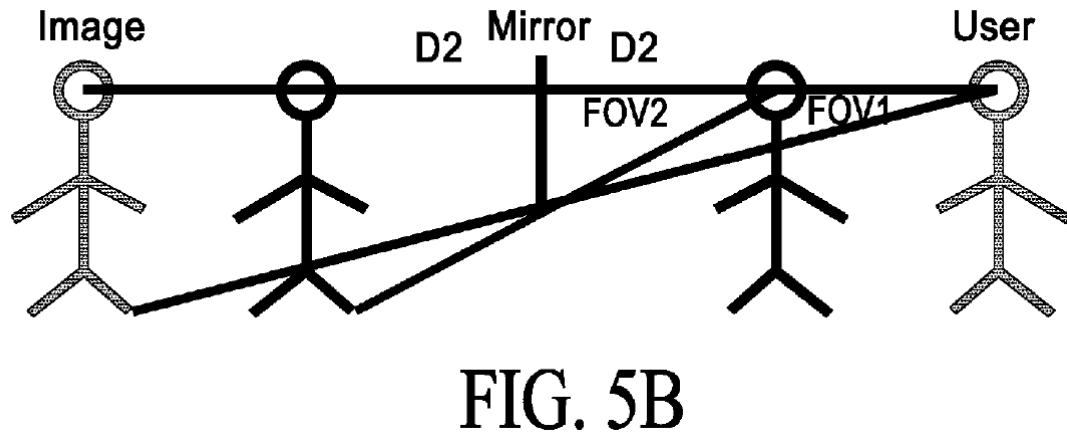
Figure 1. Overview of the system.

Iwabuchi (Ex. 1033), Fig. 1. *Iwabuchi* discloses the device has an automatic zoom function that allows the user to zoom in on a makeup part, such as on the eyes and mouth, without having to physically approach the display. *Iwabuchi* (Ex. 1033), 1-2.

B. Transforming Camera-Captured Images to Mimic Mirror Reflections Was Well Known

41. The '109 Patent Background section explains a camera-captured image is different from a mirror reflection in ways that might make the camera image seem unconvincing (or unnatural) to a user. '109 Patent (Ex. 1001), 1:61-2:48.

42. First, the '109 Patent explains a user appears larger in a camera image as the user approaches the camera, whereas a user's reflection in a mirror stays the same size as the user approaches the mirror, as illustrated in Figure 5B below:

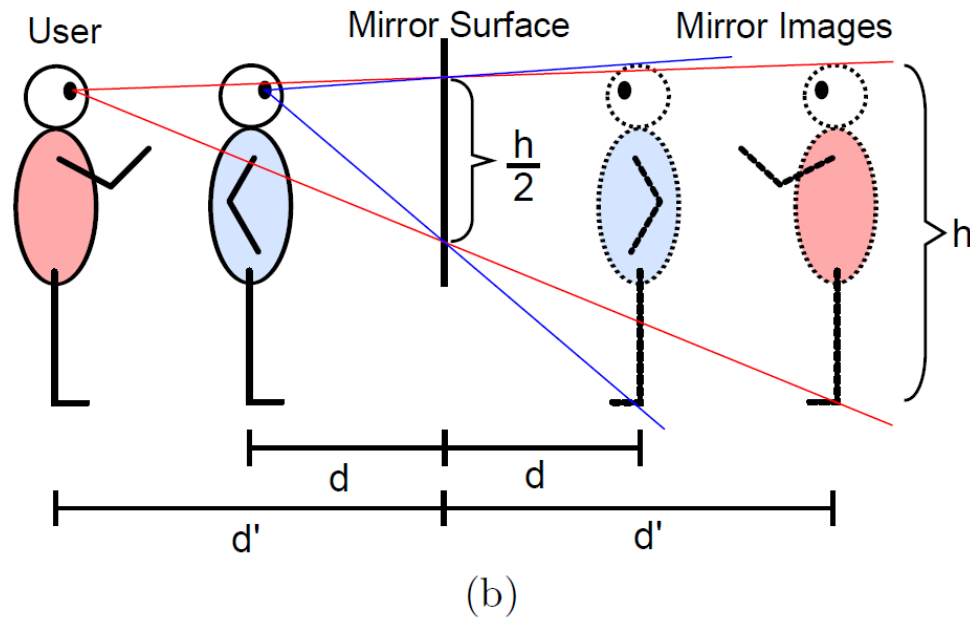


'109 Patent (Ex. 1001), Fig. 5B; *see also* '109 Patent (Ex. 1001), 2:19-27, 23:60-65.

43. This “mirror effect” was well known to a person of ordinary skill in the art. For example, as *Straka* (Ex. 1023) explains:

A virtual mirror needs to simulate the properties of a real mirror as accurate as possible. When standing in front of a mirror at a distance d , the mirror image of oneself appears exactly at the same distance but behind the mirror. However, even though this distance can change, the size of the user in the mirror image when projected on the mirror surface stays constant at half the height h of the user.

Straka (Ex. 1023), 637. *Straka* illustrates this effect in Figure 1(b) below:



Straka (Ex. 1023), Fig. 1(b).¹ To simulate this mirror effect using a digital camera, *Straka* sets focal length f of a virtual camera to be twice the user-mirror distance d . *Straka* (Ex. 1023), 641. So too does *Rosenberg* disclose a digital mirror system that simulates a real mirror. See, e.g., *Rosenberg* (Ex. 1005), [0027]-[0028]. *Rosenberg* discloses scaling real-time video images captured by the camera so that they appear like traditional, life-size mirror images. *Rosenberg* (Ex. 1005), [0077].

¹ Caption of *Straka*'s Figure 1(b): "When the user has a distance d from the mirror, the mirror image appears at the same distance behind the mirror. The height of the mirror image on the mirror surface always is half the height h of the user and does not depend on the distance d ." *Straka* (Ex. 1023), Fig. 1(b), 637.

44. *Second*, the '109 Patent explains “when the user approaches the mirror, the reflection of his eyes will always stay on the same virtual line into the mirror. Conversely, depending on a camera’s height, as the user gets closer to the camera, the user’s eyes may appear at different levels.” ’109 Patent (Ex. 1001), 2:29-33.

45. This mirror effect was also well known to a person of ordinary skill in the art and accounted for in prior art digital mirror systems. For example, *Straka* discloses approximating the position of a user’s eyes. *Straka* (Ex. 1023), 640-41. Similarly, *Rosenberg* discloses a camera mounted at eye level “provide[s a] user with a natural and accurate visual perspective of himself or herself as compared to a traditional mirror.” *Rosenberg* (Ex. 1005), [0027], [0028] (“[E]mbodiments 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 generally corresponds with a user’s typical eye level.”), [0075] (“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.”). Further, *Goto* (Ex. 1019) discloses when the camera is provided at the level of a user’s eyes, the image of the face of a user standing in front of the makeup simulator can be captured more naturally. *Goto* (Ex. 1019), [0096].

46. *Third*, the '109 Patent explains that, when one looks at a mirror, one's image appears to be reversed left and right, but not top and bottom. '109 Patent (Ex. 1001), 2:33-40.

47. This mirror effect was also well known to a person of ordinary skill in the art, and left-right inversion was performed on camera-captured images to mimic mirror reflections. For example, *Rosenberg* discloses inverting left-right of camera-captured images by flipping the image pixels around a vertical axis so that the right side of the user appears on the right side of the display, and the left side of the user appears on the left side of the display (from the user's perspective). *Rosenberg* (Ex. 1005), [0003], [0026]-[0027], [0035], [0041], [0061], [0068], [0077], [0083]. This is also shown in Figure 5 of *Rosenberg* below:

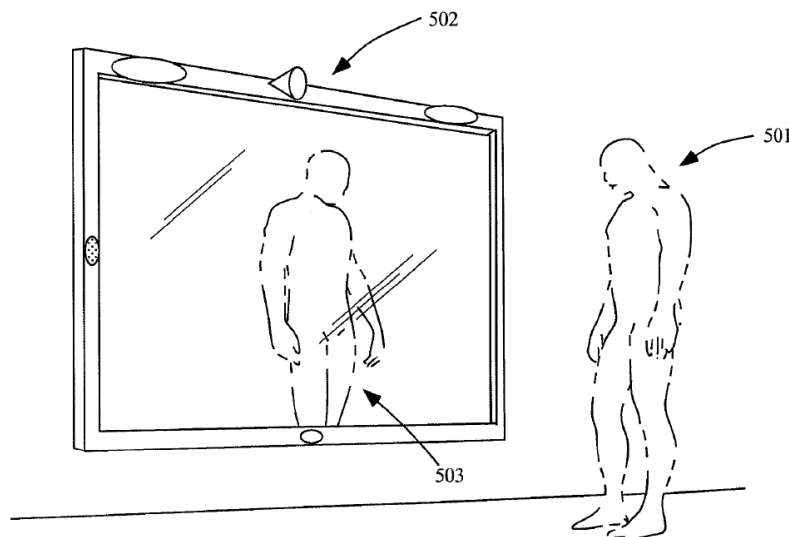
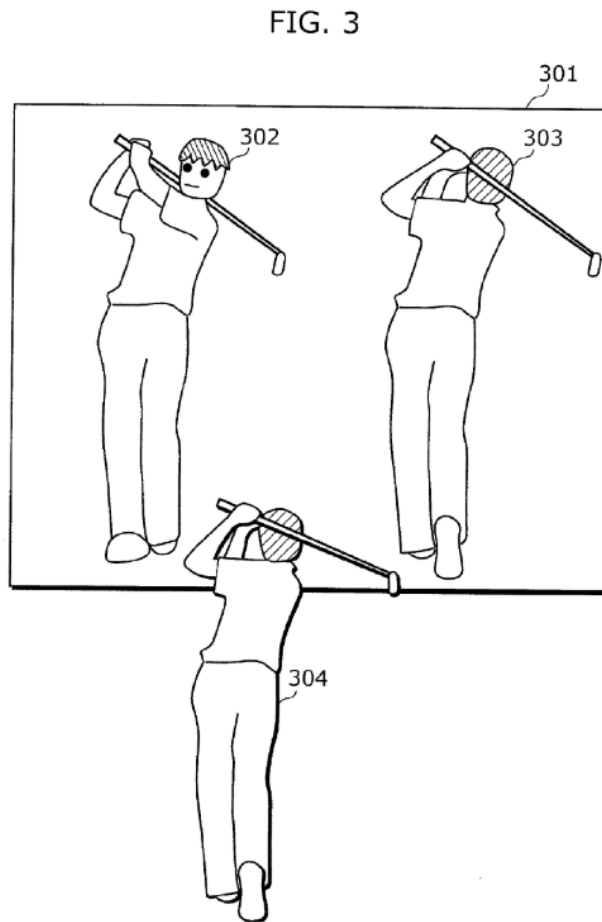


Fig. 5

Rosenberg (Ex. 1005), Fig. 5, [0077]. *Segawa* (Ex. 1034) also discloses a digital mirror performing left-right inversion on a front image of the user captured by a camera and displaying the left-right reversed image to the user. *Segawa* (Ex. 1034), [0028], [0052], [0061]-[0063], Fig. 3. This is shown below in Figure 3 of *Segawa*:



Segawa (Ex. 1034), Fig. 3. *Iwabuchi* also discloses displaying the image captured by the camera as a left and right reversing mirror would, as shown below:

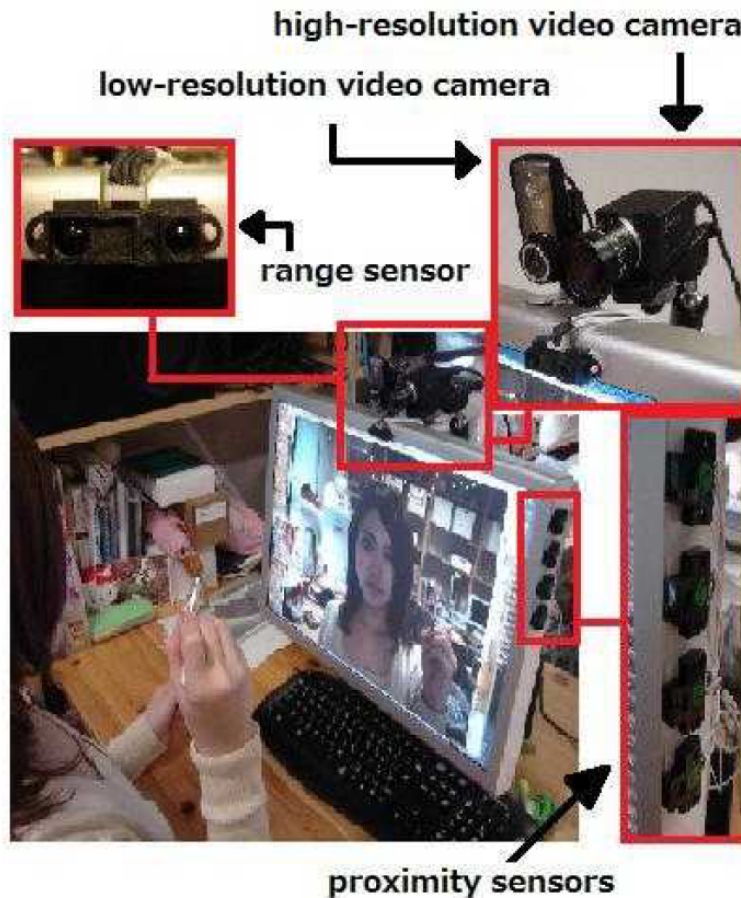


Figure 1. Overview of the system.

Segawa (Ex. 1034), Fig. 1.

C. Transforming Camera-Captured Images to Match a Camera Point of View to a Virtual Mirror Point of View Matching User's Viewpoint Was Well Known

48. As *Iwai* explains:

[I]t is obvious from the geometric optics that an image taken (photographed) from an oblique direction with respect to the front of a subject becomes a projection image obtained by the projection conversion of an image taken from a position just facing the front thereof. **The fact that the projection image is obtainable by the**

projection conversion of the front image according to a projective transformation matrix H has been well known in the technical field of image processing. For example, if a front image is electronic image data captured through a digital camera, when the captured front image undergoes projection conversion through the use of a computer resource, **it is possible to easily calculate a projection image, equivalent to when taken from an arbitrary direction (light of sight), at a relatively high speed.**

Iwai (Ex. 1010), 1:47-61; *see also Iwai* (Ex. 1010), 11:57-12:4, 18:48-52, 21:49-56, 23:1-8.

49. With respect to transforming camera-captured images to mirror images, *François* (Ex. 1035) explains that “[w]hen a person looks into a planar mirror, they see what they would see from the symmetrical (virtual) point of view” and that “the image perceived by the viewer on the mirror surface is a perspective projection on the mirror plane with respect to the virtual viewpoint.” *François* (Ex. 1035), 2.1 (Mirror geometry). This is illustrated below:

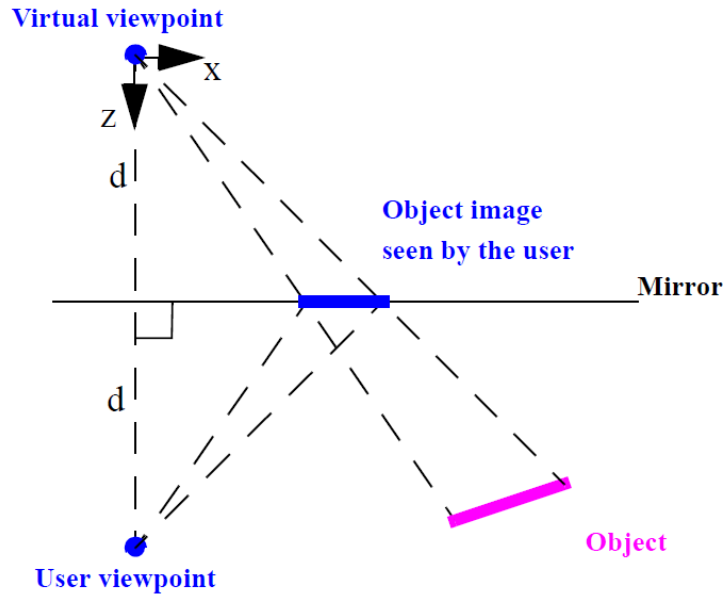


Figure 2. Mirror geometry.

François (Ex. 1035), Fig. 2. With the world coordinate system taken to be centered at the virtual viewpoint, as shown in Figure 2 above, *François* explains the relationship between the coordinates (x, y, z) of a point (e.g., point on the object in Figure 2) and the coordinates (x_p, y_p) of the point's projected image on the mirror plane, with the center of projection being the virtual viewpoint, can be represented as shown below:

$$\begin{bmatrix} U_p \\ V_p \\ W_p \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1/d & 0 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \\ 1 \end{bmatrix} \quad \begin{aligned} x_p &= U_p / W_p = dx/z \\ y_p &= V_p / W_p = dy/z \end{aligned}$$

where d is the orthogonal distance of the viewpoint to the mirror plane. *François* (Ex. 1035), 2.1 (Mirror geometry), Fig. 2.

50. Given a camera with a camera center positioned at (t_x, t_y, t_z) in the world coordinate system, and with a camera image plane that coincides with the mirror plane (i.e., mirror plane is at a distance equal to camera focal length f from camera center), and with camera coordinate axes whose directions coincide with the world coordinate axes, let (x'_p, y'_p) be the coordinates of the projected image of the point (x, y, z) on the camera image plane, which also coincides with the mirror plane, with respect to the camera center. This is illustrated by the red dot on the mirror imaging plane in Figure 5 below.

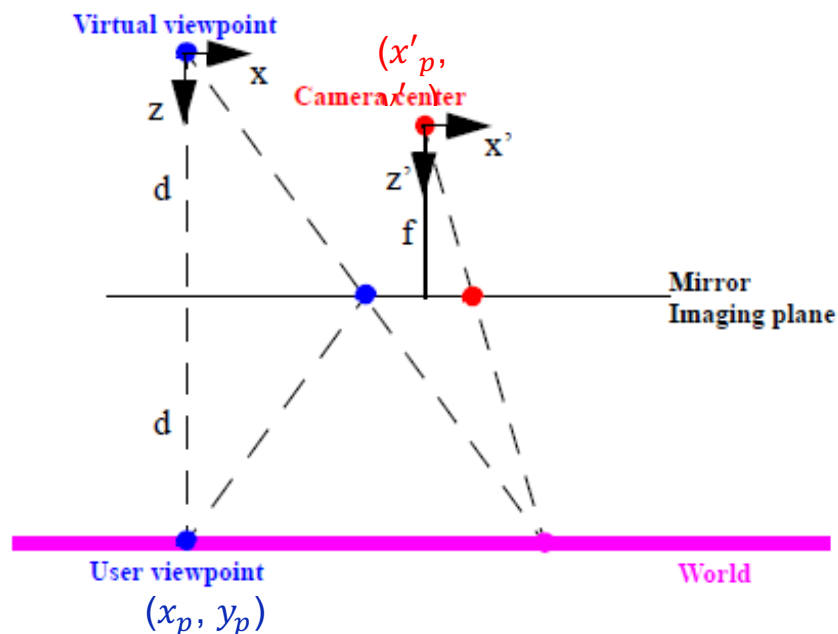


Figure 5. Flat world assumption.

François (Ex. 1035), Fig. 5.

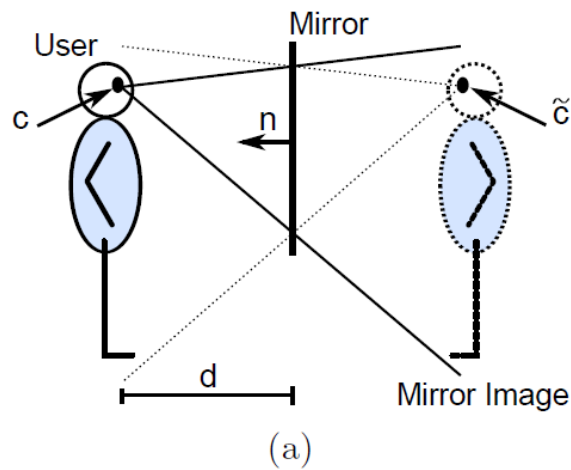
51. *François* explains that, in order to synthesize the images corresponding to the user's viewpoint from the images captured by the camera, the coordinates of the camera image (x'_p, y'_p) with respect to the camera center (see red dot on mirror imaging plane in Figure 5 above) and the coordinates (x_p, y_p) of the images corresponding to the user's viewpoint (see blue dot on mirror imaging plane in Figure 5 above) must be related geometrically. *François* (Ex. 1035), 2.3 (User view synthesis). This relationship can be simplified and represented by the equations below:

$$x_p = d((f + d)x'_p / f + t_x) / ((f + d) + t_z)$$
$$y_p = d((f + d)y'_p / f + t_y) / ((f + d) + t_z)$$

where f is the camera focal length, (t_x, t_y, t_z) is the location of the camera center, and d is the orthogonal distance of the user's viewpoint to the mirror plane. *François* (Ex. 1035), 2.3 (User view synthesis). Using the equations above, the points (x_p, y_p) of the mirror projection image can be obtained by geometrically transforming the points (x'_p, y'_p) of the camera-captured image. *François* (Ex. 1035), 2.3 (User view synthesis).

52. Like *François*, *Straka* also teaches simulating a mirror image based on a virtual camera position that mirrors the user's eyes' position. *Straka* (Ex. 1023),

4.3 (Virtual Mirror Camera). This is illustrated in the figure below, where the “position $\tilde{c}$ of the virtual camera is simply a mirrored version of the position of the eyes c ,” d represents the distance between the user and the mirror surface, and n represents the mirror normal:



Straka (Ex. 1023), Fig. 4(a). *Straka* further teaches calculating an optically correct mirror image from the user's view point using a virtual projection matrix $\tilde{P} = \tilde{K}[\tilde{R}|\tilde{t}]$, where $\tilde{R}$ is a rotation matrix to transform the camera's point of view to be normal to the mirror, $\tilde{t}$ is a translation vector corresponding to the virtual camera position $\tilde{c}$, and $\tilde{K}$ is an intrinsic matrix that mirrors and projects the scene to a display. *Straka* (Ex. 1023), 4.3 (Virtual Mirror Camera), Fig. 4.

VI. Legal Standards

53. In forming my opinions and considering the subject matter of the '109 Patent and its claims in light of the prior art, I am relying on certain legal principles

that counsel in this case has explained to me. My understanding of these concepts is summarized below.

54. I understand that the claims define the invention. I also understand that an unpatentability analysis is a two-step process. First, the claims of the challenged patent are construed to determine their meaning and scope. Second, once the claims have been construed, the content of the prior art is compared to the construed claims.

55. I have been informed by counsel that a person of ordinary skill in the art is a hypothetical person presumed to know the relevant prior art. I understand the actual inventor's skill is not determinative of the level of ordinary skill in the art. I further understand that the factors that may be considered in determining the level of skill include: the types of problems encountered in the art; prior art solutions to those problems; the rapidity with which innovations are made; the sophistication of the technology; and the educational level of active workers in the field. I understand that not all such factors may be present in every case, and that one or more of them may predominate in a given case.

A. Claim Construction

56. I have been informed that in an *inter partes* review, claim terms should be construed under the same standard that is applied in district court. I understand that under this standard, the meaning of claim terms is considered from the viewpoint of a person of ordinary skill in the art at the time of the alleged invention.

57. I have been informed that claim terms are generally given their ordinary and customary meaning as understood by one of ordinary skill in the art in light of the claims, the specification, and the prosecution history pertaining to the patent. I understand, however, that claim terms are generally not limited by the embodiments in the specification. I understand other evidence also may be considered to ascertain the meaning of claim terms, like textbooks, encyclopedias, articles, and dictionaries. I have been informed that this other evidence is often less significant and less reliable than the claims, specification, and prosecution history pertaining to the patent. I have also been informed that claims should only be construed to the extent necessary to resolve any controversy. I have applied that standard here.

B. Obviousness Under 35 U.S.C. § 103

58. I have been informed that, in an obviousness analysis, prior art must be analogous prior art to the patent being considered. I have been informed that a prior art reference is considered to be analogous, or in the same field of art, if the reference is either (1) in the same field of endeavor as the challenged patent, regardless of the problems the challenged patent and the prior art address, or (2) reasonably pertinent to the particular problem being solved by the challenged patent.

59. I understand a patent claim is unpatentable as obvious if the claimed invention would have been obvious to a person of ordinary skill in the art at the time the claimed invention was made. I understand that the existence of every element of

the claimed invention in the prior art does not necessarily prove obviousness, and that most, if not all, inventions rely upon building blocks in the prior art. I have been informed a claim may be unpatentable as obvious if differences between the subject matter patented and the prior art are such that the subject matter of the claim, as a whole, would have been obvious to a person of ordinary skill in the art at the time that the invention was made. I understand several factual inquiries underlie an obviousness determination. These factual inquiries include (1) the scope and content of the prior art; (2) the level of ordinary skill; (3) the differences between the claimed invention and the prior art; and (4) the objective evidence of non-obviousness.

60. I understand a patent claim composed of several elements is not proved obvious merely by demonstrating that each of its elements was independently known in the prior art. In evaluating whether a claim would have been obvious, one may consider whether a reason has been identified that would have prompted a person of ordinary skill in the art to combine the elements or concepts from the prior art in the way in the claimed invention. There is no single way to define the line between true inventiveness on the one hand (which is patentable) and the application of common sense and ordinary skill to solve a problem on the other (which is not patentable). For example, market forces or design incentives may be what produced a change, rather than true inventiveness.

61. I understand that whether a prior art reference, alone or in combination with one or more other prior art references, renders a patent claim unpatentable as obvious is determined from the perspective of a person of ordinary skill in the art at the time of the alleged invention. I have been told that there is no requirement that the prior art contain an express suggestion to combine known elements to achieve the claimed invention, but a suggestion to combine known elements to achieve the claimed invention may come from the prior art, as filtered through the knowledge of one of ordinary skill in the art. In addition, I have been told that inferences and creative steps a person of ordinary skill in the art would employ are relevant to the determination of obviousness.

62. I understand there is no rigid rule that a reference or a combination of references must contain an explicit “teaching, suggestion, or motivation” to combine references. But I also understand that the “teaching, suggestion, or motivation” test can be a useful guide in establishing a rationale for combining elements of the prior art. I have been told that this test poses the question as to whether there is an explicit or implied teaching, suggestion, and/or motivation to combine prior art elements in a way that realizes the claimed invention, and the test seeks to counter impermissible hindsight analysis.

63. I understand one may consider, e.g., whether (1) the change was merely the predictable result of using prior art elements according to their known functions,

or whether it was the result of inventiveness; (2) there is some teaching or suggestion in the prior art to make the modification or combination of elements claimed in the patent; (3) the claimed innovation applies a known technique that had been used to improve a similar device or method in a similar way; (4) the claimed invention would have been obvious to try, meaning that the claimed invention was one of a relatively small number of possible approaches to the problem, with a reasonable expectation of success by those skilled in the art; (5) the invention merely substituted one known element for another known element to obtain predictable results; (6) the invention merely applies a known technique to a known device, method, or product to yield a predictable result; or (7) known work in the field may have prompted variations of the same inventions in the same or different fields due to market forces or design incentives that would have been predictable to a person of ordinary skill in the art.

64. I understand that, to the extent made, any assertion regarding secondary considerations of non-obviousness must be accompanied by a showing of a nexus between the merits of the alleged invention and the evidence offered.

VII. Person of Ordinary Skill in the Art

65. I have been informed that unpatentability must be analyzed from the perspective of “a person of ordinary skill in the art” in the same field as the patent-in-suit at the time of invention. I have also been informed that several factors are considered in assessing the level of ordinary skill in the art, including: (1) the types

of problems encountered in the prior art; (2) the prior-art solutions to those problems; (3) the rate at which innovations are made; (4) the sophistication of the technology; and (5) the educational level of active workers in the field.

66. I am familiar with the technology at issue and the state of the art at the time of the earliest priority date of the '109 Patent. I believe that a person of ordinary skill in the art would have at least a bachelor's degree in computer or electrical engineering, or a closely related field such as computer science, and two years of work experience with image capture and processing systems or related fields. A person with less and/or different education, but more relevant practical experience, or vice versa, may also meet this standard. The prior art also shows such level of ordinary skill in the art.

67. I consider myself to have such a "level of ordinary skill in the art" with respect to the subject matter of the '109 Patent, as I have both a PhD in Electrical Engineering and several years of experience with image capture and processing systems. Thus, I am able to opine on how the person of ordinary skill in the art would have understood the disclosure and claims of the '109 Patent, disclosures of the prior art, motivations to combine the prior art, and what combinations would have been obvious to one of ordinary skill in the art.

VIII. Unpatentability

68. My analysis below presents the technical subject matter disclosed in the '109 Patent, as well as the knowledge of a person of ordinary skill in the art as of the earliest priority date of the '109 Patent; what I understand is December 18, 2012. See above discussion in ¶¶28-35. This analysis presents my opinions regarding the unpatentability of claims 1-18 of the '109 Patent based on references I considered from the perspective of a person of ordinary skill in the art. I considered, among other things, the following materials:

Exhibit	Description
Ex. 1001	U.S. Patent No. 8,982,109 to Vilcovsky et al. (“the '109 Patent”)
Ex. 1002	Prosecution History of U.S. Patent No. 8,982,109
Ex. 1005	U.S. Patent Application Publication No. 2007/0040033 to Rosenberg (“ <i>Rosenberg</i> ”)
Ex. 1006	Japanese Patent Application Publication No. 2007006016 to Nakazawa
Ex. 1007	Certified Translation of Japanese Patent Application Publication No. 2007006016 to Nakazawa (“ <i>Nakazawa</i> ”)
Ex. 1008	Japanese Patent Application Publication No. 2010177777 to Hatanaka
Ex. 1009	Certified Translation of Japanese Patent Application Publication No. 2010177777 to Hatanaka (“ <i>Hatanaka</i> ”)
Ex. 1010	U.S. Patent No. 6,816,187 to Iwai et al. (“ <i>Iwai</i> ”)
Ex. 1011	U.S. Patent Application Publication No. 2011/0292018 to Kubota et

Exhibit	Description
	al. (“ <i>Kubota</i> ”)
Ex. 1012	U.S. Patent Application Publication No. 2008/0239107 to Cho (“ <i>Cho</i> ”)
Ex. 1013	U.S. Patent Application Publication No. 2008/0253685 to Kuranov et al. (“ <i>Kuranov</i> ”)
Ex. 1014	U.S. Patent Application Publication No. 2007/0081208 A1 to Chang et al. (“ <i>Chang</i> ”)
Ex. 1015	U.S. Patent Application Publication No. 2014/0313230 A1 to Suggs (“ <i>Suggs</i> ”)
Ex. 1016	U.S. Patent Application Publication No. 2007/0065039 to Park et al. (“ <i>Park</i> ”)
Ex. 1017	International Application Publication No. WO 2006/108279 to Lizée et al. (“ <i>Lizée</i> ”)
Ex. 1018	U.S. Patent Application Publication No. 2008/0297589 to Kurtz et al. (“ <i>Kurtz</i> ”)
Ex. 1019	U.S. Patent Application Publication No. 2010/0226531 to Goto (“ <i>Goto</i> ”)
Ex. 1020	U.S. Patent Application Publication No. 2003/0146901 to Ryan (“ <i>Ryan</i> ”)
Ex. 1021	U.S. Patent No. 9,013,477 to Schmeitz et al. (“ <i>Schmeitz</i> ”)
Ex. 1022	U.S. Patent Application Publication No. 2011/0298910 to Haan et al. (“ <i>Haan</i> ”)
Ex. 1023	Matthias Straka et al., <i>A Free-Viewpoint Virtual Mirror with Marker-Less User Interaction</i> , Scandinavian Conference on Image Analysis SCIA 2011: Image Analysis, pp. 635–45 (“ <i>Straka</i> ”)
Ex. 1024	U.S. Patent Application Publication No. 2007/0132863 to Deguchi

Exhibit	Description
	(“ <i>Deguchi</i> ”)
Ex. 1025	U.S. Patent Application Publication No. 2013/0044188 to Nakamura (“ <i>Nakamura</i> ”)
Ex. 1026	Excerpts from EyesMatch Ltd.’s and Memomi Labs Inc.’s Objections and Responses to First Set of Interrogatories of Meta Platforms, Inc., Instagram, LLC, and WhatsApp LLC (Nos. 1-4) in <i>EyesMatch Ltd. et al v. Facebook, Inc. et al</i> , Case No. 1:21-cv-111-RGA-JLH (D. Del., July 2, 2021)
Ex. 1027	<i>Meta Platforms, Inc. f/k/a Facebook, Inc. et al. v. EyesMatch Ltd. et al.</i> , IPR2022-00489, Paper 9 (May 9, 2022).
Ex. 1028	U.S. Patent Provisional Application No. 60/656,884 to Vilcovski (“884 Provisional Application”)
Ex. 1029	U.S. Patent Provisional Application No. 60/656,885 to Vilcovski (“885 Provisional Application”)
Ex. 1030	U.S. Patent Provisional Application No. 61/738,957 to Vilcovski et al. (“957 Provisional Application”)
Ex. 1031	U.S. Patent Application Publication No. 2012/0229616 to Koike (“ <i>Koike</i> ”)
Ex. 1032	U.S. Patent Application Publication No. 2009/0051779 to Rolston (“ <i>Rolston</i> ”)
Ex. 1033	Eriko Iwabuchi et al. <i>Smart Makeup Mirror: Computer-Augmented Mirror to Aid Makeup Application</i> . In: Jacko, J.A. (eds) Human-Computer Interaction. Interacting in Various Application Domains. HCI 2009. Lecture Notes in Computer Science, vol 5613. Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-642-02583-9_54 (“ <i>Iwabuchi</i> ”)
Ex. 1034	U.S. Patent Application Publication No. 2011/0210970 to Segawa (“ <i>Segawa</i> ”)

Exhibit	Description
Ex. 1035	Alexandre R.J. François et al. <i>A handheld mirror simulation</i> , 2003 International Conference on Multimedia and Expo. ICME '03. Proceedings (Cat. No.03TH8698), Baltimore, MD, USA, 2003, pp. 1-4, doi: 10.1109/ICME.2003.1221724 (“ <i>François</i> ”)
Ex. 1036	Excerpts from Mark J. T. Smith et al. <i>A study guide for Digital Image Processing</i> , 1997, by Scientific Publishers (“ <i>Smith</i> ”)
Ex. 1037	Mahesh M. Subedar, et al. <i>Increased depth perception with sharpness enhancement for stereo video</i> , Proc. SPIE 7524, Stereoscopic Displays and Applications XXI, 75241B (17 February 2010) (“ <i>Subedar</i> ”)
Ex. 1038	U.S. Patent No. 8,139,892 to Watson (“ <i>Watson</i> ”)
Ex. 1039	U.S. Patent Application Publication No. 2011/0254691 to Ooi (“ <i>Ooi</i> ”)
Ex. 1040	U.S. Patent No. 9,355,585 to Tripathi et al. (“ <i>Tripathi</i> ”)
Ex. 1041	U.S. Patent Application Publication No. 2009/0122195 to van Baar et al. (“ <i>van Baar</i> ”)
Ex. 1042	U.S. Patent Application Publication No. 2007/0273787 to Ogino et al. (“ <i>Ogino</i> ”)

69. In my opinion, a person of ordinary skill would have understood claims 1-18 of the '109 Patent to be unpatentable. My specific opinions as to unpatentability are summarized in the below table and set forth in detail in §X:

Unpatentability Grounds	
Ground 1:	<i>Rosenberg</i> in view of <i>Nakazawa</i> renders obvious claims 1-6, 8, and 17 under 35 U.S.C. § 103.
Ground 2:	<i>Rosenberg</i> in view of <i>Nakazawa</i> and <i>Hatanaka</i> renders obvious claims 1-6, 8, 11, and 17 under 35 U.S.C. § 103.
Ground 3:	<i>Rosenberg</i> in view of <i>Nakazawa</i> and <i>Tripathi</i> renders obvious claims 1-6, 8, and 17 under 35 U.S.C. § 103.
Ground 4:	<i>Rosenberg</i> in view of <i>Nakazawa</i> , <i>Tripathi</i> , and <i>Hatanaka</i> renders obvious claim 11 under 35 U.S.C. § 103.
Ground 5:	<i>Rosenberg</i> in view of <i>Nakazawa</i> and <i>Iwai</i> renders obvious claim 7 under 35 U.S.C. § 103.
Ground 6:	<i>Rosenberg</i> in view of <i>Nakazawa</i> , <i>Hatanaka</i> , and <i>Iwai</i> renders obvious claim 7 under 35 U.S.C. § 103.
Ground 7:	<i>Rosenberg</i> in view of <i>Nakazawa</i> , <i>Tripathi</i> , and <i>Iwai</i> renders obvious claim 7 under 35 U.S.C. § 103.

Unpatentability Grounds	
Ground 8:	<i>Rosenberg</i> in view of <i>Nakazawa</i> and <i>Kubota</i> renders obvious claim 9 under 35 U.S.C. § 103.
Ground 9:	<i>Rosenberg</i> in view of <i>Nakazawa</i> , <i>Hatanaka</i> , and <i>Kubota</i> renders obvious claim 9 under 35 U.S.C. § 103.
Ground 10:	<i>Rosenberg</i> in view of <i>Nakazawa</i> , <i>Tripathi</i> , and <i>Kubota</i> renders obvious claim 9 under 35 U.S.C. § 103.
Ground 11:	<i>Rosenberg</i> in view of <i>Nakazawa</i> and <i>Cho</i> renders obvious claim 10 under 35 U.S.C. § 103.
Ground 12:	<i>Rosenberg</i> in view of <i>Nakazawa</i> , <i>Hatanaka</i> , and <i>Cho</i> renders obvious claim 10 under 35 U.S.C. § 103.
Ground 13:	<i>Rosenberg</i> in view of <i>Nakazawa</i> , <i>Tripathi</i> , and <i>Cho</i> renders obvious claim 10 under 35 U.S.C. § 103.
Ground 14:	<i>Rosenberg</i> in view of <i>Nakazawa</i> and <i>Park</i> renders obvious claim 12 under 35 U.S.C. § 103.

Unpatentability Grounds	
Ground 15:	<i>Rosenberg</i> in view of <i>Nakazawa</i> , <i>Hatanaka</i> , and <i>Park</i> renders obvious claim 12 under 35 U.S.C. § 103.
Ground 16:	<i>Rosenberg</i> in view of <i>Nakazawa</i> , <i>Tripathi</i> , and <i>Park</i> renders obvious claim 12 under 35 U.S.C. § 103.
Ground 17:	<i>Rosenberg</i> in view of <i>Nakazawa</i> and <i>Kuranov</i> renders obvious claims 13-15 under 35 U.S.C. § 103.
Ground 18:	<i>Rosenberg</i> in view of <i>Nakazawa</i> , <i>Hatanaka</i> , and <i>Kuranov</i> renders obvious claims 13-15 under 35 U.S.C. § 103.
Ground 19:	<i>Rosenberg</i> in view of <i>Nakazawa</i> , <i>Tripathi</i> , and <i>Kuranov</i> renders obvious claims 13-15 under 35 U.S.C. § 103.
Ground 20:	<i>Rosenberg</i> in view of <i>Nakazawa</i> and <i>Chang</i> renders obvious claim 16 under 35 U.S.C. § 103.
Ground 21:	<i>Rosenberg</i> in view of <i>Nakazawa</i> , <i>Hatanaka</i> , and <i>Chang</i> renders obvious claim 16 under 35 U.S.C. § 103.

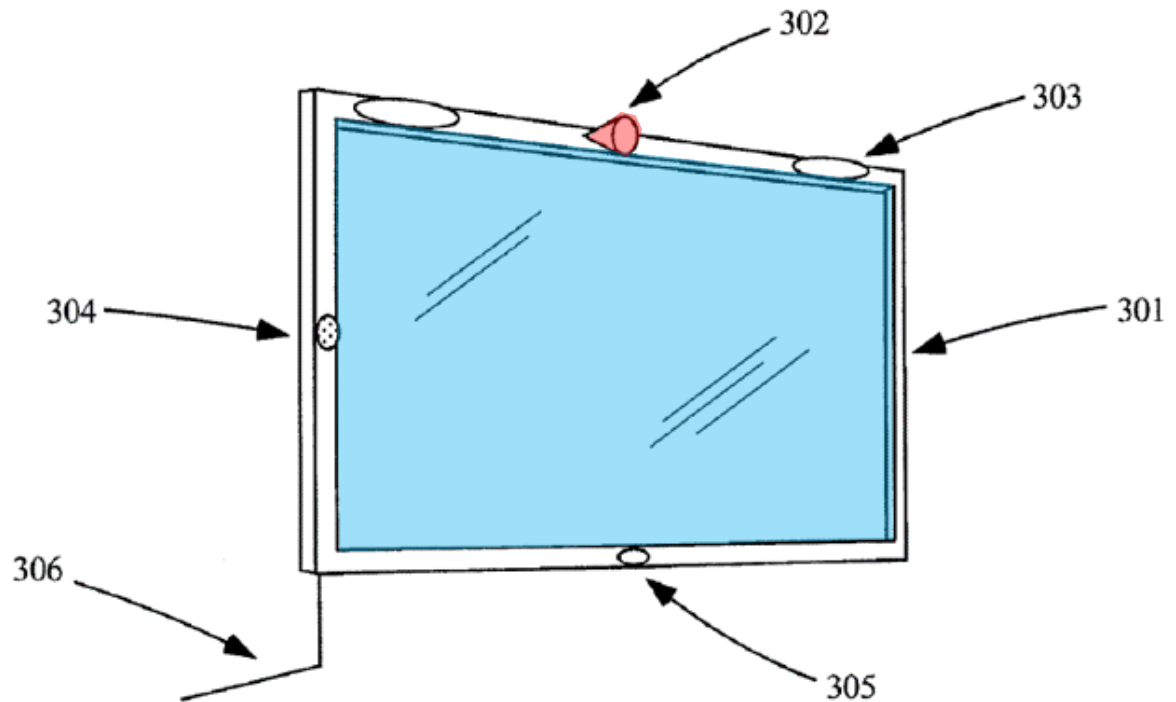
Unpatentability Grounds	
Ground 22:	<i>Rosenberg</i> in view of <i>Nakazawa</i> , <i>Tripathi</i> , and <i>Chang</i> renders obvious claim 16 under 35 U.S.C. § 103.
Ground 23:	<i>Rosenberg</i> in view of <i>Nakazawa</i> and <i>Lizee</i> renders obvious claim 18 under 35 U.S.C. § 103.
Ground 24:	<i>Rosenberg</i> in view of <i>Nakazawa</i> , <i>Hatanaka</i> , and <i>Lizee</i> renders obvious claim 18 under 35 U.S.C. § 103.
Ground 25:	<i>Rosenberg</i> in view of <i>Nakazawa</i> , <i>Tripathi</i> , and <i>Lizee</i> renders obvious claim 18 under 35 U.S.C. § 103.

IX. Overview of Prior Art

A. Overview of *Rosenberg* (Ex. 1005)

70. *Rosenberg* was filed in the United States on September 26, 2006, and published on February 22, 2007. Thus, *Rosenberg* was published more than one year prior to the priority date of the '109 patent, which I understand to be December 18, 2012. See above discussion in ¶¶28-35. I have thus been informed that *Rosenberg* qualifies as prior art to the '109 patent under at least 35 U.S.C. § 102 (b).

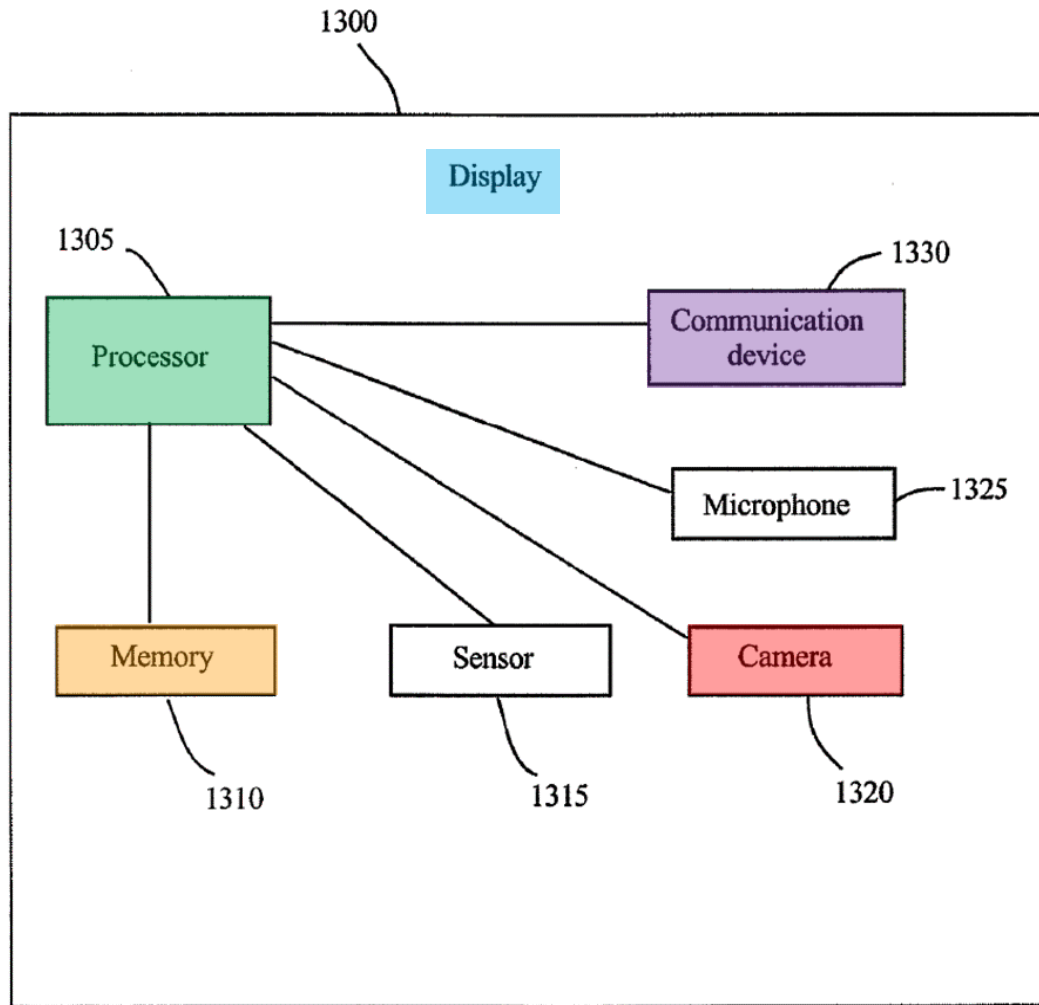
71. *Rosenberg* discloses a digital mirror system (and related method) “that emulates a traditional mirror by displaying real-time video imagery of a user.” *Rosenberg* (Ex. 1005), Abstract, claims 1, 19, 23. As shown in the figure below, *Rosenberg*’s system includes a display with a screen (e.g., an LCD display) and a digital video camera mounted above the screen. *Rosenberg* (Ex. 1005), [0062]; see also *Rosenberg* (Ex. 1005), [0059]-[0060]. The “video camera 302 is centered horizontally across the display 301 and aimed slightly downward such that it will be pointed at any typical user [] in front of the display.” *Rosenberg* (Ex. 1005), [0062].



Rosenberg (Ex. 1005), Fig. 3²; see also *Rosenberg* (Ex. 1005), [0077].

72. As shown in the figure below, *Rosenberg*'s digital mirror system also includes a **processor**, a **memory**, and a **communication device** used to “access [] communication networks via a network connection.” *Rosenberg* (Ex. 1005), [0035], [0074], [0109]. *Rosenberg* teaches that the processor and memory allow the system to “achieve unique mirroring features and functions not provided by a standard household wall mirror.” *Rosenberg* (Ex. 1005), [0035].

²Annotations to figures have been added unless otherwise noted.



Rosenberg (Ex. 1005), Fig. 13.

73. *Rosenberg* further discloses that, in a digital mirror state, the camera captures a real-time video image of the user, which is then “left-right inverted” and scaled to a display size to emulate “a traditional life-size mirror image.” *Rosenberg* (Ex. 1005), [0077]. In this way, *Rosenberg* explains that the user “is given the visual impression he or she is standing before a traditional [] mirror, viewing a traditional mirror image of himself or herself.” *Rosenberg* (Ex. 1005), [0077], Fig. 5.

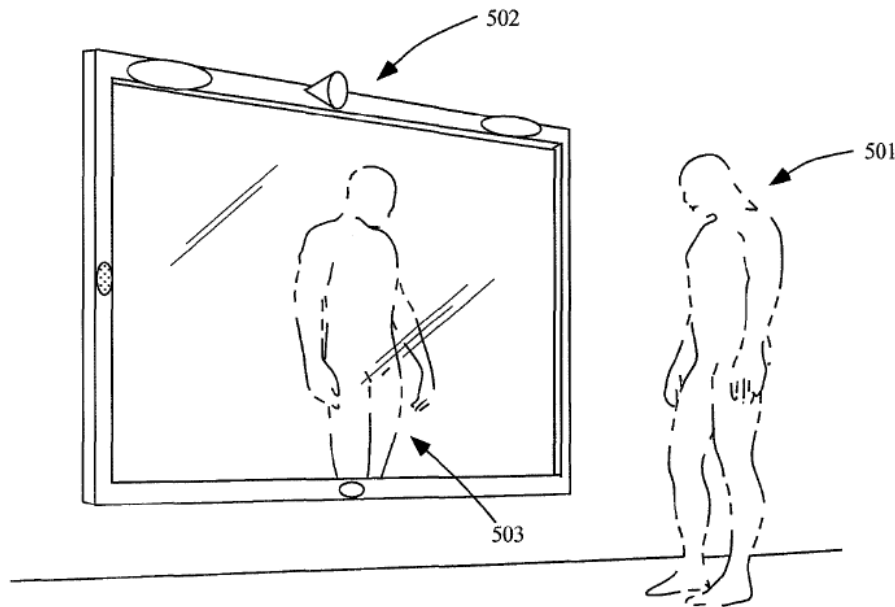


Fig. 5

Rosenberg (Ex. 1005), Fig. 5.

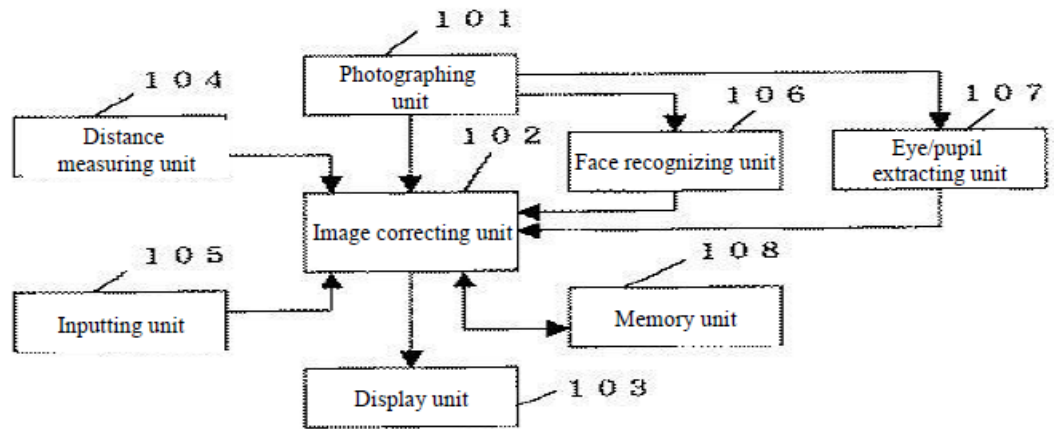
74. *Rosenberg*'s system also includes a proximity and/or motion sensor for detecting when a user is before the display screen within some proximity range, and automatically engages the digital mirror functionality when the user is within that proximity range. *Rosenberg* (Ex. 1005), [0025], [0032], [0056], [0069], [0071]-[0072], Fig. 13. *Rosenberg* explains that different sensors, including a digital camera, can be used as the proximity sensor. *Rosenberg* (Ex. 1005), [0034], [0069], [0073], [0109], Fig. 13.

B. Overview of *Nakazawa* (Ex. 1006, certified translation Ex. 1007)

75. *Nakazawa* was filed in Japan on June 22, 2005, and published on January 11, 2007. *Nakazawa* was published more than one year prior to the priority date of the '109 patent, which I understand to be December 18, 2012. *See* above discussion in ¶¶28-35. I have thus been informed that *Nakazawa* qualifies as prior art to the '109 patent under at least 35 U.S.C. § 102(b).

76. *Nakazawa* discloses a photographing device. *Nakazawa* (Ex. 1007), Abstract, [0007], [0030]. The disclosed photographing device corrects deviations in the orientation and/or line of sight in a captured image when (i) the camera is located above or below a display, and (ii) a user looks at her image in the display during image capture. *Nakazawa* (Ex. 1007), Abstract, [0001]-[0003], [0008], [0032], [0034]. *Nakazawa*'s device includes a photographing unit 101 (e.g., digital camera), a display 103 (e.g., an LCD), an image correcting unit 102, a distance measurement unit 104, an inputting unit 105, a face recognizing unit 106, an eye/pupil recognizing unit 107, and a memory unit 108. *Nakazawa* (Ex. 1007), [0030]; *see also Nakazawa* (Ex. 1007), [0002]. Each of these components is shown below:

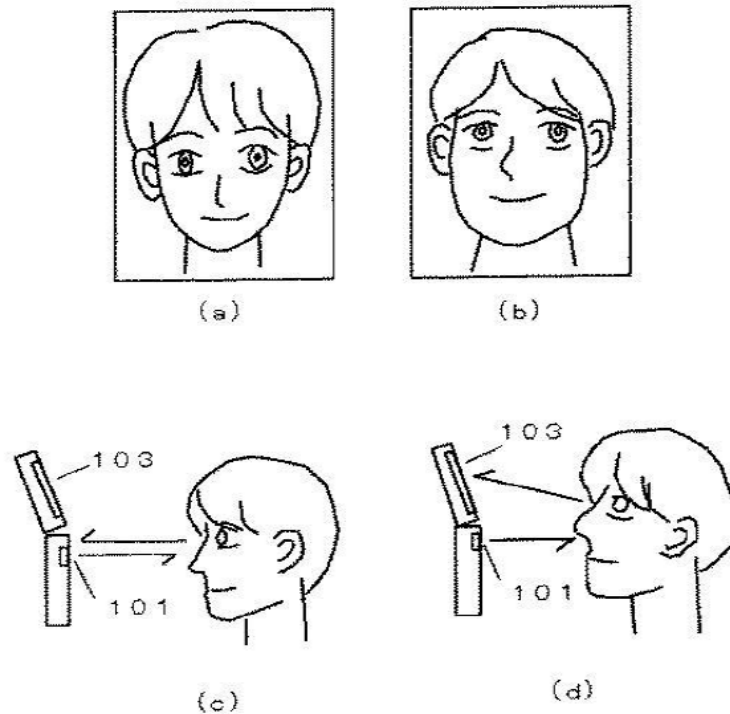
[FIG. 1]



Nakazawa (Ex. 1007), Fig. 1.

77. *Nakazawa* explains that, when a user looks at the camera during image capture (e.g., *Nakazawa* (Ex. 1007), Fig. 2(c)), an image like Figure 2(a) is captured (“a front orientation”). *Nakazawa* (Ex. 1007), [0031]-[0033]. But when the user looks at the display during image capture (e.g., *Nakazawa* (Ex. 1007), Fig. 2(d)), a distorted image like Figure 2(b) is captured. *Nakazawa* (Ex. 1007), [0031]-[0033].

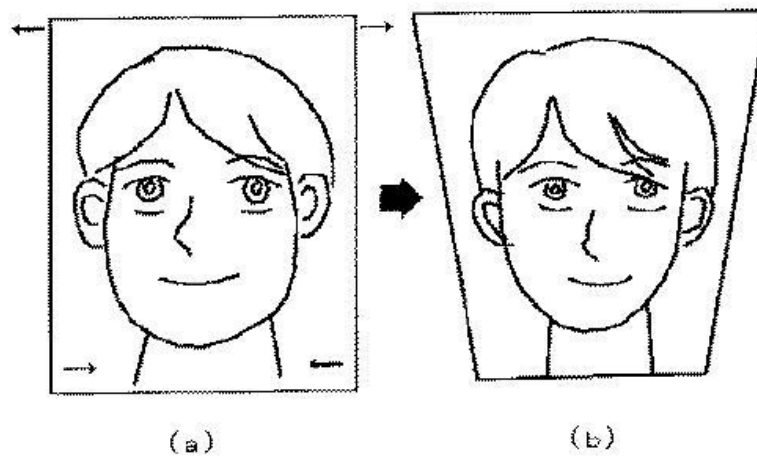
[FIG. 2]



Nakazawa (Ex. 1007), Fig. 2. To obtain an image with a front orientation (Figure 2(a)) when a user is looking at the display during image capture, *Nakazawa* discloses correcting the distortion in the image based on face orientation (Figure 2(b)) by adjusting the size of different regions across the image's field. *Nakazawa* (Ex. 1007), [0033]-[0035], Figs. 3-4. To do this, *Nakazawa* discloses increasing the magnification ratio of the image when moving away from the center of the image in the direction that the face is oriented, and decreasing the magnification ratio when moving away from the center of the image in the opposite direction. *Nakazawa* (Ex. 1007), [0033]-[0035], Figs. 3-4. For example, as shown in

Figure 3(a), *Nakazawa* transforms the distorted image to appear as in Figure 3(b) and mimic an image captured with a front orientation. *Nakazawa* (Ex. 1007), [0033]-[0035], Fig. 3.

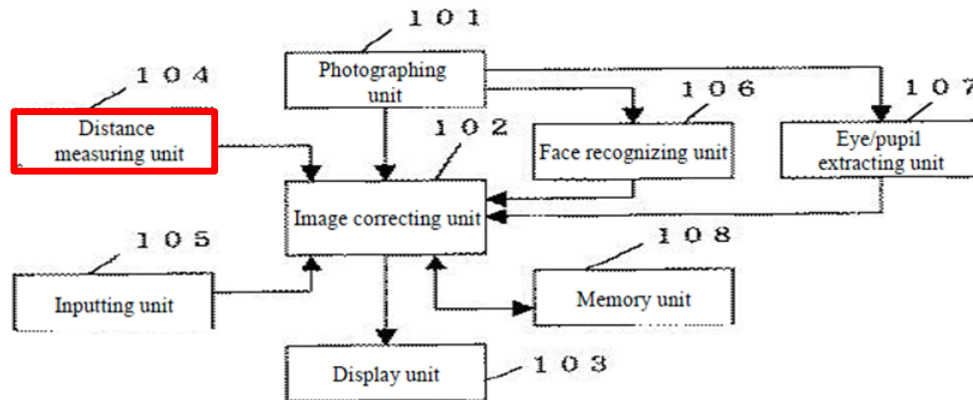
[FIG. 3]



Nakazawa (Ex. 1007), Fig. 3.

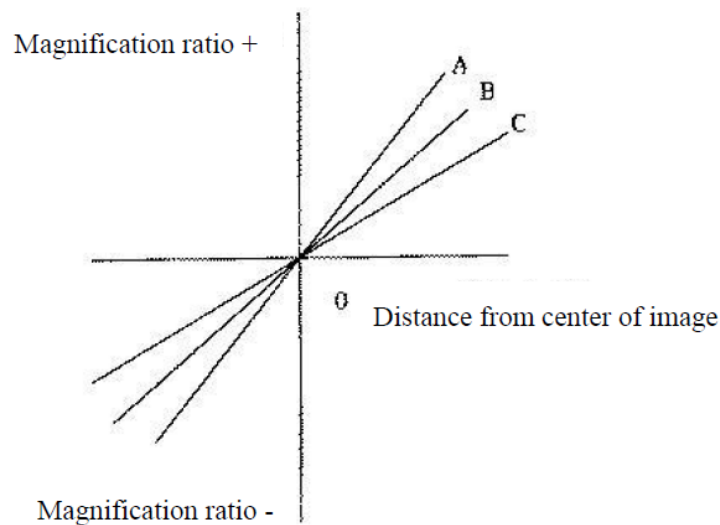
78. *Nakazawa* discloses that the distance measurement unit measures the distance between the camera and a user and outputs the measured distance to the image correcting unit. *Nakazawa* (Ex. 1007), [0015], [0030], [0038], Fig. 1. This is shown below:

[FIG. 1]



Nakazawa (Ex. 1007), Fig. 1.

Nakazawa further discloses determining the degree of magnification in its image correction based on the measured distance. *Nakazawa* (Ex. 1007), [0015], [0038], Fig. 5.



Nakazawa (Ex. 1007), Fig. 5.

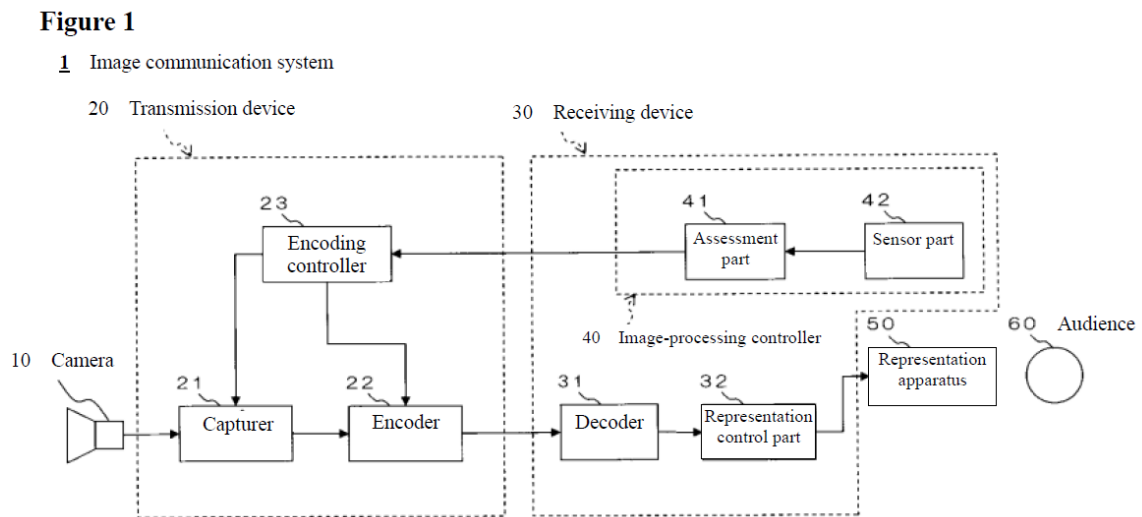
79. A person of ordinary skill in the art would have understood that *Nakazawa*'s correction processing is a projective transformation, because it corrects the point of view of the image to match the user's point of view. A person of ordinary skill in the art would have understood such projective transformation is a "***transformation mapping***" because it maps pixels in an input image to pixels in a processed output image. *See Nakazawa* (Ex. 1007), Abstract, [0001]-[0003], [0008], [0032]-[0034], Figs. 2-3. A person of ordinary skill in the art would have understood that *Nakazawa*'s degree of magnification corresponds to a projective transformation matrix. *See Park* (Ex. 1016), [0053], [0059]-[0062], Figs. 7-8 (teaching a similar image correction as a perspective transformation that is a type of geometric transformation); *Iwai* (Ex. 1010), 1:47-65, 2:43-3:7, 13:1-63. A person of ordinary skill in the art would have understood, while *Nakazawa* specifically discloses correcting a face image, *Nakazawa*'s correction would also be suitable for generally correcting user images containing projection distortion caused by the camera's point of view being at an angle from the user's point of view.

C. Overview of *Hatanaka* (Ex. 1008, certified translation Ex. 1009)

80. *Hatanaka* was filed on January 27, 2009, and published on August 12, 2010. *Hatanaka* was published more than one year prior to the priority date of the '109 patent, which I understand to be December 18, 2012. *See* above discussion in

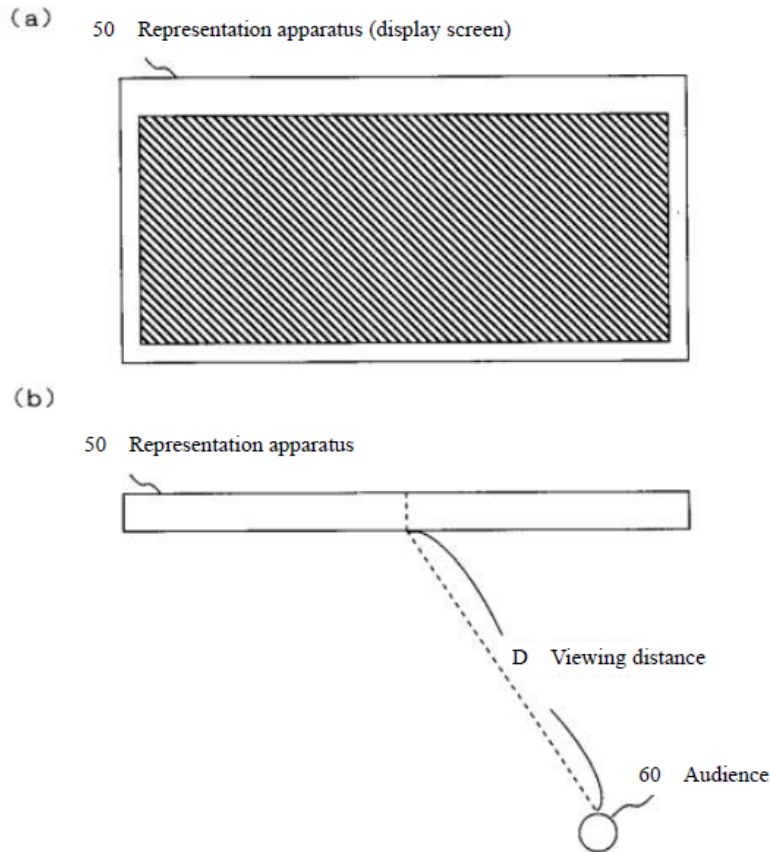
¶¶28-35. I have thus been informed that *Hatanaka* qualifies as prior art to the '109 patent under at least 35 U.S.C. § 102 (b).

81. *Hatanaka* discloses a method for reducing image-data-related processing throughput for an image communication system that displays video images. *E.g.*, *Hatanaka* (Ex. 1009), [0008], [0012]. Like *Rosenberg*'s digital mirror system, *Hatanaka*'s system includes a camera that captures video images and a display that displays the captured video images to a viewer at a viewing distance D from the display. *Hatanaka* (Ex. 1009), [0018], [0021], [0032]-[0036]; *see also* *Hatanaka* (Ex. 1009), Figs. 1, 2, 5.



Hatanaka (Ex. 1009), Fig. 1.

Figure 2



Hatanaka (Ex. 1009), Fig. 2.

82. *Hatanaka* discloses that the system includes a transmission device that transmits the video image data from the camera to the receiving device. *Hatanaka* (Ex. 1009), [0016], [0019]-[0026]. The transmission device includes an encoding controller and an encoder. *Hatanaka* (Ex. 1009), [0021]. The encoder performs video-image encoding under the control of the encoding controller. *Hatanaka* (Ex. 1009), [0024]. The receiving device also includes a decoder and an image processing control device. *Hatanaka* (Ex. 1009), [0025]-[0026], [0028]-[0029],

[0042]. The decoder receives and decodes encoded video image data and provides the decoded image data to the display for displaying to the viewer. *Hatanaka* (Ex. 1009), [0026], [0042]. Further, *Hatanaka* discloses that “the transmission device and receiving device may be configured as one unit.” *Hatanaka* (Ex. 1009), [0088].

83. *Hatanaka*’s image processing control device also has a proximity or motion sensor and assessment part. *Hatanaka* (Ex. 1009), [0028]-[0029]. The sensor measures the viewing distance D between the viewer and the display. *Hatanaka* (Ex. 1009), [0029], [0032]-[0036]. The assessment part provides instructions to the encoding controller to reduce encoding throughput as the viewing distance D increases. *Hatanaka* (Ex. 1009), [0037]. For example, the assessment part provides the encoding controller with instructions to adjust frame rate, quantization step size, compression ratio, resolution, etc., according to the viewing distance D . *Hatanaka* (Ex. 1009), [0039].

84. *Hatanaka* discloses that reducing the frame rate and/or resolution of the video image based on the viewing distance D results in a reduction of the throughput of the encoding and decoding processes, “thus enabling efficient processing of images.” *Hatanaka* (Ex. 1009), [0049]-[0052]. A person of ordinary skill in the art would have understood that reducing the frame rate (i.e., video image rate) and thus the throughput of image-data-related processing, as disclosed by *Hatanaka*, causes

the processing per frame to be performed at a varying rate because reducing frame rate (frames per second) reduced, indicating that processing steps are being performed at a varying rate. *Hatanaka* (Ex. 1009), [0012].

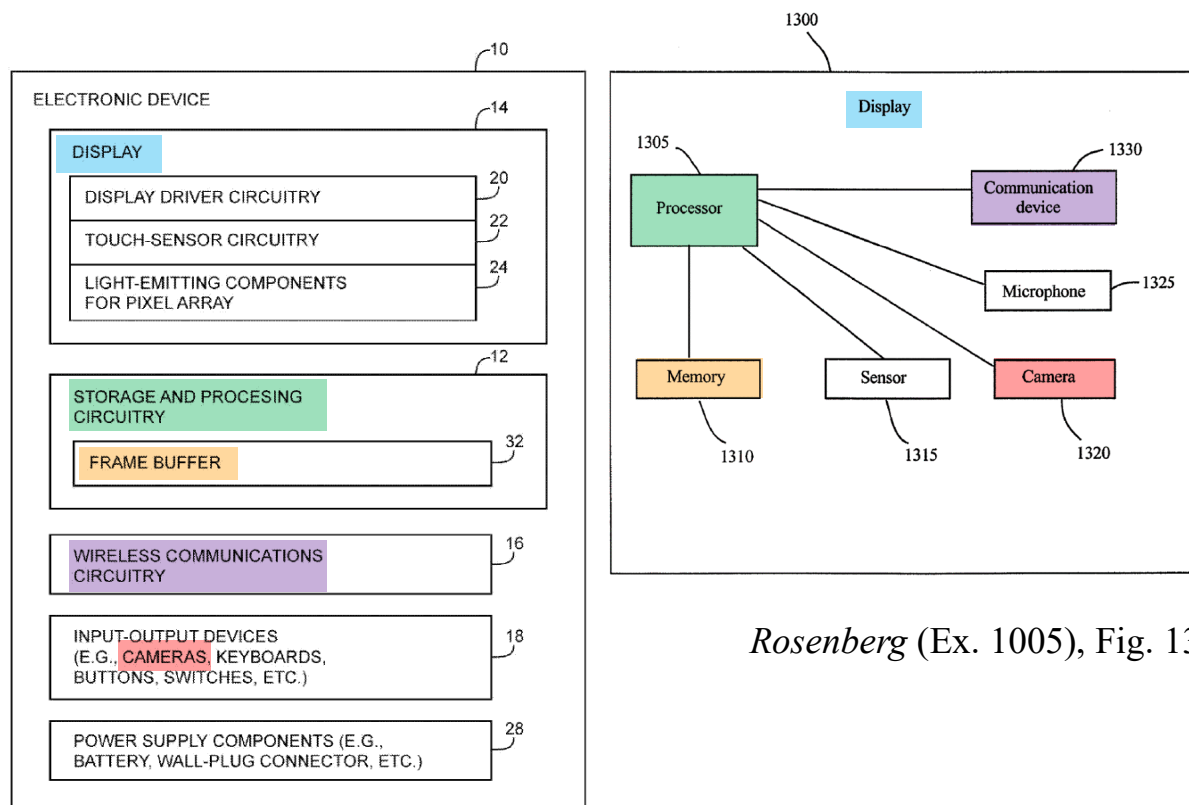
85. Further, *Hatanaka* discloses that reducing the resolution of the video image based on the viewing distance D results in a reduction of the throughput of the encoding and decoding processes, “thus enabling efficient processing of images.” *Hatanaka* (Ex. 1009), at [0049]-[0052]. A person of ordinary skill in the art would have understood that reducing the resolution of the video image and thus the throughput of the encoding and decoding processes, as disclosed by *Hatanaka*, causes the amount of processing to be reduced because reducing the resolution reduces the number of pixels that are processed in each video image.

D. Overview of *Tripathi* (Ex. 1040)

86. *Tripathi* was filed on April 3, 2012, and published on October 3, 2013. *Tripathi* was filed before the priority date of the '109 patent, which I understand to be December 18, 2012. See discussion above in ¶¶28-35. I have thus been informed that *Tripathi* qualifies as prior art to the '109 patent under at least 35 U.S.C. § 102 (e).

87. *Tripathi* discloses an electronic device with displays. E.g., *Tripathi* (Ex. 1040), 1:6-15, 3:35-37, 3:53-61. Like *Rosenberg*'s digital mirror system, *Tripathi*'s electronic device includes a display, processing circuitry, memory,

communication circuitry, and input-output devices, like a camera. *Tripathi* (Ex. 1040), 3:37-42, 4:36-68, 5:1-5, 6:20-27, 11:54-57, 12:6-15, Fig. 1; *Rosenberg* (Ex. 1005), [0035], [0044], [0062], [0074], [0109]. *Tripathi* discloses the device displays video images concurrently captured by the camera. *See Tripathi* (Ex. 1040), 10:20-24, 11:54-65, 12:6-10, 12:15-17. The *Tripathi* and *Rosenberg* systems are shown side-by-side below:



Tripathi (Ex. 1040), Fig. 1

Rosenberg (Ex. 1005), Fig. 13

88. *Tripathi* further discloses monitoring the content to be displayed and adjusting the display frame rate (refresh rate) in response to type of content. *Tripathi* (Ex. 1040), 1:23-29, 1:45-67, 3:49-52, 5:8-12. For example, *Tripathi* discloses

changing the display frame rate in response to static or dynamic content. *Tripathi* (Ex. 1040), 1:60-2:8, 5:42-56, 6:7-9, 7:36-42, 7:45-50, 9:13-34, 10:1-24, Figs. 2, 5, 10. *Tripathi* discloses monitoring the power supply status and adjusting the display frame rate in response to the status. *Tripathi* (Ex. 1040), 5:42-51, 7:64-8:53, Figs. 6-8. And *Tripathi* teaches reducing display frame rate to reduce power consumption or increasing display frame rate to improve perceived display resolution and/or display performance. *Tripathi* (Ex. 1040), 1:60-2:8, 5:65-6:3, 9:24-34, Fig. 2.

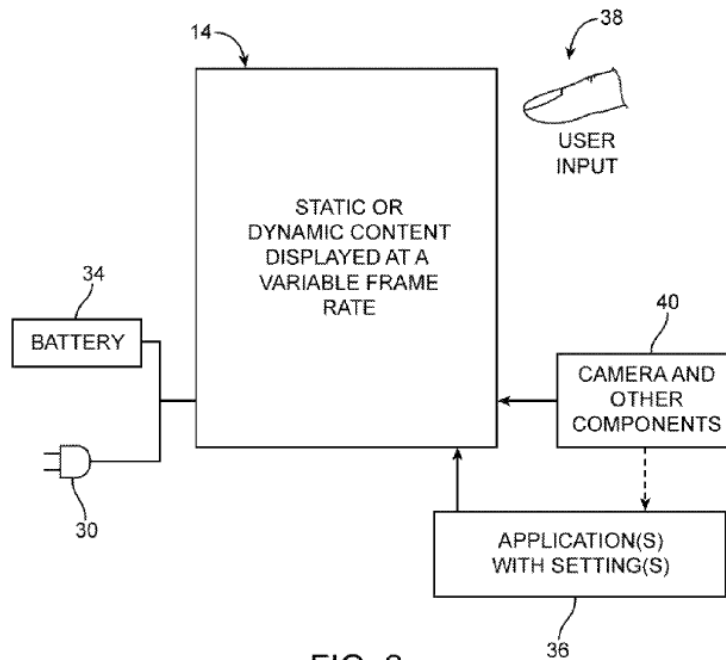


FIG. 2

Tripathi (Ex. 1040), Fig. 2.

E. Overview of *Iwai* (Ex. 1010)

89. *Iwai* was filed on June 2, 2000, and published on November 9, 2004. *Iwai* was published more than one year prior to the priority date of the '109 patent,

which I understand to be December 18, 2012. *See* above discussion in ¶¶28-35. I have thus been informed that *Iwai* qualifies as prior art to the '109 patent under at least 35 U.S.C. § 102 (b).

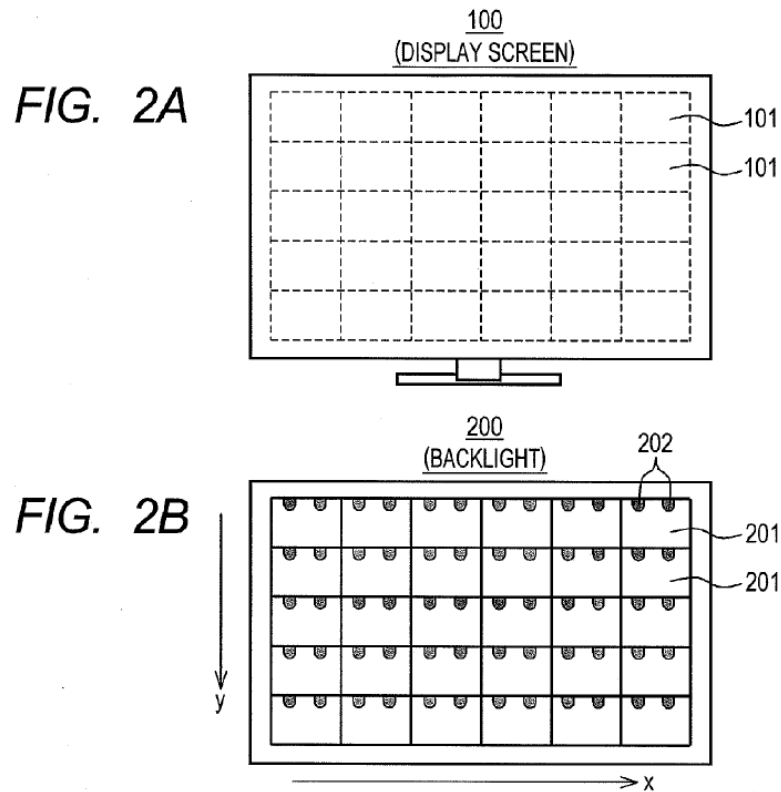
90. *Iwai* discloses a method for calibrating a digital camera for capturing an image of a user for processing or display. *Iwai* (Ex. 1010), 1:9-33, 10:29-37. *Iwai* teaches that an image taken from an oblique direction with respect to the front of a subject, like in *Rosenberg* and *Nakazawa*, would have projection distortion. *Iwai* (Ex. 1010), 1:34-55, 2:43-54, 5:24-31, 6:31-38. To resolve this issue, *Iwai* discloses estimating a “projective transformation parameter” for obtaining a projective transformation (*Iwai* (Ex. 1010), 4:46-58, 5:10-24, 6:16-24) for correcting the distortion in the user’s image. *Iwai* further discloses obtaining this parameter by performing “image registration between a picked-up image taken actually through a camera and a base image composed.” *Iwai* (Ex. 1010), 7:11-54, 9:65-10:3, 13:1-15:21.

F. Overview of *Kubota* (Ex. 1011)

91. *Kubota* was filed on April 25, 2011, and published on December 1, 2010. *Kubota* was published more than one year prior to the priority date of the '109 patent, which I understand to be December 18, 2012. *See* above discussion in ¶¶28-35. I have thus been informed that *Kubota* qualifies as prior art to the '109 patent under at least 35 U.S.C. § 102 (b).

92. *Kubota* discloses a liquid crystal display (LCD) device. *Kubota* (Ex. 1011), Title, [0004]. *Kubota* explains that an LCD device is equipped with a liquid crystal panel and a backlight behind the panel to illuminate the panel. *Kubota* (Ex. 1011), [0004], [0006]. *Kubota* explains that, in general, images are displayed at a desired brightness by controlling the optical transmittance of the liquid crystal panel according to an image signal, while the backlight emits light at a fixed brightness level. *Kubota* (Ex. 1011), [0006].

93. In one embodiment, *Kubota* discloses an LCD device with a liquid crystal panel having a display screen and a backlight having a matrix of backlight cells. *Kubota* (Ex. 1011), [0030]-[0031]. The display screen is segmented into areas 101, each including a plurality of pixels, and a pair of backlight cells 201 that illuminate corresponding areas 101. *Kubota* (Ex. 1011), [0031]. “[L]ight intensity levels of the backlight cells 201 are controlled independently in units of backlight cells.” *Kubota* (Ex. 1011), [0031]. This is shown below:



Kubota (Ex. 1011), Figs. 2A-2B.

94. *Kubota* also discloses that the LCD device provides selectable backlight control functions including a shading process. *Kubota* (Ex. 1011), [0009], [0013], [0027], [0029], [0053], Fig. 5. The shading process reduces light control values of backlight cells 201 for a peripheral part of the screen to relatively lower the brightness in the peripheral part of the screen compared to the central part of the screen. *Kubota* (Ex. 1011), [0013], [0038], [0050], [0066], Fig. 5, Figs. 9A-9B. This is shown below:

FIG. 5

BACKLIGHT CONTROL FUNCTIONS IMAGE DISPLAY MODE	(1) SPATIAL FILTER CONTROL	(2) BLACK AREA CONTROL	(3) POWER CONTROL	(4) SHADING CONTROL
	HIGH, MIDDLE OR LOW	ON OR OFF BLACK AREA THRESHOLD VALUE WHEN ON	ON OR OFF ELECTRIC POWER LIMIT VALUE WHEN ON (90%, 75%)	ON OR OFF POWER REDUCTION VALUE WHEN ON (95%, 90%)
HIGH (MIDDLE) LOW		BLACK AREA: SMALL BLACK AREA: LARGE OFF   ON  	OFF  ON 	OFF  ON 
(a) IN-STORE DEMONSTRATION (SUPERMARKET)	LOW	ON	OFF	OFF OR ON (INCREASE POWER WHEN ON)
(b) POWER REDUCTION (STANDARD)	LOW	OFF	ON	ON
(c) HIGH IMAGE QUALITY (CINEMA)	HIGH OR MIDDLE	ON	OFF	OFF

Kubota (Ex. 1011), Fig. 5.

95. The shading process “enhanc[es] the presence of displayed images, adapting to visual properties of the human (placing his/her effective visual field in the central part of the screen), and reduc[es] the electric power (power consumption).” *Kubota* (Ex. 1011), [0066].

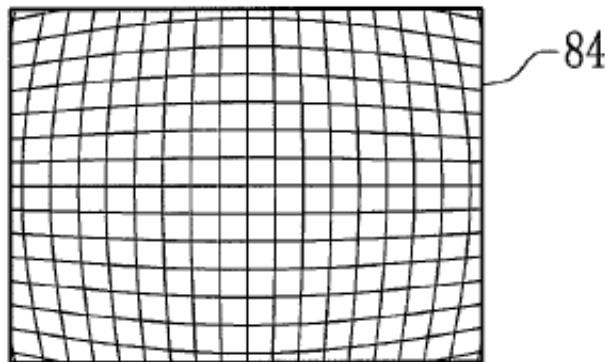
G. Overview of *Cho* (Ex. 1012)

96. *Cho* was filed on March 27, 2008, and published on October 2, 2008. *Cho* was published more than one year prior to the priority date of the ’109 patent, which I understand to be December 18, 2012. *See* above discussion in ¶¶28-35. I have thus been informed that *Cho* qualifies as prior art to the ’109 patent under at least 35 U.S.C. § 102 (b).

97. *Cho* discloses a digital camera capable of correcting wide-angle

distortion of a subject image. *Cho* (Ex. 1012), [0001], [0040], [0148]-[0149]. *Cho* explains that an image captured using a wide-angle lens, or with a large angle of incidence to the taking lens, can have wide-angle distortion (what is referred to as a barrel distortion). *Cho* (Ex. 1012), [0008], [0071], [0077] [0108]. *Cho* explains that wide-angle distortion has the effect to elongate the image radially from the center and is more prominent in the periphery of the image. *Cho* (Ex. 1012), [0006], [0074], Fig. 5C. This is illustrated in the figure below:

FIG. 5C

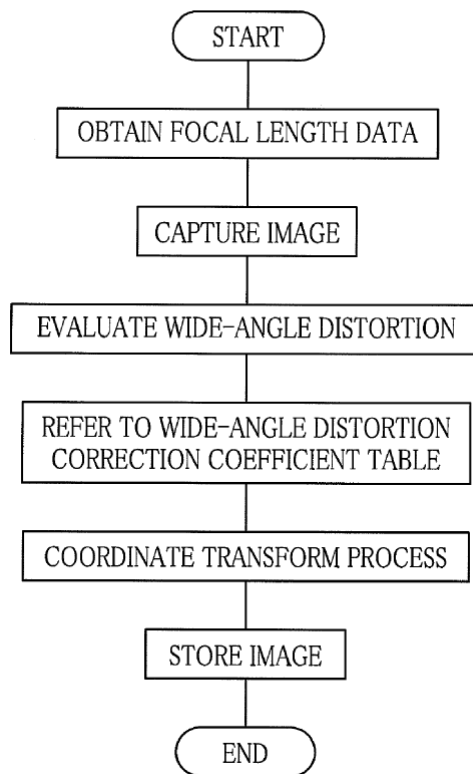


Cho (Ex. 1012), Fig. 5C.

98. To solve this problem, *Cho* discloses that its camera has a wide-angle distortion correction function that “applies image conversion processing” to “cancel out the radially-elongating wide-angle distortion.” *Cho* (Ex. 1012), [0011], [0015], [0018], [0078]-[0079]. More specifically, *Cho* discloses that the camera includes a

memory that stores a control program and a wide-angle distortion correction coefficient table. *Cho* (Ex. 1012), [0059]. As shown in Figure 7, to correct the wide-angle distortion, the following operations are performed by various sections of the camera: (i) obtain focal length data of the taking lens; (ii) based on the focal length data, evaluate the magnitude of the wide-angle distortion in the captured image; (iii) based on the magnitude of the wide-angle distortion, select a coefficient from the wide-angle correction table; and (iv) apply coordinate transform processing to raw image data using the selected coefficient to obtain the distortion-corrected image. *Cho* (Ex. 1012), [0078]-[0079], Figs. 3, 7.

FIG. 7

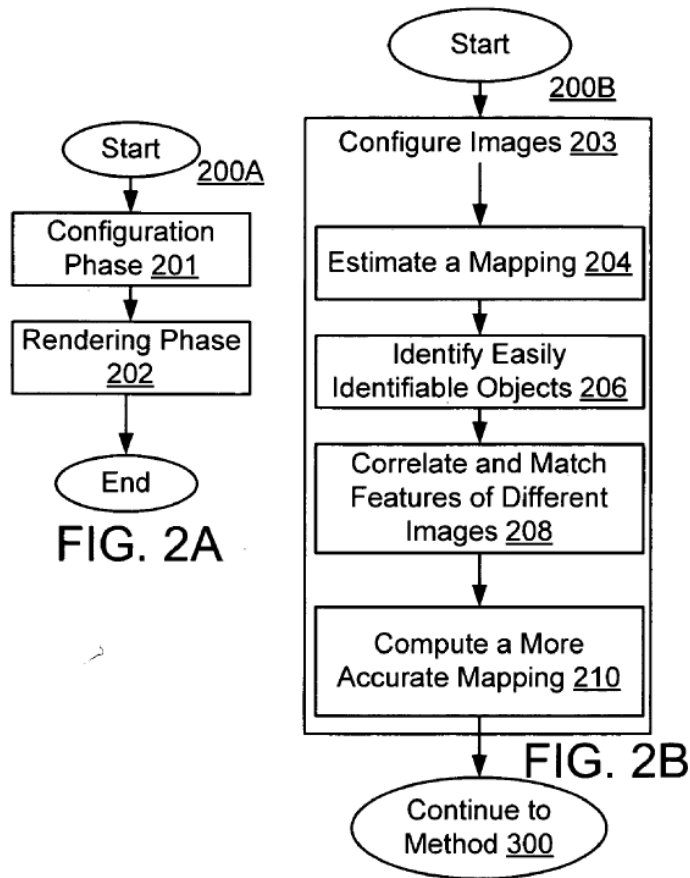


Cho (Ex. 1012), Fig. 7.

H. Overview of *Kuranov* (Ex. 1013)

99. *Kuranov* was filed on February 25, 2009, and published on October 16, 2008. *Kuranov* was published more than one year prior to the priority date of the '109 patent, which I understand to be December 18, 2012. See above discussion in ¶¶28-35. I have thus been informed that *Kuranov* qualifies as prior art to the '109 patent under at least 35 U.S.C. § 102 (b).

100. *Kuranov* discloses stitching multiple video images taken by video cameras from different locations, angles, and viewpoints. *Kuranov* (Ex. 1013), Abstract, [0005], [0030]-[0031], [0042]-[0043], [0061], Fig. 2A. *Kuranov* discloses that its stitching may include two stages, configuration (step 201) and rendering (step 202), as shown below. *Kuranov* (Ex. 1013), [0061], Fig. 2A. During the configuration phase, pairs of features extracted from corresponding source images, and representing the same object, are identified and used to estimate an initial mapping that specifies the position of each source image point in the final joined image. *Kuranov* (Ex. 1013), [0065]-[0069], Fig. 2B.



Kuranov (Ex. 1013), Figs. 2A-2B. Additional feature correlation and matching is performed to identify corresponding features in the source images and used to obtain a more accurate mapping. *Kuranov* (Ex. 1013), [0070]-[0071], Fig. 2B. During rendering, the source images are stitched based on the mapping and rendered into one image, as shown below. *Kuranov* (Ex. 1013), [0073], Fig. 3.

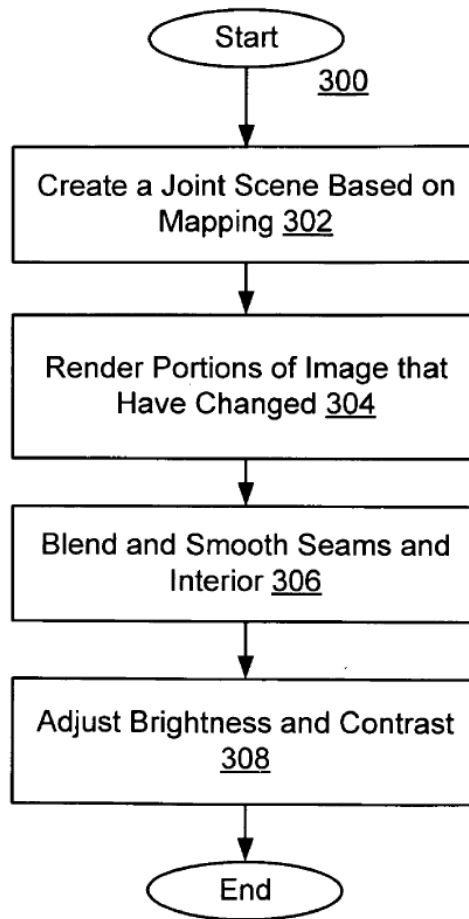


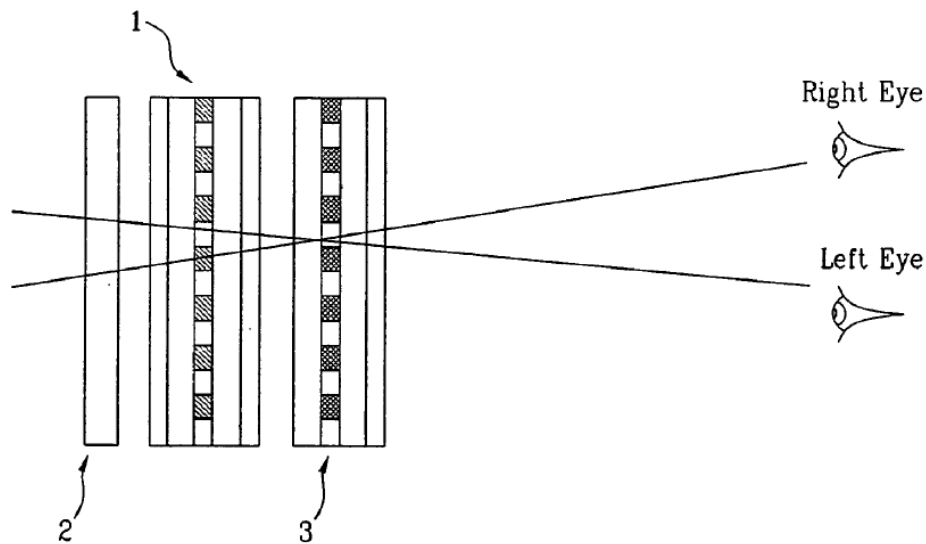
FIG. 3

Kuranov (Ex. 1013), Fig. 3.

I. Overview of *Chang* (Ex. 1014)

101. *Chang* was filed on October 11, 2006, and published on April 12, 2007. *Chang* was published more than one year prior to the priority date of the '109 patent, which I understand to be December 18, 2012. *See* above discussion in ¶¶28-35. I have thus been informed that *Chang* qualifies as prior art to the '109 patent under at least 35 U.S.C. § 102 (b).

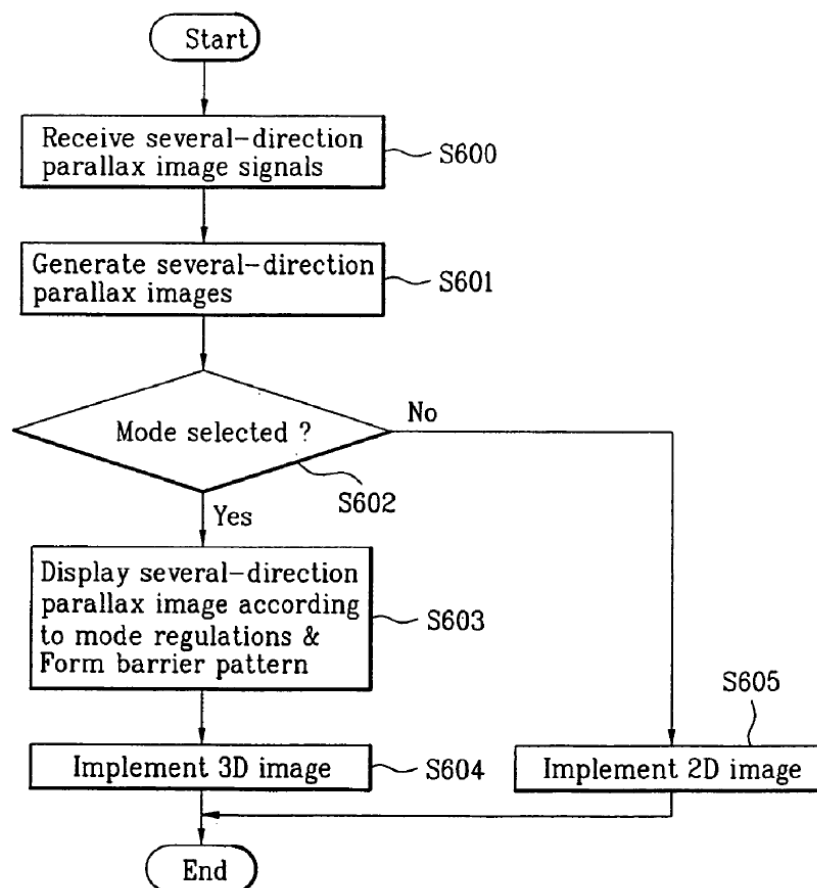
102. *Chang* discloses a system and method for displaying a 2D or 3D image according to user selection. *Chang* (Ex. 1014), [0003], [0014]-[0015], [0078]-[0089], [0099], Fig. 5. As shown below, *Chang*'s system includes an LCD display panel 1, a light source 2, and a filter 3. *Chang* (Ex. 1014), [0039].



Chang (Ex. 1014), Fig. 1.

103. *Chang*'s method includes: (i) receiving parallax image signals in several directions (*Chang* (Ex. 1014), [0025], [0061], [0071], [0080], Fig. 5); (ii) sampling and multiplexing "the received several-direction parallax image signals" by applying the parallax image signals to corresponding pixels of the display panel to "form[] parallax images of several directions" (*Chang* (Ex. 1014), [0018], [0024]-[0025], [0043]-[0045], [0052], [0057]-[0058], [0065]-[0068], [0075]-[0076], [0080], [0092], Figs. 2A, 3A, Fig. 5); (iii) determining the user's selected display

mode (e.g., vertical or horizontal) (*Chang* (Ex. 1014), [0019], [0024]-[0025], [0037], [0053]-[0056], [0062]-[0065], [0082], Fig. 5); (iv) forming a predetermined barrier pattern in the filter to separate the several-direction parallax images from each other (*Chang* (Ex. 1014), [0024]-[0025], [0047]-[0049], [0059], [0069], [0076], [0082], [0089], [0094]-[0096], Figs. 3A-3B, 4A-4B, 5); and (v) implementing a 2D or 3D image on the display panel. (*Chang* (Ex. 1014), [0003], [0014]-[0015], [0024]-[0025], [0059], [0069], [0082], [0099], Fig. 5). This is shown below:

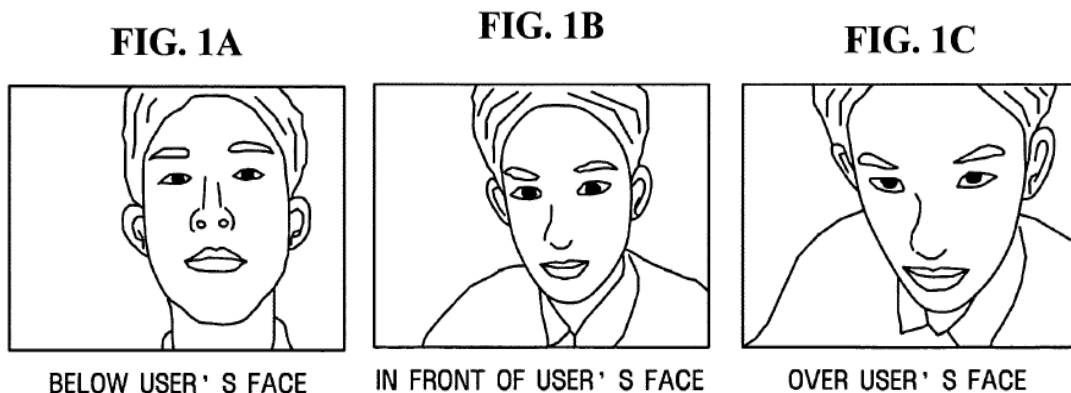


Chang (Ex. 1014), Fig. 5. *Chang* explains that its system and method advantageously allow the user to view a 3D or stereoscopic image like a real image without requiring the viewer to wear 3D glasses. *Chang* (Ex. 1014), [0006], [0008].

J. Overview of *Park* (Ex. 1016)

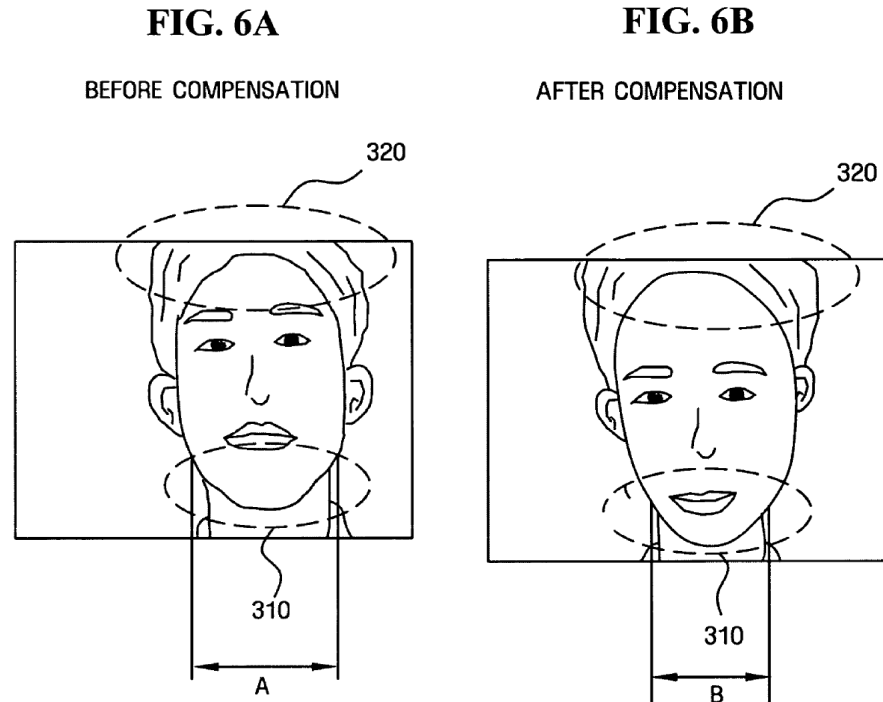
104. *Park* was filed on September 22, 2006, and published on March 22, 2007. *Park* was published more than one year prior to the priority date of the '109 patent, which I understand to be December 18, 2012. *See* above discussion in ¶¶28-35. I have thus been informed that *Park* qualifies as prior art to the '109 patent under at least 35 U.S.C. § 102 (b).

105. *Park* discloses correcting perspective distortion in an image captured by a camera above or below the user. *Park* (Ex. 1016), Abstract, [0003], [0006]-[0007], [0010]-[0014], [0034], [0059]. *Park* explains that perspective distortion, as shown below, may cause psychological rejection by a user. *Park* (Ex. 1016), [0006]-[0007], Figs. 1A-1C.



Park (Ex. 1016), Figs. 1A-1C. *Park* discloses performing matrix-based perspective

transformation to compensate the distortion in the image. *Park* (Ex. 1016), [0034]-[0036], [0050]-[0053], [0059]-[0062], Figs. 6A-6B, 7-8. This is shown below:



Park (Ex. 1016), Figs. 6A-6B.

106. *Park* explains that, if the sizes of the compensated image region and the display region are different, empty regions can occur. *Park* (Ex. 1016), [0054]-[0056]. *Park* discloses filling the pixels of the empty region before display. *Park* (Ex. 1016), [0054]-[0056]. This “prevent[s] the user from arousing psychological rejection against the empty region on which no image is displayed.” *Park* (Ex. 1016), [0054]. This is shown below:

FIG. 10A



FIG. 10B



Park (Ex. 1016), Figs. 10A-10B.

K. Overview of *Lizee* (Ex. 1017)

107. *Lizee* was filed on April 11, 2006, and published on October 19, 2006. *Lizee* was published more than one year prior to the priority date of the '109 patent, which I understand to be December 18, 2012. See above discussion in ¶¶28-35. I have thus been informed that *Lizee* qualifies as prior art to the '109 patent under at least 35 U.S.C. § 102 (b).

108. *Lizee* discloses a virtual presence system that captures a user's image and transforms the captured image to a mirrored silhouette. *Lizee* (Ex. 1017), Abstract, [0012], [0034]-[0035]. The transformation can include a left-to-right

inversion about a vertical axis, scaling the image to maintain a constant size as the user moves away from or closer to the image capture device, and various perspective modifications. *Lizee* (Ex. 1017), [0034], [0051], [0063], [0084], [0088], Fig. 3. *Lizee* further discloses performing transformations of the user's image based on the distance of the user to the image capture device. *Lizee* (Ex. 1017), [0043]-[0047]. *Lizee* discloses that the user's distance can be estimated in real-time based on the size of a selected part or portion of the user at a given position in the image as compared to the size of that part or portion at a known position. *Lizee* (Ex. 1017), [0043]-[0045]. *Lizee* discloses that the portions/parts can include "the user's head, arm, hand, torso or again any object carried by the user." *Lizee* (Ex. 1017), [0043].

X. Claims 1-18 of the '109 Patent Are Unpatentable

109. In my opinion, claims 1-18 of the '109 Patent would have been obvious based on the teachings of *Rosenberg*, *Nakazawa*, *Hatanaka*, *Tripathi*, *Iwai*, *Kubota*, *Cho*, *Kuranov*, *Chang*, *Park*, and *Lizee*, for the reasons I have provided below in each asserted ground of unpatentability.

A. Ground 1: *Rosenberg* In View Of *Nakazawa* Renders Obvious Claims 1-6, 8, and 17.

1. Rationale to Combine *Rosenberg* and *Nakazawa*

110. *Rosenberg* and *Nakazawa* are analogous to the '109 Patent because they are in the same field of endeavor as each other and as the '109 Patent. *See* above discussions in §§ IV.A (Overview of the '109 Patent), IX.A (Overview of

Rosenberg), IX.B (Overview of *Nakazawa*). A person of ordinary skill in the art would have been motivated to use *Nakazawa*'s transformation mapping in *Rosenberg*'s digital mirror system to provide a more realistic mirror image by reducing image distortion when, for example, the "camera is mounted above the screen area." *Rosenberg* (Ex. 1005), [0027]. Modifying *Rosenberg* to use *Nakazawa*'s transformation mapping would have offered the following benefits, as expressly recognized in the references: (i) providing "a more realistic replication of a true mirror image" by correcting an unnatural image perspective or orientation captured by a camera located above the screen (*Rosenberg* (Ex. 1005), [0027]-[0028]); and (ii) "giving users an increased view of the top of their head" when so desired (*Rosenberg* (Ex. 1005), [0027], [0061]; *Nakazawa* (Ex. 1007), [0001]-[0003], [0005]-[0007], [0032]-[0035]) by allowing a user to switch between corrected and uncorrected images (*Nakazawa* (Ex. 1007), [0036]).

111. Indeed, *Rosenberg* discloses that its system has "a traditional mirror mode" (also referred to as a "digital mirroring state"), wherein "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." *Rosenberg* (Ex. 1005), [0027], [0061]; *see also Rosenberg* (Ex. 1005), [0025]-[0026], [0036]-[0039], [0077], [0083], [0109], [0113]-[0115]. In a first embodiment, the camera is mounted directly above the screen, generally near

the center, whereas in a second embodiment, the camera is mounted behind the display, approximately at eye level. *Rosenberg* (Ex. 1005), [0027]. A person of ordinary skill in the art would have been motivated to use *Nakazawa*'s transformation mapping in either *Rosenberg* embodiment.

112. First, *Rosenberg* explains that positioning the camera above the screen “provides the user with a view of himself or herself from a somewhat unnatural perspective.” *Rosenberg* (Ex. 1005), [0027], [0061]. *Nakazawa* identifies the same “unnatural perspective” issue when a camera is below or above or on the side of a display. *See, e.g., Nakazawa* (Ex. 1007), Abstract, [0001]-[0003], [0008], [0034]. This issue was known to a person of ordinary skill in the art as projection or perspective distortion, caused by having different positions and/or orientations of the camera relative to the user. *See, e.g., Park* (Ex. 1016), Abstract, [0006], Fig. 6A (teaching user's image is distorted due to the position of the camera below the user's face, and such distorted image is “unnatural”), [0014], Fig. 6B (teaching “compensating for image distortion of the captured image when the image capturing unit is determined to be above or below the object”); *Suggs* (Ex. 1015), [0047]-[0048], [0052] (teaching user's position relative to display causes displayed image to appear distorted), [0049], [0053] (teaching performing perspective transformation to reduce distortion). *Nakazawa* teaches a process that corrects unnatural perspectives, such that the image appears as if it was captured from a position in

front of the user. *Nakazawa* (Ex. 1007), [0032]-[0034], Figs. 2-3. As *Rosenberg* notes, “an image that is from a vantage point perfectly straight ahead” is often preferred “because it yields a more realistic replication of a true mirror image.” *Rosenberg* (Ex. 1005), [0028], [0075]. And a person of ordinary skill in the art would have been motivated to use *Nakazawa*’s correction method in *Rosenberg*’s system to correct unnatural perspectives so that images appear to be taken from a position directly in front of the user, “yield[ing] a more realistic replication of a true mirror image” (*Rosenberg* (Ex. 1005), [0028]), while also allowing for a user to view the top of their head when so desired (*Rosenberg* (Ex. 1005), [0027], [0037], [0061]; *Nakazawa* (Ex. 1007), [0036]).

113. Second, a person of ordinary skill in the art would have also been motivated to use *Nakazawa*’s correction in *Rosenberg*’s second embodiment where the camera is placed behind the display. In such embodiments, *Rosenberg*’s camera “is centered horizontally with respect to the display screen[,] and at an elevation vertically that generally corresponds with a user’s typical eye level.” *Rosenberg* (Ex. 1005), [0061], [0027]. A person of ordinary skill in the art would have known that a user’s eye level varies from person to person—an image taken at one person’s eye level could be below or above an image taken at another person’s eye level—causing unnatural distortions. *Nakazawa* (Ex. 1007), [0001]-[0003], [0031]-[0032]; *see also Park* (Ex. 1016), [0006], [0014]. A person of ordinary skill in the art would have

been motivated to implement *Nakazawa*'s correction to *Rosenberg*'s embodiments to correct the distortions and improve user experience of using a digital mirror like a real mirror. *Rosenberg* (Ex. 1005), [0027]-[0028], [0061], [0075].

114. A person of ordinary skill in the art would have recognized that the camera positions of both embodiments in *Rosenberg* would have been suitable for providing mirror images to a user. *Rosenberg* (Ex. 1005), [0027], [0061]. *Rosenberg* suggests the system could include one or more cameras, which may be mounted at multiple elevations with respect to the screen (above a screen or behind a screen, for example) to provide different viewing angles. *Rosenberg* (Ex. 1005), [0027], [0037], [0057], [0060]-[0061]. But having multiple cameras or having a camera moving to different elevations would increase the complexity of the hardware and the overall cost of *Rosenberg*'s system. *Rosenberg* (Ex. 1005), [0061]. For example, *Rosenberg* discloses that optical elements, such as lenses, mirrors, and/or fiber optics can be used for positioning a camera within or behind a display screen. *Rosenberg* (Ex. 1005), [0075]. *Rosenberg* further discloses that, to accomplish such positioning, "a small region of active screen area [of display] is removed to allow the camera [] to capture an image through the screen surface" and that "[t]he 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." *Rosenberg* (Ex. 1005), [0075]. Alternatively, *Rosenberg* discloses that positioning a camera

behind a display screen can be accomplished by using a “display technology that is transparent during a portion of each display cycle.” *Rosenberg* (Ex. 1005), [0076]. But a person of ordinary skill in the art would have recognized that using such optical elements together with the needed display screen alterations and/or using specialized display technology to align the camera behind a display screen requires more precise alignment, incurs more cost, and is less flexible. The mounted camera cannot be easily moved and re-used with other displays, as compared to simply mounting a camera above the screen and implementing a software solution to correct distortions. A person of ordinary skill in the art would have known that *Nakazawa*’s correction would provide a solution that obviates the need for complex display screen modifications, specialized display technology, and/or precise alignment of the camera behind/within the display screen with other optical elements. Additionally, a person of ordinary skill in the art would have understood that incorporating *Nakazawa*’s correction would improve *Rosenberg*’s mirror image by not having a black-out portion from the mirror image and/or allowing for a camera to be readily used with any display without requiring modifications of the display screen and without requiring more costly specialized display screens that are transparent during portions of the display cycle.

115. A person of ordinary skill in the art would have known how to incorporate *Nakazawa*’s correction into *Rosenberg*’s digital mirror functionality and

would have expected success in doing so because such modification requires nothing more than ordinary skill. *Rosenberg*'s digital mirror system is readily equipped for such modification; it encompasses placing the camera on top or near the display screen; it also includes a processor for adjusting and/or modifying the images displayed on the screen and a memory accessible by the processor to store images. *See Rosenberg* (Ex. 1005), [0006], [0027], [0035]-[0036], [0061]-[0062], [0074], [0078], Fig. 3, Fig. 13. *Rosenberg* discloses that the processor can be a single microprocessor or a combination of multiple hardware and software components, including both programmable and hardwired processing components. *Rosenberg* (Ex. 1005), [0035]. The processor and memory of *Rosenberg*'s digital mirror system allow for adding various image processing features. For example, *Rosenberg*'s processor:

- controls the camera to capture images in response to user input (*Rosenberg* (Ex. 1005), [0006]);
- processes real-time video images from the camera by performing left-right inversion to present the user with a traditional mirror image view (*Rosenberg* (Ex. 1005), [0026]-[0027], [0035]);
- processes user input (e.g., speech processing) to adjust the operational state/mode of the system or modify displayed images (*Rosenberg*

(Ex. 1005), [0034]-[0050], [0073]-[0074], [0084], [0092], [0100]-[0102]);

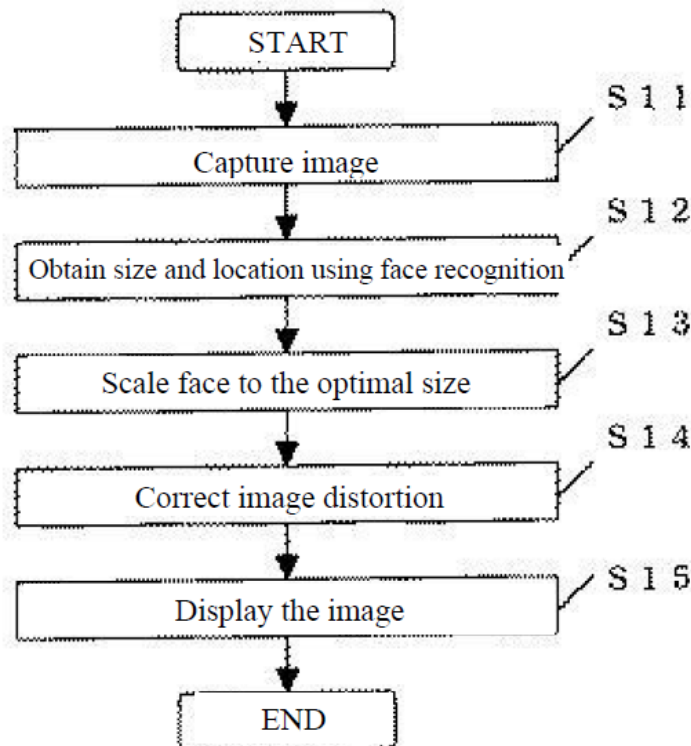
- switches operational modes/states of the system (*Rosenberg* (Ex. 1005), [0031]-[0036], [0040], [0054]-[0056], [0109], [0114]);
- adds viewing features (*Rosenberg* (Ex. 1005), [0039]-[0043], [0080]-[0088] (“mirror image-freeze feature”), [0044]-[0047], [0089]-[0092] (“mirror image-buffering”), [0048]-[0049], [0093] (“multi-view mirroring”));
- performs digital zoom (*Rosenberg* (Ex. 1005), [0050]-[0051], [0099]-[0107]);
- augments the image with virtual objects (*Rosenberg* (Ex. 1005), [0111]); and
- changes the lighting conditions of the image (*Rosenberg* (Ex. 1005), [0116]).

Rosenberg also discloses that the processor processes data from proximity or motion sensors, such as the digital camera, to determine the proximity of a user. *Rosenberg* (Ex. 1005), [0032]-[0033], [0056], [0070], [0114].

116. Like *Rosenberg*, *Nakazawa* discloses a photographing device that captures images of the user and displays the captured images to the user. *E.g.*, *Nakazawa* (Ex. 1007), Abstract, [0008]-[0011]. *Nakazawa*’s photographing device

includes an image correction unit that receives images from a digital camera and modifies the images for display. *Nakazawa* (Ex. 1007), Abstract, [0030], [0034]-[0036], Fig. 1. *Nakazawa*'s device performs similar image processing steps as in *Rosenberg*. For example, *Rosenberg* discloses capturing an image of the user, performing left-right inversion, scaling the image, and displaying the image, as discussed above in the Overview of *Rosenberg*. See § IX.A. Likewise, *Nakazawa* discloses capturing an image of the user, scaling the image to an optimal size, processing to correct image distortions, and displaying the image. *Nakazawa* (Ex. 1007), [0017], [0027], [0041]-[0042], Fig. 7.

[FIG. 7]



Nakazawa (Ex. 1007), Fig. 7. *Nakazawa*'s photographing device also includes face recognition and resizing units, and an eye/pupil recognition/extracting unit for correcting the line of sight. *Nakazawa* (Ex. 1007), [0041]-[0044]; *see also Nakazawa* (Ex. 1007), [0018], [0028], [0030]. A person of ordinary skill in the art would have understood that *Nakazawa*'s image correction unit, face recognition unit, and/or eye/pupil recognition/extracting unit would be typically implemented by a processor configured to execute software programs. *See Park* (Ex. 1016), [0059]-[0060], [0077], [0087]-[0088] (processor performing image transformation); *Kurtz* (Ex. 1018), [0129] (processor provides distortion corrections); *Goto* (Ex. 1019), [0117], [0121]-[0123], [0126]-[0127], [0141], [0151], [0156], [0159]-[0163], [0213] (processor implementing a makeup simulation program, including recognizing the face of the user from a camera-captured video in real-time); *Ryan* (Ex. 1020), [0030]-[0035], [0042]-[0049] (processor processes image of a video camera to identify face pixels and determine positions and orientations of eyes); *Schmeitz* (Ex. 1021), 25:36-48 (computer-implemented algorithms for face recognition, eye detection); *Haan* (Ex. 1022), [0074], [0087] (computer program for analyzing captured user's image to estimate user's distance); *van Baar* (Ex. 1041), [0029], [0037]-[0038], [0045]-[0048] (modern GPU can transform videos in real-time, including performing projective or perspective transformation). A person of ordinary skill in the art would have understood that *Rosenberg*'s processor would be capable of performing these

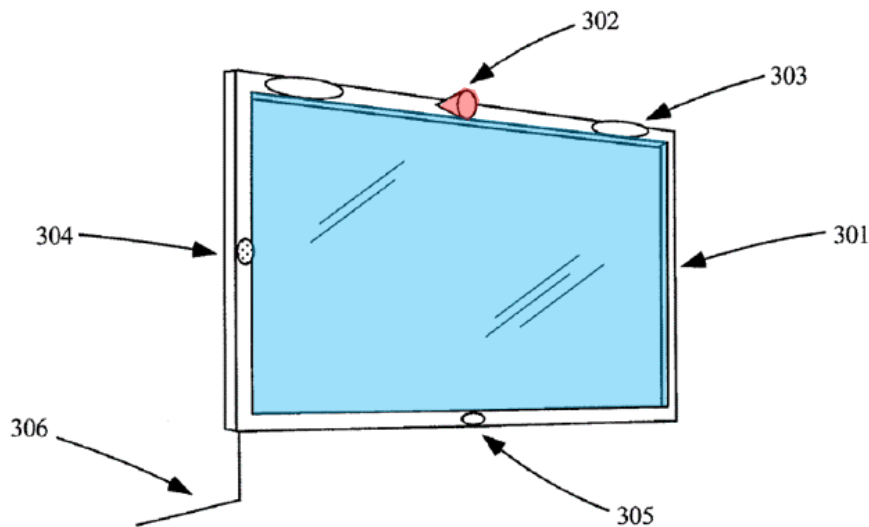
steps because it is programmable and capable of performing image-processing routines. *Rosenberg* (Ex. 1005), [0035].

117. A person of ordinary skill in the art would have expected success in using *Nakazawa*'s correction in *Rosenberg* without affecting *Rosenberg*'s digital mirror functionality. Indeed, *Nakazawa* discloses that its correction can be used for correcting and presenting images in a video call. *Nakazawa* (Ex. 1007), [0002]-[0003]. It further discloses that the image correction can be automated to reduce processing time, by registering the degree of magnification in the memory unit. *Nakazawa* (Ex. 1007), [0036]. A person of ordinary skill in the art would have understood that *Nakazawa*'s correction would be easily added to *Rosenberg*'s process for providing a real-time mirror image for display without resulting in a noticeable lag for the user. This is at least because *Nakazawa*'s correction process is a geometric transformation that includes pixel displacement and image scaling, operations already disclosed as part of *Rosenberg*'s invention (such as left-right inversion, image scaling, moving images to the left or right of a display, zooming in and out). *E.g.*, *Rosenberg* (Ex. 1005), [0026], [0034]-[0052], [0109], [0111]; *see also van Baar* (Ex. 1041), [0029], [0037]-[0038], [0045]-[0048] (modern GPU can transform videos in real-time, including performing projective or perspective transformation).

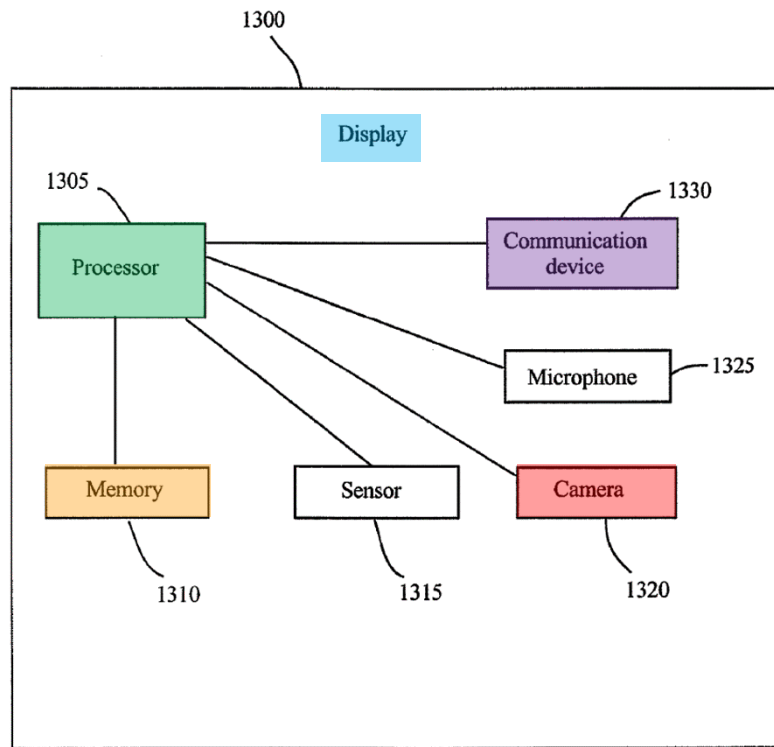
2. Independent Claim 1

- a. 1[pre]: *“A method for operating a system having a monitor, a camera, and a processor, so as to display a mirror-mimicking image on the monitor, by performing non-ordered steps comprising:”*

118. In my opinion, if the preamble is limiting, *Rosenberg* discloses a digital mirror system that includes a camera, processor, and display (“monitor”), as claimed. *Rosenberg* (Ex. 1005), [0062], [0109], Figs. 3, 13. These components are shown below:



Rosenberg (Ex. 1005), Fig. 3.



Rosenberg (Ex. 1005), Fig. 13.

119. *Rosenberg* further discloses a method of operating that system (the camera, processor, and display) “**to display a mirror-mimicking image on the monitor,**” as claimed. For example, *Rosenberg* discloses that its system employs electronic imaging hardware and software to provide a range of user-selectable mirroring capabilities and operational modes/states to a person before a display. *Rosenberg* (Ex. 1005), [0025], [0035]-[0036], [0054]-[0058]. In the disclosed traditional mirror mode, *Rosenberg*’s digital mirror system (i) captures a real-time video image of the user by the camera; (ii) flips the pixels of the image around a vertical centerline to invert the left and right of the image to mimic what would be

seen in a traditional optical mirror; (iii) scales the image to mimic a life-size mirror image; and (iv) displays the image on a display in real-time so “the user . . . 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.” *Rosenberg* (Ex. 1005), [0026], [0035], [0038], [0077], Fig. 5. This is shown below:

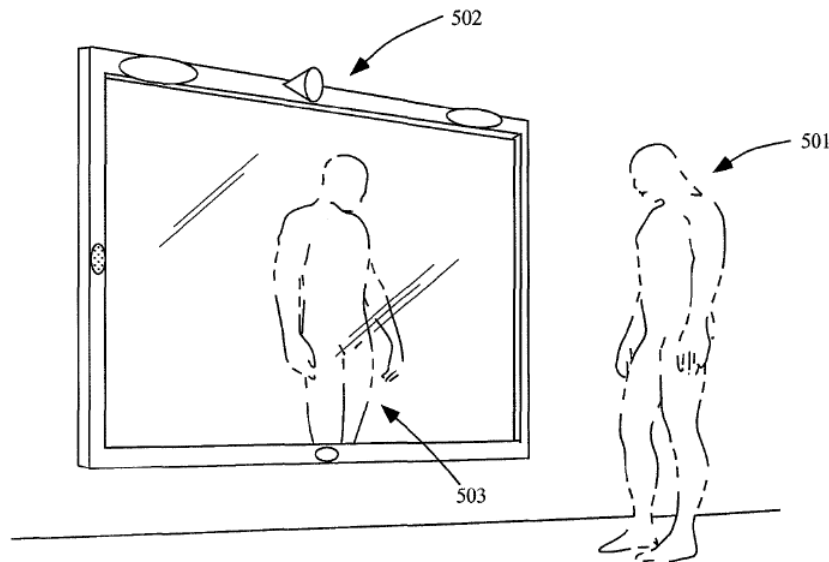


Fig. 5

Rosenberg (Ex. 1005), Fig. 5.

b. 1[a]: “obtaining a digital image from a camera;”

120. In my opinion, *Rosenberg* discloses this claim element.

121. *Rosenberg* discloses a digital camera that captures real-time digital video images. *Rosenberg* (Ex. 1005), [0026]-[0027], [0057], [0060]-[0062], [0077].

Its digital camera is in communication with a processor and transmits captured video images to that processor so that the processor can process the images in real-time. *Rosenberg* (Ex. 1005), [0003], [0018]-[0019], [0026]-[0027], [0035], [0038], [0050], [0060]-[0062], [0077], [0083], [0103]-[0106], Fig. 13. For example, *Rosenberg's* processor adjusts and modifies captured digital video images to achieve mirroring features such as left-right image inversion, zooming in/out, and generating a composite or augmented image. *See, e.g., Rosenberg* (Ex. 1005), [0035], [0050]-[0052], [0061], [0074], [0077], [0093]-[0094], [0099]-[0104]. The processor will then transmit the adjusted/modified images to a display. *Rosenberg* (Ex. 1005), [0035]-[0038], [0049], [0074]-[0077], [0081]-[0083], [0089], [0093]-[0099], [0103]-[0106], [0110]-[0111], Figs. 5-12. *Rosenberg* also discloses that its system includes a memory. *See Rosenberg* (Ex. 1005), [0035], [0068], [0074], [0109], Fig. 13. That memory stores real-time video images captured by the camera and can be accessed by the processor to enable *Rosenberg's* digital mirror functionality. *See Rosenberg* (Ex. 1005), [0068], [0074], Fig. 13. For example, *Rosenberg* discloses that its processor can access real-time video imagery stored in the memory to implement its mirror-image freeze and/or mirror-image buffering features. *Rosenberg* (Ex. 1005), [0035], [0039], [0044], [0055], [0068], [0074], [0089].

c. **1[b]: “flipping the image about a vertical axis so as to reverse right and left sides of the image;”**

122. In my opinion, *Rosenberg* discloses this claim element.

123. *Rosenberg* discloses that the processor takes the real-time digital video images captured by the camera and left-right inverts them by flipping the image pixels around a vertical centerline (“**vertical axis**”) so that the right side of the user appears on the right side of the display, and the left side of the user appears on the left side of the display (from the user’s perspective). *E.g.*, *Rosenberg* (Ex. 1005), [0002]-[0003], [0026]-[0027], [0035], [0041], [0061], [0068], [0077], [0083]. This is shown, for example, in Figure 5:

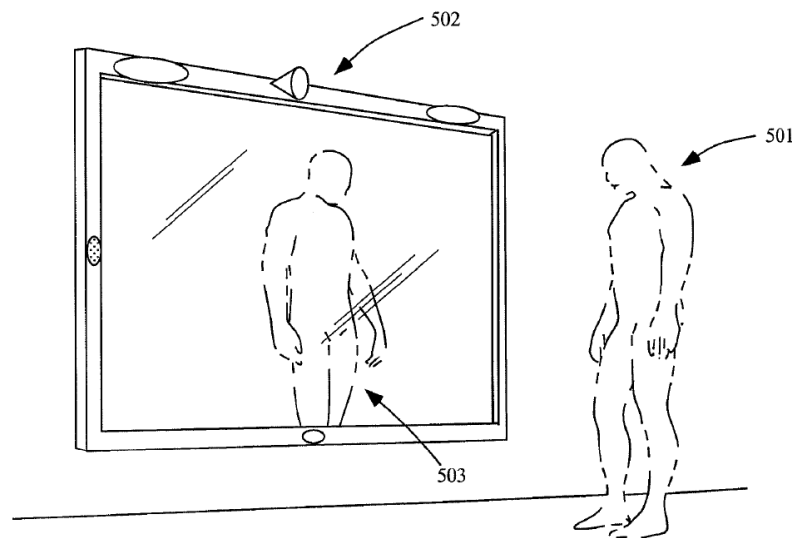


Fig. 5

Rosenberg (Ex. 1005), Fig. 5; see also *Rosenberg* (Ex. 1005), [0077].

d. 1[c]: “*applying a transformation mapping to the image to modify the image such that it appears to mimic a reflection of a mirror;*”

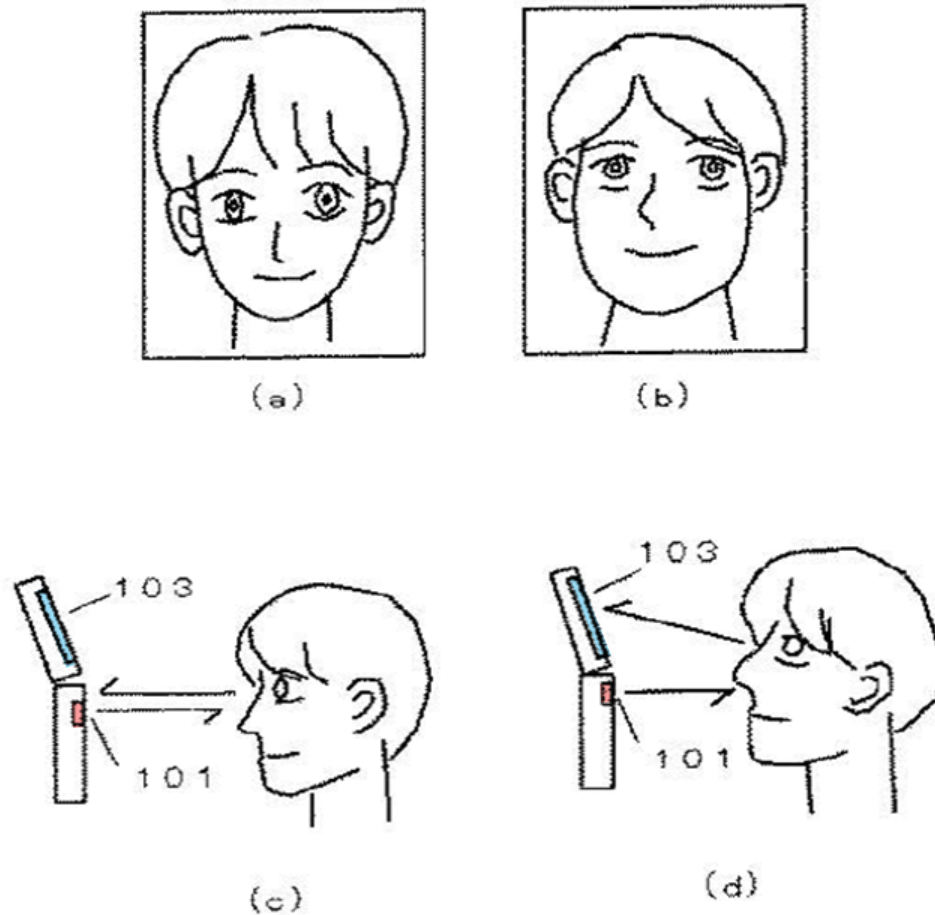
124. In my opinion, *Rosenberg* in view of *Nakazawa* renders obvious this claim limitation.

125. *Rosenberg* discloses performing left-right inversion (flipping pixels along a vertical axis) and scaling the video images so the user is given the impression that he or she is standing before a traditional wall mirror, viewing a mirror image (“*such that it appears to mimic a reflection of a mirror*”). See, e.g., *Rosenberg* (Ex. 1005), [0003], [0026]-[0027], [0035], [0041], [0061], [0068], [0077], [0083]. A person of ordinary skill in the art would have understood that *Rosenberg*’s pixel flipping and image scaling are “*transformation mapping*,” as claimed, for these steps would have been performed by mapping the position of each image pixel to another position of a corresponding pixel of a modified image. Likewise, the ’109 Patent explains that the “*transformation mapping*” can include left-right flipping and scaling. ’109 Patent (Ex. 1001), 22:1-13, 23:60-24:9, 24:51-53, 29:22-58. The ’109 Patent further indicates that such transformation mapping “essentially reassigns new addresses to each pixel of the original image.” ’109 Patent (Ex. 1001), 29:28-30.

126. To the extent that the claim limitation requires additional transformations, however, this claim limitation would have been obvious in view of

Nakazawa. *Nakazawa* discloses correcting distortion in an image when the camera capturing the image is located above or below a display, and the user looks at his or her image on the display during capture. *See Nakazawa* (Ex. 1007), Abstract, [0001]-[0003], [0008], [0032], [0034], Fig. 2. For example, as shown below, when a **camera** is located below a **display**, if the user looks at the camera during image capture (Figure 2(c)), an image like Figure 2(a) is captured; if the user looks at the display during capture (Figure 2(d)), then a distorted image like Figure 2(b) is captured. *Nakazawa* (Ex. 1007), [0031]-[0032]. *Nakazawa* also discloses that this distortion occurs when a camera is above the display. *Nakazawa* (Ex. 1007), [0034].

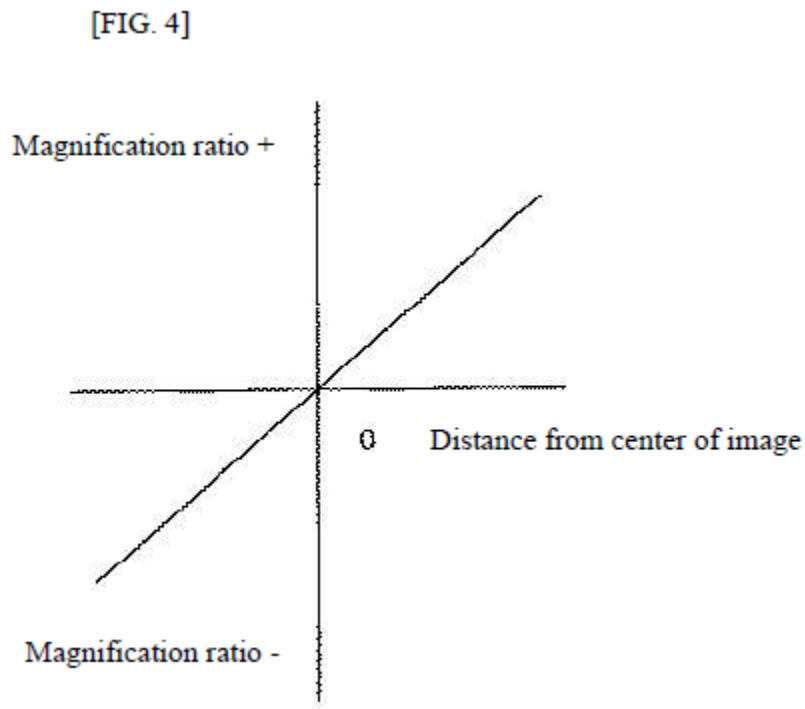
[FIG. 2]



Nakazawa (Ex. 1007), Fig. 2.

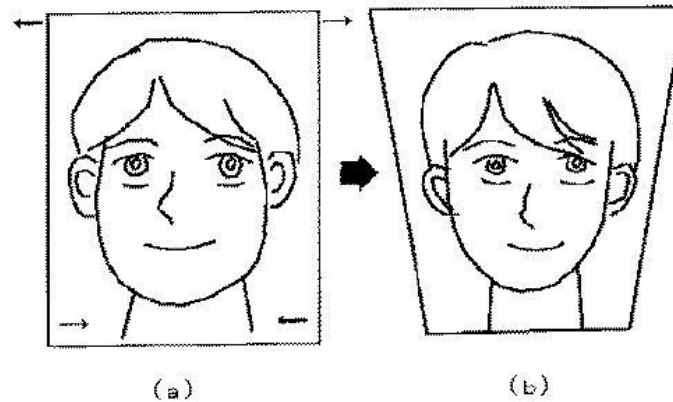
127. To correct the distortion in Figure 2(b), and instead achieve an image with a front orientation like in Figure 2(a), *Nakazawa* discloses adjusting the size of different regions across the image's field by changing the magnification ratio of different regions based on face orientation. *Nakazawa* (Ex. 1007), [0033]-[0035], Figs. 3-4. Specifically, *Nakazawa* discloses increasing the magnification ratio in regions away from the center of the image in the direction that the face is oriented,

and decreasing the magnification ratio in regions away from the center of the image in the opposite direction. *Nakazawa* (Ex. 1007), [0033]-[0035], Figs. 3-4. This is shown below:



Nakazawa (Ex. 1007), Fig. 4. As shown below, *Nakazawa*'s correction adjusts the distorted image in Figure 3(a) to instead appear as in Figure 3(b) and mimic an image captured with a front orientation. *Nakazawa* (Ex. 1007), [0033], Figs. 2-3.

[FIG. 3]



Nakazawa (Ex. 1007), Fig. 3. A person of ordinary skill in the art would have understood *Nakazawa*'s correction is a projective transformation because it corrects the point of view of the image to match the user's point of view. And a person of ordinary skill in the art would have recognized that such projective transformation is “*applying a transformation mapping to the image*” because adjusting the size of different regions across the image field is well known in the art to be a geometric transformation mapping that include mapping the positions of the pixels in an image with distortion (Figure 3(a)) to positions of corresponding pixels in a corrected image (Figure 3(b)). *Nakazawa* (Ex. 1007), Abstract, [0001]-[0003], [0008], [0032]-[0034], Figs. 2-4; *see* § IX.B (discussing how a person of ordinary skill in the art would have understood that *Nakazawa*'s transformation mapping would be implemented using a transformation matrix); *Park* (Ex. 1016), [0053], [0059]-

[0062], Figs. 7-8 (teaching a similar image correction as a perspective transformation that is a type of geometric transformation); *Iwai* (Ex. 1010), 1:47-65, 2:43-3:7, 13:1-63. Indeed, *Nakazawa*'s image correction performs the tilt or projection transformation of the '109 Patent because it corrects the geometric distortion caused by the tilt angle of the camera and for reasons explained below for claims 2-4. *Nakazawa*'s image correction also performs the elevation projection transformation of the '109 Patent because *Nakazawa* teaches correcting both deviations in orientation and line of sight. *Nakazawa*, [0001]-[0007]; *see* below discussion in §§ X.A.3-X.A.5.

128. A person of ordinary skill in the art would have understood that *Rosenberg*'s camera positioned above the screen and aimed downward would cause the camera's point of view to be at an angle from the user's point of view, resulting in perspective distortion like that in *Nakazawa*. *Rosenberg* combined with *Nakazawa*'s transformation mapping causes this perspective distortion to be corrected (i.e., “*applying a transformation mapping to the image to modify the image*”) such that the modified image would appear to be “from a vantage point perfectly straight ahead,” resulting in “a more realistic replication of a true mirror image” (“*such that it appears to mimic a reflection of a mirror*”). *Rosenberg* (Ex. 1005), [0027]-[0028], [0061], [0075]; *Nakazawa* (Ex. 1007), Abstract, [0001]-[0003], [0008], [0032]-[0034].

129. As discussed above in the rationale to combine *Rosenberg* and *Nakazawa* (see above discussion in § X.A.1), a person of ordinary skill in the art would have been motivated to implement *Nakazawa*'s transformation mapping in *Rosenberg*'s digital mirror functionality with a reasonable expectation of success. A person of ordinary skill in the art would have been motivated to use *Nakazawa*'s transformation mapping in *Rosenberg* to correct the unnatural distortion in the image captured by *Rosenberg*'s digital camera and present a more realistic mirror image to the user. *Rosenberg* (Ex. 1005), [0027]-[0028], [0061]; *Nakazawa* (Ex. 1007), [0001]-[0003], [0031]-[0034]. A person of ordinary skill in the art would have known that *Rosenberg*'s system is well-equipped to implement *Nakazawa*'s transformation mapping and generate a predictable result of a real-time mirror image mimicking a reflection of a mirror. *Rosenberg* (Ex. 1007), [0026]-[0027], [0035], [0061].

e. 1[d]: “resizing the image to reduce variations caused by changes in object’s distance to the camera;”

130. In my opinion, *Rosenberg* discloses or at least renders obvious this claim limitation. Alternatively, it is my opinion that *Rosenberg* in view of *Nakazawa* renders obvious this claim limitation.

131. The '109 Patent explains that a camera-captured image is different from a mirror reflection in various ways. '109 Patent, 2:4-48. For example, the user

appears larger in a camera image as the user approaches the camera, but a user's reflection in a mirror remains the same size as the user approaches the mirror. '109 Patent (Ex. 1001), 2:19-27; 23:60-65, Fig. 5B.

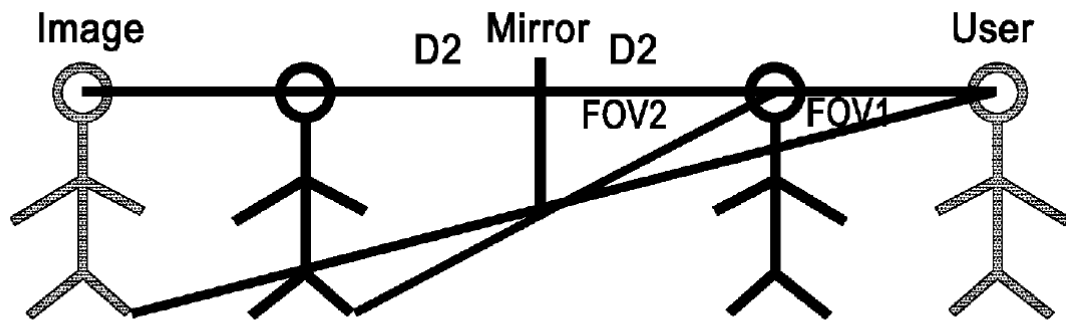
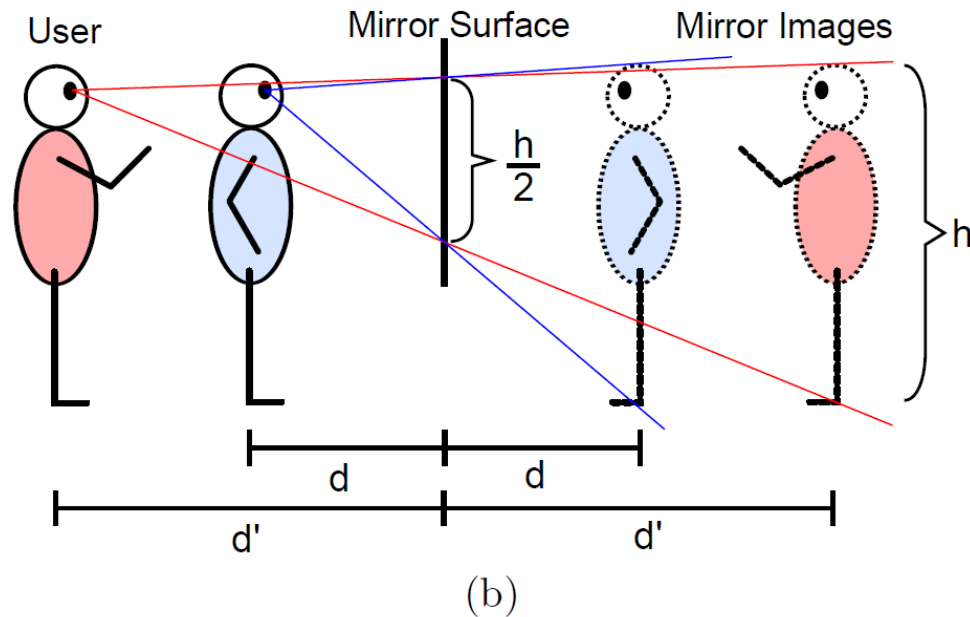


FIG. 5B

'109 Patent (Ex. 1001), Fig. 5B. As admitted in the '109 Patent, this difference was well known to a person of ordinary skill in the art. '109 Patent (Ex. 1001), 2:4-48; *see also Straka* (Ex. 1023), 637, Fig. 1(b) (illustrating the mirror effect where the height of the mirror image of the user appears to be half of the height of the user and does not depend on the distance of the user to the mirror).



Straka (Ex. 1023), Fig. 1(b). Further, the '109 Patent explains that this difference can be remedied by scaling or resizing the image based on the distance to the user so that the captured image would match the size a user would see in a mirror, in turn mimicking a mirror. '109 Patent (Ex. 1001), 17:19-23, 21:57-60, 23:65-24:9, 25:46-48, 30:3-11, Fig. 11.

132. Like the '109 Patent, *Rosenberg* discloses scaling the real-time video images from the camera so they appear like traditional life-size mirror images. *Rosenberg* (Ex. 1005), [0077]. A person of ordinary skill in the art would have understood that *Rosenberg*'s scaling ("**resizing the image**") would have adjusted the size of the image such that the user would appear to be the same size, mimicking a reflection in a mirror even if the size of the video image from the camera would vary

as the user's distance to the camera varies (***“to reduce variations caused by changes in object's distance to the camera”***).

133. A person of ordinary skill in the art would have understood that *Rosenberg*'s optical and/or digital zoom functions would also be suitable for resizing the camera image. *Rosenberg* (Ex. 1005), [0050], [0100]. This is similar to the '109 Patent's disclosure using the camera's digital and/or mechanical zoom to compensate for the changes in the distances. '109 Patent (Ex. 1001), 14:29-39, 16:17-29, 19:51-52.

134. Further, *Rosenberg* in view of *Nakazawa* renders obvious this limitation. *Nakazawa* discloses magnifying or reducing the user's face image size to a prescribed size (***“resizing the image”***) “even if the distance from the user to the photographing means is slightly different.” *Nakazawa* (Ex. 1007), [0027], [0042]. A person of ordinary skill in the art would have understood that *Nakazawa*'s resizing would be ***“to reduce variations caused by changes in object's distance to the camera”*** because it was known to a person of ordinary skill in the art that the size of the user's image varies with the user's distance to the camera. And a person of ordinary skill in the art would have magnified or reduced the size of the camera video image in *Rosenberg* to a prescribed size, as taught in *Nakazawa*, such that the user's image is adjusted to the size of the user appearing in a traditional mirror (*Rosenberg* (Ex. 1005), [0077]).

- f. 1[e]: “*displaying the image on the monitor after performing the flipping, transformation mapping, and resizing;*”

135. In my opinion, *Rosenberg* in view of *Nakazawa* renders obvious this claim limitation.

136. *Rosenberg* discloses displaying the real-time video images captured by the camera after performing left-right inversion (“flipping”) and scaling or zooming (“resizing”), as shown below. *See, e.g., Rosenberg* (Ex. 1005), [0026], [0035], [0038], [0050]-[0052], [0077], Fig. 5.

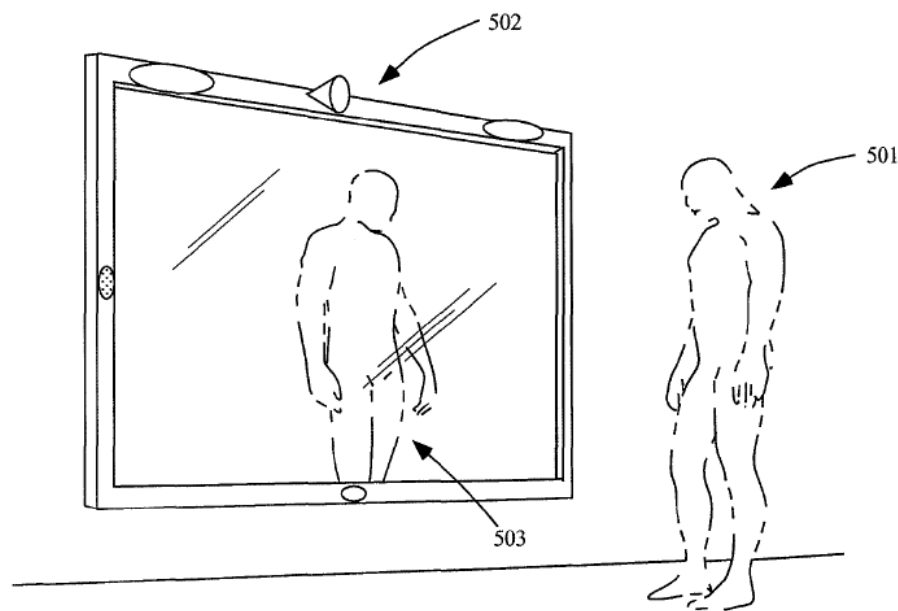
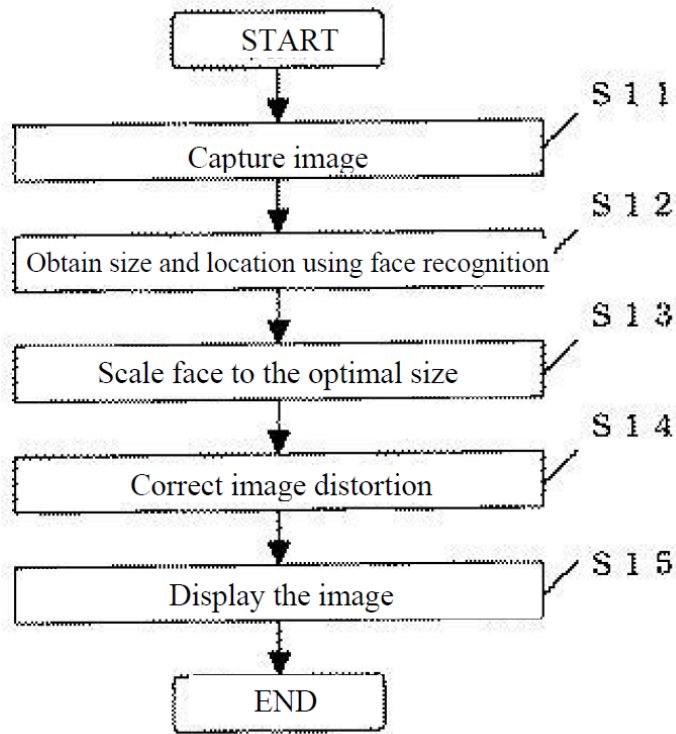


Fig. 5

Rosenberg (Ex. 1005), Fig. 5; *see also Rosenberg* (Ex. 1005), [0077].

137. *Nakazawa* likewise discloses displaying the image after resizing and performing the image distortion correction (“*transformation mapping*”), as shown below. *Nakazawa* (Ex. 1007), [0027], [0041]-[0042], Fig. 7.

[FIG. 7]



Nakazawa (Ex. 1007), Fig. 7.

138. When *Rosenberg* is modified to incorporate *Nakazawa*’s correction (“*transformation mapping*”), a person of ordinary skill in the art would have understood that the system displays the image after it has been flipped, transformed (distortion corrected), and resized so that the user would appear to be looking straight

ahead, providing a realistic replication of a mirror image. *Rosenberg* (Ex. 1005), [0028], [0077].

139. And as I explained above for claim limitation 1[c] (*see* discussion above in § X.A.2.d), a person of ordinary skill in the art would have been motivated to implement *Nakazawa*'s correction into *Rosenberg*'s digital mirror system with a reasonable expectation of success. *See* X.A.1.

g. 1[f]: “*wherein the non-ordered steps are performed on a series of images of a live video feed from the camera;*”
3

140. In my opinion, *Rosenberg* in view of *Nakazawa* renders obvious this claim limitation.

141. The '109 Patent explains that in the mirror mode, the digital camera captures live video images (“*a series of images of a live video feed from the camera*”). *See* '109 Patent (Ex. 1001), 3:2-7, 5:26-29, 6:1-5, 22:4-13, 22:36-51,

³ In my opinion, to the extent “the non-ordered steps” has discernible meaning, it at least includes obtaining an image, modifying those images, and then displaying the modified images imaged on the display, as described in the specification. *See, e.g.*, '109 Patent (Ex. 1001), 3:2-7, 5:26-29, 6:1-5, 22:4-13, 22:36-51, 24:22-34, 25:1-7, 28:5-37, 29:10-11, Figs. 9, 11-12. As noted herein, it is my opinion that the prior art discloses or renders obvious such “non-ordered steps.”

24:22-34, 25:1-7, 28:5-37, 29:10-11, Figs. 9, 11-12. It also explains that the processor receives the live video images from the camera, applies transformation mapping to the live video images, and displays the images on the monitor, as modified by the transformation mapping, in real-time (“*non-ordered steps*”). ’109 Patent (Ex. 1001), 16:43-17:28, 22:36-51, 24:22-34, 28:5-15, 29:22-37, Figs. 9, 11-12. The modified images mimic images that would have been reflected from a mirror. ’109 Patent (Ex. 1001), 18:19-21, 27:3-6, 29:7-17. For example, the transformation mapping includes tilt transformation, elevation transformation, left-right flipping, and resizing. ’109 Patent (Ex. 1001), 16:46-17:28, 22:1-13, 23:41-24:9, 25:48-51, 29:22-58.

142. Like the ’109 Patent, *Rosenberg* discloses that the processor obtains real-time video images captured by the digital camera (“*a series of images of a live video feed from the camera*”) and then performs “*non-ordered steps*” on those images, including left-right inversion (“*flipping*” step), image scaling (“*resizing*” step), and displaying the modified images in real-time such that “the user . . . 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” (“*displaying*” step). *Rosenberg* (Ex. 1005), [0006]-[0007], [0026]-[0027], [0035], [0038], [0050], [0055], [0060]-[0061], [0077], [0083], [0106], [0113], Fig. 5. When *Rosenberg* is modified to incorporate *Nakazawa*’s correction (“*transformation*

mapping”), which corrects for distortions due to tilt and elevation of the camera, so that the user’s image appears to have been taken from a camera positioned at eye-level height and pointing horizontally, a person of ordinary skill in the art would have understood that the transformation mapping would have been performed on the captured video images along with *Rosenberg*’s “*flipping*” and “*resizing*” steps such that realistic mirror images are generated and displayed to the user. *Rosenberg* (Ex. 1005), [0025]-[0027], [0035]-[0036], [0055], [0060], [0077], [0083]; *Nakazawa* (Ex. 1007), Abstract, [0001]-[0003], [0008], [0031]-[0034].

143. As discussed above for claim limitation 1[c] (*see* above discussion in § X.A.2.d), a person of ordinary skill in the art would have understood that adding *Nakazawa*’s correction to *Rosenberg* would not affect *Rosenberg*’s real-time digital mirror functionality. A person of ordinary skill in the art would have understood that *Nakazawa*’s correction, like the image processing routines performed in *Rosenberg*, would not cause a noticeable lag for the user when viewing mirror images in real-time. This is because *Nakazawa*’s correction is a geometric transformation similar to the processing disclosed in *Rosenberg* (left-right inversion, scaling, moving images to the left or right of a display, zooming in and out). *Rosenberg* (Ex. 1005), [0026], [0034]-[0052], [0111]. Moreover, *Nakazawa* teaches that its correction can be performed in real-time because *Nakazawa* teaches its method can be automated and for video calls (*Nakazawa* (Ex. 1007), [0002]-[0003], [0036]), and a person of

ordinary skill in the art would have known video calls would be conducted in real-time for having a live virtual meeting. *See also* § X.A.1.

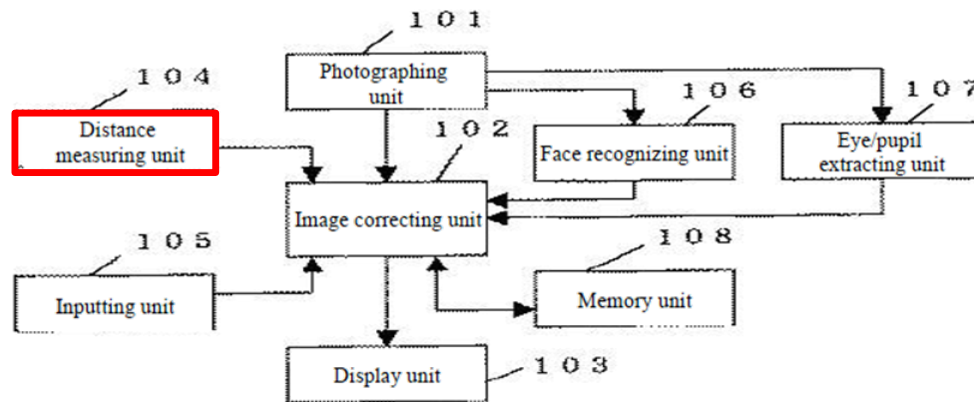
h. 1[g]: “determining distance to a user appearing in the live video feed; and”

144. In my opinion, *Rosenberg* alone or in view of *Nakazawa* renders obvious this claim limitation.

145. First, *Rosenberg* discloses that its digital mirror system includes proximity and/or motion sensors for detecting when a user is approaching or standing in front of the display. *Rosenberg* (Ex. 1005), [0025], [0032]-[0033], [0056], [0069]-[0073], [0109], [0114], Fig. 13. When the sensor detects a user within a specified proximity range, the system automatically engages its digital mirror functionality. *Rosenberg* (Ex. 1005), [0025], [0032]-[0033], [0056], [0069]-[0073], [0109], [0114], Fig. 13. When the sensor detects the user is no longer before the mirror for more than a threshold amount of time, the system automatically switches to a digital picture frame state or a low power state. *Rosenberg* (Ex. 1005), [0025], [0032]-[0033], [0056], [0069]-[0073], [0109], [0114], Fig. 13. *Rosenberg* further discloses that the digital camera can be used, either alone or in combination with other sensors, to provide this proximity and/or motion sensing functionality. *Rosenberg* (Ex. 1005), [0034], [0069], [0073], [0109], Fig. 13.

146. Second, *Nakazawa* discloses a distance measuring unit that measures the distance between the camera and a user and outputs the measured distance to the image correcting unit. *Nakazawa* (Ex. 1007), [0015], [0030], [0038], Fig. 1. This is shown below:

[FIG. 1]



Nakazawa (Ex. 1007), Fig. 1. *Nakazawa* further discloses determining the degree of magnification in its image correction based on the measured distance. *Nakazawa* (Ex. 1007), [0015], [0038]; see discussion in §IX.B. Various image processing methods were known to a person of ordinary skill in the art at the time of the alleged invention, and were suitable for measuring the distance between the camera and user, such as by identifying the user's eyes in the captured images and determining distance by estimating the distance based on the number of pixels or other features of the user in the camera-captured images (*Haan* (Ex. 1022), [0074]; *Lizee*

(Ex. 1017), [0043]-[0046], *Ooi* (Ex. 1039), [0074]). Indeed, the '109 Patent uses such known methods to determine the user's distance. The '109 Patent describes using images from the camera and calculating the distance based on geometrical assumptions of the user's features, such as the user's height or shoes. '109 Patent (Ex. 1001), 18:44-57, 24:63-25:7.

147. A person of ordinary skill in the art would have found it obvious to incorporate *Nakazawa*'s distance measurement in *Rosenberg* to implement its proximity sensing function because (i) *Rosenberg*'s proximity sensing function encompasses a distance measurement, and (ii) determining a user's distance to the camera allows for determining when and whether the user is within a specified proximity range in front of the screen before engaging or disengaging the digital mirror functionality in *Rosenberg*. *Rosenberg* (Ex. 1005), [0025], [0032]-[0034], [0056], [0069]-[0073], [0109], [0114], Fig. 13; *see also* §X.A.1. When *Rosenberg* is modified to incorporate *Nakazawa*'s distance measuring unit (“**determining distance to a user**”), a person of ordinary skill in the art would have understood that the user to which the distance is measured in *Nakazawa* would be the user using *Rosenberg*'s digital mirror and appearing in *Rosenberg*'s real-time video images captured by the camera (“**live video feed**”).

148. Further, a person of ordinary skill in the art would have recognized that various known distance sensing devices and/or technique as disclosed in *Rosenberg*

would be suitable for implementing the distance measurement described in *Nakazawa*, such as using the digital camera and processor of *Rosenberg*'s system as discussed above. *Rosenberg* (Ex. 1005), [0034], [0069], [0073], [0109], Fig. 13. A person of ordinary skill in the art would have understood that when using *Rosenberg*'s digital camera, real-time video images captured by the camera would be sent to the processor to detect whether the user is within the proximity range to engage the mirror functionality. *Rosenberg* (Ex. 1005) at [0025], [0056], [0061]-[0062], [0072], [0114], claim 17.

- i. **1[h]: “varying rate at which the non-ordered steps are performed on the series of images according to the distance.”⁴**

149. In my opinion, *Rosenberg* in view of *Nakazawa* renders obvious this claim limitation.

150. The '109 Patent discloses performing transformation mapping on the video images in real-time. '109 Patent (Ex. 1001), 6:1-5, 15:4-12, 15:41-58, 22:36-51, 24:22-34, 26:1-7. It also discloses performing transformation mapping based on

⁴ To the extent “the non-ordered step” has discernible meaning, it is my opinion that the prior art discloses it by disclosing or rendering obvious varying the rate of every step at the outset, or varying the rate across the non-ordered steps, as discussed herein.

the user's distance to the camera. For example, it discloses that the transformation mapping can be triggered when a user is detected in front of the camera. '109 Patent (Ex. 1001), 18:40-57; 23:18-23, Figs. 9, 12. And it discloses performing transformation mapping based on the user's distance to the screen, such as when the user moves toward or backward from the screen for more than a set distance amount. '109 Patent (Ex. 1001), 27:41-28:4. A person of ordinary skill in the art would have understood that in both these instances, whether the system performs transformation mapping would be based on the distance of the user to the camera or screen ("*according to the distance*"). '109 Patent (Ex. 1001), 18:40-57, 27:49-58, 27:64-28:4.

151. A person of ordinary skill in the art would have understood that the '109 Patent's distance-dependent performance of the transformation mapping is "*varying [the] rate*" at which this processing step is performed on the live video images from the camera ("*the series of images*"). A person of ordinary skill in the art would have understood that "*rate*" refers to the frequency of performing the transformation mapping, such as at a set time interval. '109 Patent (Ex. 1001), 27:41-58 ("every x seconds"). And a person of ordinary skill in the art would have understood that because the determination on whether to perform the transformation mapping is based on the user's distance, the rate of performing the transformation would vary over a period of live video images as the user's distance varies, such as

the user moves toward or backward from the screen over the period of the live video images captured by the camera.

152. *Rosenberg* in view of *Nakazawa* discloses such “*varying rate*.” *Rosenberg* discloses that its system can switch between different operational modes/states, such as a digital mirroring state (or a traditional mirror mode) and a digital picture frame state based on a user’s distance. *Rosenberg* (Ex. 1005), [0025], [0032]-[0034], [0054]-[0056], [0069]-[0073], [0083], [0109], [0114]. And, like the ’109 Patent, *Rosenberg* discloses that its system automatically engages the digital mirror state when the user approaches or stands in front of the display within a certain distance. *E.g.*, *Rosenberg* (Ex. 1005), [0025], [0032]-[0033], [0054]-[0056], [0069]-[0073], [0109], [0114], claim 21, Fig. 13. If the user is no longer in the vicinity of the camera/display for a threshold amount of time, *Rosenberg* discloses that its system leaves the digital mirror state and switches to a digital picture frame state. *Rosenberg* (Ex. 1005), [0025], [0032]-[0033], [0054]-[0056], [0069]-[0073], [0109], [0114], claim 21, Fig. 13. In the digital mirror state, a real-time mirror image emulating a traditional mirror image is displayed. *Rosenberg* (Ex. 1005), [0025]-[0027], [0035], [0077]. In the digital picture frame state, instead of displaying the user’s mirror image, the screen displays digital pictures, like photographs, artwork, or other imagery. *Rosenberg* (Ex. 1005), [0054]-[0056], [0112]-[0114]. A person of ordinary skill in the art would have understood that the rate at which *Rosenberg*’s

mirror image processing steps (e.g., obtaining image, left-right flipping, scaling, and displaying) are performed would vary as user distance varies over the period of the real-time video images captured by the camera. For example, over a period of 15 minutes of video images captured from the camera, if the user is in front of the camera for 4 minutes, away from the camera for 2 minutes, back in front of the camera for 4 minutes, away from the camera for 3 minutes, and back in front of the camera for 2 minutes, the rate at which *Rosenberg's* mirror image processing steps are performed over the 15-minute period would vary because it would not be performed at a fixed set time interval, e.g., every x seconds, on the video images from the camera, but rather at a variable time interval. If *Rosenberg's* steps are performed every 30 milli-seconds while the user is in front of the camera, the interval becomes longer, i.e., 2 minutes, the first time the user steps away from the camera, and the interval becomes 3 minutes the second time the user steps away from the camera. This is because the *Rosenberg's* mirror image processing steps are performed on the video images whenever the user is within the proximity range of the camera/screen.

153. And as discussed above regarding limitation 1[g] (§X.A.2.h), a person of ordinary skill in the art would have understood that in *Rosenberg* combined with *Nakazawa*, *Rosenberg's* real-time video images captured by the camera would be sent to the processor to detect whether the user is within the proximity range to

engage or disengage the digital mirror state. *Rosenberg* (Ex. 1005) at [0025], [0056], [0061]-[0062], [0072], [0114], claim 17. Thus, a person of ordinary skill in the art would have understood that *Rosenberg*'s the real-time video images captured by the camera would be sent to the processor during the digital mirroring and digital picture frame states for determining the user's distance.

154. As discussed above regarding claim limitations 1[a] (*see* discussion above in § X.A.2.b), 1[b] (*see* discussion above in § X.A.2.c), 1[d] (*see* discussion above in § X.A.2.e), and 1[e] (*see* discussion above in § X.A.2.f), *Rosenberg* discloses that, in the digital mirror state, the processor performs image processing steps that include “*obtaining*” a digital image, performing left-right inversion (“*flipping*”), image scaling (“*resizing*”), and also displaying the modified images on the display screen in real-time (“*displaying*”). *Rosenberg* (Ex. 1005), [0026], [0035], [0038], [0077], Fig. 5. A person of ordinary skill in the art would have understood that, when *Rosenberg*'s digital mirror switches between the digital mirroring and digital picture frame states, the rate at which *Rosenberg*'s image processing steps (“*the non-ordered steps*”) are performed on the real-time video images from the camera (“*the series of images*”) would vary. As similarly disclosed in the '109 Patent, *Rosenberg*'s steps are not performed at a fixed set time interval over the period of the real-time video images from the camera, but rather depending on the distance of the user to the camera (“*according to the distance*”).

155. Further, when *Rosenberg* is modified to incorporate *Nakazawa*'s correction (“***transformation mapping***”), a person of ordinary skill in the art would have understood that the combined image processing steps would also include *Nakazawa*'s transformation mapping. See discussion in §X.A.2.d. As discussed, adding *Nakazawa*'s transformation mapping in *Rosenberg* would correct the unnatural distortion in the image captured by *Rosenberg*'s digital camera and display a more realistic mirror image to the user. *Rosenberg* (Ex. 1005), [0027]-[0028], [0061]; *Nakazawa* (Ex. 1007), [0001]-[0003], [0031]-[0032]. See also § X.A.1. And a person of ordinary skill in the art would have known that *Nakazawa*'s transformation mapping step would be performed during *Rosenberg*'s digital mirror state, not the digital picture frame state, which would result in the image processing rate on the real-time video images varying according to the user's distance to the camera, as discussed above. A person of ordinary skill in the art would have understood that the combined image processing steps of *Rosenberg* and *Nakazawa* would constitute the claimed “***non-ordered steps***” because, they include obtaining an image, modifying those images, and then displaying the modified images on the display, as described in the '109 Patent. See, e.g., '109 Patent, 3:2-7, 5:26-29, 6:1-5, 22:4-13, 22:36-51, 24:22-34, 25:1-7, 28:5-37, 29:10-11, Figs. 9, 11-12.

3. Dependent Claim 2

“The method of claim 1, wherein the transformation mapping renders an image appearing to have been taken from a camera positioned at eye-level height and pointing horizontally.”

156. In my opinion, *Rosenberg* in view of *Nakazawa* renders obvious the additional limitation of claim 2.

157. The '109 Patent discloses that the camera is positioned above the display and tilted downwards “to allow maximum dynamic range of the user’s movement in front of the screen.” '109 Patent (Ex. 1001), 15:26-31, 17:1-10, 21:19-22, 23:32-34, 24:25-30, 24:37-39, 26:18-20, Figs. 1, 2A-2B, 3A-3B, 8, 13. But such configuration results in projection distortions in the images of the user. '109 Patent (Ex. 1001), 15:30-35; 23:45-51, 26:20-25, Fig. 8. This is shown below:

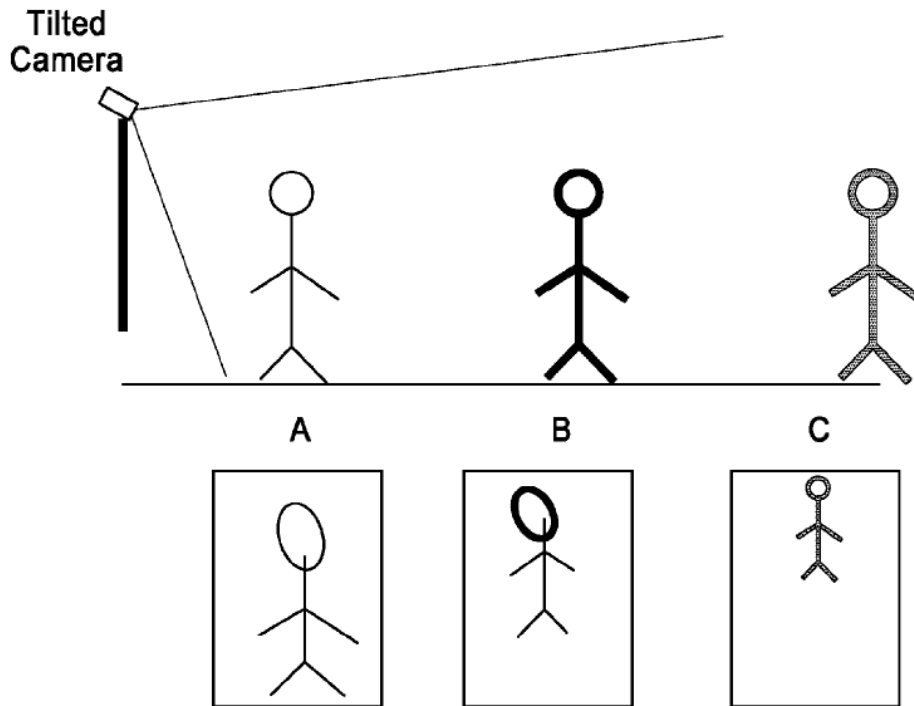
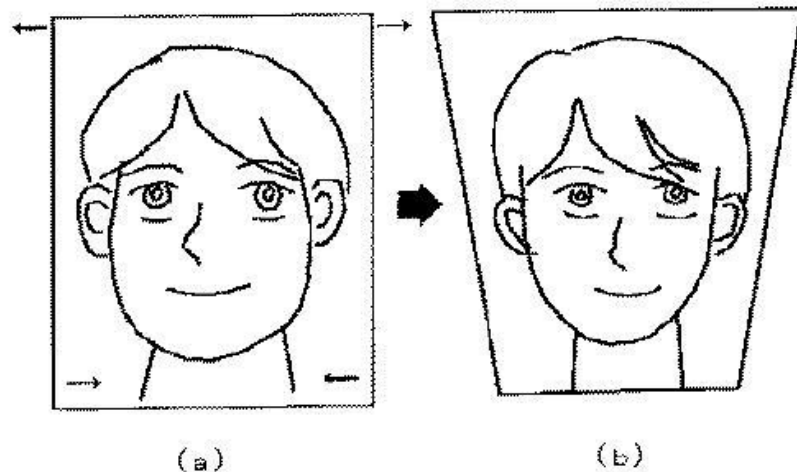


FIG. 8

'109 Patent (Ex. 1001), Fig. 8. The '109 Patent describes performing transformation mapping, e.g., tilt transformation, to correct the projection distortion in the image so that the modified image would appear as if the camera was pointed straight horizontally. '109 Patent (Ex. 1001), 23:41-51, 29:22-42. The '109 Patent also describes performing transformation mapping, e.g., elevation transformation (i.e., elevation spatial translation transformation), to modify the offset in the image captured by the camera and thereby “transform[] the image to appear as if the image was taken from the screen location at the user’s eyes level (match the eye height to the image in the screen height).” '109 Patent (Ex. 1001), 23:52-58, 29:22-42.

158. *Nakazawa* discloses correcting projective distortion in the user's image and generates a corrected image that appears to have been taken by a camera pointing straight horizontally. As discussed above, *Nakazawa* teaches that when the camera is positioned above or below the display, the orientation of the face image captured by the camera would appear unnatural. *Nakazawa* (Ex. 1007), [0002]-[0003], [0034]. *Nakazawa* teaches that its correction ("**transformation mapping**") corrects the orientation deviation and obtains a "corrected image appearing to be captured with front orientation," as shown below. *Nakazawa* (Ex. 1007), [0007]-[0008], [0019], [0030], [0033]-[0035], [0038], Fig. 3.



Nakazawa (Ex. 1007), Fig. 3.

159. A person of ordinary skill in the art would have understood that *Nakazawa*'s corrected image appears to be captured with a front orientation as "***an image appearing to have been taken from a camera ... pointing horizontally***"

because the user in the corrected image appears to be looking straight, and *Nakazawa* explicitly discloses correcting the deviation in the orientation of the image. *Nakazawa*, [0001], [0030]. Also, in *Rosenberg*, the display screen is mounted on a wall and positioned in a vertical direction, and the camera is mounted above the screen pointing down to the user. *Rosenberg* (Ex. 1005), [0002], [0025]-[0027], [0054], [0059]-[0062], [0077], Figs. 3, 5. When *Rosenberg* is combined with *Nakazawa*, the image captured by the camera would be corrected as if the user is looking straight at a vertical display, which would in turn appear to be captured from a camera “*pointing horizontally*.”

160. A person of ordinary skill in the art would have also understood that when *Rosenberg* is modified with *Nakazawa*’s correction (“*transformation mapping*”), the transformation mapping would include a tilt transformation as in the ’109 Patent, because it would correct the projection distortion in the image caused by the tilt angle of the camera. ’109 Patent (Ex. 1001), 19:31-40 (projection distortion creates the effect that closer body parts appear larger and further body parts appear smaller), 23:45-51 (tilt transformation corrects distortion in image caused by camera being tilted downwards). Specifically, *Rosenberg*’s camera positioned above the screen and aimed downward at the user would cause the user’s image to appear wider than normal in the parts closer to the camera and narrower than normal in the parts further from the camera. *Rosenberg* (Ex. 1005), [0027],

[0062]. This would be the opposite of the distortion shown in Figure 2(b) in *Nakazawa*. To correct the distortion, as taught by *Nakazawa* (see, e.g., *Nakazawa* (Ex. 1007), [0034]-[0035]), a person of ordinary skill in the art would have increased the magnification ratio of the parts narrower than normal and decreased the magnification ratio of the parts wider than normal. See also *Park* (Ex. 1016), Fig. 1(C), [0007] (teaching an image captured by a camera above a user result in wider forehead and narrower chin). A person of ordinary skill in the art would have understood that after the correction, the point of view of the image would have been corrected to match that of the forward orientation of the user's face and to be pointing horizontally, correcting the unnatural perspective. *Rosenberg* (Ex. 1005), [0027]; *Nakazawa* (Ex. 1007), [0007]-[0008], [0019], [0030], [0033]-[0035], [0038], Fig. 3.

161. A person of ordinary skill in the art would have been motivated to modify the mirror image processing of *Rosenberg* as modified with *Nakazawa's* correction to vertically translate the corrected image such that it “***appear[s] to have been taken from a camera positioned at eye-level height***” to realistically emulate a traditional mirror. *Rosenberg* teaches that a mirror image “***appearing to have been taken from a camera positioned at eye-level height***” more realistically replicates a traditional mirror. *Rosenberg* teaches a camera mounted at eye level (“***a camera positioned at eye-level height***”) “provide[s a] user with a natural and accurate visual perspective of himself or herself as compared to a traditional mirror.” *Rosenberg*

(Ex. 1005), [0027]; *see also Rosenberg* (Ex. 1005), [0028] (“[E]mbodiments 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 ... at an elevation vertically that generally corresponds with a user’s typical eye level.”), [0075] (teaching captured image from a vantage point straight ahead more realistically replicates a traditional mirror). *Rosenberg* teaches that in the embodiments where the camera is mounted above the display screen, the vantage point will be higher than the eye-level vantage point. *Rosenberg* (Ex. 1005), [0027].

162. A person of ordinary skill in the art would have understood that when *Rosenberg* is modified with *Nakazawa*’s correction (“***transformation mapping***”), the transformation mapping would include an elevation transformation because it would match the elevation of the eyes in the image to the user’s eyes level as in the ’109 Patent. ’109 Patent (Ex. 1001), 23:53-57. A person of ordinary skill in the art would have understood that, due to variations in the heights of users and/or camera positions, the elevation of a user’s eyes in the mirror image may not align with the user’s eye level, resulting in a mirror image that does not “***appear[] to have been taken from a camera positioned at eye-level height.***” *Nakazawa* discloses correcting deviations in the line of sight the captured image. *Nakazawa* (Ex. 1007), Abstract, [0001]-[0003], [0007]-[0008], [0032], [0034]. A person of ordinary skill in the art would have understood that correcting line of sight requires aligning the user’s eye

level, and would have been motivated to modify *Rosenberg* in view of *Nakazawa*'s steps to vertically translate the corrected image upward or downward to align with the user's eye level. A person of ordinary skill in the art would have understood this corrected image "***appear[s] to have been taken from a camera positioned at eye-level height.***" See, e.g., *Straka* (Ex. 1023), 640-41 (teaching offsetting the virtual camera position to mirror the position of the user's eyes and generating translation vector for matrix for transforming actual camera image to mirror image).

163. A person of ordinary skill in the art would have expected success making such modification because *Rosenberg*'s system is capable of performing such vertical translation. *Rosenberg* (Ex. 1005), [0048], [0052], [0093]-[0094], [0098] (teaching moving a mirror image to the left or right of the display). A person of ordinary skill in the art would have understood that such translation is also a form of transformation mapping because the translation would have been performed by reassigning the position (i.e., "address") of each image pixel to a corresponding vertically-offset position in order to obtain the modified image. See also § X.A.1.

4. Dependent Claim 3

"The method of claim 1, wherein the transformation mapping comprises at least a tilt transformation and an elevation transformation."

164. In my opinion, *Rosenberg* in view of *Nakazawa* renders obvious the additional limitation of claim 3.

165. For the reasons discussed in claim 2, a person of ordinary skill in the art would have understood that in *Rosenberg* as modified by *Nakazawa*, *Nakazawa*'s correction comprises at least “***a tilt transformation***” because it corrects the projection distortions in the image caused by the tilt angle of the camera relative to the user, like the '109 Patent. *See* § X.A.3.

166. Further, *Nakazawa*'s correction comprises “***an elevation transformation***.” A person of ordinary skill in the art would have understood that *Nakazawa*'s correction steps for correcting an image that is captured by an angled camera placed above or below the user's face and/or eyes' level, in order to obtain a “corrected image appearing to be captured with front orientation” corresponds not only to a tilt transformation that rotates the camera to make it point horizontally but also to a vertical elevation transformation. *Nakazawa* (Ex. 1007), Figs. 2-3, Abstract, [0001]-[0003], [0007], [0031]-[0034]. Additionally, *Nakazawa* teaches that his “invention relates to a photographing device that corrects deviations in **orientation** and **line of sight** of a captured facial image” (*Nakazawa* (Ex. 1007), [0001] (emphasis added)) and that it “provide[s] a photographing device that is capable of image correction so that the line of sight of the captured image and the displayed image are aligned, even if the photographing means and the displaying means are separated” (*Nakazawa* (Ex. 1007), [0007]). *See also Nakazawa* (Ex. 1007), Figs. 2-3; *see also* § X.A.3.

167. Further, a person of ordinary skill in the art would have understood that an image appearing to have been taken from a camera positioned at eye-level height more realistically replicates a traditional mirror. *Rosenberg* (Ex. 1005), [0075]. A person of ordinary skill in the art would have been motivated to vertically translate the corrected image to align the user's eye level in the mirror image. And a person of ordinary skill in the art would have understood such vertical translation as “*elevation transformation*” because it would map a vertical position of each pixel of the image to a vertical position of a corresponding pixel of a modified image, changing the vertical position of the user's image. *See* § X.A.3.

5. Dependent Claim 4

“The method of claim 3, wherein the tilt transformation modifies an input image taken with a non-horizontally pointing camera and transforming the image to appear as if the camera was pointed straight horizontally.”

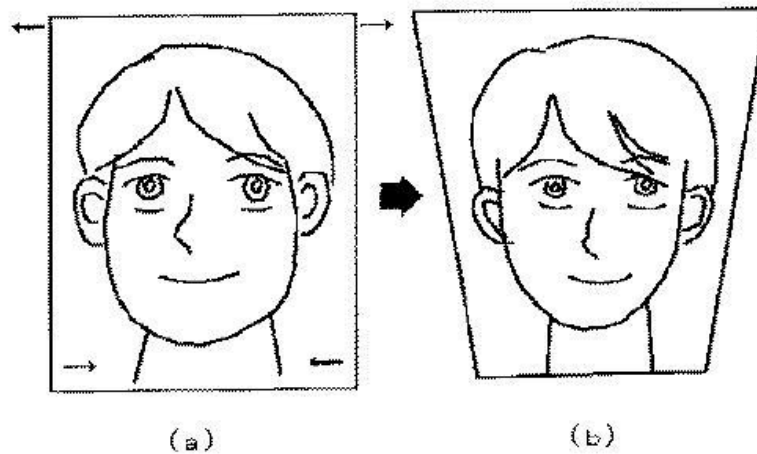
168. In my opinion, *Rosenberg* in view of *Nakazawa* renders obvious the additional limitation of claim 4.

169. *Rosenberg* discloses that the camera mounted above the display is aimed downward at the user and thus the image captured by the camera is “***an input image taken with a non-horizontally pointing camera.***” *Rosenberg* (Ex. 1005), [0027], Fig. 3. As I discussed above regarding claims 2 and 3 (*see* discussion above in §§ X.A.2 and X.A.3), a person of ordinary skill in the art would have understood

that performing *Nakazawa*'s image correction in *Rosenberg* would perform a “***tilt transformation***,” as claimed. And as I explained above regarding claim 2 (see discussion above in § X.A.2), a person of ordinary skill in the art would have understood that *Nakazawa*'s corrected image having a front orientation “***appear[s] as if the camera was pointed straight horizontally***” because the user in the corrected image appears to be looking straight horizontally at the camera. *Nakazawa* (Ex. 1007), [0001], [0005], [0007]-[0008], [0019], [0030], [0033]-[0035], [0038], Fig. 3.

170. When *Rosenberg* is combined with *Nakazawa*, the image captured by *Rosenberg*'s camera above the display and aimed at the user (“***an input image taken with a non-horizontally pointing camera***”) would have been transformed by *Nakazawa*'s correction, which corrects the projection distortions caused by the camera tilt angle, with resulting transformed image having the user appearing to look straight horizontally (“***appear[ing] as if the camera was pointed straight horizontally***”). For example, a person of ordinary skill in the art would have understood that the distortion in *Rosenberg* would have the upper body of the user appear larger than the lower body of the user (opposite to the distortion illustrated below in Figure 3(a)), and the corrected image of *Rosenberg* would appear to look straight horizontally like Figure 3(b) below):

[FIG. 3]



Nakazawa (Ex. 1007), Fig. 3.

6. Dependent Claim 5

“The method of claim 3, wherein the elevation transformation modifies an input image taken with a camera positioned at arbitrary height and transforming the image to appear as if the camera was positioned at a user’s eye level.”

171. In my opinion, *Rosenberg* in view of *Nakazawa* renders obvious the additional limitation of claim 5.

172. *Rosenberg* teaches that the camera can be mounted above or behind the display at “eye [] level of typical users,” but does not specify the actual height of the camera. *Rosenberg* (Ex. 1005), [0027]-[0028], [0061]-[0062], [0077], Figs. 3, 5. A person of ordinary skill in the art would have understood that the height of

Rosenberg's camera would be “***at arbitrary height***” because it would vary based on the size and height of the display or the average or median height of the intended “typical user[.]” *Rosenberg* (Ex. 1005), [0027]. For the reasons discussed in claims 2 and 3 (*see* discussion above in §§ X.A.2 and X.A.3), a person of ordinary skill in the art would have been motivated to modify the processing of *Rosenberg*, as modified with *Nakazawa*'s correction, to include an elevation transformation (e.g., a vertical offset) so the image would “***appear as if the camera was positioned at a user's eye level,***” in turn emulating a traditional mirror. When *Rosenberg* is combined with *Nakazawa*, the image captured by *Rosenberg*'s camera would be “***an input image taken with a camera positioned at arbitrary height,***” and would have been corrected by *Nakazawa*'s correction. An elevation transformation would have been performed on the corrected image to match the height of the user's eyes in the image to the user's eye level such that the image “***appear[s] as if the camera was positioned at a user's eye level.***” *See, e.g., Nakazawa* (Ex. 1007), Figs. 2-3, Abstract, [0001]-[0003], [0007], [0031]-[0034].

7. Dependent Claim 6

“The method of claim 1, wherein the step of resizing the image is performed integral to the step of applying the transformation mapping.”

173. In my opinion, *Rosenberg* in view of *Nakazawa* renders obvious the additional limitation of claim 6.

174. As discussed above regarding limitation 1[d] (*see* discussion above in § X.A.2.e), *Rosenberg* discloses or at least renders obvious “**resizing the image**,” and a person of ordinary skill in the art would have understood that *Rosenberg*’s “resizing” step would have been a “**transformation mapping**” because the ’109 Patent discloses that transformation mapping can include resizing. ’109 Patent (Ex. 1001), 22:1-13, 23:60-24:9, 24:51-53, 29:22-58. To the extent that “**transformation mapping**” requires additional transformations (as discussed above regarding limitation 1[c] (*see* discussion above in § X.A.2.d)), a person of ordinary skill in the art would have understood that *Rosenberg*’s resizing would have been performed in real-time with the additional transformations disclosed in *Rosenberg* combined with *Nakazawa*, e.g., flipping (as discussed above regarding limitation 1[b] (*see* discussion above in § X.A.2.c)), projection/tilt transformation (as discussed above regarding limitation 1[c] (*see* discussion above in § X.A.2.d) and claim 2 (*see* discussion above in § X.A.3)), and elevation transformation (as discussed above regarding claims 2 and 5 (*see* discussion above in §§ X.A.3 and X.A.6)) to obtain the real-time mirror images for display. *Rosenberg* (Ex. 1005), [0025]-[0027], [0035], [0077], [0082]. When *Rosenberg* is modified with *Nakazawa*, a person of ordinary skill in the art would have understood that *Rosenberg*’s resizing step would be “**integral to the step of applying the transformation mapping**” because it would have been performed as part of the combined transformations performed on the real-

time video images as disclosed in the '109 Patent. '109 Patent (Ex. 1001), 22:1-13, 23:45-24:9, 24:51-53, 29:22-58 (teaching the transformation mapping can include tilt, scale, spatial translation).

175. As I also discussed above regarding limitation 1[d] (*see* discussion above in § X.A.2.e), *Rosenberg* in view of *Nakazawa* renders obvious “**resizing the image.**” And as I discussed above, a person of ordinary skill in the art would have understood that the “resizing” step would have been performed in real-time as part of a combination of transformations performed on the real-time video images, and thus would have considered the resizing step as being “**integral to the step of applying the transformation mapping.**” For example, a person of ordinary skill in the art would have understood that the “resizing” step can be a scaling matrix or scaling parameter of a transformation matrix for performing *Nakazawa*’s transformation mapping. *See* § IX.B (discussing how a person of ordinary skill in the art would have understood that *Nakazawa*’s transformation mapping would be implemented using a transformation matrix). And it was also known that when multiple transformations are performed, applying the transformations would be a multiplication of transformation and scaling matrices. *Straka* (Ex. 1023), 641; *Park* (Ex. 1016), [0060]-[0061].

8. Dependent Claim 8

“The method of claim 1, further comprising applying a translation transformation to move the image within display area of the monitor.”

176. In my opinion, *Rosenberg* discloses the additional limitation of claim 8.

177. *Rosenberg* teaches that the digital mirror system has real-time zoom-in and zoom-out functions, as shown below. *Rosenberg* (Ex. 1005), [0050]-[0051], [0099]-[0105], Figs. 10-11.

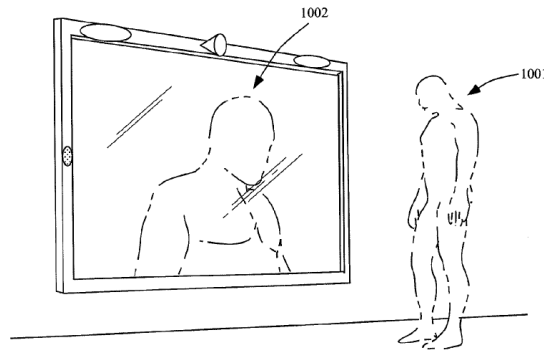


Fig. 10

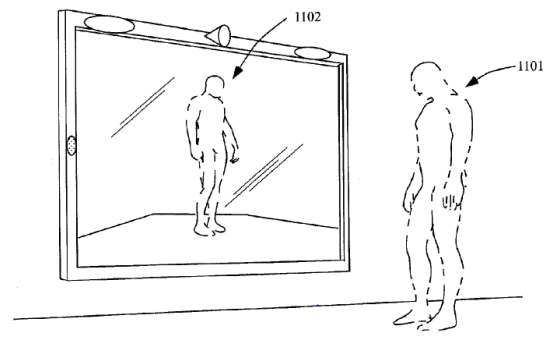


Fig. 11

Rosenberg (Ex. 1005), Figs. 10-11. *Rosenberg* teaches the user can command the location of a zoom guide to “move left,” “move right,” “move up,” and “move down,” whereupon the mirror image is zoomed. *Rosenberg* (Ex. 1005), [0052], [0106], Fig. 12.

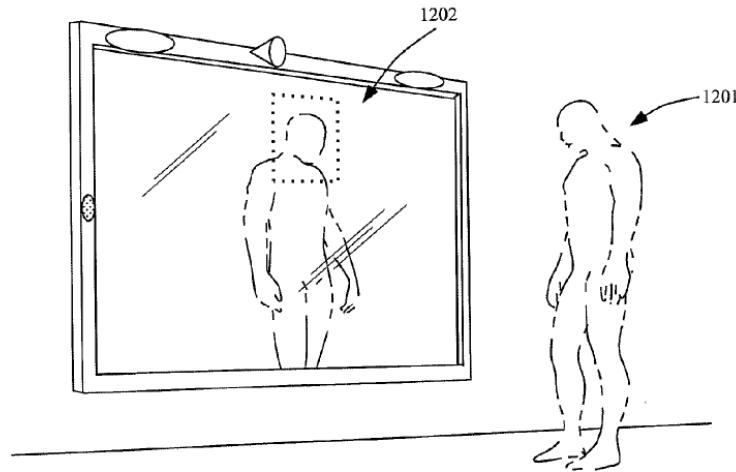


Fig. 12

Rosenberg (Ex. 1005), Fig. 12 (showing zoom guide 1202). A person of ordinary skill in the art would have understood that zooming in or out of a portion of the mirror image on the display, as disclosed by *Rosenberg*, would require translating the mirror image in the screen (“***applying a translation transformation to move the image within display area of the monitor***”). This is because the pixel numbers and positions of the mirror image would need to be changed to implement the zoom functions, as taught by *Rosenberg*.

178. *Rosenberg* also teaches that the digital mirror enables the user to freeze a mirror image and move the frozen image to the left or right side of the display while also displaying the real-time mirror image in the center, as shown below. *Rosenberg* (Ex. 1005), [0048], [0093]-[0098], [0110], Figs. 8-9.

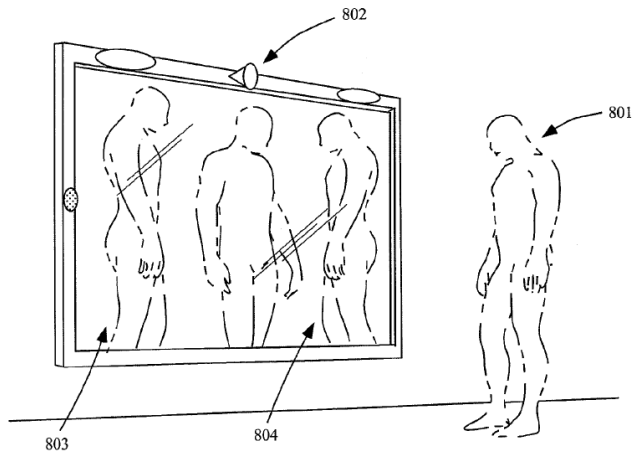


Fig. 8

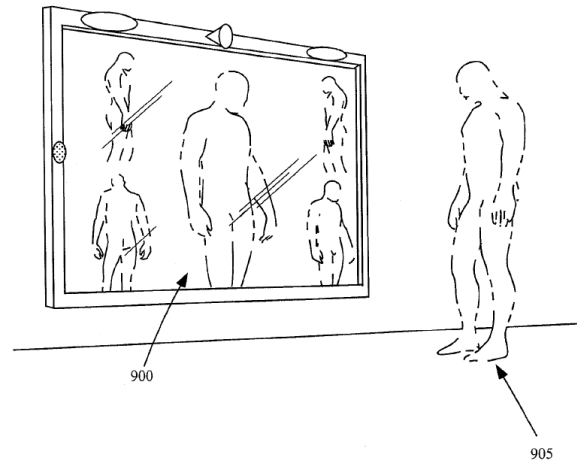


Fig. 9

Rosenberg (Ex. 1005), Figs. 8-9.

179. *Rosenberg* teaches that this function allows the user to see his/her profile from different sides or compare the real-time image with previous images. And a person of ordinary skill in the art would have understood that moving the mirror image to the left or right of the display would constitute “*applying a translation transformation to move the image within display area of the monitor,*” as claimed, because it shifts the position of the mirror image left or right on the display.

9. Dependent Claim 17

- a. “*The method of claim 1, storing the live video feed in a digital storage device and selectively operating the system in one of a mirror mode or display mode,*”

180. In my opinion, *Rosenberg* in view of *Nakazawa* renders obvious this additional limitation of claim 17.

181. *Rosenberg* discloses that the system has a traditional mirror emulation mode (“***mirror mode***”), where the digital mirror displays real-time mirror images. *Rosenberg* (Ex. 1005), [0025]-[0027], [0035], [0077], [0082]. It also discloses that the system has user-selectable functions, like a mirror image-buffering feature (“***display mode***”) (*Rosenberg* (Ex. 1005), [0044]-[0047], [0068], [0078], [0089]-[0093]). *Rosenberg* discloses that the user can command the digital mirror to selectively engage the mirror buffering feature or the traditional mirror mode. *Rosenberg* (Ex. 1005), [0027], [0039]-[0041], [0044], [0069], [0081], [0084], [0089]. When engaging the mirror-buffering feature, *Rosenberg* discloses displaying previously stored real-time images, allowing a user to see views at different orientations. *Rosenberg* (Ex. 1005), [0044]-[0048], [0088], [0091], [0093].

182. *Rosenberg* discloses that the system has a memory (“***digital storage device***”) configured to store real-time video images (“***storing the live video feed***”), such as for 10 seconds, to implement the mirror-buffering feature. *Rosenberg* (Ex. 1005), [0044]-[0046], [0053], [0089]-[0091].

b. “wherein during mirror mode displaying on the monitor transformed images of what the camera sees at that particular moment”

183. In my opinion, *Rosenberg* in view of *Nakazawa* renders obvious this additional limitation of claim 17.

184. *Rosenberg* discloses that in the traditional mirror emulation mode, the processor obtains real-time video images captured by the digital camera (“*what the camera sees at that particular moment*”), and performs image processing on these images, such as left-right inversion (“flipping”) and image scaling (“resizing”), and displays real-time mirror images on the display. *Rosenberg* (Ex. 1005), [0025]-[0027], [0035], [0077], [0082]. This is shown below:

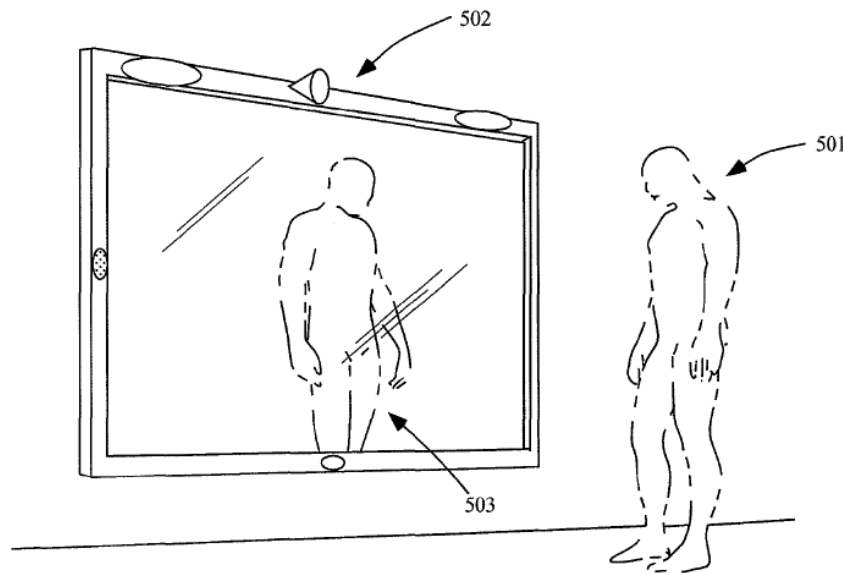


Fig. 5

Rosenberg (Ex. 1005), Fig. 5. When *Rosenberg* is modified by *Nakazawa*, the real-time video images would have been additionally corrected by *Nakazawa*'s correction (“*transformed*”) before being sent to the display screen. *Rosenberg* (Ex. 1005), [0027]-[0028], [0077]; *Nakazawa* (Ex. 1007), [0001]-[0003], [0007], [0031]-[0033]; see discussion above in §§X.A.2.d, X.A.2.f.

- c. ***“while during display mode displaying on the monitor a transformed images of what the camera saw in the past and obtained from the digital storage device.”***

185. In my opinion, *Rosenberg* in view of *Nakazawa* renders obvious this additional limitation of claim 17.

186. *Rosenberg* discloses that when the user engages the mirror-image buffering feature, the previously stored real-time images (“***what the camera saw in the past***”) are displayed on the mirror. *Rosenberg* (Ex. 1005), [0045]-[0046], [0068], [0090]-[0091], Figs. 8-9. *Rosenberg* discloses that this feature allows the user to view his/her image from any desired angle. *Rosenberg* (Ex. 1005), [0080], [0091]. This feature is illustrated in the example below.

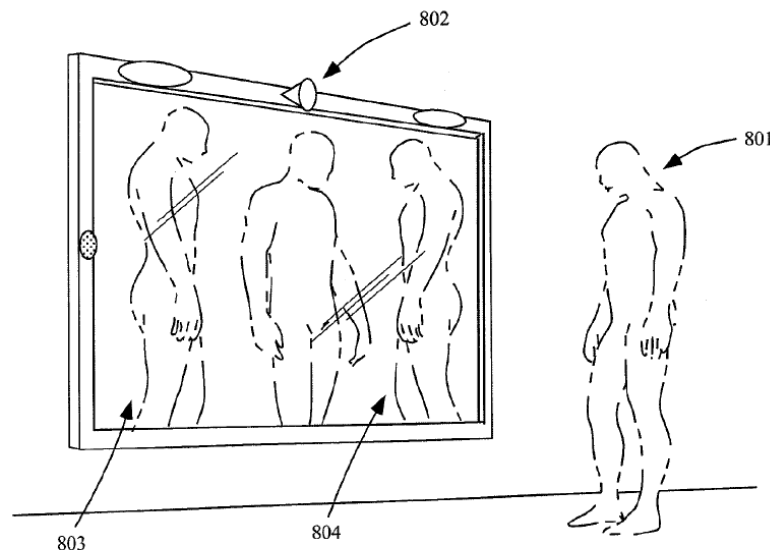


Fig. 8

Rosenberg (Ex. 1005), Fig. 8.

187. As explained above regarding limitations 1[c] and 1[e] (*see* discussion above in §§ X.A.2.d, X.A.2.f), when *Rosenberg* is modified by *Nakazawa*, the stored real-time video images would have been corrected by *Nakazawa*'s correction (“*transformed*”) before being stored in the memory (“*the digital storage device*”). *Rosenberg* (Ex. 1005), [0028], [0077]. A person of ordinary skill in the art would have understood that *Rosenberg*'s processor would access the memory to obtain the stored mirror images from the memory before sending those images to the display screen. *Rosenberg* (Ex. 1005), [0077], [0089]-[0091], Fig. 13.

B. Ground 2: *Rosenberg* In View Of *Nakazawa* and *Hatanaka* Renders Obvious Claims 1-6, 8, 11, and 17.

1. Rationale to Combine *Rosenberg*, *Nakazawa*, and *Hatanaka*

188. As discussed above in § X.A.1, a person of ordinary skill in the art would have been motivated to combine *Rosenberg* and *Nakazawa* and would have achieved success in doing so. Further, a person of ordinary skill in the art would have been motivated to combine *Rosenberg* and *Nakazawa* with *Hatanaka*. As an initial matter, these references are analogous to the '109 Patent. They are in the same field of endeavor as each other and the '109 Patent. *See* above discussions in §§ IV.A (Overview of the '109 Patent), IX.A (Overview of *Rosenberg*), IX.B (Overview of *Nakazawa*), IX.C (Overview of *Hatanaka*).

189. As explained above regarding limitation 1[h] (*see* discussion above in § X.A.2.i), *Rosenberg* in view of *Nakazawa* renders obvious varying the rate of performing the image processing steps of *Rosenberg* incorporating *Nakazawa*'s transformation mapping. A person of ordinary skill in the art would have also found it obvious to vary the rate of performing the processing steps of *Rosenberg* combined with *Nakazawa* in view of *Hatanaka*'s teachings.

190. *Hatanaka* teaches reducing image-data-related processing throughput, such as by reducing the frame rate and/or resolution of the encoded video image data, as viewing distance D increases. *Hatanaka* (Ex. 1009), [0008], [0012], [0018], [0023], [0037]-[0039]. *Hatanaka* likewise teaches minimizing the amount of encoding throughput and the amount of post-encoding data when the sensor does not detect any viewer. *Hatanaka* (Ex. 1009), [0037], [0039], [0051], claims 1-3. *Hatanaka* teaches that, because the viewer is not always near the display while live video images are in display, its method allows for encoding/decoding processing at a lower frame rate and/or resolution when there is no viewer in the immediate vicinity of the display, thus reducing image-data-related processing throughput and enabling efficient processing of images. *Hatanaka* (Ex. 1009), Abstract, [0012], [0039], [0051]. *Hatanaka* notes that "there are no restrictions on the method used to adjust the resolution, frame rate, etc., according to viewing distance D." *Hatanaka* (Ex. 1009), [0039].

191. Like *Hatanaka*, *Rosenberg* teaches turning off a mirror display or switching to a lower power state when the proximity/motion sensor detects that the user is not within a certain area/region for a threshold amount of time so as not to “wast[e] power by continually displaying mirroring imagery when there is nobody looking in the mirror.” *Rosenberg* (Ex. 1005), [0025], [0032], [0056], [0069]-[0072], [0112]-[0115]. A person of ordinary skill in the art would have found *Hatanaka*’s teaching of reducing image-related-data processing throughput as the viewing distance *D* (*Rosenberg*’s distance of the user) increases, such as by reducing the frame rate and/or resolution of the video images, a suitable alternative for conserving power when the user/viewer is no longer in the vicinity of the display.

192. As I discussed above regarding limitations 1[a]-1[e] (*see* discussion above in §§ X.A.2.b-X.A.2.f), the image processing steps of *Rosenberg* (as modified with *Nakazawa*) include obtaining video images from the camera, performing left-right inversion and transformation mapping on the video images, and displaying the modified images on the display. A person of ordinary skill in the art would have reduced the rate of these processing steps in *Rosenberg* (as modified by *Nakazawa*) such that the real-time video images are processed and displayed to the user at a lower frame rate or a lower resolution when *Rosenberg*’s proximity sensor no longer detects the user in the proximity area/region, that is “when there is no audience in the immediate vicinity of the representation apparatus (display),” “enabling efficient

processing of images.” *Rosenberg* (Ex. 1005), [0025], [0032], [0056], [0069]-[0072], [0112]-[0115]; *Hatanaka* (Ex. 1009), [0051].

193. A person of ordinary skill in the art also would have understood that modifying *Rosenberg* in view of *Hatanaka* has the benefit of conserving power without sacrificing visual quality when *Rosenberg*’s display is operational, as also taught by *Rosenberg*. For example, *Rosenberg* teaches putting the display in a lower power state, such as in a dimmed state. *Rosenberg* (Ex. 1005), [0070]. Thus, *Rosenberg* recognizes alternative solutions for conserving power, and a person of ordinary skill in the art would have further improved *Rosenberg*’s display in view of *Hatanaka* because *Hatanaka*’s method would provide a solution to conserve power even when the display is operational as a digital mirror by reducing the overall processing burden on the processor and memory while conserving the perceived visual quality.

194. Further, a person of ordinary skill in the art also would have recognized some benefits of conserving power by reducing the image processing rate or resolution after detecting that the user is no longer in the vicinity of the camera/screen. For example, *Rosenberg* discloses continuing the digital mirror state for a threshold amount of time after the user steps away from the mirror. *Rosenberg* (Ex. 1005), [0025], [0033], [0056], [0070]-[0071]. A person of ordinary skill in the art would have recognized that reducing the rate and/or resolution of the image

processing steps of *Rosenberg* (as modified by *Nakazawa*) during this threshold amount of time, during which no user is viewing the mirror image, would have conserved additional power. Additionally, *Rosenberg* discloses that a digital mirror “installed upon a living room wall may not be desirably configured to turn itself off when a user is not standing directly before it.” *Rosenberg* (Ex. 1005), [0054], [0112]. Reducing the image processing rate and/or resolution after detecting that the user is no longer in the vicinity of the camera/screen allows *Rosenberg*’s digital mirror to continue to appear like a traditional mirror as desired for a living room setting while conserving power.

195. Further, a person of ordinary skill in the art would have been motivated to implement *Hatanaka*’s teaching of reducing image-related-data processing throughput as the viewing distance D (*Rosenberg*’s distance of the user) increases, for example, as the user moves further away from the screen within the proximity range to further improve *Rosenberg*’s energy efficiency. *Hatanaka* discloses reducing image-data-related processing throughput, such as by reducing the resolution of the video image, to the extent the viewer cannot recognize the image. *Hatanaka* (Ex. 1009), [0049]. It was well known to a person of ordinary skill in the art that a person’s visual acuity deteriorates as the user moves away from the screen. *Smith* (Ex. 1036), 19-20 (explaining the viewing distance is inversely proportional to the retinal image size); *Subedar* (Ex. 1037), 4 (teaching objects closer to the

observer will appear sharper than objects that are further away); *Watson* (Ex. 1038), 4:41-47, 4:65-5:41 (teaching that the retinal image size is inversely proportional to the viewing distance and that removing high frequency components to reduce image resolution, does not significantly affect visibility). When a user is far away, e.g., by several feet, a user would not be able to recognize fine details on the screen. *See Rosenberg* (Ex. 1005), [0056], [0114] (teaching the proximity range being six to eight feet in front of the screen area). In such instances, a person of ordinary skill in the art would have recognized reducing the image processing rate and/or resolution in *Rosenberg* as the user's distance to the screen increases as taught in *Hatanaka* would reduce image-data-related processing throughput and thus improving energy efficiency without sacrificing user experience since the perceived visual quality is not affected. *Watson* (Ex. 1038), 4:41-47.

196. For example, when a user is far away from the screen, positional changes between sequential frames in the real-time video images become smaller on the retina, and the user would become less perceptive to such smaller changes between the frames. Thus, the image quality perceived by the user would not change by reducing the display rate of the video image. When *Rosenberg* is modified by *Nakazawa*, a person of ordinary skill in the art would have been motivated to reduce the rate of the image processing steps to reduce image-data-related throughput and

improve energy efficiency while not affecting the visual quality of the mirror images perceived by the user.

197. Similarly, when a user is far away from the screen, the spatial details (e.g., edges or spatial changes) within each displayed video frame become smaller on the retina and therefore would correspond to retinal content with higher spatial frequency and which a user cannot discern (i.e., the human visual system cannot discern higher spatial frequency). Thus, the user would become less perceptive to the high frequency components in the real-time video images. Thus, the image quality perceived by the user would not change by reducing the resolution of the video images as the user's distance increases. When *Rosenberg* is modified by *Nakazawa*, a person of ordinary skill in the art would have been motivated to reduce the resolution of the real-time video images as taught by *Hatanaka* to reduce image-data-related throughput and improve energy efficiency while not affecting the image quality perceived by the user.

198. A person of ordinary skill in the art would have known how to reduce the rate of the image processing steps of *Rosenberg* (as modified by *Nakazawa*) in view of *Hatanaka* because such modification would require nothing more than ordinary skill. For example, a person of ordinary skill in the art would have programed the processor to perform the image processing steps of *Rosenberg* (as modified by *Nakazawa*) at a rate lower than the "rapid update rate" or the real-time

rate used in *Rosenberg. Rosenberg* (Ex. 1005), [0038] (“Typically an update rate of 60 HZ or more will be pleasing to a human user. In some embodiments update rates substantially higher than this may be used.”), [0035] (processor is “programmable”). For example, the rate may be reduced by skipping frames or performing the image processing steps every other frame. *See also Ogino* (Ex. 1042), [0056] (teaching reducing the display frame rate from 60 Hz of the input signal by processing the input image signal at every other frame).

199. A person of ordinary skill in the art would have known how to reduce the resolution of the digital mirror image in *Rosenberg* as modified by *Nakazawa* because such modification would require nothing more than ordinary skill. For example, a person of ordinary skill in the art would have programmed the processor to perform a lowpass filtering (e.g., averaging) followed by a downsampling step on the real-time video images obtained from the camera by averaging or sub-sampling adjacent pixels. In fact, such downsampling operation was routinely used for reducing image resolution. *See, e.g., Hatanaka* (Ex. 1009), [0049]. This operation further corresponds to a scaling/resizing (e.g., reducing the image size) operation which is already taught and performed in *Rosenberg. Rosenberg* (Ex. 1005), [0077]. A person of ordinary skill in the art would have expected success in implementing such operation because it would have been applying a known technique to improve

a similar device in the same way to yield the predictable result of efficient image processing.

2. Independent Claim 1

a. 1[pre]-1[g]

200. As discussed above regarding limitations 1[pre]-1[g] (*see* discussion above in §§ X.A.2.a-X.A.2.h), it is my opinion that *Rosenberg* in view of *Nakazawa* renders obvious these claim limitations.

b. 1[h]: “varying rate at which the non-ordered steps are performed on the series of images according to the distance.”

201. In my opinion, *Rosenberg* combined with *Nakazawa* and further in view of *Hatanaka* renders obvious this claim limitation.

202. *Hatanaka* teaches reducing image-data-related processing throughput, such as reducing the frame rate and/or resolution of the encoded video image data, as the viewing distance D increases. *Hatanaka* (Ex. 1009), [0008], [0012], [0018], [0023], [0037]-[0039]. *Hatanaka* teaches that, because the viewer is not always near the display while the live video images are in display, its method allows for processing at a lower frame rate and/or resolution when there is no viewer in the immediate vicinity of the display, enabling efficient processing of images. *Hatanaka* (Ex. 1009), [0039], [0051].

203. Sharing the same efficiency concerns, *Rosenberg* discloses turning off the mirror display or switching to a lower power state when the proximity/motion sensor detects the user in the vicinity of the digital mirror for a threshold amount of time so as not to “wast[e] power by continually displaying mirroring imagery when there is nobody looking in the mirror.” *Rosenberg* (Ex. 1005), [0025], [0032], [0056], [0069]-[0072], [0112]-[0115]. A person of ordinary skill in the art would have reduced the rate of the image processing steps of *Rosenberg* (as modified by *Nakazawa*) that are performed on the real-time video images from the camera (“*varying rate at which the non-ordered steps are performed on the series of images*”) when the user moves away from the display (*Hatanaka* (Ex. 1009), [0049], [0051]; *Rosenberg* (Ex. 1005), [0056], [0069], [0114])—that is when the user’s distance to the camera, which corresponds to the user’s distance to the display in the considered digital mirror system (like *Hatanaka*’s viewing distance D), increases (“*according to the distance*”). A person of ordinary skill in the art would have programmed the processor to operate at a lower processing rate after the proximity sensor detects that the user is no longer in the vicinity of the display or after the proximity sensor detects that the user’s distance increased beyond a certain range. A person of ordinary skill in the art would have understood that reducing the rate of image processing steps is a suitable alternative for power conservation and improve *Rosenberg*’s digital mirror, as I discussed above (*see* discussion above in § X.B.1).

See Rosenberg (Ex. 1005), [0025], [0033], [0056], [0070]-[0071]. And a person of ordinary skill in the art would have programed the processor to reduce its processing rate as the user moves away from the screen to the extent the user's visual acuity cannot recognize fine details in the image. *E.g., Hatanaka* (Ex. 1009), [0049].

204. It is my opinion that a person of ordinary skill in the art would have been motivated to combine *Rosenberg*, *Nakazawa*, and *Hatanaka* for the reasons discussed above in the rationale to combine *Rosenberg*, *Nakazawa*, and *Hatanaka*. *See* discussion above in § X.B.1.

3. Claims 2-6 and 8

205. As discussed above regarding claims 2-6 (*see* discussion above in §§X.A.3-X.A.7) and claim 8 (*see* discussion above in § X.A.8), *Rosenberg* in view of *Nakazawa* renders obvious the additional limitations in these claims.

4. Claim 11

a. 11[pre]: “The method of claim 1, further comprising:”

206. As discussed above regarding claim 1 (*see* discussion above in §§ X.A.2, X.B.2), *Rosenberg* in view of *Nakazawa*, or *Rosenberg* in view of *Nakazawa* and *Hatanaka* renders obvious claim 1.

b. 11[a]: “determining distance to a user appearing in the image; and”

207. In my opinion, as discussed above regarding limitation 1[g] (*see* discussion above in §X.A.2.h), *Rosenberg* in view of *Nakazawa* renders obvious this additional limitation of claim 11. Further, a person of ordinary skill in the art would have understood that, in *Rosenberg*’s digital mirror system, the user to whom the distance is measured would be the same “user appearing in the image,” and *Rosenberg* in combination with *Nakazawa* discloses this element.

c. 11[b]: “varying resolution of the image according to the distance.”

208. In my opinion, *Rosenberg* in view of *Nakazawa* and *Hatanaka* renders obvious this additional limitation of claim 11.

209. *Hatanaka* teaches reducing image-data-related processing throughput, such as by reducing the resolution of the encoded video image data, as viewing distance increases. *Hatanaka* (Ex. 1009), [0008], [0012], [0018], [0023], [0037]-[0039]. *Hatanaka* teaches that, because the viewer is not always near the display while the live video images are displayed, encoding/decoding processing at a lower resolution when there is no viewer in the immediate vicinity of the display enables efficient image processing. *Hatanaka* (Ex. 1009), [0039], [0051]. *Hatanaka* further teaches reducing the resolution of the video image to reduce image-data-related processing to the extent that the viewer cannot recognize the image. *Hatanaka*

(Ex. 1009), [0049]. *Hatanaka* also notes that there are no restrictions on the method used to adjust the resolution according to the viewing distance. *Hatanaka* (Ex. 1009), [0039].

210. *Rosenberg* shares the same efficiency concerns and teaches not to “wast[e] power by continually displaying mirroring imagery when there is nobody looking in the mirror.” *Rosenberg* (Ex. 1005), [0025], [0032], [0056], [0069]-[0072], [0112]-[0115]. A person of ordinary skill in the art would have been motivated to modify *Rosenberg* by reducing the resolution of the image for display (“**varying resolution of the image**”) when the user steps out of the vicinity of the display (see *Hatanaka* (Ex. 1009), [0051]; *Rosenberg* (Ex. 1005), [0056], [0069], [0114])—that is, when the user’s distance to the camera, which is also the user’s distance to the display in the digital mirror system (like *Hatanaka*’s viewing distance *D*) increases to greater than a certain distance (“**according to the distance**”). A person of ordinary skill in the art would have been motivated to modify *Rosenberg* by reducing the resolution of the image for display (“**varying resolution of the image**”) as the user moves further away from the display and has less visual acuity to improve energy efficiency. See *Hatanaka* (Ex. 1009), [0049]; see discussions in § X.B.1.

211. As I discussed above in § X.B.1, a person of ordinary skill in the art would have programmed the processor to reduce the resolution of the real-time video images from the camera, such as by adding a downsampling step before other image

processing steps of *Rosenberg* as modified by *Nakazawa*. A person of ordinary skill in the art would have considered reducing the resolution of the video image from the camera and thus reducing the processing throughput of the image processing steps of *Rosenberg* (as modified by *Nakazawa*) to be more energy efficient. *See, e.g., Rosenberg* (Ex. 1005), [0025], [0033], [0056], [0070]-[0071]; *Hatanaka* (Ex. 1009), [0049]; *see* discussions in § X.B.1.

5. Claim 17

212. As discussed above regarding claim 17 (*see* discussion above in §X.A.9), *Rosenberg* in view of *Nakazawa* renders obvious the additional limitations in this claim.

C. Ground 3: *Rosenberg* In View Of *Nakazawa* and *Tripathi* Renders Obvious Claims 1-6, 8, and 17

1. Rationale to Combine *Rosenberg*, *Nakazawa*, and *Tripathi*

213. As I explained in the overview of *Rosenberg* above (*see* discussion above in § IX.A), *Rosenberg* in view of *Nakazawa* renders obvious varying the rate of performing the image processing steps. A person of ordinary skill in the art would have also found it obvious to vary the rate of performing the processing steps of *Rosenberg* combined with *Nakazawa* in view of *Tripathi*. These references are analogous to the '109 Patent. They are in the same field of endeavor as each other and the '109 Patent. *See* above discussions in §§ IV.A (Overview of the '109 Patent),

IX.A (Overview of *Rosenberg*), IX.B (Overview of *Nakazawa*), IX.D (Overview of *Tripathi*).

214. Like *Rosenberg*'s digital mirror system, *Tripathi* teaches that, during the operation of its device, "a camera may be used to capture image data of the environment [] while the captured data is concurrently displayed on the display." *Tripathi* (Ex. 1040), 11:54-60, 12:11-24. *Tripathi* discloses monitoring the power supply status and increasing or decreasing the display frame rate in response to the status. *Tripathi* (Ex. 1040), 5:42-51, 7:64-8:53, Figs. 6-8. *Tripathi* also discloses increasing or decreasing the display frame rate of video content based on the type of content, such as static or dynamic content. *Tripathi* (Ex. 1040), 2:1-8, 5:36-57, 6:29-39, Fig. 3. *Tripathi* explains reducing the display frame rate reduces power consumption, and increasing the display frame rate improves the perceived display resolution. (Ex. 1040), 5:65-6:3. A person of ordinary skill in the art would have been motivated to implement such a design in *Rosenberg*'s system to reduce power consumption without degrading the user experience. See *Ogino* (Ex. 1042), [0007], [0027], [0059]; *Kuranov* (Ex. 1013), [0052]-[0053], [0103]-[0105]; *Tripathi* (Ex. 1040), 2:1-8, 5:36-57, 5:65-6:3, 6:29-39.

215. Like *Tripathi*, *Rosenberg* seeks to reduce power consumption. *Rosenberg* (Ex. 1005), [0025], [0032], [0056], [0069]-[0072], [0112]-[0115]. *Rosenberg* discloses switching to a lower power state when the proximity/motion

sensor detects that the user is not within a certain area/region for a threshold amount of time. *Rosenberg* (Ex. 1005), [0069]-[0072]. Further, *Rosenberg* discloses that its display content can be static (e.g., user moved out of vicinity) or dynamic (e.g., user entering vicinity or moving back and forth within vicinity). *Rosenberg* (Ex. 1005), [0070]. A person of ordinary skill in the art would have found *Tripathi*'s teaching of varying display frame rate a suitable option for improving the display performance and improving power efficiency in *Rosenberg*, when a user comes near or moves away from the mirror. *Rosenberg* (Ex. 1005), [0033], [0070]. For example, when the user moves away from the vicinity of the display, *Rosenberg* display can be switched to a low power mode. *Rosenberg* (Ex. 1005), [0069]-[0072]. *Tripathi* teaches adjusting the display frame rate for optimizing power performance when the power supply status changes. *Tripathi* (Ex. 1040), 5:42-51, 7:64-8:53, Figs. 7-8. Further, when the user is stationary or when the user is outside the vicinity of the display (i.e., at a farther distance from the display), the content of the video images would be the stationary user and/or surrounding room (e.g., bathroom (*Rosenberg* (Ex. 1005), [0003], [0033], [0069]-[0070])), living room (*Rosenberg* (Ex. 1005), [0054], [0112])). *Tripathi* teaches that such content is static content, for which the display frame rate is reduced to conserve power. *Tripathi* (Ex. 1040), 1:60-67. *Tripathi* teaches "[t]he perceived resolution of a display (i.e., the resolution perceived by a user of the

device) depends on factors such as ... the type of display content being displayed and the display frame rate.” *Tripathi* (Ex. 1040), 9:50-54.

216. A person of ordinary skill in the art would have understood that modifying *Rosenberg* to include adjusting display frame rate based on power supply or display content as taught by *Tripathi* would improve *Rosenberg*’s digital mirror system’s performance in terms of reduced power consumption. *See Ogino* (Ex. 1042), [0007], [0027], [0059] (teaching adapting video frame rate to the motion amount and scene to reduce power consumption). A person of ordinary skill in the art would have understood that reducing the display frame rate when the content is static would not degrade the perceived display resolution and, thus, would maintain the perceived visual quality as this was also well known in the prior art. *See Ogino* (Ex. 1042), [0059] (teaching that the frame rate can be lowered when displaying a still image having no motions, i.e., static content); *see also Kuranov* (Ex. 1013), [0052]-[0053] (teaching “not rendering the parts of the [video] image that do not change” and that doing so “reduces processing and results in less Central Processing Unit (CPU) usages.”), [0103]-[0105] (teaching that static content does not need to be processed for display and that “[i]nstead, the previous image, grid, or region may be used in the final image, as is.”).

217. When the user moves within the vicinity of the display (i.e., closer distance to the display), a person of ordinary skill in the art would have increased

the display frame rate as taught by *Tripathi* to emulate the function of a real mirror and improve user experience. *Rosenberg* (Ex. 1005), [0027]-[0028], [0055], [0061], [0113]. For example, as the user moves within the vicinity of the display, a change in the captured scene would occur with increased motion in the content of the video images, which *Tripathi* discloses is dynamic display content for which the display frame rate is increased to reduce retinal blur. *Tripathi* (Ex. 1040), 9:50-67. A person of ordinary skill in the art would have understood that such a modification would improve *Rosenberg*'s display performance while achieving its goal of replicating a real mirror because it would result in an improved user experience with a higher perceived visual quality.

218. A person of ordinary skill in the art would have also been motivated to adjust the rate of the other image processing steps of *Rosenberg* (as modified with *Nakazawa*)—obtaining video images from the camera, performing left-right inversion and transformation mapping—in view of *Tripathi*. For example, a person of ordinary skill in the art would have reduced the rate of the other processing steps to be the same as the reduced display frame rate to further conserve power. This is because there would be no need to perform the other processing steps at a higher rate if not all the processed images are displayed. Also, a person of ordinary skill in the art would have been motivated to increase the rate of the processing steps to be the same as the increased display frame rate so that mirror images would be displayed

to the user at the higher rate when the user is moving within the vicinity of the display.

219. A person of ordinary skill in the art would have known how to change the rate of the processing steps of *Rosenberg* (as modified by *Nakazawa*) in view of *Tripathi* because such modification would require nothing more than ordinary skill. *Tripathi* discloses monitoring the operation of the device, such as the type of display content, using software running on the processor. *Tripathi* (Ex. 1040), 5:28-36. As I explained above regarding claim 1 (*see* discussion above in § X.A.2), *Rosenberg* combined with *Nakazawa* discloses determining user distance using a distance measuring unit/sensor and processor of *Rosenberg*'s system. A person of ordinary skill in the art would have readily used *Rosenberg-Nakazawa*'s determined user distance to monitor whether the display content in *Rosenberg* is static (e.g., user moved out of vicinity) or dynamic (e.g., user entering vicinity or moving back and forth within vicinity). Additionally, a person of ordinary skill in the art would understand that using the *Rosenberg-Nakazawa*'s distance measuring unit/sensor would achieve improved real-time performance and reduced power consumption as compared to performing more computationally intensive analysis of the video image content. Also, a person of ordinary skill in the art would have known how to adjust the display frame rate and the rate of the other image processing steps of *Rosenberg* (as modified by *Nakazawa*), such as by adjusting the clock speed of the device

(*Tripathi* (Ex. 1040), 7:29-31 (reducing clock speed to reduce display frame rate) or by programming the processor to adjust the number of frames to be skipped (*Rosenberg* (Ex. 1005), [0035] (processor is “programmable”)). A person of ordinary skill in the art would understand that reducing the clock speed of the device can also be used to reduce the rate of at which the processing is performed.

2. Independent Claim 1

a. 1[pre]-1[g]

220. As discussed above regarding limitations 1[pre]-1[g] (*see* discussion above in §§ X.A.2.a-X.A.2.h), *Rosenberg* in view of *Nakazawa* renders obvious these claim limitations.

b. 1[h]: “varying rate at which the non-ordered steps are performed on the series of images according to the distance.”

221. In my opinion, *Rosenberg* in view of *Nakazawa* and *Tripathi* renders obvious this claim limitation.

222. The '109 Patent explains that, while a user may be imaged in real time, the image may be presented later based on user behavior. '109 Patent (Ex. 1001), 27:64-28:4. If, for example, the user is stationary, the transformed image may be updated in semi-real time, but when the user moves a large distance, the transformed image may be updated more frequently. '109 Patent (Ex. 1001), 27:64-28:4.

223. Similarly, *Tripathi* discloses adjusting the display frame rate based on the type of video display content, including reducing the display frame rate for static content or increasing the display frame rate for dynamic content. *Tripathi* also discloses monitoring the power supply status and adjusting the display frame rate in response to the status. This is shown below:

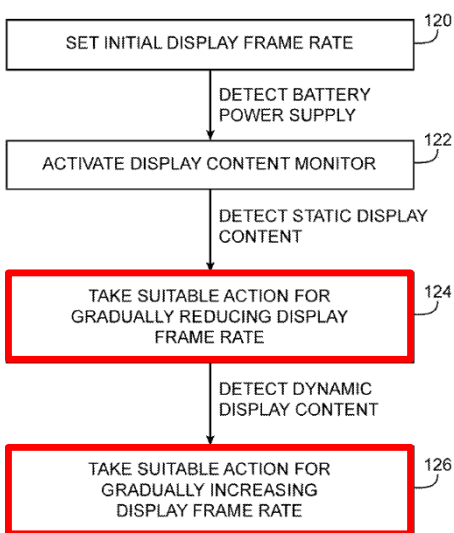


FIG. 10

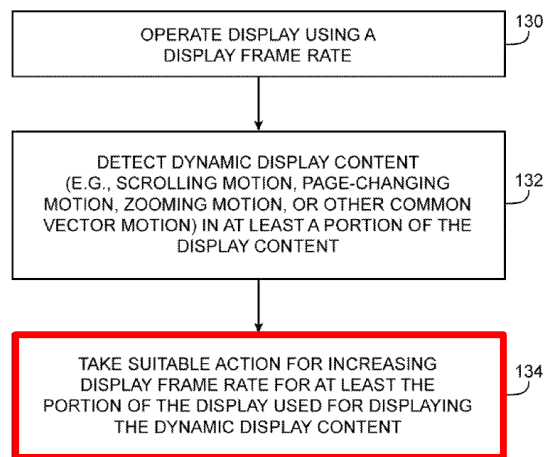


FIG. 11

Tripathi (Ex. 1040), Figs. 10-11; *see also Tripathi* (Ex. 1040), 2:1-8, 5:36-57, 6:29-39, Figs. 3, 10, 11. As I discussed above in § X.C.1, a person of ordinary skill in the art would have changed the rate of the image processing steps of *Rosenberg* (as modified by *Nakazawa*) (“*varying rate at which the non-ordered steps are performed on the series of images*”) when the user is stationary or moves outside the vicinity of the display (“*according to the distance*”), as shown below:

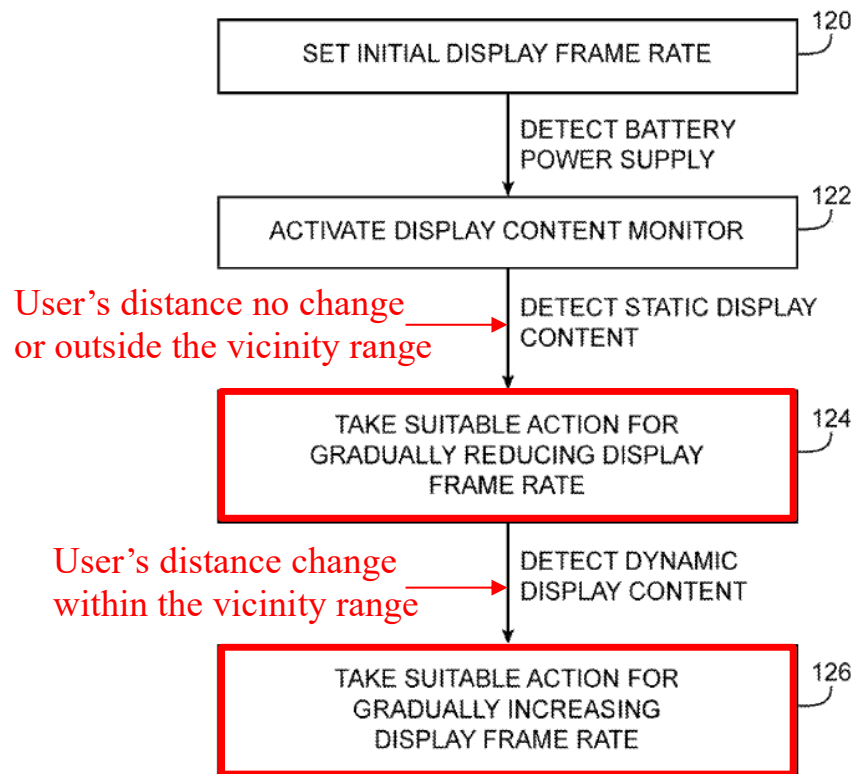


FIG. 10

Tripathi (Ex. 1040), Fig. 10. Further, a person of ordinary skill in the art would have increased the rate of the image processing steps of *Rosenberg* (as modified by *Nakazawa*) (“*varying rate at which the non-ordered steps are performed on the series of images*”) when the user is moving into or within the vicinity of the display (“*according to the distance*”), as shown above and below:

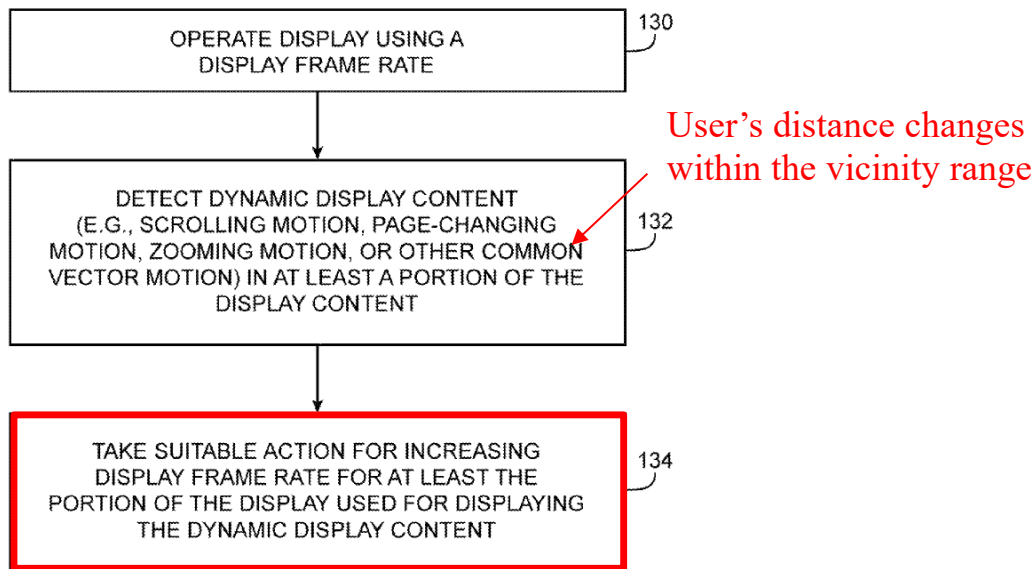


FIG. 11

Tripathi (Ex. 1040), Fig. 11.

224. A person of ordinary skill in the art would have been motivated to combine *Rosenberg*, *Nakazawa*, and *Tripathi* for the reasons discussed above in the rationale to combine *Rosenberg*, *Nakazawa*, and *Tripathi*. See discussion above in § X.C.1. A person of ordinary skill in the art would have programmed the processor in *Rosenberg* to adjust the rate of the image processing steps of *Rosenberg* (as modified by *Nakazawa*) to conserve power or improve display performance of *Rosenberg*'s digital mirror in view of *Tripathi*. A person of ordinary skill in the art would have expected success in doing so because it would have been using a known technique to improve a similar device in the same way and yield the predictable

results of reduced power consumption and improved display performance of mirror images. *See* discussion above in § X.C.1.

3. Claims 2-6, 8, and 17

225. As discussed above regarding claims 2-6, 8, and 17 (*see* discussion above in §§ X.A.3- X.A.9), *Rosenberg* in view of *Nakazawa* renders obvious the additional limitations in these claims.

D. Ground 4: *Rosenberg* In View Of *Nakazawa*, *Tripathi*, and *Hatanaka* Renders Obvious Claim 11

1. Claim 11

a. 11[pre]: “The method of claim 1, further comprising:”

226. As I discussed above regarding claim 1 (*see* discussion above in § X.C.2; *see also* § X.C.1), *Rosenberg* in view of *Nakazawa* and *Tripathi* renders obvious claim 1.

b. 11[a]: “determining distance to a user appearing in the image; and”

227. In my opinion, as discussed above regarding limitation 1[g] (*see* discussion above in § X.A.2.h), *Rosenberg* in view of *Nakazawa* renders obvious this additional limitation of claim 11. And a person of ordinary skill in the art would have understood that the user to which the distance is measured would be the same “user appearing in the image,” and *Rosenberg* in combination with *Nakazawa* discloses this element.

c. 11[b]: “varying resolution of the image according to the distance.”

228. In my opinion, *Rosenberg* in view of *Nakazawa*, *Tripathi*, and *Hatanaka* renders obvious this additional limitation of claim 11. As I discussed above in § X.C.1, a person of ordinary skill in the art would have been motivated to combine *Rosenberg*, *Nakazawa*, and *Tripathi*, and would have had a reasonable expectation of success in doing so. Additionally, a person of ordinary skill in the art would have been motivated to combine *Rosenberg*, *Nakazawa*, and *Hatanaka*, and would have had a reasonable expectation of success in doing so, as I explained above in § X.B.1. In my opinion, a person of ordinary skill in the art would have been motivated to combine *Rosenberg* as modified by *Nakazawa* and *Tripathi* with *Hatanaka* for those reasons as I explained above in §§ X.B.1 and X.C.1. As I discussed above (*see* discussion above in §§ X.B.1, X.B.4.c), *Hatanaka* discloses reducing image-data-related processing throughput, such as reducing the resolution of the encoded video image data, as viewing distance increases. *Hatanaka* (Ex. 1009), [0008], [0012], [0018], [0023], [0037]-[0039]. A person of ordinary skill in the art would have been motivated to modify *Rosenberg* by reducing the resolution of the real-time mirror image for display (“*varying resolution of the image*”) as the user moves further away from the display and has less visual acuity, to improve energy efficiency, as I discussed above. *E.g.*, *Hatanaka* (Ex. 1009),

[0049]. And a person of ordinary skill in the art would have had a reasonable expectation of success in doing so. *See Rosenberg* (Ex. 1005), [0025], [0033], [0056], [0070]-[0071]; *Hatanaka* (Ex. 1009), [0049]; *see* discussion above in §§ X.B.1, X.B.4.c.

E. *Rosenberg In View Of Nakazawa and Iwai* (Ground 5), *Rosenberg In View Of Nakazawa, Hatanaka, and Iwai* (Ground 6), or *Rosenberg In View Of Nakazawa, Tripathi, and Iwai* (Ground 7) Renders Obvious Claim 7

1. Rationale to Combine

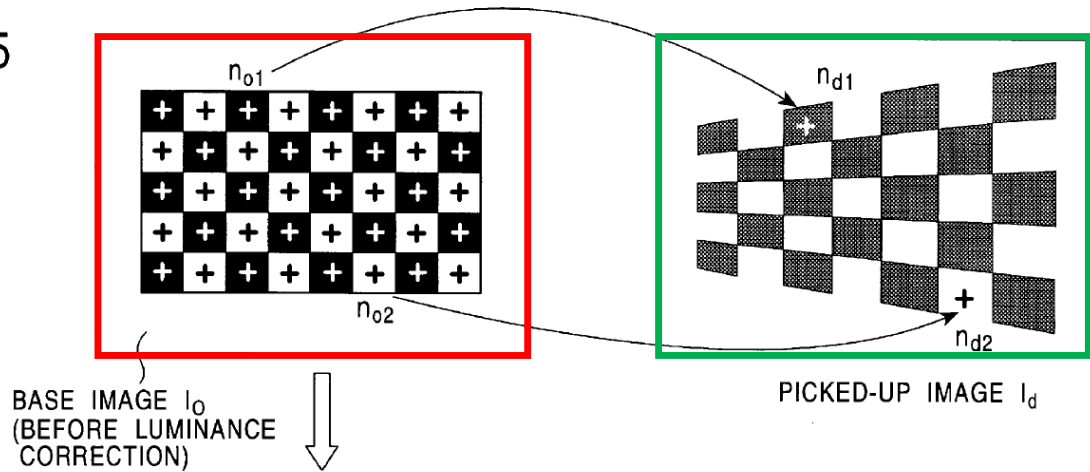
229. In my opinion, a person of ordinary skill in the art would have been motivated to combine *Rosenberg*, *Nakazawa*, and *Iwai*. A person of ordinary skill in the art would have also been motivated to combine *Rosenberg*, *Nakazawa*, *Hatanaka*, and *Iwai*. Further, a person of ordinary skill in the art would have been motivated to combine *Rosenberg*, *Nakazawa*, *Tripathi*, and *Iwai*. The references are analogous to the '109 Patent. They are in the same field of endeavor as each other and the '109 Patent. *See* above discussions in §§ IV.A (Overview of the '109 Patent), IX.A (Overview of *Rosenberg*), IX.B (Overview of *Nakazawa*), IX.C (Overview of *Hatanaka*), IX.D (Overview of *Tripathi*), IX.E (Overview of *Iwai*).

230. *Nakazawa* discloses its correction changes the image's magnification ratio based on the face image orientation (*Nakazawa* (Ex. 1007), [0033]-[0034], Figs. 3-4), but the degree of correction is based on the parameter "degree of

magnification” that varies with the distance to the user (*Nakazawa* (Ex. 1007), [0035]); *see* discussions in § IX.B. This is because the angular difference between the camera’s point of view and the user’s point of view changes as the user’s distance to the camera changes. The closer the user is to the camera, the greater the angular difference between the camera point of view and the user’s point of view, the greater the distortion in the image, and the larger the degree of magnification required to correct the image. *See Nakazawa* (Ex. 1007), [0035], Fig. 5. Alternatively, *Nakazawa* discloses setting degrees of magnification in advance and storing them in the memory, e.g., in a table. *Nakazawa* (Ex. 1007), [0037]-[0038]. The magnification information can be displayed to the user for selection, or can be automatically determined based on the user’s distance. *Nakazawa* (Ex. 1007), [0025], [0036], [0038]. As discussed in § IX.B, a person of ordinary skill in the art would have understood that *Nakazawa*’s degree of magnification corresponds to a projective transformation matrix. *See Park* (Ex. 1016), [0053], [0059]-[0062], Figs. 7-8 (teaching a similar image correction as a perspective transformation that is a type of geometric transformation); *Iwai* (Ex. 1010), 1:47-65, 2:43-3:7, 13:1-63. To the extent that *Nakazawa* does not expressly disclose details of how to set the degrees of magnification in advance, a person of ordinary skill in the art would have been motivated to find teachings to fill in the implementation details, and would have recognized *Iwai*’s calibration method provides a suitable option.

231. *Iwai* discloses that parameters of a projection transformation matrix can be calculated by performing image registration between a composed base image and a picked-up image taken by a camera. *Iwai* (Ex. 1010), 7:11-54, 9:65-10:3, 14:1-15:21. The base image includes a pattern with a predetermined geometrical configuration, such as squares or a checkered pattern, is generated by predetermined processing, and is stored in a memory. *See, e.g., Iwai* (Ex. 1010), 2:18-21, 2:43-54, 4:42-65, 5:66-6:5, 7:23-38, 9:60-64, 10:24-28, 12:14-21, 18:11-20, Figs. 2A-2B, 4-5. The picked-up image is obtained by taking a photograph of the base image and is also stored in a memory. *Iwai* (Ex. 1010), 5:5-9, 6:5-9, 7:16-21, 7:38-47, 10:62-65, Figs. 4-5. The parameters of *Iwai*'s projection transformation matrix are calculated based on the correspondence in pixels between the base image and picked-up image, minimizing any brightness error between the corresponding pixels over the entire images. *Iwai* (Ex. 1010), 4:42-58, 5:10-24, 6:10-24, 7:48-54, 11:1-3, 11:67-12: 4, 13:1-15:21. Examples of *Iwai*'s base image and picked-up image are shown below:

FIG. 5



Iwai (Ex. 1010), Fig. 5 (modified).

232. A person of ordinary skill in the art would have understood that *Iwai*'s calibration method using image registration would be a suitable option for obtaining the degrees of magnifications in *Nakazawa*'s transformation mapping. A person of ordinary skill in the art would have understood that *Iwai*'s calibration method can be repeated for obtaining the degrees of magnification for a plurality of distances and storing them in a table, as disclosed in *Nakazawa*. This is because *Iwai* discloses that its method has no limitation "on the distance to the subject or the pattern size" because the projective transformation can resolve the scale of the photographed pattern as that pattern's distance varies. *Iwai* (Ex. 1010), 7:55-65.

233. A person of ordinary skill in the art would have been motivated to use *Iwai*'s calibration method to obtain the degrees of magnification in *Nakazawa*'s transformation mapping to benefit from the "stab[ility] and high-accuracy" of *Iwai*'s

parameter estimation. *Iwai* (Ex. 1010), 1:15-18, 4:42-45, 7:52-54, 12:59-64. A person of ordinary skill in the art would have been motivated to use *Iwai*'s calibration method to obtain the degrees of magnification in advance as this would allow *Nakazawa*'s transformation mapping to be performed automatically and in real-time (*Nakazawa* (Ex. 1007), [0038]), thus reducing any lag time between image capture and display in the traditional mirror mode of *Rosenberg* (as modified by *Nakazawa*) (*Rosenberg* (Ex. 1005), [0038]).

234. A person of ordinary skill in the art would have understood that when *Rosenberg* is modified with *Nakazawa* (or with *Nakazawa* and *Hatanaka*, or with *Nakazawa* and *Tripathi*), *Iwai*'s calibration method would be implemented using *Rosenberg*'s camera, memory, and processor. A person of ordinary skill in the art would have expected success in doing so because *Rosenberg*'s system is well equipped for such modifications, and such modifications would have involved only ordinary skill. Using *Iwai*'s calibration in *Rosenberg*'s system requires adding known operational steps to the program code in *Rosenberg*'s memory. See *Rosenberg* (Ex. 1005), [0109] (memory stores program code to be executed by processor and images); *Iwai* (Ex. 1010), 6:53-67, 10:11-17, 12:30-35 (memory stores computer program, i.e., program code, for implementing calibration). Further, image calibration through image registration is a standard and well-known method in the art. *Iwai* (Ex. 1010), 1:47-65, 3:47-54, Fig. 11. A person of ordinary skill in

the art would have understood that the modification would generate the predictable result of determining and storing one or more transformation mapping parameters (e.g., parameters of degree(s) of magnification) for performing *Nakazawa*'s correction (i.e., transformation mapping).

2. Dependent Claim 7

a. 7[pre]: “The method of claim 1, further comprising the steps:”

235. As discussed above regarding claim 1 (§§ X.A.2, X.B.2, and X.C.2), *Rosenberg* in view of *Nakazawa*, or alternatively, *Rosenberg* in view of *Nakazawa* and *Hatanaka*, or alternatively, *Rosenberg* in view of *Nakazawa* and *Tripathi* renders obvious claim 1.

b. 7[a]: “obtaining a reference image;”

236. In my opinion, *Rosenberg* in view of *Nakazawa* (or *Rosenberg* in view of *Nakazawa* and *Hatanaka*, or alternatively, *Rosenberg* in view of *Nakazawa* and *Tripathi*) and *Iwai* renders obvious this additional limitation of claim 7.

237. *Iwai* discloses an arithmetic processing section of the processor generating a base image comprising a pattern having a predefined geometrical configuration. *Iwai* (Ex. 1010), 4:42-65, 5:66-6:5, 7:22-37, 9:60-64, 10:24-28, 11:26-29, 12:36-40, Figs. 2A-2B. This is shown below:

FIG. 2A

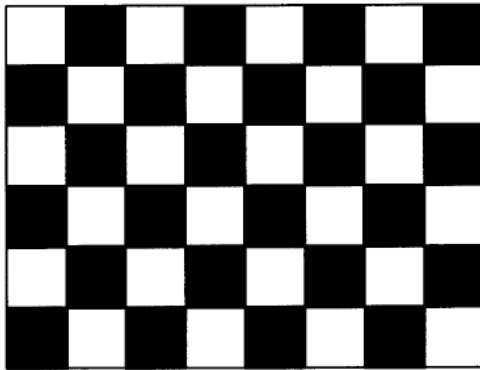
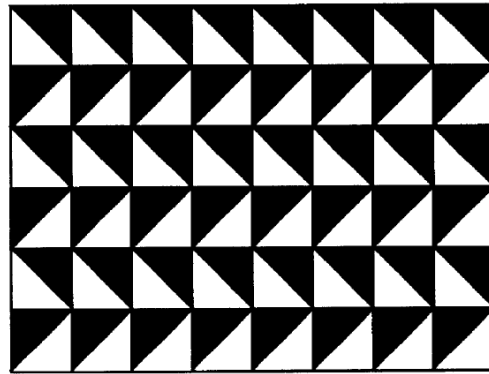


FIG. 2B



Iwai (Ex. 1010), Figs. 2A-2B. A person of ordinary skill in the art would have understood generating a base image to be “*obtaining a reference image*” because the base image contains a calibration pattern to be used for calibration and is an image without distortion. *See Iwai* (Ex. 1010), 11:7-23, 12:8-21, Figs. 2A-2B. And it was known that a calibration pattern comprises reference points for calculating a camera’s distortion parameters. *Iwai* (Ex. 1010), 3:55-67.

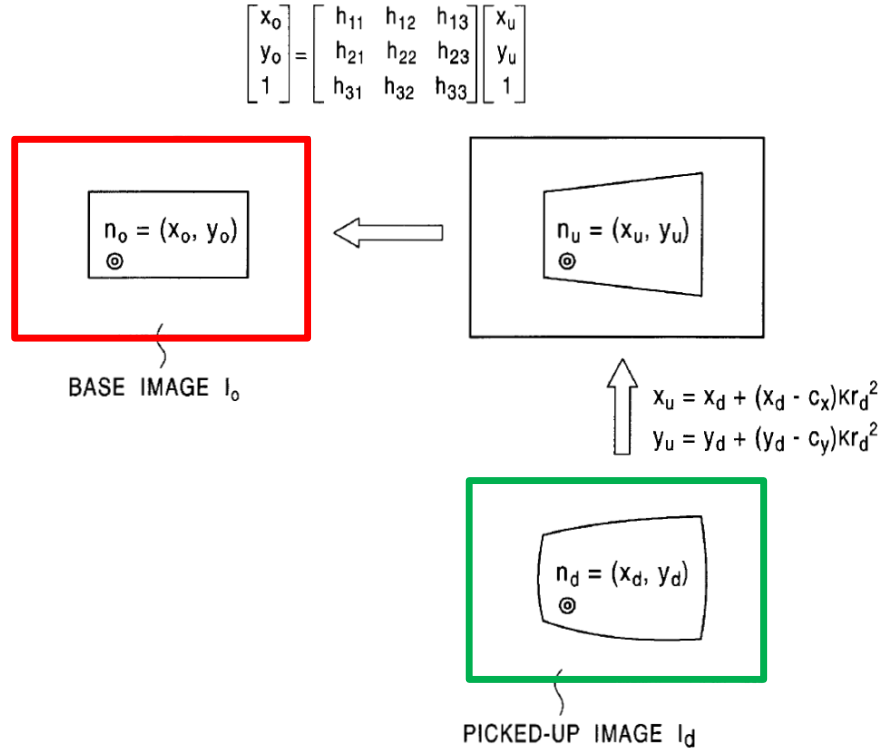
238. A person of ordinary skill in the art would have been motivated to use *Iwai*’s calibration method using image registration to obtain degrees of magnification for a plurality of distances in advance for automatically performing *Nakazawa*’s transformation mapping in *Rosenberg* and would have expected success in making this modification, for the reasons discussed above in the rationale to combine *Rosenberg*, *Nakazawa*, and *Iwai*; *Rosenberg*, *Nakazawa*, *Hatanaka*, and *Iwai*; and *Rosenberg*, *Nakazawa*, *Tripathi*, and *Iwai*. *See* § X.E.1.

c. 7[b]: “performing registration of the digital image with the reference image;”

239. In my opinion, *Rosenberg* in view of *Nakazawa* (or *Rosenberg* in view of *Nakazawa* and *Hatanaka*, or alternatively, *Rosenberg* in view of *Nakazawa* and *Tripathi*) and *Iwai* renders obvious this additional limitation of claim 7.

240. *Iwai* discloses obtaining a **picked-up image** by projecting the base image stored in the memory and taking a photograph of the projected base image. *Iwai* (Ex. 1010), 5:5-9, 6:5-9, 7:16-21, 7:38-47, 10:62-65, Figs. 4-5. A person of ordinary skill in the art would have understood that the **picked-up image** is a “*digital image*” because *Iwai* discloses that the image can be captured by a digital camera and processed by computer applications. *Iwai* (Ex. 1010), 1:21-33, 1:47-61. *Iwai* further discloses calculating distortion parameters by performing image registration between the **base image** and the **picked-up image** (“*performing registration of the digital image with the reference image*”). *Iwai* (Ex. 1010), 7:11-54, 9:65-10:3, 14:1-15:21. In one example, *Iwai* discloses calculating the parameters of a projection transformation matrix H , which describes the correspondence of the pixels of the picked-up image to the base image based on minimizing a brightness error between the corresponding pixels of both images. *Iwai* (Ex. 1010), 4:42-58, 5:10-24, 6:10-24, 7:48-54, 11:1-3, 11:67-12:4, 13:1-15:21. This is shown below:

FIG. 4



Iwai (Ex. 1010), Fig. 4. When *Rosenberg* combined with *Nakazawa* (or *Rosenberg* combined with *Nakazawa* and *Hatanaka*, or *Rosenberg* combined with *Nakazawa* and *Tripathi*) is modified in view of *Iwai*'s calibration method, *Iwai*'s projective transformation matrix H (above) would be replaced by *Nakazawa*'s correction (transformation mapping also called degree of magnification in *Nakazawa*). That is, the picked-up image containing distortion would be transformed by *Nakazawa*'s correction. The degree of magnification for *Nakazawa*'s correction takes the form of a transformation mapping represented by a matrix H whose parameters are calculated by means of *Iwai*'s calibration method using image registration.

241. As I discussed above regarding limitation 7[a] (*see* § X.E.2.b), a person of ordinary skill in the art would have been motivated to use *Iwai*'s calibration method using image registration to obtain degrees of magnification for a plurality of distances in advance for automatically performing *Nakazawa*'s transformation mapping and would have expected success in making this modification, as discussed above. *See also* § X.E.1.

242. For these reasons, it is my opinion that *Rosenberg* in view of *Nakazawa* (or *Rosenberg* in view of *Nakazawa* and *Hatanaka*, or alternatively, *Rosenberg* in view of *Nakazawa* and *Tripathi*) and *Iwai* renders obvious this element.

d. 7[c]: “using data obtained from the registration to generate the transformation mapping.”

243. In my opinion, *Rosenberg* in view of *Nakazawa* (or *Rosenberg* in view of *Nakazawa* and *Hatanaka*, or alternatively, *Rosenberg* in view of *Nakazawa* and *Tripathi*) and *Iwai* renders obvious this additional limitation of claim 7.

244. A person of ordinary skill in the art would have understood that the parameters of the projection transformation matrix H in *Iwai* would be “***data obtained from the registration***” because these parameters are calculated based on associating pixels of the picked-up and base images and minimizing a brightness error over the images. The calculated parameters (i.e., h_{11} , ..., h_{33} in Figure 4 above) are then used to generate matrix H (transformation mapping). *Iwai* (Ex. 1010),

Fig. 4, 4:42-58, 5:10-24, 6:10-24, 7:48-54, 11:1-3, 11:67-12:4, 13:1-15:21. *Iwai* further discloses performing a projective transformation to other picked-up images from which distortion is removed, through the use of the transformation parameters. *Iwai* (Ex. 1010), 5:24-32, 6:25-38. A person of ordinary skill in the art would have understood that performing such projective transformation would first require using the transformation parameters obtained from the registration to generate the projective transformation mapping (“***using data to ... generate the transformation mapping***”).

245. As discussed above regarding limitation 1[c] (§§ X.A.2.c and X.B.2.a), when *Rosenberg* combined with *Nakazawa* (or *Rosenberg* combined with *Nakazawa* and *Hatanaka*, or *Rosenberg* combined with *Nakazawa* and *Tripathi*) is modified in view of *Iwai*’s calibration method, *Iwai*’s projective transformation matrix *H* (above) would be replaced by *Nakazawa*’s correction (“***transformation mapping***”). Thus, the “***data obtained from the registration***” would be the parameters of the degree(s) of magnification used during *Nakazawa*’s correction (“***using data ... to generate the transformation mapping***”) to remove the distortion in the image in *Rosenberg*.

246. As discussed above regarding limitation 7[a] (§ X.E.2.b), a person of ordinary skill in the art would have been motivated to use *Iwai*’s calibration method using image registration to obtain degrees of magnification for a plurality of

distances in advance for automatically performing *Nakazawa*'s transformation mapping in *Rosenberg* and would have expected success in making this modification, as discussed above. *See also* § X.E.1.

**F. *Rosenberg* In View Of *Nakazawa* and *Kubota* (Ground 8),
Rosenberg In View Of *Nakazawa*, *Hatanaka*, and *Kubota* (Ground
9), or *Rosenberg* In View Of *Nakazawa*, *Tripathi*, and *Kubota*
(Ground 10) Renders Obvious Claim 9.**

1. Rationale to Combine

247. In my opinion, a person of ordinary skill in the art would have been motivated to combine *Rosenberg*, *Nakazawa*, and *Kubota*. A person of ordinary skill in the art would have also been motivated to combine *Rosenberg*, *Nakazawa*, *Hatanaka*, and *Kubota*. Further, a person of ordinary skill in the art would have been motivated to combine *Rosenberg*, *Nakazawa*, *Tripathi*, and *Kubota*. These references are in the same field of endeavor as each other and the '109 Patent. *See* above discussions in §§ IV.A (Overview of the '109 Patent), IX.A (Overview of *Rosenberg*), IX.B (Overview of *Nakazawa*), IX.C (Overview of *Hatanaka*), IX.D (Overview of *Tripathi*), IX.F (Overview of *Kubota*).

248. *Rosenberg* discloses an LCD display. *Rosenberg* (Ex. 1005), [0029], [0076]. *Kubota* discloses a shading process for an LCD display that “enhance[es] the presence of displayed images adapting to visual properties of the human (placing his/her effective visual field in the central part of the screen), and reduc[es] [] power

consumption.” *Kubota* (Ex. 1011), [0066]. A person of ordinary skill in the art would have been motivated to improve upon *Rosenberg*’s LCD display to have the shading control function of *Kubota* to enhance the display of the user’s mirror image.

249. *Rosenberg* discloses that the real-time mirror image is displayed at the center of the display. *Rosenberg* (Ex. 1005), [0094], Fig. 5. A person of ordinary skill in the art would have understood that implementing *Kubota*’s shading process in *Rosenberg* would enhance the user’s mirror image by placing the user’s effective visual field in the central part of the screen where the mirror image is displayed. *Kubota* (Ex. 1011), [0066]. A person of ordinary skill in the art would have also understood that a user may zoom and/or re-center to view certain areas in close up, such as eyelashes, skin blemishes, makeup (*Rosenberg* (Ex. 1005), [0003], [0099]) or hairstyles and clothing (*Rosenberg* (Ex. 1005), [0003], [0108]). Implementing *Kubota*’s process in *Rosenberg* would enhance the zoom-in areas to facilitate close-up views. Additionally, *Kubota* and *Rosenberg* are concerned with power efficiency, and a person of ordinary skill in the art would have been motivated to implement *Kubota*’s shading process in *Rosenberg* to reduce power consumption. *Kubota* (Ex. 1011), [0066].

250. A person of ordinary skill in the art would have understood that when *Rosenberg* (when combined with *Nakazawa*, or with *Nakazawa* and *Hatanaka*, or with *Nakazawa* and *Tripathi*) is modified to implement *Kubota*’s shading process,

Rosenberg's LCD display would have been modified to have subregions of pixels and a matrix of backlight cells, as taught in *Kubota*, and the shading process would be implemented with *Rosenberg*'s processor. A person of ordinary skill in the art would have expected success in implementing *Kubota*'s shading process in *Rosenberg* because it would have been using a known technique to improve a similar device in the same way and yield predictable results of enhanced displays of mirror images and reduced power consumption.

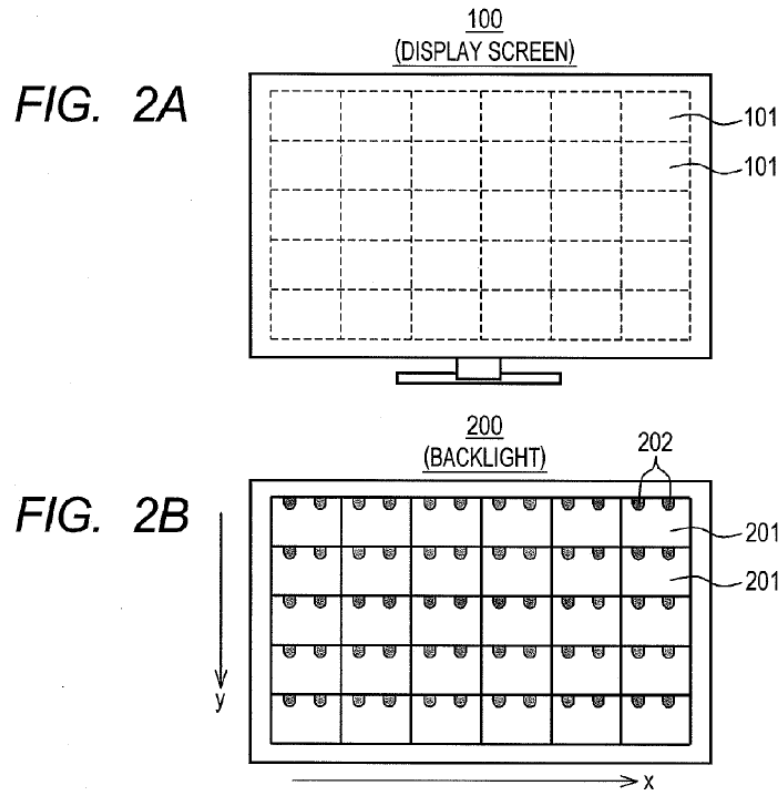
2. Dependent Claim 9

“The method of claim 1, further comprising changing illumination intensity of individual or groups of pixels of the monitor, so as to enhance shading or illumination in the image.”

251. In my opinion, *Rosenberg* as modified by *Nakazawa* (or *Rosenberg* as modified by *Nakazawa* and *Hatanaka*, or alternatively, *Rosenberg* as modified by *Nakazawa* and *Tripathi*) in view of *Kubota* renders obvious the additional limitation of claim 9.

252. *Kubota* discloses an LCD device that has a liquid crystal panel with a display screen and a backlight comprising a matrix of backlight cells. *Kubota* (Ex. 1011), [0030]-[0031]. The display screen is segmented into areas 101, each including a plurality of pixels and a pair of backlight cells 201 that illuminate corresponding areas 101. *Kubota* (Ex. 1011), [0030]-[0031]. Light intensity levels of the backlight cells 201 are controlled independently in units of backlight cells by

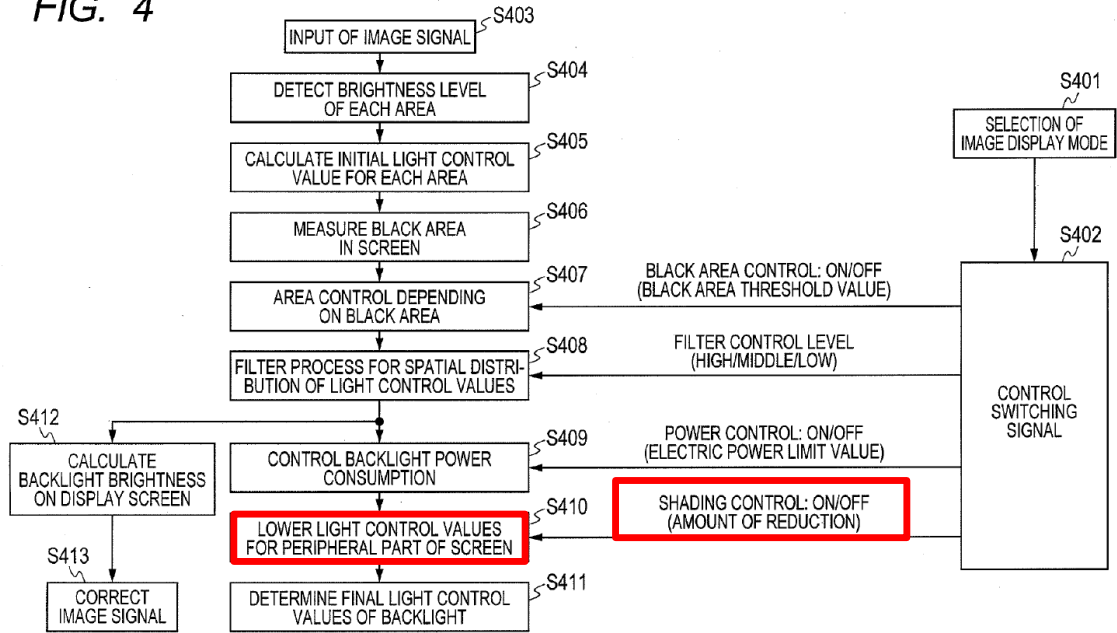
means of LED light source(s) 202. *Kubota* (Ex. 1011), [0030]-[0031]. This is shown below:



Kubota (Ex. 1011), Figs. 2A-2B.

253. *Kubota* discloses that its LCD device provides a shading process. *Kubota* (Ex. 1011), [0009], [0013], [0027], [0029], [0053], [0066], Figs. 4, 5, 9A, 9B. The shading process reduces light control values of backlight cells 201 for a peripheral part of the screen to relatively lower the brightness in the peripheral part of the screen compared to the central part of the screen. *Kubota* (Ex. 1011), [0038], [0050], [0066], Fig. 4, Figs. 9A-9B.

FIG. 4



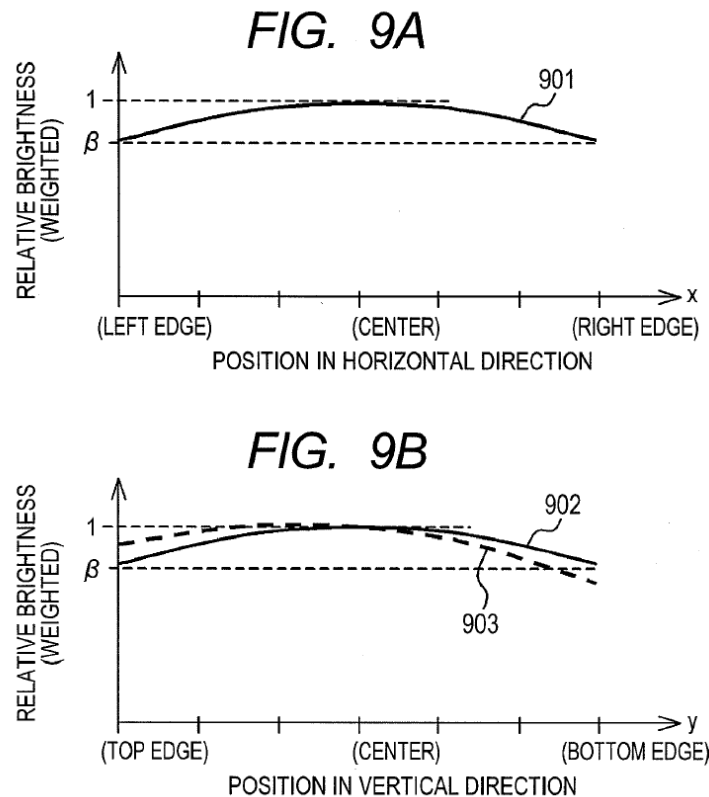
Kubota (Ex. 1011), Fig. 4.

FIG. 5

BACKLIGHT CONTROL FUNCTIONS	(1) SPATIAL FILTER CONTROL	(2) BLACK AREA CONTROL	(3) POWER CONTROL	(4) SHADING CONTROL
	HIGH, MIDDLE OR LOW	ON OR OFF BLACK AREA THRESHOLD VALUE WHEN ON	ON OR OFF ELECTRIC POWER LIMIT VALUE WHEN ON (90%, 75%)	ON OR OFF POWER REDUCTION VALUE WHEN ON (95%, 90%)
IMAGE DISPLAY MODE	HIGH 	BLACK AREA: SMALL OFF	OFF	OFF
	(MIDDLE) 	BLACK AREA: LARGE ON	ON	ON
LOW 				
(a) IN-STORE DEMONSTRATION (SUPERMARKET)	LOW	ON	OFF	OFF OR ON (INCREASE POWER WHEN ON)
(b) POWER REDUCTION (STANDARD)	LOW	OFF	ON	ON
(c) HIGH IMAGE QUALITY (CINEMA)	HIGH OR MIDDLE	ON	OFF	OFF

Kubota (Ex. 1011), Fig. 5.

254. For example, the shading process reduces brightness in the peripheral part of the screen (right and left edges, top and bottom edges) to be relatively lower than in the central part of the screen. *Kubota* (Ex. 1011), [0066]. This is shown below:



Kubota (Ex. 1011), Figs. 9A-9B. A person of ordinary skill in the art would have understood that reducing brightness in the peripheral areas of the screen would require reducing the intensity of the backlight cells illuminating those areas (*Kubota* (Ex. 1011), [0012], [0031]) (“*changing illumination intensity*”), and those areas

(right and left edges, top and bottom edges) each include a plurality of pixels (*Kubota* (Ex. 1011), [0030]) (“*of individual or groups of pixels of the monitor*”).

255. A person of ordinary skill in the art would have been motivated to implement *Kubota*’s shading process in *Rosenberg* to enhance the user’s mirror image and would have had a reasonable expectation of success in doing so, for the reasons discussed above in the rationale to combine *Rosenberg*, *Nakazawa*, and *Kubota*; *Rosenberg*, *Nakazawa*, *Hatanaka*, and *Kubota*; and *Rosenberg*, *Nakazawa*, *Tripathi*, and *Kubota*. See § X.F.1.

G. *Rosenberg* In View Of *Nakazawa* and *Cho* (Ground 11), *Rosenberg* In View Of *Nakazawa*, *Hatanaka*, and *Cho* (Ground 12), or *Rosenberg* In View Of *Nakazawa*, *Tripathi*, and *Cho* (Ground 13) Renders Obvious Claim 10.

1. Rationale to Combine

256. In my opinion, a person of ordinary skill in the art would have been motivated to combine *Rosenberg*, *Nakazawa*, and *Cho*. A person of ordinary skill in the art would have also been motivated to combine *Rosenberg*, *Nakazawa*, *Hatanaka*, and *Cho*. Further, a person of ordinary skill in the art would have been motivated to combine *Rosenberg*, *Nakazawa*, *Tripathi*, and *Cho*. These references are in the same field of endeavor as each other and the ’109 Patent. See above discussions in §§ IV.A (Overview of the ’109 Patent), IX.A (Overview of *Rosenberg*), IX.B (Overview of *Nakazawa*), IX.C (Overview of *Hatanaka*), IX.D

(Overview of *Tripathi*), IX.G (Overview of Cho).

257. *Rosenberg* discloses that “in some embodiments[,] wide-angle lenses are used upon the camera 302 to provide extended image capture areas.” *Rosenberg* (Ex. 1005), [0062]. A person of ordinary skill in the art would have recognized that the images captured by *Rosenberg*’s digital camera with wide-angle lenses would contain wide-angle distortion in two instances. As explained by *Cho*, it was known that wide-angle lenses would cause wide-angle distortion (i.e., barrel distortion) in the captured image. *Cho* (Ex. 1012), [0008], [0071], [0077].

258. *Cho* provides a solution for correcting such wide-angle distortion—a wide-angle distortion correction function. *Cho* (Ex. 1012), [0011], [0015], [0018], [0078]-[0079], [0080]-[0081], [0088]-[0089]. A person of ordinary skill in the art would have been motivated to use *Cho*’s solution in *Rosenberg* to address the known problem of wide-angle distortion, improving *Rosenberg*’s stated goal of emulating a traditional mirror image. *Rosenberg* (Ex. 1005), [0026]-[0028]. A person of ordinary skill in the art would have also expected success in implementing *Cho*’s wide-angle distortion correction function in *Rosenberg* (as modified by *Nakazawa* or as modified by *Nakazawa* and *Hatanaka*, or as modified by *Nakazawa* and *Tripathi*) because it would have been using a known technique to improve a similar device in the same way. *Cho* explains that its correction is applicable to digital video cameras. *Cho* (Ex. 1012), [0149]. A person of ordinary skill in the art would have

understood that *Rosenberg*'s system—including a digital video camera, a processor, and a memory—is equipped to implement *Cho*'s correction function. Using *Cho*'s correction method in *Rosenberg*'s system requires adding known operational steps to the program code and adding a coefficient table for storage in *Rosenberg*'s memory. *Cho* (Ex. 1012), [0059] (memory stores control program and distortion correction coefficient table); *Rosenberg* (Ex. 1005), [0109] (memory stores program code to be executed by the processor and images). A person of ordinary skill in the art would have understood that the modification would generate the predictable result of an image without wide-angle distortion.

2. Dependent Claim 10

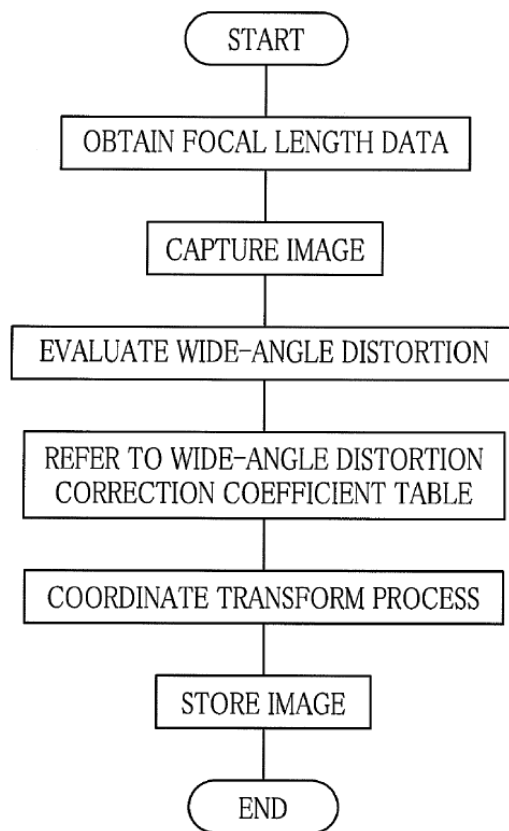
“The method of claim 1, further comprising applying at least one of a barrel-effect transformation and a fish-eye transformation.”

259. In my opinion, *Rosenberg* as modified by *Nakazawa* (or *Rosenberg* as modified by *Nakazawa* and *Hatanaka*, or alternatively, *Rosenberg* as modified by *Nakazawa* and *Tripathi*) in view of *Cho* renders obvious the additional limitation of claim 10.

260. *Cho* discloses correcting wide-angle distortion. *Cho* (Ex. 1012), [0011], [0015], [0018], [0078]-[0079], [0080]-[0081], [0088]-[0089]. As shown below, to correct the wide-angle distortion, the control sections of the camera: (i) obtain the focal length data of the taking lens; (ii) based on the focal length data, evaluate the

magnitude of the wide-angle distortion; (iii) based on the magnitude of the wide-angle distortion, select a set of coefficients from the wide-angle correction table; and (iv) apply coordinate transform processing to raw image data using the selected set of coefficients. *Cho* (Ex. 1012), [0060]-[0066], [0078]-[0079].

FIG. 7



Cho (Ex. 1012), Fig. 7. A person of ordinary skill in the art would have understood that *Cho*'s correction is “*applying . . . a barrel-effect transformation*” because *Cho* explains that wide-angle distortion is barrel distortion, and the correction transforms the coordinates of pixels in the image using a coordinate transformation function.

Cho (Ex. 1012), [0011], [0017], [0060]-[0062], [0065]-[0066], [0071], [0073]. A person of ordinary skill in the art would have implemented *Cho*'s correction as part of the image-processing steps of *Rosenberg* (as modified by *Nakazawa* or as modified by *Nakazawa* and *Hatanaka*, or as modified by *Nakazawa* and *Tripathi*) to remove wide-angle distortion, improving the system's ability to mimic a mirror image, for the reasons discussed above in the rationale to combine *Rosenberg*, *Nakazawa*, and *Cho*; *Rosenberg*, *Nakazawa*, *Hatanaka*, and *Cho*; and *Rosenberg*, *Nakazawa*, *Tripathi*, and *Cho*. See § X.G.1.

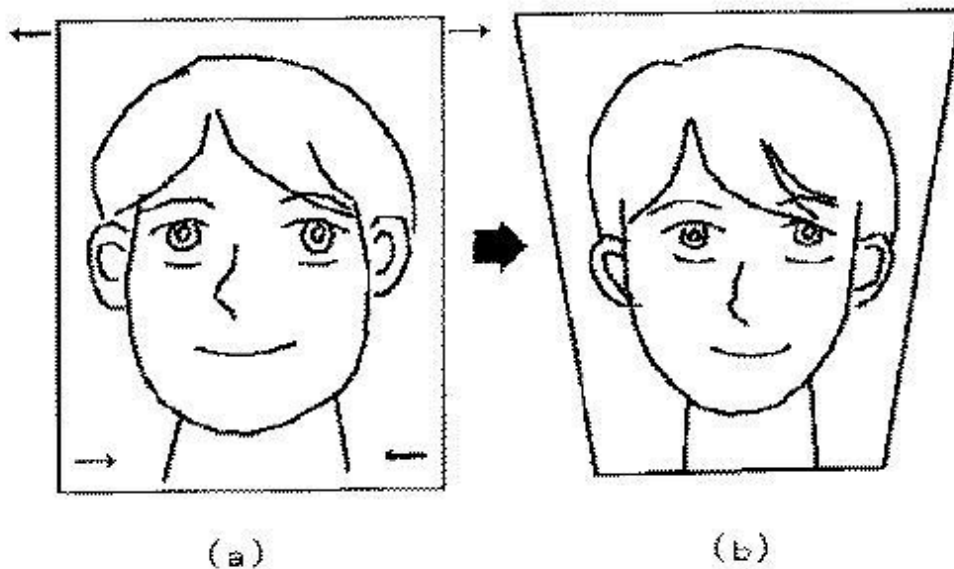
H. *Rosenberg* In View Of *Nakazawa* and *Park* (Ground 14), *Rosenberg* In View Of *Nakazawa*, *Hatanaka*, and *Park* (Ground 15), or *Rosenberg* In View Of *Nakazawa*, *Tripathi*, and *Park* (Ground 16) Renders Obvious Claim 12.

1. Rationale to Combine

261. In my opinion, a person of ordinary skill in the art would have been motivated to combine *Rosenberg*, *Nakazawa*, and *Park*. A person of ordinary skill in the art would have also been motivated to combine *Rosenberg*, *Nakazawa*, *Hatanaka*, and *Park*. Further, a person of ordinary skill in the art would have been motivated to combine *Rosenberg*, *Nakazawa*, *Tripathi*, and *Park*. These references are in the same field of endeavor as each other and the '109 Patent. See above discussions in §§ IV.A (Overview of the '109 Patent), IX.A (Overview of *Rosenberg*), IX.B (Overview of *Nakazawa*), IX.C (Overview of *Hatanaka*), IX.D

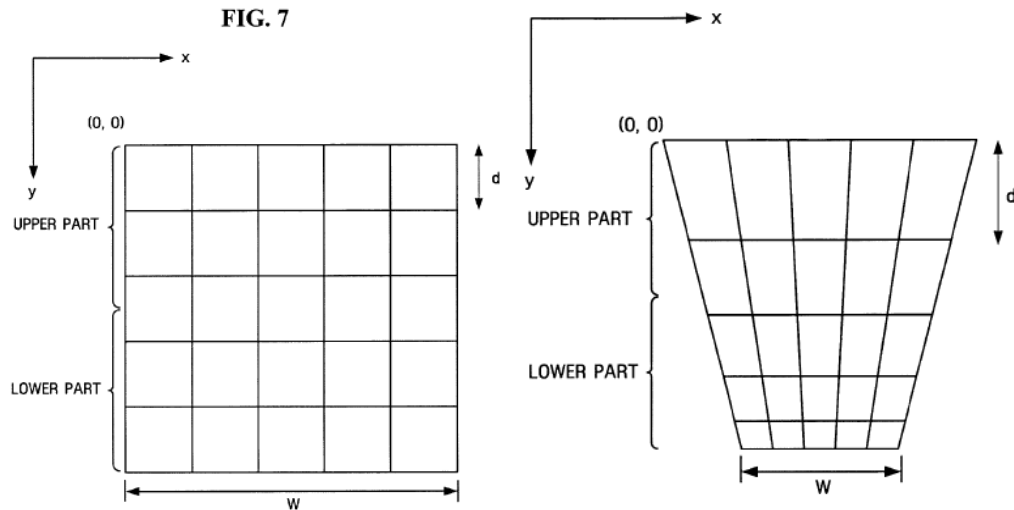
(Overview of *Tripathi*), IX.J (Overview of *Park*).

262. Like *Rosenberg* and *Nakazawa*, *Park* discloses capturing a user image and displaying the image after performing image transformation, as discussed above in the overview of *Park*. See § IX.J. And like *Nakazawa*, *Park* also discloses performing perspective transformation to correct distortions in the image captured by a camera above or below the user. *Park* (Ex. 1016), Abstract, [0003], [0006]-[0007], [0010]-[0014], [0034], [0059]. Indeed, both *Nakazawa* and *Park* disclose adjusting the width of the lower part of the image to be narrower than the width of the upper part to correct the distortion, as shown below. *Nakazawa* (Ex. 1007), [0033], Fig. 3; *Park* (Ex. 1016), [0054]-[0056], Figs. 7-8.



Nakazawa (Ex. 1007), Fig. 3.

FIG. 8



Park (Ex. 1016), Figs. 7-8. As *Park* explains, if the region of the compensated image is different from the region on which the compensated image is displayed, an empty region can occur. *Park* (Ex. 1016), [0054]-[0056]. A person of ordinary skill in the art also would have recognized that when *Rosenberg* is modified with *Nakazawa*'s transformation, if the sizes of the display screen and the image are different after the transformation, empty regions would form. *Park* discloses pixel filling to address this empty region problem. A person of ordinary skill in the art would have been motivated to implement *Park*'s pixel-filling solution in *Rosenberg* (as modified by *Nakazawa*, or as modified by *Nakazawa* and *Hatanaka*, or as modified by *Nakazawa* and *Tripathi*) to address this empty region problem, and "prevent the user from arousing psychological rejection against the empty region on which no image is displayed." *Park* (Ex. 1016), [0054].

263. A person of ordinary skill in the art would have expected success in doing so because it would have been using a known technique to solve a known problem in a similar device in the same way. *Park* discloses that its processing can be implemented as program code executed on a processor. *Park* (Ex. 1016), [0015], [0087], [0088]. Implementing *Park*'s pixel filling in *Rosenberg* (as modified by *Nakazawa* or as modified by *Nakazawa* and *Hatanaka*, or as modified by *Nakazawa* and *Tripathi*) would only require adding known program code to memory for execution by *Rosenberg*'s processor. *Rosenberg* (Ex. 1005), [0109] (memory stores program code to be executed by the processor and images), Fig. 13. A person of ordinary skill in the art would have understood that such modification would generate the predictable result of a transformed image displayed to the user without an empty region to mimic a mirror reflection.

2. Dependent Claim 12

“The method of claim 1, further comprising a step of pixel filling, wherein pixel image is extrapolated into empty pixels left after applying the transformation mapping.”

264. In my opinion, *Rosenberg* combined with *Nakazawa* (or *Rosenberg* combined with *Nakazawa* and *Hatanaka*, or alternatively, *Rosenberg* combined with *Nakazawa* and *Tripathi*) in view of *Park* renders obvious the additional limitation of claim 12.

265. *Park* discloses performing matrix-based perspective transformation to compensate distortion in the image. *Park* (Ex. 1016), [0034]-[0037], [0050]-[0053], [0060]-[0062], Figs. 6A-8. *Park* explains that if the sizes of the compensated image region and the display region are different, empty regions can occur. *Park* (Ex. 1016), [0054]-[0056]. *Park* discloses filling the pixels of the empty region, after the perspective transformation and before displaying the compensated image (“*pixel filling ... after applying the transformation mapping*”). *Park* (Ex. 1016), [0054]-[0056]. This is shown below:

FIG. 10A



FIG. 10B



Park (Ex. 1016), Figs. 10A-10B.

266. A person of ordinary skill in the art would have understood that *Park*'s transformation is a transformation mapping because it is a matrix-based transformation that changes the coordinates of the pixels in the image. *Park* (Ex. 1016), [0060]-[0062]. A person of ordinary skill in the art would have also understood that the empty regions contain “*empty pixels left after applying the transformation mapping*” because *Park* discloses that the empty region occurs after the perspective transformation and performing pixel filling in the empty region after applying the perspective transformation. *Park* (Ex. 1016), [0054]-[0056]. *Park* discloses that “the empty region is filled with pixel values of the compensated image existing at the closest position in the same row.” *Park* (Ex. 1016), [0056]. A person of ordinary skill in the art would have understood such processing as having “*pixel image . . . extrapolated into empty pixels*” because the pixel values inside the boundary of the transformed image are used to obtain values for filling the empty pixels outside the boundary of the transformed image.

267. A person of ordinary skill in the art would have been motivated to implement *Park*'s pixel filling in *Rosenberg* as modified by *Nakazawa* (or as modified by *Nakazawa* and *Hatanaka*, or as modified by *Nakazawa* and *Tripathi*) and would have had a reasonable expectation of success in making this modification, for the reasons discussed above in the rationale to combine *Rosenberg* and

Nakazawa; Rosenberg, Nakazawa, Hatanaka, and Park; and Rosenberg, Nakazawa, Tripathi, and Park. See § X.H.1.

I. *Rosenberg In View Of Nakazawa and Kuranov (Ground 17), Rosenberg In View Of Nakazawa, Hatanaka, and Kuranov (Ground 18), or Rosenberg In View Of Nakazawa, Tripathi, and Kuranov (Ground 19) Renders Obvious Claims 13-15.*

1. Rationale to Combine

268. In my opinion, a person of ordinary skill in the art would have been motivated to combine *Rosenberg, Nakazawa, and Kuranov*. A person of ordinary skill in the art would have also been motivated to combine *Rosenberg, Nakazawa, Hatanaka, and Kuranov*. Further, a person of ordinary skill in the art would have been motivated to combine *Rosenberg, Nakazawa, Tripathi, and Kuranov*. These references are in the same field of endeavor as each other and the '109 Patent. *See* above discussions in §§ IV.A (Overview of the '109 Patent), IX.A- IX.D, IX.H. *See* above discussions in §§ IV.A (Overview of the '109 Patent), IX.A (Overview of *Rosenberg*), IX.B (Overview of *Nakazawa*), IX.C (Overview of *Hatanaka*), IX.D (Overview of *Tripathi*), IX.H (Overview of *Kuranov*).

269. *Rosenberg* discloses that the digital mirror system can include more than one digital camera. *Rosenberg* (Ex. 1005), [0057]. *Rosenberg* also discloses using a wide-angle lens in the camera to “provide extended image capture areas.” *Rosenberg* (Ex. 1005), [0062]. It was known to a person of ordinary skill in the art

that connecting images from cameras that have overlapping imaging areas also allows for obtaining a wide-angle image. *See Deguchi* (Ex. 1024), [0003] (“It is known to dispose a plurality of imaging optical systems (imaging means) such that image areas thereof partially overlap each other[,] thereby allowing it [to] take a panoramic moving image (or a wide-angle image).”); *see also Deguchi* (Ex. 1024), Abstract, [0009], [0011] (teaching connecting captured images having overlapping image areas to obtain a wide-angle image). Thus, a person of ordinary skill in the art would have known that using two or more cameras, such as two cameras, with overlapping imaging areas in *Rosenberg* would be a suitable alternative to using a wide-angle lens for providing extended image areas. However, it was also known that it was difficult to connect images from two or more cameras with overlapping areas with precision and little errors. *Deguchi* (Ex. 1024), [0004]-[0008]. *Kuranov*’s automatic image stitching provides a suitable solution that addresses this problem of registration errors in overlapping areas when joining images. *See Kuranov* (Ex. 1013), [0061]-[0065], [0068]-[0071], [0077]-[0080], [0090]-[0100], [0106]-[0107].

270. A person of ordinary skill in the art would have expected success in implementing *Kuranov*’s automatic image stitching in *Rosenberg* as modified by *Nakazawa* because it would have been using a known technique to solve a known problem in a similar device in the same way. *Kuranov* explains that its stitching applies to video streams captured by video cameras like in *Rosenberg* (*Kuranov*

(Ex. 1013), [0002], [0005], [0031], [0045]-[0048], [0052]-[0053], [0061], [0103]-[0105]), and can be embodied in hardware (including one or more processors and memory) and/or computer code (*Kuranov* (Ex. 1013), [0033]-[0039], [0043]). Implementing *Kuranov*'s image stitching in *Rosenberg* as modified by *Nakazawa* (or as modified by *Nakazawa* and *Hatanaka*, or as modified by *Nakazawa* and *Tripathi*) would require adding known program code to the memory for execution by *Rosenberg*'s processor. *Rosenberg* (Ex. 1005), [0109] (memory stores program code to be executed by processor and images), Fig. 13. A person of ordinary skill in the art would have understood that the modification would generate the predictable result of having a wide-angle image with an extended image area.

2. Dependent Claim 13

a. 13[pre]: “*The method of claim 1, further comprising the steps:*”

271. As discussed above regarding claim 1 (§§ X.A.2, X.B.2, and X.C.2), *Rosenberg* in view of *Nakazawa*, or alternatively, *Rosenberg* in view of *Nakazawa* and *Hatanaka*, or alternatively, *Rosenberg* in view of *Nakazawa* and *Tripathi* renders obvious claim 1.

- b. 13[a]: “*obtaining a second digital image from a second camera;*”
- c. 13[b]: “*flipping the second image about a vertical axis so as to reverse right and left sides of the second image;*”
- d. 13[c]: “*applying a transformation mapping to the second image to modify the second image such that it appears to mimic a reflection of a mirror;*”
- e. 13[d]: “*resizing the second image to reduce variations caused by changes in object's distance to the second camera;*”

272. In my opinion, *Rosenberg* alone, or further in view of *Nakazawa*, renders obvious each of these additional limitations of claim 13.

273. First, *Rosenberg* discloses that its system can include more than one digital camera for capturing and displaying images. See *Rosenberg* (Ex. 1005), [0057]. *Rosenberg* also discloses using a wide-angle lens in the camera to “provide extended image capture areas.” *Rosenberg* (Ex. 1005), [0062]. It was known to a person of ordinary skill in the art that connecting images from cameras that have overlapping imaging areas also allows for obtaining a wide-angle image. See *Deguchi* (Ex. 1024), [0003] (“It is known to dispose a plurality of imaging optical systems (imaging means) such that image areas thereof partially overlap each other thereby allowing it take a panoramic moving image (or a wide-angle image”); see also *Deguchi* (Ex. 1024), Abstract, [0009], [0011] (teaching connecting captured images having overlapping image areas to obtain a wide-angle image). Thus, a

person of ordinary skill in the art would have known that using two or more cameras, such as two cameras, with overlapping imaging areas in *Rosenberg* would be a suitable alternative to using a wide-angle lens for providing extended image areas. Accordingly, a person of ordinary skill in the art would have found it obvious to use two or more cameras with overlapping imaging areas as a suitable alternative to *Rosenberg*'s wide-angle lens embodiment for providing extended image areas. See *Rosenberg* (Ex. 1005), [0062].

274. Second, as discussed above regarding limitations 1[a]-1[d] (§§X.A.2.b-X.A.2.e), *Rosenberg* or *Rosenberg* in view of *Nakazawa* renders obvious performing the steps of these limitations (flipping, transformation mapping, and resizing) on a first digital image from the first camera to obtain a mirror image.

275. Third, as discussed for limitation 13[f] below (X.I.2.f), the steps of these limitations would also be performed on “***a second digital image from a second camera***” to obtain a joint image with extended image area. And for the same reasons discussed above regarding limitations 1[a]-1[d] (§§ X.A.2.b-X.A.2.e), *Rosenberg* (or *Rosenberg* in view of *Nakazawa*) renders obvious performing the steps of these limitations on the second digital image from the second camera.

276. For these reasons, it is my opinion that *Rosenberg* alone, or further in view of *Nakazawa*, renders obvious these elements.

f. 13[e]: “*stitching the image and the second image after performing the flipping, transformation mapping, and resizing, to thereby obtain a stitched image;*”

277. In my opinion, *Rosenberg* combined with *Nakazawa* (or *Rosenberg* combined with *Nakazawa* and *Hatanaka*, or alternatively, *Rosenberg* combined with *Nakazawa* and *Tripathi*) in view of *Kuranov* renders obvious each of these additional limitations of claim 13.

278. *Kuranov* discloses stitching multiple video images captured from different locations, angles, and viewpoints (“*stitching the image and the second image*”). *Kuranov* (Ex. 1013), [0005], [0030]-[0031], [0042]-[0043], [0061], Figs. 1C, 2A, 2B; *see* discussions in §IX.H. When two cameras with overlapping imaging areas in *Rosenberg* are stitched to obtain a wide-angle image, a person of ordinary skill in the art would have understood that “*the flipping, transformation mapping, and resizing*” would be performed on the digital image captured by each camera to obtain two mirror images before stitching the two images into a wide-angle image. This is because performing these steps to each camera image would simplify the stitching process. For example, after performing these steps on both images from both cameras, both modified images would appear to have a similar orientation (*e.g.*, facing straight horizontally, as discussed regarding claim 2) and elevation (*e.g.*, align with user eye levels, as discussed regarding claim 2), and be without distortion (*e.g.*, projection distortion, as discussed regarding limitation 1[c]). *See also Deguchi*

(Ex. 1024), [0028] (teaching “distortion makes it difficult to obtain a beautiful boundary between two images” and performing transformation mapping before joining two images), Fig. 1, [0037] (teaching that the same processing steps are performed on the first image and on the second image before stitching), [0041]-[0045] (teaching performing projective transformation mapping before joining two images).

279. A person of ordinary skill in the art would have found it obvious to use *Kuranov*’s stitching to obtain and display a wide-angle image having an extended image area in *Rosenberg*, as modified by *Nakazawa* (or as modified by *Nakazawa* and *Hatanaka*, or as modified by *Nakazawa* and *Tripathi*), for the reasons discussed above in the rationale to combine *Rosenberg*, *Nakazawa*, and *Kuranov*; *Rosenberg*, *Nakazawa*, *Hatanaka*, and *Kuranov*; and *Rosenberg*, *Nakazawa*, *Tripathi*, and *Kuranov*. See § X.I.1.

g. 13[f]: “*displaying the stitched image on the monitor.*”

280. In my opinion, *Rosenberg* combined with *Nakazawa* (or *Rosenberg* combined with *Nakazawa* and *Hatanaka*, or alternatively, *Rosenberg* combined with *Nakazawa* and *Tripathi*) in view of *Kuranov* renders obvious each of these additional limitations of claim 13.

281. *Rosenberg* discloses displaying the image on the monitor after performing the flipping, transformation mapping, and resizing, as discussed above

regarding limitation 1[e] (§ X.A.2.f). *Kuranov* similarly discloses displaying the stitched image on a display screen (“**monitor**”). *Kuranov* (Ex. 1013), [0005], [0075], [0105]. When *Rosenberg* (as modified by *Nakazawa* or as modified by *Nakazawa* and *Hatanaka*, or as modified by *Nakazawa* and *Tripathi*) implements *Kuranov*’s stitching, the stitched image joining two mirror images would be displayed to the user as a mirror image.

282. For the reasons discussed above regarding limitation 13[e] (§ X.I.2.f), a person of ordinary skill in the art would have been motivated to use *Kuranov*’s stitching in *Rosenberg* (as modified by *Nakazawa* or as modified by *Nakazawa* and *Hatanaka*, or as modified by *Nakazawa* and *Tripathi*) to obtain and display a stitched image, emulating a traditional mirror with extended image area, and would have had a reasonable expectation of success in making this modification. *See Rosenberg* (Ex. 1005), [0003]-[0005], [0025]-[0027], [0057], [0062] (teaching mirrors with greater functionality and versatility are needed). *See also* § X.I.1.

3. Dependent Claim 14

“The method of claim 13, wherein field of views of the camera and of the second camera overlap, and further comprising the step of overlay decision to determine best location in overlapping parts of the field of views to perform the stitching.”

283. In my opinion, *Rosenberg* combined with *Nakazawa* (or *Rosenberg* combined with *Nakazawa* and *Hatanaka*, or alternatively, *Rosenberg* combined with

Nakazawa and *Tripathi*) in view of *Kuranov* renders obvious the additional limitation of claim 14.

284. In my opinion, a person of ordinary skill in the art would have understood that the area imaged by a camera constitutes a camera's field of view. As discussed above regarding limitation 13[e] (§ X.I.2.f), a person of ordinary skill in the art would have found it obvious to use *Kuranov*'s stitching to connect images from two or more cameras with overlapping imaging areas ("***field of views of the camera and of the second camera overlap***") to provide extended image areas, as desired in *Rosenberg*. See *Rosenberg* (Ex. 1005), [0062]; see also § X.I.1.

285. *Kuranov* recognizes the problem of overlapped areas ("***overlapping parts of the field of views***") when estimating the mapping to perform the stitching. And *Kuranov* explains that different types of alignments can be performed together or as alternatives to address this problem. *Kuranov* (Ex. 1013), [0043], [0065]-[0070], [0077]-[0080] (points-based alignment), [0081]-[0083] (outer boundary-based alignment), [0084]-[0089] (mesh- or graph-based alignment), [0090]-[0093] (moving-object-based alignment). After performing such an alignment, *Kuranov* discloses "determin[ing] which image better represents [the] overlapping area." *Kuranov* (Ex. 1013), [0094]. Specifically, *Kuranov* discloses adjusting the depth associated with one or more images (or the order in which images are stitched together) in the overlapping areas such that "some overlapping images can be pushed

forward (so that the images of the edges of the images are no longer obscured from view) to be seen” and “[o]ther images may be pushed back (and obscured from view).” *Kuranov* (Ex. 1013), [0094]. *Kuranov* explains that this determination process can “select the preferred order of viewing and obtain[] the stitched image that the user likes the best.” *Kuranov* (Ex. 1013), [0094].

286. A person of ordinary skill in the art would have understood that *Kuranov*’s determination process aligns and joins images (“***to perform the stitching***”) in their overlapping areas near seam locations where the image representation has switched between different images. And a person of ordinary skill in the art would have understood that *Kuranov*’s determination process is “***determin[ing] best location***” to perform the stitching because the seam locations are determined based on the “better” image representation among the overlapping images. *Kuranov* (Ex. 1013), [0077], [0090], [0094].

287. A person of ordinary skill in the art would have found it obvious to use *Kuranov*’s stitching, including the overlay decision to determine the best location in the overlapping areas of the images to perform the stitching, in *Rosenberg* (as modified by *Nakazawa* or as modified by *Nakazawa* and *Hatanaka*, or as modified by *Nakazawa* and *Tripathi*), for the reasons discussed above regarding limitation 13[e] (§ X.I.2.f). *See also* § X.I.1.

4. Dependent Claim 15

“The method of claim 14, further comprising a smoothing operation to correct artifacts caused by the step of stitching.”

288. In my opinion, *Rosenberg* combined with *Nakazawa* (or *Rosenberg* combined with *Nakazawa* and *Hatanaka*, or alternatively, *Rosenberg* combined with *Nakazawa* and *Tripathi*) in view of *Kuranov* renders obvious the additional limitation of claim 15.

289. *Kuranov* discloses that, during rendering, “seams are blended and smoothened at the seams and interior for better realism” (“***a smoothing operation***”). *Kuranov* (Ex. 1013), [0073], [0106], [0107]. *Kuranov* explains that “the images from different cameras when joined[,] may look a bit different or un-natural at the joining seams.” *Kuranov* (Ex. 1013), [0106]. According to *Kuranov*, blending and smoothening “at the seam of stitching improves realism and makes the image appear more natural.” *Kuranov* (Ex. 1013), [0106]. Such smoothing includes adjusting or averaging the brightness, contrast, and/or colors to “remove the jagged edge effect and [] provide a smooth transition from one frame to another” (“***to correct artifacts caused by the step of stitching***”). *Kuranov* (Ex. 1013), [0107].

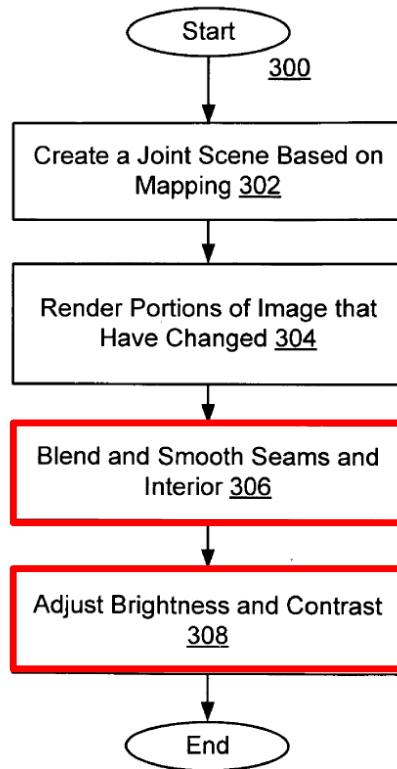
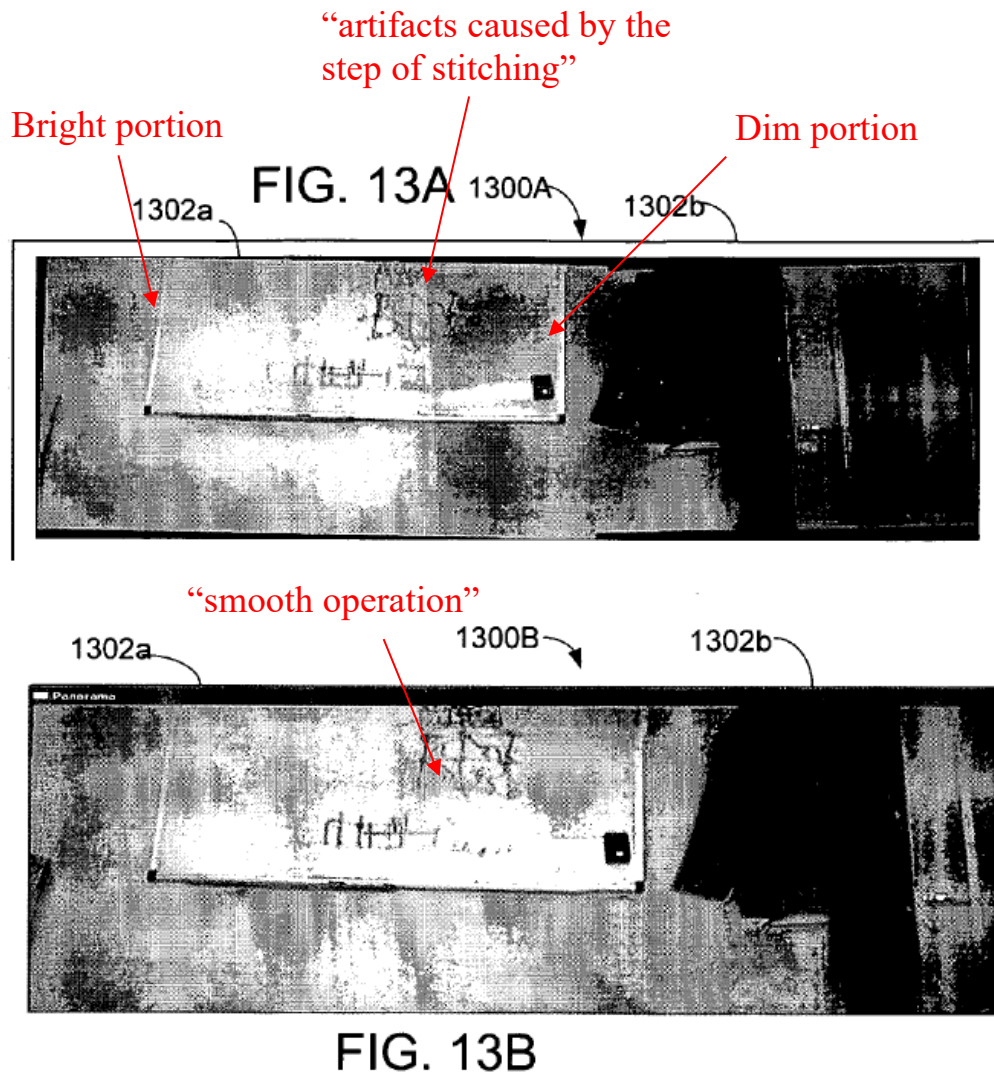


FIG. 3

Kuranov (Ex. 1013), Fig. 3. *Kuranov* illustrates the smoothing operation in the figures below:



Kuranov (Ex. 1013), Figs. 13A-13B, [0109]-[0112].

290. A person of ordinary skill in the art would have found it obvious to use *Kuranov*’s stitching, including the smoothing operation, in *Rosenberg* (as modified by *Nakazawa* or as modified by *Nakazawa* and *Hatanaka*, or as modified by *Nakazawa* and *Tripathi*), for the reasons discussed above regarding limitation 13[e] (§ X.I.2.f). *See also* § X.I.1.

**J. *Rosenberg In View Of Nakazawa and Chang* (Ground 20),
Rosenberg In View Of Nakazawa, Hatanaka, and Chang (Ground
21), or *Rosenberg In View Of Nakazawa, Tripathi, and Chang*
(Ground 22) Renders Obvious Claim 16.**

1. Rationale to Combine

291. In my opinion, a person of ordinary skill in the art would have been motivated to combine *Rosenberg*, *Nakazawa*, and *Chang*. A person of ordinary skill in the art would have also been motivated to combine *Rosenberg*, *Nakazawa*, *Hatanaka*, and *Chang*. Further, a person of ordinary skill in the art would have been motivated to combine *Rosenberg*, *Nakazawa*, *Tripathi*, and *Chang*. These references are in the same field of endeavor as each other and the '109 Patent. *See* above discussions in §§ IV.A (Overview of the '109 Patent), IX.A (Overview of *Rosenberg*), IX.B (Overview of *Nakazawa*), IX.C (Overview of *Hatanaka*), IX.D (Overview of *Tripathi*), IX.I (Overview of *Chang*).

292. As discussed above in § X.I.1, *Rosenberg* discloses that its digital mirror system can include more than one digital camera. *Rosenberg* (Ex. 1005), [0057]. *Rosenberg* also identifies the need to provide greater functionality and versatility than traditional mirrors. *See Rosenberg* (Ex. 1005), [0003]-[0005], [0025]-[0027], [0057]. Thus, while *Rosenberg* discloses emulating a traditional mirror, a person of ordinary skill in the art would have been motivated to modify *Rosenberg* to implement *Chang*'s 3D display method to improve the functionality

and user experience of *Rosenberg*'s system. Indeed, like *Rosenberg*'s various user-selectable digital mirror functionalities and features, *Chang* discloses that a user can select whether to display a 2D or 3D image. *Chang* (Ex. 1014), [0024]-[0025], [0037], [0056], [0065], [0082]-[0083], [0087]-[0089], Fig. 5. A person of ordinary skill in the art would have been motivated to provide a 3D image with depth information option to the user, "similar to a real image," to improve a user's experience using *Rosenberg*'s digital mirror. *Chang* (Ex. 1014), [0006].

293. A person of ordinary skill in the art would have understood that when *Rosenberg* is modified to implement *Chang*'s 3D display, *Rosenberg*'s cameras would be arranged to capture parallax image signals. Indeed, it was known to a person of ordinary skill in the art to use images synchronously captured by a pair of cameras, arranged left and right with parallax, to obtain a 3D or stereoscopic image. See *Nakamura* (Ex. 1025), [0004]; *Chang* (Ex. 1014), [0006]. The left and right cameras capture images for the left eye and right eye, respectively. *Nakamura* (Ex. 1025), [0004]. And a person of ordinary skill in the art would have understood that *Rosenberg*'s LCD display would have been modified to include a filter for forming a predetermined barrier pattern as taught in *Chang*. *Chang* (Ex. 1014), [0024]-[0025], [0037], [0082]. A person of ordinary skill in the art would have understood that *Rosenberg*'s processor and LCD display would implement the image signal processing and filter and render the 3D image on the display screen. A person of

ordinary skill in the art would have expected success in implementing *Chang*'s 3D display in *Rosenberg* (as modified by *Nakazawa* or as modified by *Nakazawa* and *Hatanaka*, or as modified by *Nakazawa* and *Tripathi*) because it would have been using a known technique to improve a similar device in the same way and yield the predictable result of displaying 3D images on *Rosenberg*'s LCD.

2. Dependent Claim 16

a. 16[pre]: “*The method of claim 1, further comprising the steps:*”

294. As discussed above regarding claim 1 (§§ X.A.2, X.B.2, and X.C.2), *Rosenberg* in view of *Nakazawa*, or alternatively, *Rosenberg* in view of *Nakazawa* and *Hatanaka*, or alternatively, *Rosenberg* in view of *Nakazawa* and *Tripathi* renders obvious claim 1.

- b. 16[a]: “*obtaining a second digital image from a second camera;*”**
- c. 16[b]: “*flipping the second image about a vertical axis so as to reverse right and left sides of the second image;*”**
- d. 16[c]: “*applying a transformation mapping to the second image to modify the second image such that it appears to mimic a reflection of a mirror;*”**
- e. 16[d]: “*resizing the second image to reduce variations caused by changes in object's distance to the second camera;*”**

295. In my opinion, *Rosenberg* alone, or further in view of *Nakazawa*, renders obvious each of these additional limitations of claim 16.

296. First, *Rosenberg* discloses that its system can include more than one digital camera for capturing and displaying images. See *Rosenberg* (Ex. 1005), [0057]. For the reasons discussed above in § X.J.1, a person of ordinary skill in the art would have found it obvious to arrange two cameras left and right with parallax in *Rosenberg* to capture parallax image signals for rendering a 3D or stereoscopic image.

297. Second, as discussed above regarding limitations 1[a]-1[d] (§§ X.A.2.b-X.A.2.e), *Rosenberg* in view of *Nakazawa* renders obvious performing the steps of these limitations (flipping, transformation mapping, and resizing) on a first digital image from the first camera to obtain a mirror image.

298. Third, for reasons discussed regarding limitation 16[e] below (§ X.J.2.f), the steps of these limitations would also be performed on “***a second digital image from a second camera,***” arranged with the first camera as a pair of left and right cameras with parallax, to obtain a 3D image with depth information, as discussed above. And for the reasons discussed above regarding limitations 1[a]-1[d] (§§ X.A.2.b-X.A.2.e), *Rosenberg* or *Rosenberg* in view of *Nakazawa* renders obvious performing the steps of these limitations on the second digital image from the second camera.

- f. 16[e]: “*displaying the image and the second image after performing the flipping, transformation mapping, and resizing, to thereby obtain a three-dimensional image on the monitor.*”

299. In my opinion, *Rosenberg* combined with *Nakazawa* (or *Rosenberg* combined with *Nakazawa* and *Hatanaka*, or alternatively, *Rosenberg* combined with *Nakazawa* and *Tripathi*) in view of *Chang* renders obvious this additional limitation of claim 16.

300. As discussed above in the overview of *Chang*, *Chang* discloses displaying parallax image signals on an LCD panel with a filter to implement a 3D image on an LCD screen (“*displaying the image and the second image ... to thereby obtain a three-dimensional image on the monitor*”). See § IX.I. A person of ordinary skill in the art would have captured parallax images by using two cameras arranged left and right with parallax in *Rosenberg* and displaying the two images on the LCD screen as taught in *Chang* to obtain a 3D image on the display, as discussed above regarding limitations 16[a]-16[d] (§§ X.J.2.b-X.J.2.e). See also discussions in § X.J.1.

301. A person of ordinary skill in the art would have understood that “*the flipping, transformation mapping, and resizing*” would be performed on the image captured by each of the two cameras before displaying these images to obtain a 3D image because performing these steps on each camera image would improve the

correspondence of the left-eye and right-eye images of the 3D image on the display, leading to a more accurate disparity (e.g., pixels corresponding to the same object should be only separated by a distance that is proportional to the depth of that object), which is needed for 3D visual perception. As discussed above regarding limitation 13[e] (§ X.I.2.f), after performing these steps on both images from both cameras, both modified images would have similar orientation and elevation and no distortion, which would allow for preserving accurate disparity-based visual correspondences in the left-eye image and right-eye image on the screen.

302. A person of ordinary skill in the art would have found it obvious to implement *Chang*'s 3D display in *Rosenberg* to provide a user-selectable 3D-display function in *Rosenberg* (as modified by *Nakazawa* or as modified by *Nakazawa* and *Hatanaka*, or as modified by *Nakazawa* and *Tripathi*), improving the functionality and versatility of *Rosenberg*'s digital mirror system, as discussed above regarding limitations 16[a]-16[d] (§§ X.J.2.b-X.J.2.e). *See also* § X.J.1.

**K. *Rosenberg* In View Of *Nakazawa* and *Lizee* (Ground 23),
Rosenberg In View Of *Nakazawa*, *Hatanaka*, and *Lizee* (Ground
24), or *Rosenberg* In View Of *Nakazawa*, *Tripathi*, and *Lizee*
(Ground 25) Renders Obvious Claim 18.**

1. Rationale to Combine

303. In my opinion, a person of ordinary skill in the art would have been motivated to combine *Rosenberg*, *Nakazawa*, and *Lizee*. A person of ordinary skill

in the art would have also been motivated to combine *Rosenberg*, *Nakazawa*, *Hatanaka*, and *Lizee*. Further, a person of ordinary skill in the art would have been motivated to combine *Rosenberg*, *Nakazawa*, *Tripathi*, and *Lizee*. See above discussions in §§ IV.A (Overview of the '109 Patent), IX.A (Overview of *Rosenberg*), IX.B (Overview of *Nakazawa*), IX.C (Overview of *Hatanaka*), IX.D (Overview of *Tripathi*), IX.K (Overview of *Lizee*).

304. As discussed above regarding limitation 1[g] (§ X.A.2.h), *Rosenberg* discloses that its digital camera could be used to provide a proximity-sensing functionality, and a person of ordinary skill in the art would have understood that *Rosenberg* in view of *Nakazawa* would determine the distance to a user appearing in the real-time video images. *Rosenberg* (Ex. 1005), [0069], [0073], [0109], Fig. 13; *Nakazawa* (Ex. 1007), [0015], [0030], [0038], Fig. 1. While *Rosenberg* combined with *Nakazawa* does not disclose specific details as to how to use the digital camera to determine the user's distance, a person of ordinary skill in the art would have been motivated to find teachings in the prior art to fill in such implementation details, and would have recognized that *Lizee*'s teaching of using a part or portion of the user in the image captured by the camera provides a suitable option. In fact, *Lizee* discloses that "a selected part or portion of the user [] including, but not limited to the user's head, arm, hand, torso or again **any** object carried by the user" can be used for estimating distance. *Lizee* (Ex. 1017), [0043] (emphasis

added). Thus, a person of ordinary skill in the art would have found it obvious to estimate the user's distance based on the size of features of the user or objects worn by the user in the camera-captured image in *Rosenberg* combined with *Nakazawa*. See also *Haan* (Ex. 1022), [0074] (teaching estimating the user's distance to the camera based on the size or other features of the user).

305. A person of ordinary skill in the art would have found it obvious to estimate the user's distance based on the features of the user's shoes, for example. *Rosenberg* discloses emulating a traditional mirror for a user to view clothing choices. *Rosenberg* (Ex. 1005), [0053], [0108]. A person of ordinary skill in the art would have found using the shoes the user wears as a suitable object in *Lizee*'s method for estimating user distance because in many instances of using the mirror for the user to view clothing choices, the image would include shoes. In other instances, when the shoes do not appear in the image, a person of ordinary skill in the art would have understood that other parts of the user or objects carried by the user would be used for other instances, as taught by *Lizee*.

306. A person of ordinary skill in the art would have understood that *Rosenberg*'s processor, memory, digital camera, and other hardware or software components would be capable of performing *Lizee*'s distance estimation. A person of ordinary skill in the art would have expected success in implementing *Lizee*'s distance estimation in *Rosenberg* (as modified by *Nakazawa* or as modified by

Nakazawa and *Hatanaka*, or as modified by *Nakazawa* and *Tripathi*) because it would have been using a known technique to improve a similar device in the same way and yield the predictable result of estimating the user's distance.

2. Dependent Claim 18

“The method of claim 1, further comprising calculating distance to a user appearing in the image by identifying user's shoes and triangulating to the shoes.”

307. In my opinion, *Rosenberg* combined with *Nakazawa* (or *Rosenberg* combined with *Nakazawa* and *Hatanaka*, or alternatively, *Rosenberg* combined with *Nakazawa* and *Tripathi*) in view of *Lizee* renders obvious the additional limitation of claim 18.

308. *Lizee* discloses recognizing the user in the image captured by the image-capturing device and estimating the user's distance to the imaging device based on features of a part of the user or an object the user carries (e.g., size or number of pixels corresponding to that part or that object in captured image), compared to features of that part or that object at a known distance (***“calculating distance to a user”***). *Lizee* (Ex. 1017), [0043]-[0046]. When *Rosenberg* or *Rosenberg* as modified by *Nakazawa* (or as modified by *Nakazawa* and *Hatanaka*, or as modified by *Nakazawa* and *Tripathi*) is combined with *Lizee*, a person of ordinary skill in the art would have understood that the user to which the distance is calculated would be the user using *Rosenberg*'s digital mirror and appearing in *Rosenberg*'s real-time video

images captured by the camera (“*a user appearing in the image*”). A person of ordinary skill in the art would have understood that “conventional image recognition techniques” would be used for “*identifying*” the user and the part or object of the user as taught by *Lizee*. *Lizee* (Ex. 1017), [0046]. A person of ordinary skill in the art would have found it obvious to identify the user’s shoes in the image for estimating the user’s distance in various instances where the user uses the digital mirror image as a traditional mirror, for the reasons discussed above in § X.K.1.

309. When shoes are used, a person of ordinary skill in the art would have understood *Lizee*’s distance estimation as “*triangulating to the shoes.*” In *Rosenberg*’s system, the camera is mounted above the screen and aimed downwards. *Rosenberg* (Ex. 1005), [0062]. A person of ordinary skill in the art would have recognized that the camera’s angle can be predetermined. *See Park* (Ex. 1016), [0065] (teaching a predetermined tilt of a camera can be stored for performing image compensation). A person of ordinary skill in the art would have been able to use basic geometric calculations using the predetermined angle of the camera, the known distance, features (e.g., size) of the shoes at the known distance, and the corresponding features (e.g., size) of the shoes in the camera-captured image to determine the user’s distance to the camera or screen. A person of ordinary skill in the art would have understood such calculations as “*triangulating*” because the

distance between two points is determined using the position/orientation of the camera and a known distance.

310. As discussed above, a person of ordinary skill in the art would have found it obvious to modify *Rosenberg* (as modified by *Nakazawa* or as modified by *Nakazawa* and *Hatanaka*, or as modified by *Nakazawa* and *Tripathi*) to use *Lizee*'s distance estimation based on features (e.g., size) of the user's shoes in the image captured by *Rosenberg*'s digital camera and would have had a reasonable expectation of success in making this modification. *See* § X.K.1.

XII. Conclusion

311. For the reasons above, it is my opinion that claims 1-18 of the '109 Patent would have been obvious in view of the prior art.

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

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

Respectfully submitted,

Date: May 29, 2024

By: 

Lina J. Karam