

Patent Owner EyesMatch: Oral Argument

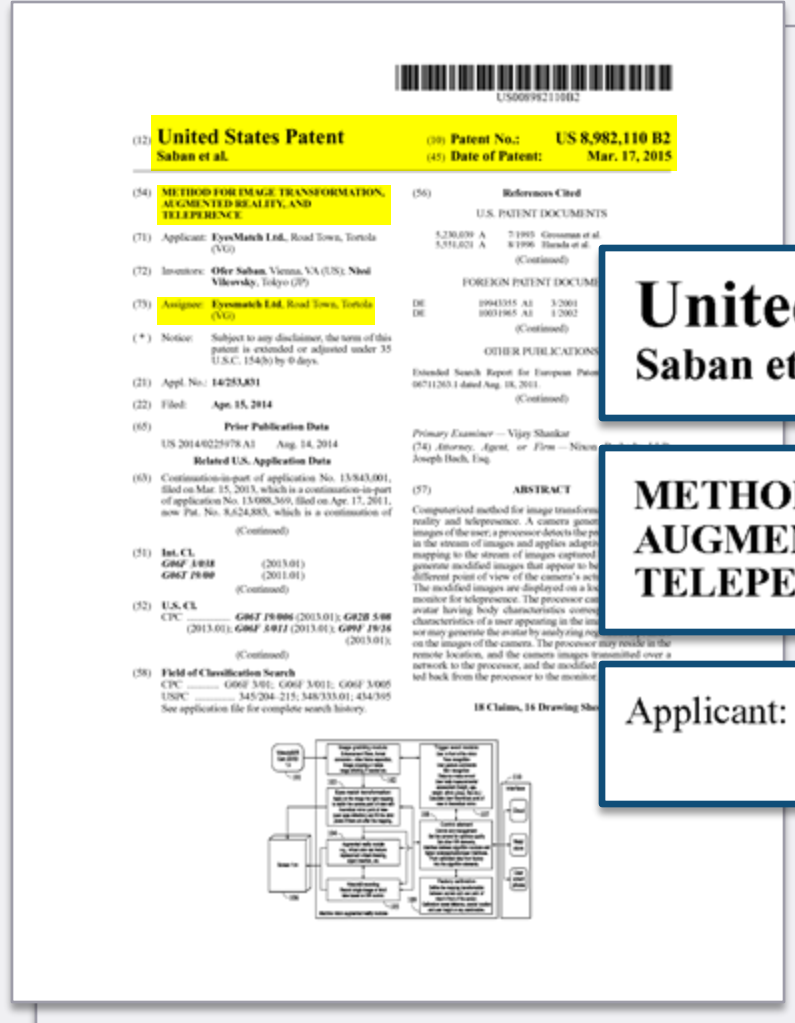
September 17, 2025

Samsung Electronics Co. Ltd., et al. v. EyesMatch Ltd.; Case No. IPR2024-00810

CHALLENGED PATENT

DEMONSTRATIVE EXHIBIT – NOT EVIDENCE

The 110 Patent



United States Patent
Saban et al.

(10) **Patent No.:** **US 8,982,110 B2**
(45) **Date of Patent:** **Mar. 17, 2015**

**METHOD FOR IMAGE TRANSFORMATION,
AUGMENTED REALITY, AND
TELEPERENCE**

Applicant: **EyesMatch Ltd.,** Road Town, Tortola
(VG)

ASSERTED GROUNDS

DEMONSTRATIVE EXHIBIT – NOT EVIDENCE

110 Patent Asserted Grounds

Ground	References	Claim
1	Haan and Francois	1-6, 10-12, 16-17
2	Rosenberg and Park	1-6, 10-12
3	Geisner and Lizée	1-18
4	Haan, Francois, and Geisner	7-9, 13-15, 18
5	Rosenberg, Park, Geisner	3-4, 7-9, 11-8

CHALLENGED INDEPENDENT CLAIM

U.S. Patent No. 8,982,110 Challenged Independent Claim 1

1 Preamble. A computerized method for operating a display system, the display system having a camera, a monitor, and a processor, the method comprising:

- 1a. operating the camera to generate a stream of images of the user;
- 1b. operating the processor to detect the presence of the user in the stream of images
- 1c. operating the processor to apply adaptive transformation mapping to the stream of images captured by the camera to generate modified images that appear to be captured from a different point of view of the camera's actual point of view; and,
- 1d. displaying the modified images on the monitor;
- 1e. wherein the different point of view corresponds to an image taken from a different angle and a different distance than the actual images captured by the camera; and
- 1f. wherein during mirror tracking mode the processor utilizes the angle of the images captured by the camera and applies parametric input for a mapping transformation that changes imaging perspective of the images captured by the camera.

U.S. Patent No. 8,982,110 Challenged Independent Claim 1

1 Preamble. A computerized method for operating a display system, the display system having a camera, a monitor, and a processor, the method comprising:

1a. operating the camera to generate a stream of images of the user;

1b. operating the processor to detect the presence of the user in the stream of images

1c. operating the processor to apply adaptive transformation mapping to the stream of images captured by the camera to generate modified images that appear to be captured from a different point of view of the camera's actual point of view; and,

1d. displaying the modified images on the monitor;

1e. wherein the different point of view corresponds to an image taken from a different angle and a different distance than the actual images captured by the camera; and

1f. wherein during mirror tracking mode the processor utilizes the angle of the images captured by the camera and applies parametric input for a mapping transformation that changes imaging perspective of the images captured by the camera.

- Whether the Board should adopt Petitioners' district court construction of **“mirror tracking mode”**
- Whether the Asserted Grounds disclose or render obvious limitation 1(f): **“wherein during mirror tracking mode the processor utilizes the angle of the images captured by the camera. . .”**
 - **Ground 1 (and 4):** Haan and Francois
 - **Ground 2 (and 5):** Rosenberg and Park
 - **Ground 3:** Geisner and Lizée

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CLAIM CONSTRUCTION

Petitioners' IPR Claim Construction Position

“mirror tracking mode”

1013, 1017 (Fed. Cir. 2017). No terms require construction because the claims encompass the prior-art mappings under any reasonable construction. 37 C.F.R. § 42.100(b). Petitioners reserve the right to respond to constructions offered by

Petitioners' District Court Claim Construction Position

“mirror tracking mode”

A POSA would understand “mirror tracking mode” to mean a mode of operation where the display “mimics the reflection of a mirror” as construed for the '109 Patent. Thus, this term should be construed as “a mode of operation in which the user sees their reversed reflection appearing at approximately double the distance from the camera and the reflection maintains approximately the same size regardless of the user movement.”

EyesMatch v. Samsung, Samsung's Responsive Claim Construction Br. (Ex. 2009) at 27 (29 of PDF) (cited: POR (Paper No. 27) at 10).

District Court Claim Construction Order

“mirror tracking mode”

The Court accordingly hereby construes “mirror tracking mode” to mean **“a mode of operation in which the user sees their reversed reflection appearing at roughly double the distance from the camera and the reflection maintains roughly the same size regardless of the user movement.”**

EyesMatch v. Samsung, Claim Construction Order (Ex. 2008) at 41 (cited: POR (Paper No. 27) at 11).

Petitioners' District Court Construction Should Be Adopted

Petitioners sought a narrow construction in district court.

“mirror tracking mode”

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EyesMatch v. Samsung, Samsung's Responsive Claim Construction Br. (Ex. 2009) at 27 (cited: POR (Paper No. 27) at 10).

Petitioners' District Court Construction Should Be Adopted

Petitioners sought a narrow construction in district court.

“When a user looks at himself in the mirror, what he actually sees is the reflection of himself as if he was standing at a distance that is double the distance from him to the mirror. This is illustrated in FIG. 5A, wherein the user standing at distance $D1$ sees himself at a distance equal to twice $D1$. Similarly, as shown in FIG. 5B, a user standing at distance $D2$ will see himself at a distance $2 \times D2$.”

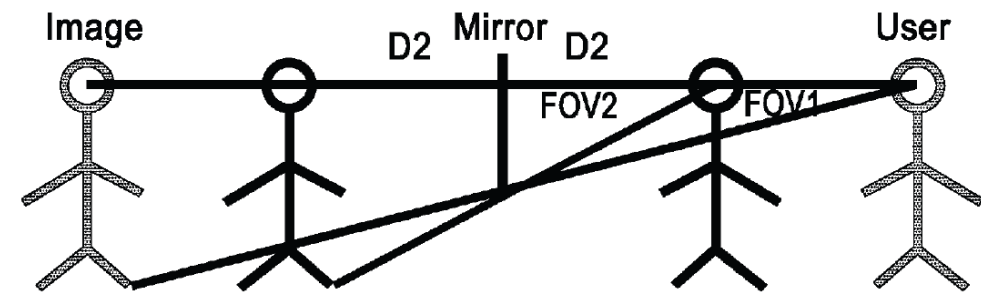


FIG. 5B

109 Patent (Ex. 1021) at 2:4-10, Fig. 5B (cited: Petition (Paper No. 1) at 9 and Karam 2nd Decl. (Ex. 1033) ¶ 8 (cited: Petitioners' Reply (Paper No. 32) at 10)).

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Petitioners sought a narrow construction in district court.

“Consequently, as illustrated in FIG. 5B, when the user approaches the mirror, the FOV angle increases, which is why **he continues to see the same size reflection** ($FOV1 < FOV2$), so that the user actually sees himself roughly at the same size, but closer.”

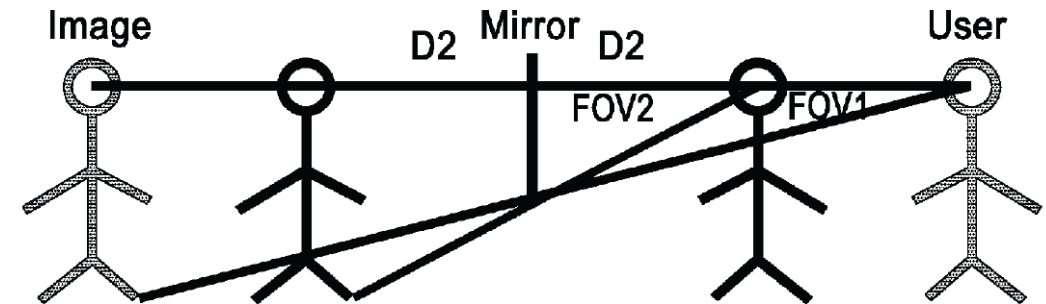


FIG. 5B

109 Patent (Ex. 1021) at 2:19-23, Fig. 5B (cited: Petition (Paper No. 1) at 9 and Karam 2nd Decl. (Ex. 1033) ¶ 8 (cited: Petitioners' Reply (Paper No. 32) at 10)).

Petitioners' District Court Construction Should Be Adopted

Petitioners sought a narrow construction in district court.

The '109 Patent emphasizes that prior art “techniques are not convincing and are not yet accepted as a reliable image of the individual as if he was looking at himself in a conventional mirror.” '109 Patent at 1:65-2:1. . . . First, the '109 Patent explains that conventional mirror images are reversed. *Id.* at 14:40-41. However, the '109 Patent makes clear that mimicking a mirror's reflection requires **more** than simply displaying a reversed image/video of a user. . . .

Second, the '109 Patent describes that “when a user looks at himself in the mirror, what he actually sees is the reflection of himself as if he was standing at a distance that is **double the distance** from him to the mirror.” *Id.* at 2:4-6; *see also id.* at Figs. 5A and 5B, illustrating a user standing at a distance from a mirror (“D1” in Fig. 5A and “D2” in Fig. 5B) and seeing himself (i.e., his reflected “image”) at twice the distance from the mirror (2xD1 or 2xD2, respectively). Third, when describing conventional mirrors, the '109 Patent provides that “the angle of the user's Field of View (FOV) changes when the user changes the distance, e.g., gets closer, to the mirror.” *Id.* at 2:10-12. “Consequently, as illustrated in FIG. 5B, when the user approaches [a conventional] mirror . . . he continues to see the **same size reflection . . . so that the user actually sees himself roughly at the same size**, but closer.” *Id.* at 2:19-23; *see also* 14:25-5

Petitioners' District Court Construction Should Be Adopted

Petitioners never contend the district court's construction was wrong.

- “Petitioners’ proposal that the Board need not construe this limitation because the prior art discloses each limitation under any reasonable construction still stands.”
Petitioners’ Reply (Paper 32) at 4, 5.
- “But the Board is not bound by a district court’s construction, much less a non-final one.”
Petitioners’ Reply (Paper 32) at 4, 5.
- “Moreover, Petitioners’ proposed constructions in the litigation are *consistent* with the mappings submitted in the Petition as intrinsic properties of a mirror.”
Petitioners’ Reply (Paper 32) at 2-3.
- “But Petitioners continue to believe that no construction is necessary to resolve the disputes before the Board.”
Petitioners’ Opp. to Mtn. to Strike (Paper 45) at 8.

Petitioners' District Court Construction Should Be Adopted

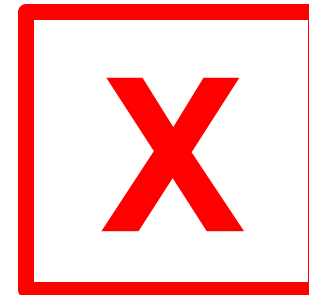
Of Course Petitioners' Positions Are Inconsistent, and A Construction Is Necessary

- In “traditional mirror emulation mode, the digital mirror is operative to replicate the performance of a standard household mirror, providing the user with a left-right reversed frontal image of himself or herself when standing before the display.” Rosenberg (Ex. 1006), ¶ [0027]

Petitioner's IPR Position (No Construction)



Petitioner's District Court Position (Double Distance, Same Size Requirement)



Petitioners' District Court Construction Should Be Adopted

Petitioners failed to explain their inconsistent positions.

“Keeping in mind that Petitioner has the burden to show a reasonable likelihood of prevailing in showing that at least one claim is unpatentable, it is incumbent upon Petitioner to address substantively the District Court’s claim construction of a limitation when construction of that limitation is likely to be a focal point of the *inter partes* review proceeding. By failing to reconcile its proffered claim construction here with its very different construction proffered in District Court—which the District Court agreed with—Petitioner fails to satisfy this burden.”

OrthoPediatrics Corp. v. K2M, Inc., No. IPR2018-01548, Paper 9 at 11 (P.T.A.B. Mar. 1, 2019) (cited: POR (Paper No. 27) at 13).

Petitioners' District Court Construction Should Be Adopted

The *Markman* standard was adopted for IPRs to end gamesmanship and provide consistency

“By maintaining consistency among the various proceedings, the integrity, predictability, and reliability of the patent system is thus enhanced.”

Changes to the Claim Construction Standard for Interpreting Claims in Trial Proceedings Before the Patent Trial and Appeal Board, 83 Fed. Reg. 51,340, 51,345 (Oct. 11, 2018) (cited: POR (Paper 27) at 13).

If we were to adopt Petitioner's claim construction as presented in the Petition, and if the district court were to adopt Petitioner's claim constructions as proposed there, the subsequent decisions issued in reliance on these inconsistent claim constructions may lack “uniformity” between us and the district court and may undermine the “predictability” of the '296 patent's claim scope and the “integrity of the patent system” overall. See Changes to the Claim Construction Standard for Interpreting Claims in Trial Proceedings Before the Patent Trial and Appeal Board, 83 Fed. Reg. at 51,342. Petitioner has not provided us with any arguments as to why such problems are not present here, much less provided any reason behind its inconsistent claim constructions in general.

Kiosoft Techs., LLC v. PayRange, Inc., No. IPR2021-00086, Paper 12 at 16 (P.T.A.B. Mar. 22, 2021) (cited: POR (Paper 27) at 13).

Petitioners Failed to Explain Their Inconsistent Positions

Petitioners failed to explain why they took inconsistent claim construction positions in district court and in their Petition.

function.” The Petition failed to do so. At a minimum, the Petition should have explained why the plain and ordinary meaning of the “component” terms should apply in this proceeding (why the inconsistent positions are warranted) or set forth an alternative means-plus-function claim construction. CTPG 45.

As a clarification, our rules do not necessarily prohibit petitioners from taking inconsistent claim construction positions before the Board and a district court. See *10x Genomics, Inc. v. Bio-Rad Lab’s, Inc.*, IPR2020-00086, Paper 8 at 18 (PTAB Apr. 27, 2020). However, here, where Petitioner has emphasized in district court that whether the “component” terms are means-plus-function limitations not only “will be most significant” but, “will be case . . . dispositive” and both parties previously provided the district court with competing means-plus-function claim constructions, we determine the Petition to be deficient under our rules.⁴

Petitioners' District Court Construction Should Be Adopted

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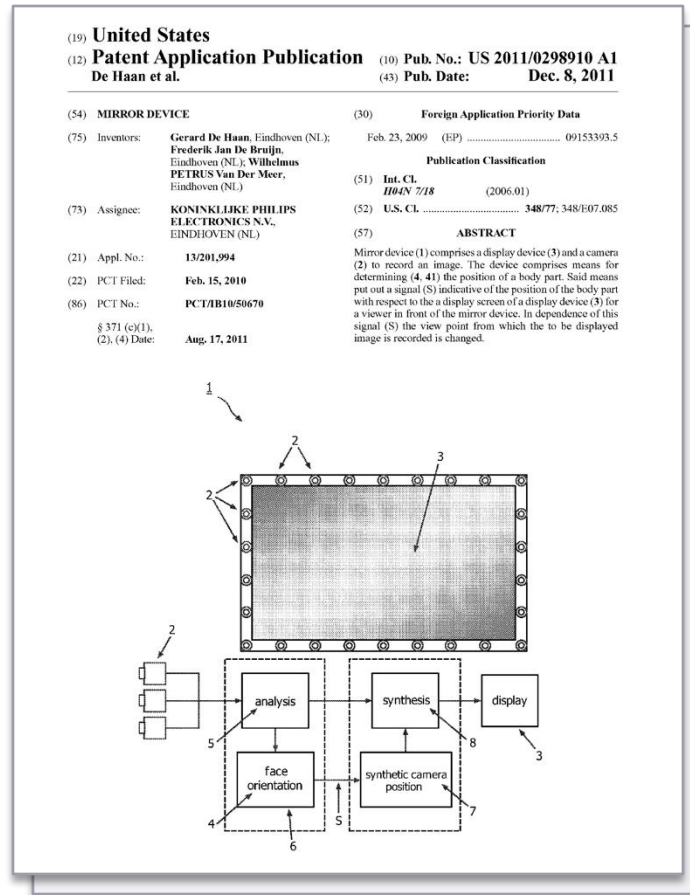
Kiosoft Techs., LLC v. PayRange, Inc., No. IPR2021-00086, Paper 12 at 16 (Mar. 22, 2021) (cited: POR (Paper No. 27) at 13).

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- Whether the Asserted Grounds disclose or render obvious limitation 1(f): **“wherein during mirror tracking mode the processor utilizes the angle of the images captured by the camera. . .”**
 - **Ground 1 (and 4):** Haan and Francois
 - Ground 2 (and 5): Rosenberg and Park
 - Ground 3: Geisner and Lizée

GROUND 1 DOES NOT DISCLOSE OR RENDER OBVIOUS LIMITATION 1(f)

Ground 1 Asserted Art: Haan

Haan discloses a mirror device operating contrary to a conventional mirror.



- “Within embodiments of the invention the displayed image is magnified as a function of the distance to the mirror device.” Haan (Ex. 1005), ¶ [0072]
- “FIG. 8 illustrates an exemplary relation between the magnification M of the image and the distance d in centimeter to the mirror.” Haan (Ex. 1005), ¶ [0075]
- “In embodiment there can be a range of distances for which the magnification factor is less than 1.” Haan (Ex. 1005), ¶ [0076]

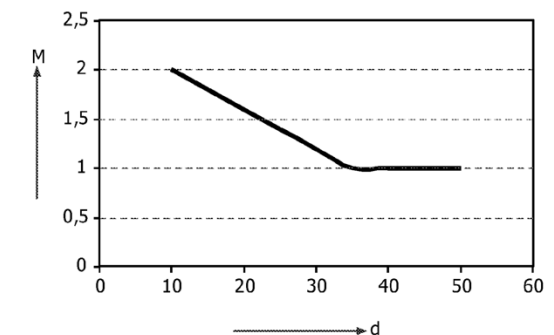


FIG. 8

Ground 1 Asserted Art: Francois

Francois discloses a handheld mirror simulation device.



- “In order to simulate a real mirror on a computer screen, images of the observed world, consistent with the viewer’s position, must be synthesized and displayed in real-time. This is of course geometrically impossible, but with a few simplifying assumptions (e.g. planar world), the image transform required was made simple yet convincing enough to consider building an actual device.” Francois (Ex. 1009), § 4.3
- “The current prototype system (see Figure 12) is comprised of an LCD screen manipulated by the user, a single camera fixed on the screen, and a tracking device.” Francois (Ex. 1009), § 4.3
- “The synthesized video stream is a close approximation of what the user would see on the screen surface if it were a real mirror.” Francois (Ex. 1009), § 4.3

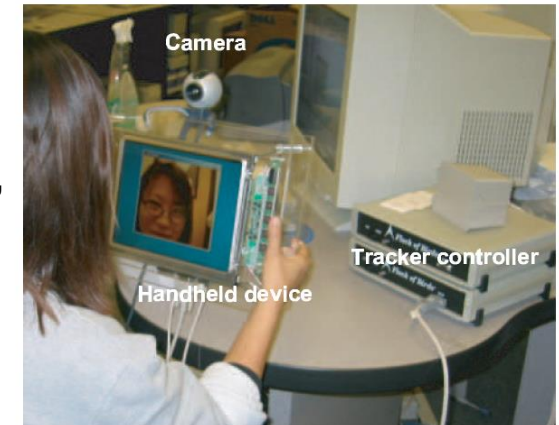


Figure 12: The handheld mirror simulation system (“Virtual Mirror”).

(cited: Petition (Paper No. 1) at 17).

Ground 1: Petition Does Not Show Or Even Address How *Haan/Francois* Discloses Double Distance, Same Size Requirement

Ground 1

Haan teaches the claimed mirror tracking mode. EX1001, cl. 1; EX1003, ¶¶205-210. Similar to the '110 Patent, Haan's system switches between a display mode (mirror tracking mode) and a reflective mode (idle mode) based on user position/orientation. *See, e.g.*, EX1005, [0080]-[0082], [0090]-[0092], [0097]; EX1003, ¶207. If a viewer is "within a range of angles and/or positions," the mirror is in display mode performing transformations; otherwise, it is in reflective/idle mode. EX1005, [0093]-[0094], [0080], [0082]; *see supra* §§IX.B.iii, iv, vi. For example, if the viewer is within 35 cm of the camera, a tracking mode is entered, applying resizing transformation. EX1005, [0075]-[0076]; *cf. id.*, [0093]-[0094] (idle mode); EX1003, ¶207.

Ground 1: Petitioners' Expert Did Not Show Or Even Address How *Haan/Francois* Disclosed Or Rendered Obvious The Double Distance, Same Size Requirement

205. Haan in view of Francois renders obvious “during mirror tracking mode the processor utilizes the angle of the images captured by the camera and applies parametric input for a mapping transformation that changes imaging perspective of the images captured by the camera.”

[...]

207. Similarly, Haan discloses a camera's field of view changes depending on the user's distance from the mirror device (i.e., the user's position/orientation). Ex. 1005 (Haan) at [0097]. Haan describes that its mirror device may switch between a display mode (or a transparent mode if a semi-transparent layer is used) and a reflective mode. Ex. 1005 (Haan) at [0080]-[0081], [0090]-[0092]. Haan explains that “x stands for the angle of orientation or the distance at which the mirror device changes from reflective mode to display mode.” Ex. 1005 (Haan) at [0082]. If a viewer is “within a range of angles and/or positions,” the mirror operates in a mirror mode wherein transformations are performed, as described above. Ex. 1005 (Haan) at [0093]; see also supra §§XI.B.c, XI.B.d, XI.B.e (1[b], 1[c], 1[e]). For example, **if the distance between the face of a viewer and the camera is within 35 cm, the system may operate in a mirror mode, applying resizing transformations.** Ex. 1005 (Haan) at [0075]-[0076]. However, if a user is not within the range of angles or positions, the system is in idle mode, acting as an ordinary display and/or as a regular reflective mirror. Ex. 1005 (Haan) at [0091]-[0094].

Petition Must Include All Arguments for Unpatentability

Petitioners were required to present all their arguments for unpatentability in their Petitions.

“Petitioner may not submit new evidence or argument in reply that it could have presented earlier, e.g. to make out a prima facie case of unpatentability.”

“It is also improper for a reply to present new evidence (including new expert testimony) that could have been presented in a prior filing, for example, newly cited prior art references intended to ‘gap-fill’ by teaching a claim element that was not present in the prior art presented with the petition.”

Petitioners Have Failed to Explain Their Inconsistent Positions

function.” The Petition failed to do so. At a minimum, the Petition should have explained why the plain and ordinary meaning of the “component” terms should apply in this proceeding (why the inconsistent positions are warranted) or set forth an alternative means-plus-function claim construction. CTPG 45.

As a clarification, our rules do not necessarily prohibit petitioners from taking inconsistent claim construction positions before the Board and a district court. See *10x Genomics, Inc. v. Bio-Rad Lab's, Inc.*, IPR2020-00086, Paper 8 at 18 (PTAB Apr. 27, 2020). However, here, where Petitioner has emphasized in district court that whether the “component” terms are means-plus-function limitations not only “will be most significant” but, “will be case . . . dispositive” and both parties previously provided the district court with competing means-plus-function claim constructions, we determine the Petition to be deficient under our rules.⁴

Cambridge Mobile Telematics, Inc. v. Sfara, Inc., No. IPR2024-00952, Paper 12 at 8, 8-9 (P.T.A.B. Dec, 13, 2024) (designated informative) (cited: Order re: Conduct of the Proceedings (Paper No. 36) at 3).

DEMONSTRATIVE EXHIBIT – NOT EVIDENCE

Petition Asserted No Construction Required – Plain Meaning – for All Terms

“mirror tracking mode”

1013, 1017 (Fed. Cir. 2017). No terms require construction because the claims encompass the prior-art mappings under any reasonable construction. 37 C.F.R. § 42.100(b). Petitioners reserve the right to respond to constructions offered by

Dr. Karam's Analogy Underscores Petitioners' Failure of Proof

20 Maybe to give you more
21 clarification, if you say "office furniture,"
22 it could be a chair or a desk, but still it's
23 office furniture.

24 So this -- the claim construction
25 is comprised with my opinion applied to it.
1 It's my -- the plain and ordinary meaning can
2 be broader, but my opinion on that is still
3 consistent with this.

Only Petitioners' Reply Contends That *Haan/Francois* Discloses Or Renders Obvious the Double Distance, Same Size Requirement

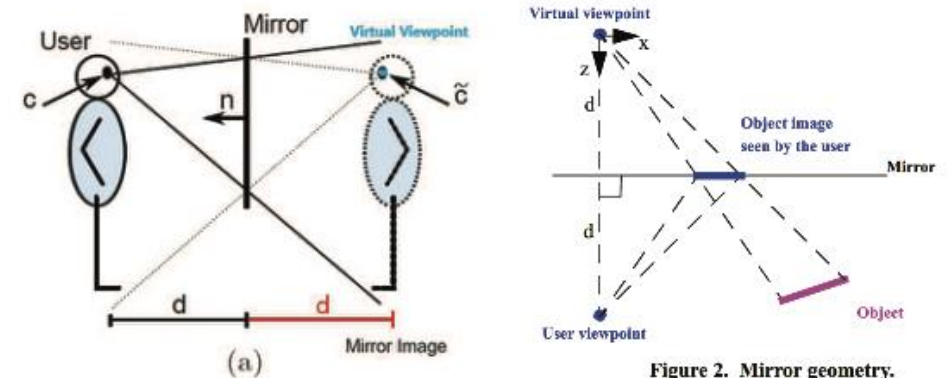
The Petition and Dr. Karam's testimony also show how Haan teaches "double the distance" (i.e. displaying the image in accordance with the user's distance from the mirror/camera). Pet., 36, 45; EX1003, ¶99. Therefore, a POSITA would have understood that Haan teaches displaying an image with the optical properties of a mirror, which require the image to maintain the same size and double the distance.

Ground 1: Reply Relies on Previously Undisclosed Background Art

Dr. Karam offers new opinions based on previously undisclosed art.

C. IT WAS WELL KNOWN IN THE ART THAT A MIRROR REFLECTION APPEARS AT ROUGHLY DOUBLE THE DISTANCE AND MAINTAINS ROUGHLY THE SAME SIZE.

23. There is no dispute that within the foundational understanding of digital mirror systems a POSITA would have known that the mirror reflection appears at roughly double the distance and maintains the same size. For instance, both *Straka* and *Francois 2* acknowledge that the virtual camera in a digital mirror should be positioned approximately symmetrically to the user's viewpoint—aligning with the virtual reflection of the user's eye position, as illustrated below. *Straka* (Ex. 1037), Fig. 4(a); *Francois 2* (Ex. 1035), Fig. 2.



Straka (Ex. 1037), Fig. 4(a) (annotated); *Francois 2* (Ex. 1035), Fig. 2.

Straka (Ex. 1037), *Francois II* (Ex.1035) (cited: Karam 2nd Decl. (Ex. 1033) ¶¶ 23 (cited: Petitioners' Reply (Paper No. 32) at 10, 12)).

Ground 1: Reply Relies on Previously Undisclosed Background Art

Dr. Karam offers new opinions based on previously undisclosed art.

A Free-Viewpoint Virtual Mirror with Marker-Less User Interaction

Matthias Straka, Stefan Hauswiesner, Matthias Rüther, and Horst Bischof

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Abstract. We present a Virtual Mirror system which is able to simulate a physically correct full-body mirror on a monitor. In addition, users can freely rotate the mirror image which allows them to look at themselves from the side or from the back, for example. This is achieved through a multiple camera system and visual hull based rendering. A real-time 3D reconstruction and rendering pipeline enables us to create a virtual mirror image at 15 frames per second on a single computer. Moreover, it is possible to extract a three dimensional skeleton of the user which is the basis for marker-less interaction with the system.

Keywords: Virtual Mirror, Shape-from-Silhouette, CUDA, Markerless User-Interaction, Free-Viewpoint Video.

1 Introduction

A virtual mirror is an Augmented Reality (AR) system which renders an image of the user from a virtual viewpoint and creates the illusion of a mirror image. In addition to that, it allows to add virtual objects and to modify the image in a way that is not possible with physical mirrors. In this paper, we propose a physically correct simulation of a full-body mirror using a multi-camera system and a single monitor. We also extend its viewing capabilities by allowing users to rotate their mirror image using solely natural hand gestures. This is beneficial, for example, in dressing rooms where users want to see how they look from the side or from behind in new clothes.

The concept of a virtual mirror is not new in the area of computer vision and AR [5,6]. One common property of existing virtual mirror systems is that they consist of a single camera with a fixed position where the horizontally flipped video stream is shown to the user on a monitor. However, such systems generally do not allow one to simulate a correct mirror because video devices are only able to capture a projected image and not the reflection of the user from his viewpoint. Free viewpoint video systems on the other hand are able to render an arbitrary view of a person by combining images from multiple fixed cameras [3,9,18]. This allows for the accurate simulation of optical effects, including rendering of a reflection image. Due to the amount of image data,

A. Heyden and F. Kahl (Eds.): SCIA 2011, LNCS 6688, pp. 635–645, 2011.
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A HANDHELD MIRROR SIMULATION

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ABSTRACT

We present the design and construction of a handheld mirror simulation device. The perception of the world reflected through a mirror depends on the viewer's position with respect to the mirror and the 3-D geometry of the world. In order to simulate a real mirror on a computer screen, images of the observed world, consistent with the viewer's position, must be synthesized and displayed in real-time. Our system is built around a LCD screen manipulated by the user, a single camera fixed on the screen, and a tracking device. The continuous input video stream and tracker data is used to synthesize, in real-time, a continuous video stream displayed on the LCD screen. The synthesized video stream is a close approximation of what the user would see on the screen surface if it were a real mirror. Our system provides a generic interface for applications involving rich, first-person interaction, such as the Virtual Daguerreotype.

Keywords
Human-Computer Interface; Real-time video processing.

1. INTRODUCTION

We present the design and construction of a handheld mirror simulation device. Rather than attempting to solve the difficult vision problem of a general, exact mirror simulation, our focus is on the design and construction of a first person Human-Computer Interface (HCI) to be used in new interactive experiments and applications. While remaining simple, our first prototype must provide a better experience to the user than the traditional fixed camera / fixed display / horizontal image flip mirror setting. A major novelty in our approach is the hands-on aspect, which requires a more elaborate model to convincingly reproduce the interaction between the user and the mirror as an object. One important clue is the evolution of the user's field of view in the mirror as her position with respect to the mirror changes. Furthermore, our goal is to produce a working but extensible system, to serve as a platform for future enhancements to the HCI device subsystem itself, as well as to allow easy integration in applications.

Our system is composed of a handheld LCD screen manipulated by the user, a single camera fixed on the screen, and two 6 degrees of freedom trackers giving in real time the positions and orientations of the camera and the user's head. The major system components and their relations are illustrated in figure 1. The user sees on the screen what they would see on a real mirror.

The perception of the world reflected through a mirror depends on the viewer's position with respect to the mirror and the

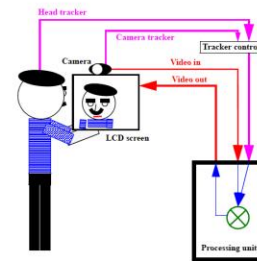


Figure 1. Handheld mirror simulation system.

3-D geometry of the world. In order to simulate a real mirror on a computer screen, images of the observed world, consistent with the viewer's position, must be synthesized and displayed in real-time. The continuous input video stream and tracker data is used to synthesize, in real-time, a continuous video stream displayed on the LCD screen. The synthesized video stream is a close approximation of what the user would see on the screen surface if it were a real mirror.

This paper is organized as follows. In section 2, we outline the geometric analysis of mirror and camera imaging, leading to the image transform for mirror simulation, based on the flat world assumption. In section 3, we briefly explain the software and hardware design of our prototype. In section 4, we relate our work to other mirror experiments, and to upcoming applications. Finally, we conclude the paper in section 5.

2. GEOMETRIC ANALYSIS

2.1 Mirror geometry

When a person looks into a planar mirror, they see what they would see from the symmetrical (virtual) point of view (see figure 2). Assimilating image formation by the eye to a perspective projection, the image perceived by the viewer on the mirror surface is

- Neither Straka nor Francois II was cited in the Petition or Dr. Karam's First Declaration.
- Petitioners and Dr. Karam were aware of both references because they relied on Straka and Francois II in the 109 IPR filed a little over two weeks after the 110 IPR was filed.

Straka (Ex. 1037), Francois II (Ex.1035) (cited: Karam 2nd Decl. (Ex. 1033) ¶¶ 9-10, 16 (cited: Petitioners' Reply (Paper No. 32) at 10,11, 12, 17, 18, 19)).

Petitioners' reliance on *Axonics* is misplaced.

⁷ Even if Petitioners are raising new arguments, which they are not, Petitioners are allowed to “respond to any such new claim construction issues raised by the patent owner.” Practice Guide at 45; *Axonics, Inc. v. Medtronic, Inc.*, 75 F.4th 1374, 1381 (Fed. Cir. 2023).

***Axonics, Inc. v. Medtronic, Inc.*, 75 F.4th 1374 (Fed. Cir. 2023)**

The holding in *Axonics* concerned instances in which the Patent Owner or the Board has proposed a new construction.

“But before the Board decides a case under a construction adopted after the institution decision, it must give a petitioner an opportunity to respond to the new construction, **whether that construction was first proposed by the patent owner or the Board.**”

- Construction at issue in this case is one that Petitioners chose not to address

***Axonics, Inc. v. Medtronic, Inc.*, 75 F.4th 1374 (Fed. Cir. 2023)**

***Axonics* does not authorize a petitioner to rely on new prior art, such as art supplying the missing purported “background knowledge” of a POSITA.**

“That is not to say a petitioner may rely on new prior art in response to a new claim construction presented in the patent owner response. We have held that a petitioner may not in reply rely on new prior art to teach a claim limitation.”

- Petition did not rely on Straka or Francois at all, let alone to establish how limitation 1(f) was met

Petitioners' reliance on *Meta* is misplaced.

- “Rather, we find these arguments properly elaborate on the Petition, in response to the proposed construction of ‘link’ in Patent Owner’s Response.”
 - Unlike in *Meta*, this is ***Petitioners’ own construction*** that it chose not to **address** in its Petition
 - Petitioners here do far more than “elaborate” on the discussion of the Grounds in the Petition

Petitioners' reliance on *Meta* is misplaced.

- “Patent owner does not explain why a reply that cites a **subcomponent** of an item cited in the petition would necessarily go beyond properly elaborating on the arguments in the petition.”
 - Unlike in *Meta*, the double distance, same size requirement is ***not a subcomponent*** of mirror tracking.
 - Petitioners' district court construction imposes additional requirements never addressed in the Petition

Patent Owner Has Not Narrowly Interpreted Petitioners' Construction

- “To the extent any narrowing has been proposed, it is through Patent Owner’s narrow interpretation of the magistrate judge’s recommended construction. For example, in attempting to distinguish Rosenberg, Patent Owner argues that the claims require a “difficult,” “complex,” or “unconventional” transformation to “convincingly mimic[] a conventional mirror,” or “detailed 3D geometric information.” POR, 20, 29, 35, 37; Ex. 2013, ¶¶ 57, 65, 105, 116, 117.”

Petitioners’ Opp. to Mtn. to Strike (Paper No. 45) at 6-7.

However, the ’109 Patent makes clear that mimicking a mirror’s reflection requires *more* than simply displaying a reversed image/video of a user. . . . [T]he ’109 Patent describes that “when a user looks at himself in the mirror, what he actually sees is the reflection of himself as if he was standing at a distance that is *double the distance* from him to the mirror.” . . . Third, when describing conventional mirrors, the ’109 Patent provides that “the angle of the user’s Field of View (FOV) changes when the user changes the distance, e.g., gets closer, to the mirror.” *Id.* at 2:10-12. “Consequently, as illustrated in FIG. 5B, when the user approaches [a conventional] mirror . . . he continues to see the *same size reflection . . . so that the user actually sees himself roughly at the same size*, but closer.” *Id.* at 2:19-23; *see also* 14:25-5

Petitioner Samsung’s Responsive Claim Construction Brief (Ex. 2009) at 13-14.

Haag-Streit AG v. Eidolon Optical, LLC

Petitioners may not attempt to gap-fill with alleged background knowledge that was not previously argued for limitation 1(f).

We do not agree with Petitioner’s position. Although Petitioner does not seek to *formally* change the asserted ground at issue to add Nishizawa, with the discussion in the Reply summarized above (and the related testimony of Dr. Jiao), Petitioner improperly seeks to rely on Nishizawa to set forth new positions to address the “electrical resistor” limitation—i.e., not merely to show the state of the art at the time of the invention, as asserted. Mot. 3–4; *see* Trial Practice Guide Update, 15 (“It is also improper to present in reply new evidence (including new expert testimony) that could have been presented in a prior filing, for example newly cited prior art references intended to ‘gap-fill’ by teaching a claim element that was not present in the prior art presented with the petition.”).

Haag-Streit AG v. Eidolon Optical, LLC

Petitioners' argument that there is no attempt to gap-fill or offer an alternative was the same argument rejected in *Haag-Streit*.

For example, in the Reply, Petitioner provides Nishizawa as evidence of the new position that the prior art, *in general*, taught the use of a fixed “electrical resistor.” See Pet. Reply 34. This understanding is supported by Petitioner’s statement that one of ordinary skill in the art “would be motivated to combine *any resistor, whether variable or not*, with an LED knowing that current must be limited for the LED” (Pet. Reply 34 (emphasis added)), which implicitly frames Nishizawa’s resistor as *an alternative* to the “variable” resistor Patent Owner argues Devonshire discloses. See PO

Haag-Streit AG v. Eidolon Optical, LLC

Petitioners attempt to gap-fill with alleged background knowledge that was not previously argued for limitation 1(f).

exhibit until filing the Reply. For the first time in the Reply, Petitioner discusses the prosecution history of the '796 application to set forth new positions to address the added limitations in claims 9 and 10. Mot. 6. Specifically, we agree with Patent Owner, that with the discussion in the Reply summarized above (and the related testimony of Dr. Jiao), Petitioner improperly seeks to rely on the common knowledge of one of ordinary skill in the art—as an *alternative* to Longobardi—to address the added limitations recited in claims 9 and 10. See Mot. 6 (arguing “Petitioner tries to gap-fill

Only Petitioners' Reply Contends That *Haan/Francois* Discloses Or Renders Obvious the Double Distance, Same Size Requirement

The Petition and Dr. Karam's testimony also show how Haan teaches "double the distance" (i.e. displaying the image in accordance with the user's distance from the mirror/camera). Pet., 36, 45; EX1003, ¶99. Therefore, a POSITA would have understood that Haan teaches displaying an image with the optical properties of a mirror, which require the image to maintain the same size and double the distance.

Ground 1: Reply Relies on Previously Undisclosed Background Art

Dr. Karam offers new opinions based on previously undisclosed art.

A Free-Viewpoint Virtual Mirror with Marker-Less User Interaction

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Abstract. We present a Virtual Mirror system which is able to simulate a physically correct full-body mirror on a monitor. In addition, users can freely rotate the mirror image which allows them to look at themselves from the side or from the back, for example. This is achieved through a multiple camera system and visual hull based rendering. A real-time 3D reconstruction and rendering pipeline enables us to create a virtual mirror image at 15 frames per second on a single computer. Moreover, it is possible to extract a three dimensional skeleton of the user which is the basis for marker-less interaction with the system.

Keywords: Virtual Mirror, Shape-from-Silhouette, CUDA, Markerless User-Interaction, Free-Viewpoint Video.

1 Introduction

A virtual mirror is an Augmented Reality (AR) system which renders an image of the user from a virtual viewpoint and creates the illusion of a mirror image. In addition to that, it allows to add virtual objects and to modify the image in a way that is not possible with physical mirrors. In this paper, we propose a physically correct simulation of a full-body mirror using a multi-camera system and a single monitor. We also extend its viewing capabilities by allowing users to rotate their mirror image using solely natural hand gestures. This is beneficial, for example, in dressing rooms where users want to see how they look from the side or from behind in new clothes.

The concept of a virtual mirror is not new in the area of computer vision and AR [5,6]. One common property of existing virtual mirror systems is that they consist of a single camera with a fixed position where the horizontally flipped video stream is shown to the user on a monitor. However, such systems generally do not allow one to simulate a correct mirror because video devices are only able to capture a projected image and not the reflection of the user from his viewpoint. Free viewpoint video systems on the other hand are able to render an arbitrary view of a person by combining images from multiple fixed cameras [3,9,18]. This allows for the accurate simulation of optical effects, including rendering of a reflection image. Due to the amount of image data,

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A HANDHELD MIRROR SIMULATION

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ABSTRACT

We present the design and construction of a handheld mirror simulation device. The perception of the world reflected through a mirror depends on the viewer's position with respect to the mirror and the 3-D geometry of the world. In order to simulate a real mirror on a computer screen, images of the observed world, consistent with the viewer's position, must be synthesized and displayed in real-time. Our system is built around a LCD screen manipulated by the user, a single camera fixed on the screen, and a tracking device. The continuous input video stream and tracker data is used to synthesize, in real-time, a continuous video stream displayed on the LCD screen. The synthesized video stream is a close approximation of what the user would see on the screen surface if it were a real mirror. Our system provides a generic interface for applications involving rich, first-person interaction, such as the Virtual Daguerreotype.

Keywords
Human-Computer Interface; Real-time video processing.

1. INTRODUCTION

We present the design and construction of a handheld mirror simulation device. Rather than attempting to solve the difficult vision problem of a general, exact mirror simulation, our focus is on the design and construction of a first person Human-Computer Interface (HCI) to be used in new interactive experiments and applications. While remaining simple, our first prototype must provide a better experience to the user than the traditional fixed camera / fixed display / horizontal image flip mirror setting. A major novelty in our approach is the hands-on aspect, which requires a more elaborate model to convincingly reproduce the interaction between the user and the mirror as an object. One important clue is the evolution of the user's field of view in the mirror as her position with respect to the mirror changes. Furthermore, our goal is to produce a working but extensible system, to serve as a platform for future enhancements to the HCI device subsystem itself, as well as to allow easy integration in applications.

Our system is composed of a handheld LCD screen manipulated by the user, a single camera fixed on the screen, and two 6 degrees of freedom trackers giving in real time the positions and orientations of the camera and the user's head. The major system components and their relations are illustrated in figure 1. The user sees on the screen what they would see on a real mirror.

The perception of the world reflected through a mirror depends on the viewer's position with respect to the mirror and the

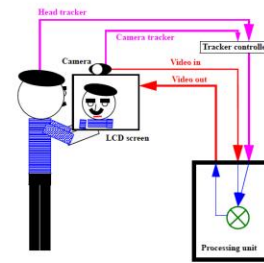


Figure 1. Handheld mirror simulation system.

3-D geometry of the world. In order to simulate a real mirror on a computer screen, images of the observed world, consistent with the viewer's position, must be synthesized and displayed in real-time. The continuous input video stream and tracker data is used to synthesize, in real-time, a continuous video stream displayed on the LCD screen. The synthesized video stream is a close approximation of what the user would see on the screen surface if it were a real mirror.

This paper is organized as follows. In section 2, we outline the geometric analysis of mirror and camera imaging, leading to the image transform for mirror simulation, based on the flat world assumption. In section 3, we briefly explain the software and hardware design of our prototype. In section 4, we relate our work to other mirror experiments, and to upcoming applications. Finally, we conclude the paper in section 5.

2. GEOMETRIC ANALYSIS

2.1 Mirror geometry

When a person looks into a planar mirror, they see what they would see from the symmetrical (virtual) point of view (see figure 2). Assimilating image formation by the eye to a perspective projection, the image perceived by the viewer on the mirror surface is

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- Petitioners and Dr. Karam were aware of both references because they relied on Straka and Francois II in the 109 IPR filed a little over two weeks after the 110 IPR was filed.

Straka (Ex. 1037), Francois II (Ex.1035) (cited: Karam 2nd Decl. (Ex. 1033) ¶¶ 9-10, 16 (cited: Petitioners' Reply (Paper No. 32) at 10,11, 12, 17, 18, 19)).

Ground 1: *Haan/Francois* Does Not Disclose or Render Obvious Limitation 1(f)

Haan's disclosure of magnification is contrary to a traditional mirror.

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

[0076] For distances d larger than a threshold value, for instance in this example 35 cm distance, the magnification is kept at a fixed value of, in this example 1. This can be done for instance by using the device as a simple mirror, i.e. not displaying an image on the display device, but using the device in the reflective mode. For smaller distances, as the viewer moves his head or torso closer to the display screen, an enlarged image is displayed, i.e. with a magnification larger than 1. To avoid a sudden jump in the image there is a smooth transition between the two regions. In embodiment there can be a range of distances for which the magnification factor is less than 1. This can be for instance useful when a hat is tried on, a normal mirror would show the face, but only part of the hat. By using a magnification smaller than 1, it does become possible to see the hat even at relatively small distances from the mirror. This would also be useful in small size changing cubicles.

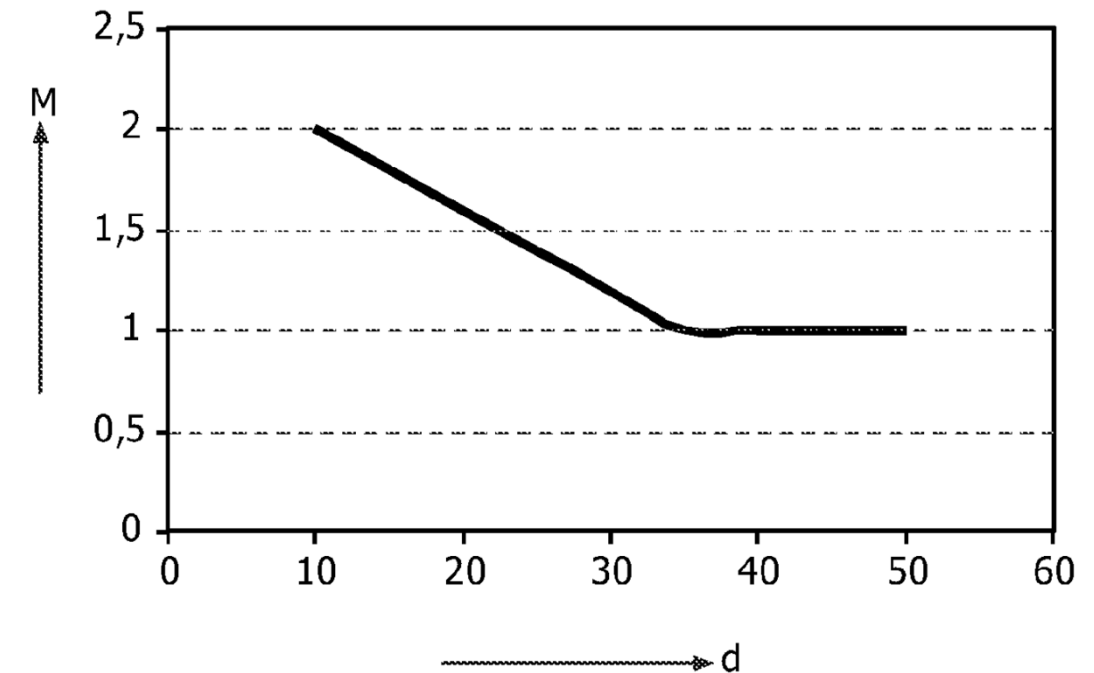


FIG. 8

Ground 1: Haan Teaches Away From a Traditional Mirror

Declaration of Dr. Forsyth

76. In paragraphs 72 through 76 and Figures 7 and 8 of Haan, Haan discloses changing the magnification of the user's image as the user's distance from the camera changes. This disclosure is contrary to how a conventional mirror operates. With a conventional mirror, the image of the person looking into the mirror will stay the same size regardless of the person's movement toward or away from the mirror. A POSITA would have known these disclosures in Haan to be contrary to a conventional mirror and would have regarded them to mean that Haan expressly chose to depart from implementing the optical property of a conventional mirror, whereby the size of the user is approximately the same regardless of movement toward or away from the camera. For example, as discussed above in Section II.B.

Ground 1: Haan Teaches Away From a Traditional Mirror

Declaration of Dr. Forsyth

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

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

Ground 1: Haan Misstates Basic Camera Properties

Haan contains a gross error regarding camera properties.

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

Ground 1: Haan Misstates Basic Camera Properties

Declaration of Dr. Forsyth

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

Ground 1: Francois Does Not Disclose Limitation 1(f)

Declaration of Dr. Forsyth

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

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

GROUND 1: NO MOTIVATION TO COMBINE FOR LIMITATION 1(f)

Ground 1: No Motivation to Combine Haan & Francois

Declaration of Dr. Forsyth

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

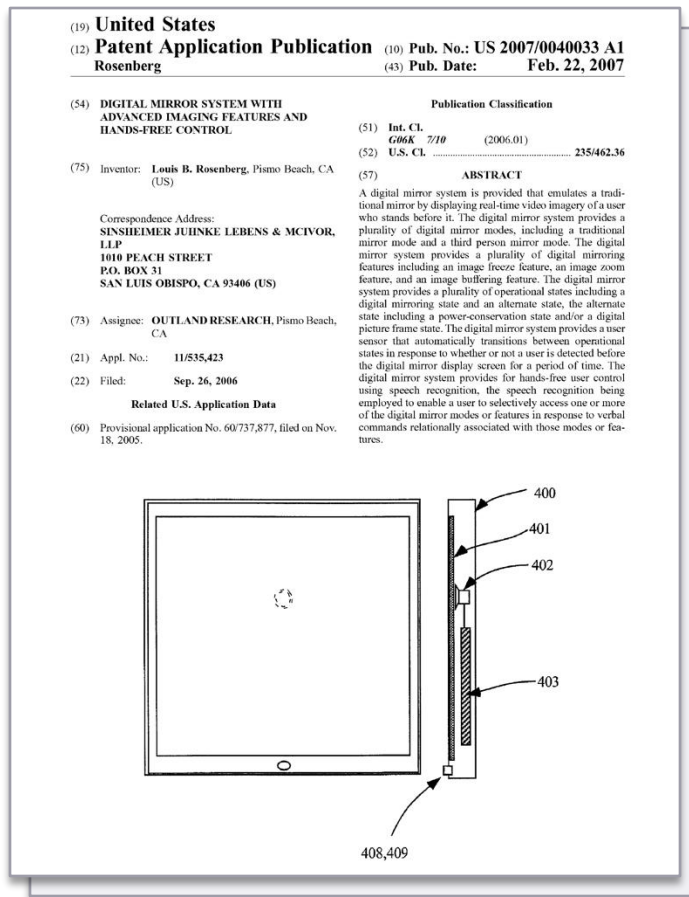
85. Additionally, a POSITA would not have been motivated to combine Haan and Francois because Haan teaches away from having a user's image appear at roughly the same size regardless of the user's distance to the camera and because Francois only discloses basic image inversion and does not disclose the user appearing at roughly double the distance to the camera nor appearing at roughly the same size regardless of user movement.

- Whether the Board should adopt Petitioners' district court construction of **“mirror tracking mode”**
- Whether the Asserted Grounds disclose or render obvious limitation 1(f): **“wherein during mirror tracking mode the processor utilizes the angle of the images captured by the camera. . .”**
 - Ground 1 (and 4): Haan and Francois
 - **Ground 2 (and 5): Rosenberg and Park**
 - Ground 3: Geisner and Lizée

GROUND 2 DOES NOT DISCLOSE OR RENDER OBVIOUS LIMITATION 1(f)

Ground 2 Asserted Art: Rosenberg

Rosenberg mimics a mirror by simply inverting a user's image.

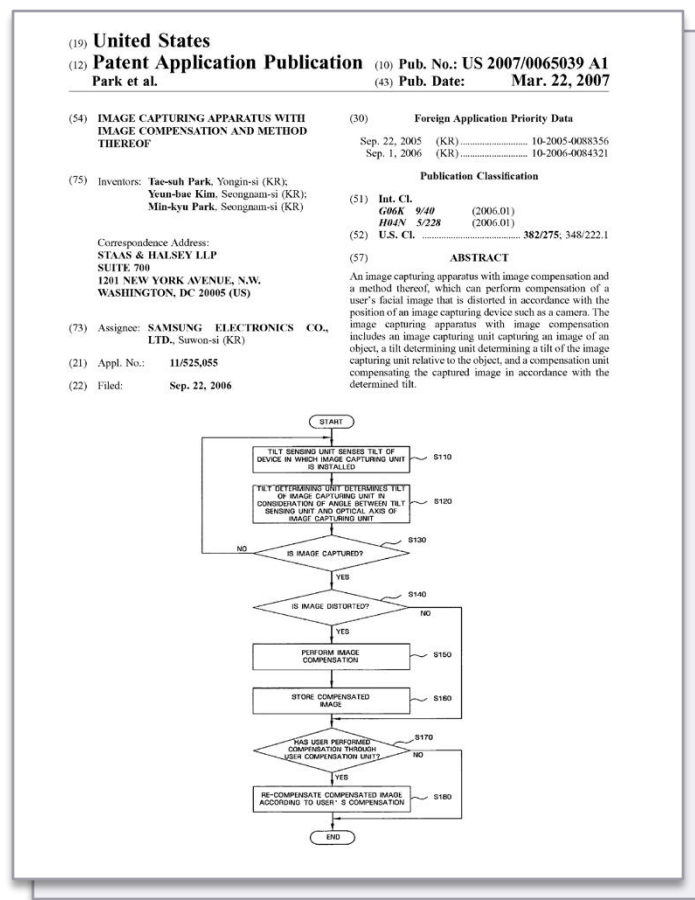


- “The digital mirror system is adapted to provide real-time captured images that approximate what a user would see when viewing an ordinary mirror, with the addition of various other image processing features.” Rosenberg (Ex. 1006), ¶ [0006]
(cited: Petition (Paper No. 1) at 18).
- In “traditional mirror emulation mode, the digital mirror is operative to replicate the performance of a standard household mirror, providing the user with a left-right reversed frontal image of himself or herself when standing before the display.” Rosenberg (Ex. 1006), ¶ [0027]
(cited: Petition (Paper No. 1) at 54).
- “When in a traditional mirror emulation mode, the frozen image is a left-right inverted image of the user.” Rosenberg (Ex. 1006), ¶ [0039]
(cited: POR (Paper No. 27) at 32).
- “For example, a typical verbal command used to switch modes between the traditional mirror emulation mode and the third-person mirror mode is ‘flip’ because the user is flipping the image left-right about a vertical centerline.” Rosenberg (Ex. 1006), ¶ [0041]
(cited: Karam 2nd Decl. (Ex. 1033) ¶ 13) cited: Petitioners’ Reply at 10).

Ground 2 Asserted Art: Park

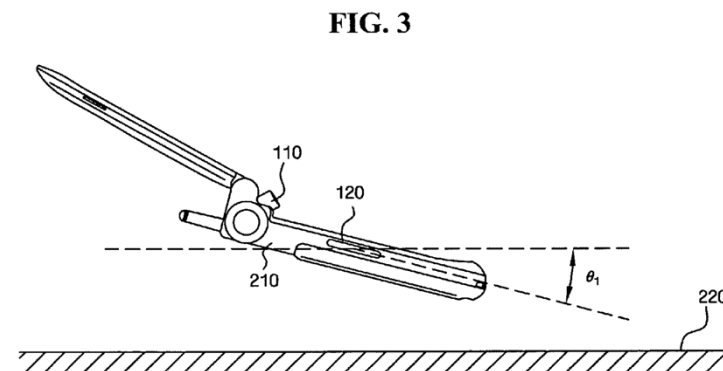
Park is directed to tilt correction, such as when a user takes a picture while looking down towards a camera.

- “An aspect of the present invention provides an image capturing apparatus with image compensation and a method thereof, which can obtain an image desired by a user by determining the tilt status of a mobile communication device that captures the image of an object and performing compensation of the captured image in accordance with the determined tilt status of the device during a video telephony using the mobile communication device.” Park (Ex. 1011), ¶ [0010]
- “[T]he image sensing unit 120 can sense the tilt between the person and the image capturing unit from a relative position between facial feature points of the person, using the image captured by the image capturing unit 110.” Park (Ex. 1011), ¶ [0041]



DEMONSTRATIVE EXHIBIT – NOT EVIDENCE

(cited: POR (Paper No. 27) at 7).



Ground 2: Petition Does Not Show Or Even Address How *Rosenberg/Park* Discloses Double Distance, Same Size Requirement

Rosenberg-Park renders obvious this limitation. EX1003, ¶¶269-276.

Rosenberg teaches a mirror tracking mode, which detects whether “a user is physically present.” EX1006, [0025], [0032]-[0033], [0056], [0069]-[0073], [0109], [0114], Fig. 13; *see* EX1003, ¶270. When a proximity sensor detects a user within a specified proximity range, the system automatically engages its mirror mode (“mirror tracking mode”). EX1006, [0025], [0026], [0028], [0035], [0077]; EX1003, ¶270. When the sensor detects the user is no longer before the mirror, the system automatically switches to a digital picture frame state. EX1006, [0083], [0114], [0025], [0032]-[0033], [0056], [0069]-[0073], [0109]; EX1003, ¶271. Rosenberg also discloses the digital camera can be used, alone or with other sensors, to provide proximity/motion sensing functionality. EX1006, [0034], [0069], [0073], [0109], Fig. 13; EX1003, ¶271.

Ground 2: Petitioners' Expert Did Not Show How *Rosenberg/Park* Met The Double Distance, Same Size Requirement

269. Rosenberg in view of Park renders obvious this limitation.

270. **Rosenberg teaches a mirror tracking mode**. For example, Rosenberg discloses a “sensor for detecting when a user is physically present before and/or approaches and/or stands before the display screen of the mirror within some proximity range.” Ex. 1006 (Rosenberg) at [0025] (also teaching **“the system automatically enters a mirroring mode when a user steps in front of the display screen for more than a threshold amount of time”**); *see also* Ex. 1006 (Rosenberg) t [0032]-[0033], [0056], [0069]-[0073], [0109], [0114], Fig. 13. When the sensor disclosed in Rosenberg detects that the user is within a specified proximity range, the virtual mirror system **“automatically engages the digital mirror functionality of the present invention.”** Ex. 1006 (Rosenberg) at [0025]. In other words, Rosenberg’s system detects the presence of a user to automatically engage a mirror mode. *See* Ex. 1006 (Rosenberg) at [0026], [0028], [0035], [0077]. A POSITA would have understood this discloses a “mirror tracking mode” because during the mirror mode, real-time images of the user captured by the camera are modified (e.g., left-right inversion, scaling) to generate and display real-time mirror images to the user.

Ground 2: Only Petitioners' Reply Contends That *Rosenberg/Park* Discloses Or Renders Obvious the Double Distance, Same Size Requirement

PO contends that Rosenberg and Park do not disclose limitation 1(f). POR, 31. As discussed in the Petition, the combination discloses the “mirror tracking mode” at least because Rosenberg discloses a digital mirror system that replicates the properties of a traditional mirror. Pet., 18-19, 56, 64-67; EX1006, Abstract (“A digital mirror system ...that *emulates a traditional mirror* ...”); EX1006, [0003] (Background) (“One of the oldest pieces of technology known to humankind is the mirror....the basic operation of the mirror has remained largely unchanged for thousands of years.”), [0075], [0077]; EX1034 at 142:21-143:1 (“Q So Rosenberg discloses a digital mirror system. Correct? A That’s correct.”). A POSITA would further understand that emulating a traditional mirror includes the reverse-reflection, double-distance, same-size features recited in the Magistrate’s construction, even if the Board were to apply that construction here. *See supra* § 0; *see also* EX1034 at 143:8-12; 145:13-20.

Additionally, a POSITA would have understood Rosenberg to display user images at a doubled distance and same size. EX2012, 61:8-12; 60:16-20. Rosenberg discloses a digital mirror system “with a displayed size and scaling such that it appears like *a traditional life-size mirror image*.” EX1006, [0077]. A POSITA would have understood that to display a user image appearing “like a traditional life-size mirror image,” Rosenberg/Park’s image would be scaled to maintain the same size of the user reflection. EX1033, ¶10. The scaled image would also appear to the user as it were positioned at a virtual location behind the display, at a distance twice that from the user to the screen. EX1033, ¶12, 14; *see also* EX1034, 52:11-18, 55:11-56:6 (both scaling and changing point of view of camera changes image size); *see supra* § III.A.1.e. Therefore, Rosenberg discloses, or at least renders obvious, displaying a user image at double the distance while maintaining the same size of the image.

Ground 2: Reply Relies on Previously Undisclosed Background Art

Dr. Karam offers new opinions based on previously undisclosed art.

A Free-Viewpoint Virtual Mirror with Marker-Less User Interaction

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We present the design and construction of a handheld mirror simulation device. Rather than attempting to solve the difficult vision problem of a general, exact mirror simulation, our focus is on the design and construction of a first person Human-Computer Interface (HCI) to be used in new interactive experiments and applications. While remaining simple, our first prototype must provide a better experience to the user than the traditional fixed camera / fixed display / horizontal image flip mirror setting. A major novelty in our approach is the hands-on aspect, which requires a more elaborate model to convincingly reproduce the interaction between the user and the mirror as an object. One important clue is the evolution of the user's field of view in the mirror as her position with respect to the mirror changes. Furthermore, our goal is to produce a working but extensible system, to serve as a platform for future enhancements to the HCI device subsystem itself, as well as to allow easy integration in applications.

Our system is composed of a handheld LCD screen manipulated by the user, a single camera fixed on the screen, and two 6 degrees of freedom trackers giving in real time the positions and orientations of the camera and the user's head. The major system components and their relations are illustrated in figure 1. The user sees on the screen what they would see on a real mirror.

The perception of the world reflected through a mirror depends on the viewer's position with respect to the mirror and the

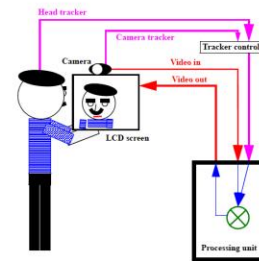


Figure 1. Handheld mirror simulation system.

3-D geometry of the world. In order to simulate a real mirror on a computer screen, images of the observed world, consistent with the viewer's position, must be synthesized and displayed in real-time. The continuous input video stream and tracker data is used to synthesize, in real-time, a continuous video stream displayed on the LCD screen. The synthesized video stream is a close approximation of what the user would see on the screen surface if it were a real mirror.

This paper is organized as follows. In section 2, we outline the geometric analysis of mirror and camera imaging, leading to the image transform for mirror simulation, based on the flat world assumption. In section 3, we briefly explain the software and hardware design of our prototype. In section 4, we relate our work to other mirror experiments, and to upcoming applications. Finally, we conclude the paper in section 5.

2. GEOMETRIC ANALYSIS

2.1 Mirror geometry

When a person looks into a planar mirror, they see what they would see from the symmetrical (virtual) point of view (see figure 2). Assimilating image formation by the eye to a perspective projection, the image perceived by the viewer on the mirror surface is

- Neither Straka nor Francois II was cited in the Petition or Dr. Karam's First Declaration.
- Petitioners and Dr. Karam were aware of both references because they relied on Straka and Francois II in the 109 IPR filed a little over two weeks after the 110 IPR was filed.

Straka (Ex. 1037), Francois II (Ex.1035) (cited: Karam 2nd Decl. (Ex. 1033) ¶¶ 9-10, 16 (cited: Petitioners' Reply (Paper No. 32) at 10,11, 12, 17, 18, 19)).

Petition Must Include All Arguments for Unpatentability

Petitioners were required to present all their arguments for unpatentability in their Petitions.

“Petitioner may not submit new evidence or argument in reply that it could have presented earlier, e.g. to make out a prima facie case of unpatentability.”

“It is also improper for a reply to present new evidence (including new expert testimony) that could have been presented in a prior filing, for example, newly cited prior art references intended to ‘gap-fill’ by teaching a claim element that was not present in the prior art presented with the petition.”

Ground 2: Only Petitioners' Reply Contends That *Rosenberg/Park* Discloses Or Renders Obvious the Double Distance, Same Size Requirement

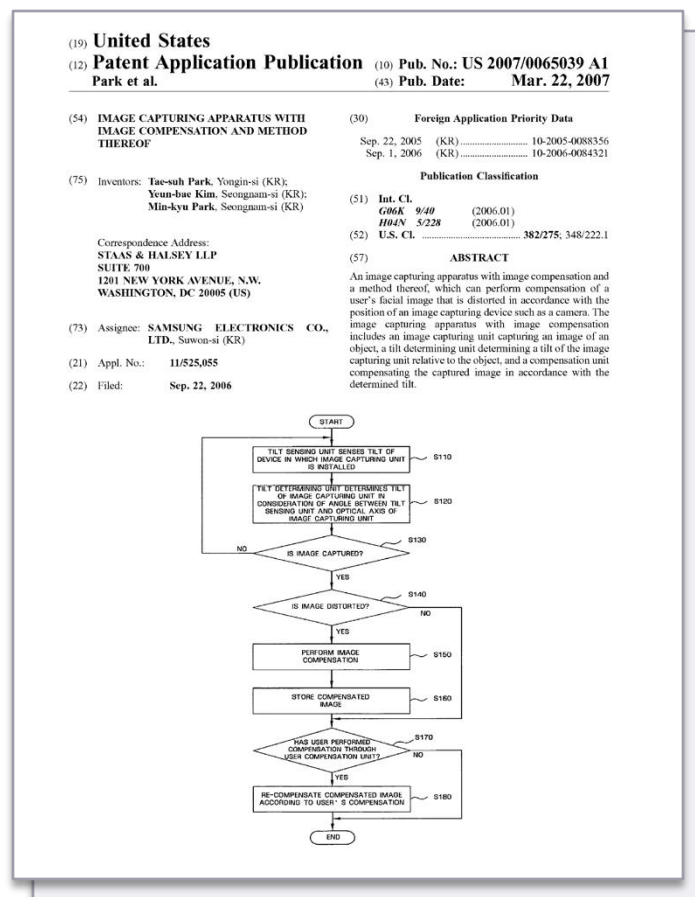
PO contends that Rosenberg and Park do not disclose limitation 1(f). POR, 31. As discussed in the Petition, the combination discloses the “mirror tracking mode” at least because Rosenberg discloses a digital mirror system that replicates the properties of a traditional mirror. Pet., 18-19, 56, 64-67; EX1006, Abstract (“A digital mirror system ...that *emulates a traditional mirror* ...”); EX1006, [0003] (Background) (“One of the oldest pieces of technology known to humankind is the mirror....the basic operation of the mirror has remained largely unchanged for thousands of years.”), [0075], [0077]; EX1034 at 142:21-143:1 (“Q So Rosenberg discloses a digital mirror system. Correct? A That’s correct.”). A POSITA would further understand that emulating a traditional mirror includes the reverse-reflection, double-distance, same-size features recited in the Magistrate’s construction, even if the Board were to apply that construction here. *See supra* § 0; *see also* EX1034 at 143:8-12; 145:13-20.

Additionally, a POSITA would have understood Rosenberg to display user images at a doubled distance and same size. EX2012, 61:8-12; 60:16-20. Rosenberg discloses a digital mirror system “with a displayed size and scaling such that it appears like *a traditional life-size mirror image*.” EX1006, [0077]. A POSITA would have understood that to display a user image appearing “like a traditional life-size mirror image,” Rosenberg/Park’s image would be scaled to maintain the same size of the user reflection. EX1033, ¶10. The scaled image would also appear to the user as it were positioned at a virtual location behind the display, at a distance twice that from the user to the screen. EX1033, ¶12, 14; *see also* EX1034, 52:11-18, 55:11-56:6 (both scaling and changing point of view of camera changes image size); *see supra* § III.A.1.e. Therefore, Rosenberg discloses, or at least renders obvious, displaying a user image at double the distance while maintaining the same size of the image.

Park's Disclosure of Tilt Correction is Unrelated to Mirror Mimicking

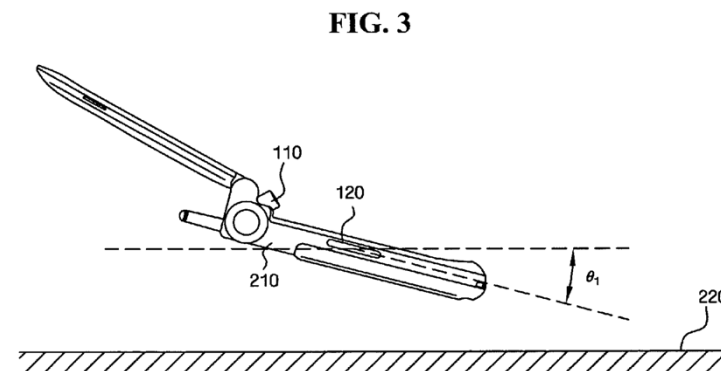
Park is directed to tilt correction, such as when a user takes a picture while looking down towards a camera.

- “An aspect of the present invention provides an image capturing apparatus with image compensation and a method thereof, which can obtain an image desired by a user by determining the tilt status of a mobile communication device that captures the image of an object and performing compensation of the captured image in accordance with the determined tilt status of the device during a video telephony using the mobile communication device.” Park (Ex. 1011), ¶ [0010]
- “[T]he image sensing unit 120 can sense the tilt between the person and the image capturing unit from a relative position between facial feature points of the person, using the image captured by the image capturing unit 110.” Park (Ex. 1011), ¶ [0041]



DEMONSTRATIVE EXHIBIT – NOT EVIDENCE

(cited: POR (Paper No. 27) at 7).



Ground 2: Park Does Not Disclose Or Render Obvious Limitation 1(f)

Declaration of Dr. Forsyth

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

Ground 2: Petitioners' Cited Material From Rosenberg Does Not Show District Court Construction Is Met

Additionally, a POSITA would have understood Rosenberg to display user images at a doubled distance and same size. EX2012, 61:8-12; 60:16-20. Rosenberg discloses a digital mirror system “with a displayed size and scaling such that it appears like *a traditional life-size mirror image*.” EX1006, [0077]. A POSITA would have understood that to display a user image appearing “like a traditional life-size mirror image,” Rosenberg/Park’s image would be scaled to maintain the same size of the user reflection. EX1033, ¶10. The scaled image would also appear to the user as it were positioned at a virtual location behind the display, at a distance twice that from the user to the screen. EX1033, ¶12, 14; *see also* EX1034, 52:11-18, 55:11-56:6 (both scaling and changing point of view of camera changes image size); *see supra* § III.A.1.e. Therefore, Rosenberg discloses, or at least renders obvious, displaying a user image at double the distance while maintaining the same size of the image.

- Citations do not establish why or how a POSITA would understand *Rosenberg/Park* to disclose transformations of images such that the images:

- appear roughly double the distance to the user

AND

- Maintain roughly the same size regardless of user movement

Ground 2: Scaling in Rosenberg

Dr. Karam opined that paragraph 77 of Rosenberg meets the district court's construction.

3 "A representation of that
4 real-time video image is then
5 displayed upon the wall-mounted
6 screen of the digital mirror with a
7 displayed size and scaling such that
8 it appears like a traditional
9 life-size mirror image."

10 So indeed a POSITA would
11 understand that Rosenberg is teaching and
12 disclosing his invention is capable or is
13 teaching, disclosing his invention can make
14 the person see himself or herself as appearing
15 in a traditional life-size mirror.

Karam Dep. (Ex. 2012) at 60:3-15 (cited: Petitioners' Reply (Paper No. 32) at 17).

[0077] FIG. 5 illustrates a computer rendering of a human user 501 standing in front of a wall-mounted embodiment of the advanced digital mirror system 502 according to at least one embodiment of the present invention. The user's image is captured as a real-time video image by a camera upon or within the digital mirror 502 as described previously. A representation of that real-time video image is then displayed upon the wall mounted screen of the digital mirror 502 with a displayed size and scaling such that it appears like a traditional life-size mirror image 503. In a traditional mirror emulation mode, the real-time video image is left-right inverted prior to display upon the screen. Thus the user 501 standing before the digital display is given the visual impression that he or she is standing before a traditional wall mirror, viewing a traditional mirror image of himself or herself.

Rosenberg (Ex. 1006), ¶ 0077 (cited: POR (Paper No. 27) at 36).

Ground 2: Rosenberg Never Discloses the Double Distance, Same Size Requirement

FIG. 5 illustrates a computer rendering of a human user **501** standing in front of a wall-mounted embodiment of the advanced digital mirror system **502** according to at least one embodiment of the present invention. The user's image is captured as a real-time video image by a camera upon or within the digital mirror **502** as described previously. A representation of that real-time video image is then displayed upon the wall mounted screen of the digital mirror **502** with a displayed size and scaling such that it appears like a traditional life-size mirror image **503**. In a traditional mirror emulation mode, the real-time video image is left-right inverted prior to display upon the screen. Thus the user **501** standing before the digital display is given the visual impression that he or she is standing before a traditional wall mirror, viewing a traditional mirror image of himself or herself.

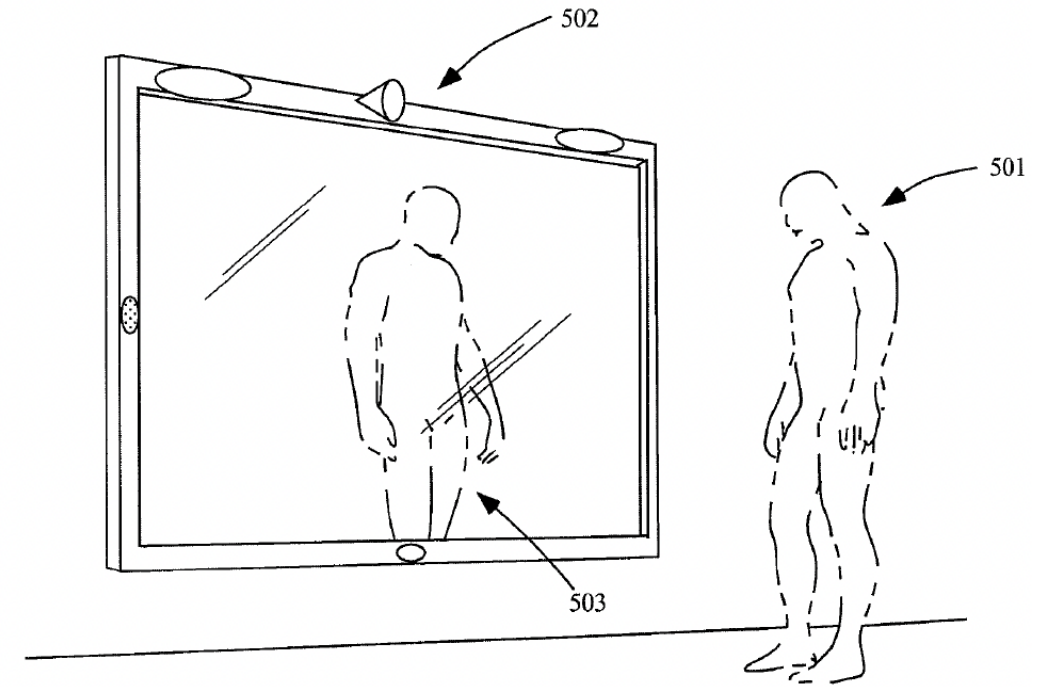


Fig. 5

Ground 2: Rosenberg Mirror Mimicking Is Simple Inversion

A POSITA would have understood paragraph 77 in the context of Rosenberg's teaching that mimicking a traditional mirror only requires simple inversion.

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

Ground 2: Rosenberg Teaches Away From Double the Distance

Rosenberg

Thus a user may be looking in the mirror, engage the mirror image-freeze feature, and have the then current (or substantially current) image that was displayed upon engaging the feature, freeze upon the screen for an extended period. This will allow the user, for example, to examine the frozen image in detail. This is particularly useful for a user who wishes to change his or her distance and/or location with respect to the mirror to get a better view of his or her image, but NOT have the image change as the user moves. For example, a user may wish to step closer to the mirror and view a portion of his or her face from only a few inches away. With a traditional optical mirror, such an act would cause the reflected image to change such that the user who is just a few inches away ends up staring into his or her own eyes. In reality he may wish to freeze the image, step close, and then view some other portion of the face. The mirror image-freeze feature of the present invention enables this enhanced mirroring operation.

Ground 2: A POSITA Would Regard Rosenberg As Teaching Away

Declaration of Dr. Forsyth

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

Ground 2: A POSITA Would Regard Rosenberg As Teaching Away

Declaration of Dr. Forsyth

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

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

Importance of These Properties Was Not Obvious

Even if known, it would not have been obvious to a POSITA that these conventional mirror properties were important enough to implement.

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

Dr. Forsyth: Importance of Double Distance, Same Size Was Not Obvious

Q: Is it your opinion that providing double the distance in same size properties of a conventional mirror more difficult and more complex than flipping the image?

A: Yes.

Q: In your view, a POSITA would not know how to implement these known conventional mirror properties with known transformation techniques?

A: I think my view is stated that a POSITA would not have realized it was important. And the support for that view in the fact that Rosenberg doesn't do it, nor do a number of other people.

Q: So in your opinion, a POSITA would not have realized those features are important?

A: In my opinion, a POSITA -- a POSITA would not have realized those features were important. And a number of documents I've looked at here describe mirror emulation without having those features, suggesting that authors at the time did not realize that it was important either.

GROUND 2: NO MOTIVATION TO COMBINE FOR LIMITATION 1(f)

Ground 2: No Motivation to Combine *Rosenberg/Park*

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

111. Additionally, a POSITA would not have been motivated to combine Rosenberg and Park because Rosenberg teaches away from having a user's image appear at roughly the same size regardless of the user's distance to the camera (Ex. 1006, ¶ 0039) and because Park, at most, only discloses basic image inversion and does not disclose the user appearing at roughly double the distance to the camera nor appearing at roughly the same size regardless of user movement.

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

GROUND 4 DOES NOT DISCLOSE OR RENDER OBVIOUS LIMITATION 1(f)

Ground 4 Relies On *Haan/Francois*, Which Does Not Disclose Or Render Obvious Limitation 1(f)

Haan in view of Francois renders obvious claim 1 (from which claims 7-9, 13-15, 18 depend). *Supra* §IX.B. Geisner teaches the additional limitations in claims 7-9, 13-15, and 18. EX1003, ¶393; §§XI.C.iv-v, XI.C.viii-x, §XI.C.xii. A POSITA would have been motivated to combine Haan, Francois, and Geisner to achieve the alleged inventions in claims 7-9, 13-15, 18 with a reasonable expectation of success, as discussed above. EX1003¶¶389-396.

GROUND 5 DOES NOT DISCLOSE OR RENDER OBVIOUS LIMITATION 1(f)

Ground 5 Relies On *Rosenberg/Park*, Which Does Not Disclose Or Render Obvious Limitation 1(f)

XIII. Ground 5: Rosenberg in view of Park and Geisner renders obvious claims 3-4, 7-9, and 11-18

Rosenberg-Park-Geisner renders obvious claims 3-4, 7-9, and 11-18.

EX1003, ¶¶397-399.

As explained, it would have been obvious to combine Rosenberg and Park.

Supra §X.A; EX1003, ¶397. A POSITA would have found it obvious to add Geisner to the combination. Geisner is analogous to Rosenberg, Park, and the '110 Patent because they are in the same field of endeavor. EX1003, ¶398; *supra* §§X.A, XI.A.



THANK YOU