

Paper No. ____

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

VALVE CORPORATION.
Petitioner,

v.

IMMERSION CORPORATION,
Patent Owner.

Case No. TBD

Patent No. 9,116,546

PETITION FOR *INTER PARTES* REVIEW
UNDER 35 U.S.C. §§ 311-319 AND 37 C.F.R. § 42.1 *et seq.*

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APPENDIX LISTING OF EXHIBITS

Exhibit	Description
1001	U.S. Patent No. 9,116,546
1002	Prosecution History of U.S. Patent No. 9,116,546
1003	Declaration of Dr. Gregory Welch (“Welch”)
1004	CV of Dr. Gregory Welch
1005	Plaintiff’s Preliminary Infringement Contentions, <i>Immersion Corp. v. Valve Corp.</i> , 2:23-cv-00712 (W.D. Wash.) (served Oct. 20, 2023)
1006	Exhibit D to Plaintiff’s Preliminary Infringement Contentions, <i>Immersion Corp. v. Valve Corp.</i> , 2:23-cv-00712 (W.D. Wash.) (served Oct. 20, 2023)
1007	Amended Joint Status Report and Discovery Plan, <i>Immersion Corp. v. Valve Corp.</i> , 2:23-cv-00712, Dkt No. 42 (W.D. Wash) (filed Oct. 18, 2023)
1008	U.S. Patent Application Publication No. 2002/0120188 (“Brock”)
1009	U.S. Patent Application Publication No. 2007/0106457 (“Rosenberg”)
1010	U.S. Patent Application Publication No. 2006/0103634 (“Kim”)
1011	U.S. Patent Application Publication No. 2009/0189746 (“Ullrich ’746”)
1012	U.S. Patent Application Publication No. 2010/0253525 (“Engel”)
1013	U.S. Patent Application Publication No. 2010/0283731 (“Grant ’731”)
1014	U.S. Patent Application Publication No. 2011/0046659 (“Ramstein”)
1015	New Oxford American Dictionary, Third Edition (2010), definition of “parameter”
1016	The American Heritage Dictionary, Fifth Edition (2011), definition of “parameter”
1017	<i>Apple Inc. v. Immersion Corp.</i> , IPR2016-01372, Paper 35 (Jan. 11, 2018) (Final Written Decision)

1018	G. Paschew and A. Richter, “High-resolution tactile display operated by an integrated ‘Smart Hydrogel’ actuator array.” In Y. Bar-Cohen, editor, <i>Electroactive Polymer Actuators and Devices (EAPAD) 2010</i> , Vol. 7642, p. 764234. International Society for Optics and Photonics, SPIE, 2010.
1019	New Oxford American Dictionary, Third Edition (2010), definition of “pressure”
1020	The American Heritage Dictionary, Fifth Edition (2011), definition of “pressure”
1021	U.S. Patent Application Publication No. 2012/0249474 (“Pratt”)
1022	U.S. Patent Application Publication No. 2012/0143182 (“Ullrich ’182”)
1023	New Oxford American Dictionary, Third Edition (2010), definitions of “actuator” and “actuate”
1024	The American Heritage Dictionary, Fifth Edition (2011), definitions of “actuator” and “actuate”
1025	U.S. Patent Application Publication No. 2009/0106655 (“Grant ’655”)
1026	Federal Judicial Caseload Statistics (2024)
1027	<i>Immersion Corp. v. Valve Corp.</i> , 2:23-cv-00712, Dkt. No. 15 (Proof of Service) (May 18, 2023)
1028	U.S. Patent No. 8,659,571

I. MANDATORY NOTICES

A. Real Party-In-Interest – § 42.8(b)(1)

Petitioner Valve Corporation is the real party-in-interest.

B. Related Matters – § 42.8(b)(2)

1. United States Patent & Trademark Office

U.S. Patent No. 9,116,546 (“the ’546 patent”) was filed on August 29, 2012 as Application No. 13/597,300. U.S. Patent Nos. 9,501,149, 9,846,485 and 10,234,948 claim priority to the ’546 patent.

2. United States Patent Trial and Appeal Board

Valve Corporation v. Immersion Corporation, Case Nos. IPR2024-00477, IPR2024-00478.

3. District Court Matters

The ’546 patent is asserted in the following case: *Immersion Corporation v. Valve Corporation*, 2:23-cv-00712-TL (W.D. Wash.).

C. Counsel and Service Information – § 42.8(b)(3) and (b)(4)

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A power of attorney is submitted with this Petition. Counsel for Petitioner consents to service of all documents via electronic mail.

Petitioner requests cancellation of claims 1-18, 21-24, and 26-29 of the '546 patent.

II. INTRODUCTION

The '546 patent discusses a system for enhancing a user's experience with a device (*e.g.*, a mobile device) by generating a “haptic effect” in the device based on sensor input. The patent explains that “haptic effects” impact users' sense of touch by, for example, causing the device to vibrate. EX1001, 1:11-24, 2:29-41.

The use of haptic effects was known in the prior art. The '546 patent primarily focuses on generating haptic effects based on so-called “extra-sensory information” (herein, “ESI”), *i.e.*, “information that cannot normally be perceived by a human being,” such as electromagnetic fields. EX1001, 2:16-20. Providing a haptic effect that users feel when ESI is detected by a sensor can allow users to “perceive attributes of an environment that would normally be difficult or impossible to perceive.” EX1001, 8:60-63.

Generating haptic effects to allow users to perceive ESI, however, was known in the prior art. For example, Rosenberg (EX1009) and Brock (EX1008) each describe generating haptic effects in handheld devices based on electromagnetic fields (including magnetic and electric fields, respectively).

Years before the '546 patent, these references explained that providing haptic effects allows users “to feel tactile cues” representing a device’s “orientation...with respect to the earth,” Rosenberg, [0007], and to sense “non-visible fields” and “‘feel’ subtle electrical potentials...associated with nerves or nerve bundles...even though they are not visible,” Brock, [0026], [0029], [0065], [0069], [0134].

During the '546 patent’s prosecution, the applicants amended the claims to require “modulating the haptic signal” based on updated sensor input, and argued that “modulated” haptic effects distinguished over the prior art. *Infra* §V.

However, both Rosenberg and Brock disclose modulating haptic effects based on changing sensor input. Rosenberg describes changing haptic feedback (*e.g.*, changing the magnitude and/or frequency of vibration) as ESI sensor input regarding compass orientation changes. *Infra* §IX.A.2.e. Brock similarly describes modulating a haptic effect in a controller based on changing ESI sensor input. *Infra* §IX.B.2.e. Neither Rosenberg nor Brock was considered by the Patent Examiner.

Ground 1 demonstrates that claims 1-18, 21-24, and 26-29 are unpatentable over Rosenberg.

Ground 2 demonstrates that claims 1-3, 5-7, 9-11, 13-16, 21-23, and 26-28 are unpatentable over Brock.

III. CERTIFICATION OF STANDING

The '546 patent is available for IPR and Petitioner is not barred or estopped from requesting IPR of the challenged claims. 37 C.F.R. §42.104(a).

IV. TABLE OF GROUNDS

Petitioner requests cancellation of the following claims.

Ground	Reference(s)	Claim(s)	Basis
1	Rosenberg	1-18, 21-24, 26-29	102/103
2	Brock	1-3, 5-7, 9-11, 13-16, 21-23, 26-28	102/103

Rosenberg and Brock are prior art to the '546 patent at least under pre-AIA 35 U.S.C. §102(b) based on the following publication dates:

Reference	Publication Date
Brock	2002-08-29
Rosenberg	2007-05-10

V. THE '546 PATENT AND PROSECUTION HISTORY

Figure 3 of the '546 patent shows a device 300 that “may be a cellular phone, a PDA, a smart phone, a laptop computer, a game console, and/or a handheld electronic device capable of...providing haptic feedback.” EX1001, 4:41-54.

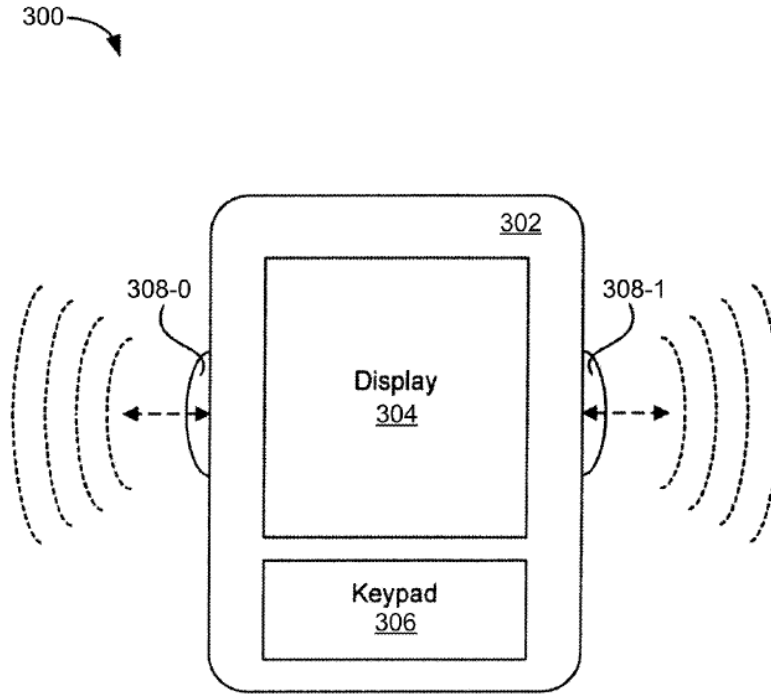


Fig. 3

The patent explains that device 300 can provide haptic feedback in several ways, including by vibrating. EX1001, 4:41-45.

The patent explains that haptic feedback is generated based on information obtained from a sensor. In particular, the patent focuses on sensing “extra-sensory information,” *i.e.*, “information that cannot normally be perceived by a human being,” such as electromagnetic fields. EX1001, 2:17-20, 4:23-28, 6:39-45, 6:66-7:2, 9:12-15, 10:2-5, 11:14-18, 11:56-60, 12:63-67, 15:12-19. Input from the sensor is processed to create an “output signal [that] is configured to produce an output effect,” *i.e.*, a haptic effect, in the device. EX1001, 6:58-7:12, 8:64-9:42, Figs. 4-5.

Finally, the patent says the haptic effect can be modulated when the input received from the sensor changes. Mapping sensor input to an output signal (*i.e.*, haptic signal) “can be done continuously as sensor input is received, and thus, the corresponding output signal can be continuously modulated...[and] the corresponding output effect (such as a haptic effect) that is generated can also be continuously modulated.” EX1001, 7:62-8:3.

In the application as initially filed, claim 1 recited a computer-readable medium storing instructions to generate a haptic effect by receiving extra-sensory input from a sensor, mapping it to a haptic signal, and using that signal to generate the haptic effect. EX1002, 44. The Examiner rejected the claim as unpatentable over prior art. EX1002, 111-126. In response, the applicants amended claim 1 to require that the instructions cause modulation of the haptic effect based on changing values of “interaction parameters” sensed by the sensor, and made analogous amendments to other independent claims. EX1002, 138-150. The applicants argued that such modulation distinguished over the prior art. EX1002, 150-157.

VI. CHALLENGED CLAIMS

The challenged claims are reproduced in the Claim Listing (*infra* §XII).

Independent claim 1 is reproduced below with labeling added for reference:

1[PRE]. A non-transitory computer-readable medium having instructions stored thereon that, when executed by a processor, cause the processor to generate a haptic effect, the generating the haptic effect comprising:

[1A] receiving input from a sensor, wherein the input comprises extra-sensory information, wherein the input further comprises one or more interaction parameters, and wherein each interaction parameter comprises a value;

[1B] mapping the received input to a haptic signal; and;

[1C] sending the haptic signal to an actuator to generate the haptic effect;

[1D] the mapping the received input to the haptic signal further comprising modulating the haptic signal when new input is received, wherein the new received input comprises an update of at least one value of at least one interaction parameter of the received input; and;

[1E] the sending the haptic signal to the actuator to generate the haptic effect further comprising sending the modulated haptic signal to the actuator to modulate the generated haptic effect.

Independent claim 5 recites a “*computer-implemented method for generating a haptic effect*”¹ that claim 1’s “*instructions*” cause a processor to perform. Independent claim 9 recites a system with conventional components that perform claim 5’s method. Independent claim 13 is similar to claim 1, except that claim 13 (a) does not require that the sensor input be ESI and (b) requires one of a list of types of haptic signals and effects. Independent claim 21 recites a method that claim 13’s “*instructions*” cause a processor to perform. Independent claim 26 recites a system with conventional components that perform claim 21’s method.

The dependent claims recite minor additional features, *e.g.*, limiting the haptic effect to vibration (claims 3, 7, 11), deformation (claims 4, 8, 12, 17, 18, 24, 29), or force haptics (claims 15, 16, 23, 28). These and the other dependent claim features were disclosed in Rosenberg and/or Brock as explained below.

VII. LEVEL OF ORDINARY SKILL IN THE ART

A person of ordinary skill in the art (POSA) would have a bachelor’s degree in electrical engineering, computer science, or a related field, plus at least two years of industry experience or graduate-level academic experience with human-computer interaction. Welch, ¶¶40-45.

¹ Herein, claim language is *italicized*. ***Bold italics*** indicate added emphasis.

VIII. CLAIM INTERPRETATION

Claim terms are construed herein according to their ordinary meaning in light of the specification and file history. 37 C.F.R. §42.100(b). Because the Petition’s prior art discloses each element of the challenged claims under any plausible construction, no outer-boundary constructions are necessary. *Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co.*, 868 F.3d 1013, 1018-1019 (Fed. Cir. 2017).

IX. UNPATENTABILITY GROUNDS

A. Ground 1: Rosenberg Anticipates and/or Renders Obvious Claims 1-18, 21-24, and 26-29²

1. Rosenberg (EX1009)

Rosenberg discloses a “portable computing device” with a “geospatial haptic compass” providing “tactile feedback to a user corresponding to a direction of orientation of the portable computing device.” [0002]. The device senses the geospatial orientation, *e.g.*, cardinal direction (north, south, east, west), toward which it is aimed (including after compensating for tilt), and outputs a tactile sensation, *e.g.*, vibration or texture sensation, as the user “varies the orientation of the...device with respect to the earth.” [0007], [0025]-[0026], [0036], [0043], [0047], [0050], [0076]. For example, the device can provide a tactile sensation when pointed north. [0008], [0028]. Welch, ¶¶65-71.

² Unless otherwise noted, citations in Section IX.A are to Rosenberg.

Figure 1 illustrates an exemplary device. [0016]. Figure 3 depicts its “computational architecture.” [0043].

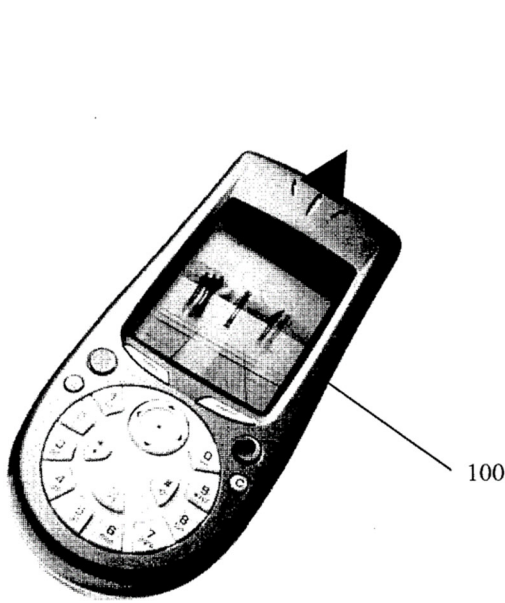


FIG. 1

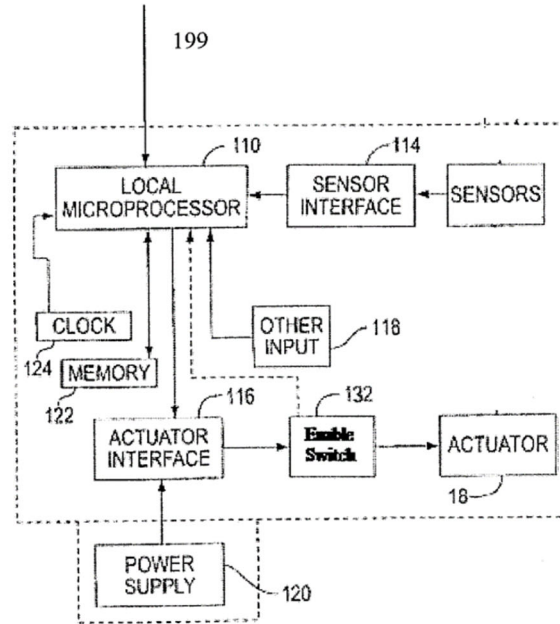
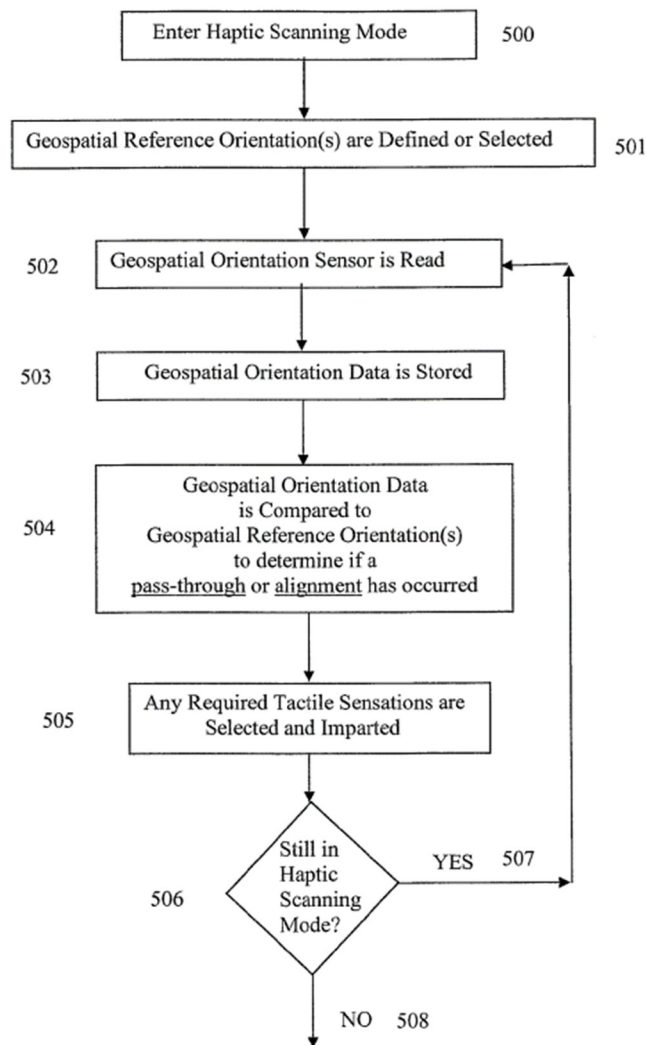


FIG. 3

The device includes a microprocessor that receives input signals from sensor(s) and provides output signals to an actuator. [0043]. Suitable sensors include a “magnetometer,” which provides “orientational data” (*e.g.*, an angle value between 0.0 and 360.0 degrees) to the processor. [0043], [0076], [0023]-[0026]. The actuator can be any conventional haptic actuator that provides “tactile sensations” to users. [0031]-[0037], [0046], [0054]. Welch, ¶¶72-75.

The processor runs software called “Haptic Compassing Routines” that “read one or more geospatial orientational sensors and in response to data received from the sensors, selectively impart an appropriate tactile cue upon the user at an appropriate time.” [0033]; *see also* [0043], [0046]. Figure 5 “illustrates a flowchart of software operations related to the Haptic Compassing Routines.” [0020], [0073]. Welch, ¶¶76-77.

FIG. 5



After the device enters a “Haptic Scanning Mode” (step 500), a geospatial reference orientation (*e.g.*, north) is selected (step 501) as the orientation the user seeks. [0073]-[0075]. The device’s processor then reads the geospatial orientation sensor to obtain data indicating the device’s current orientation (step 502). [0076]. “One common form of the data is as an angle value from 0.0 degrees to 360.0 degrees such that the angular value represents the clockwise angle away from NORTH.” [0076]. The orientation data, stored in memory (step 503), are compared to the desired reference orientation (step 504) “to determine if a tactile sensation is to be produced,” *e.g.*, when the device is aligned with, or passes through, the reference orientation. [0077]. Welch, ¶78.

Per Rosenberg, orientation data can be mapped to haptic effects in several ways. One technique, called “pass-through,” creates a haptic effect when a user moves the compass through an orientation of interest—*i.e.*, beginning on one side of that orientation and moving past and to the other side of it. [0062]. Another technique, “alignment,” creates a haptic effect when the compass is aligned with (or substantially aligned with, *e.g.*, within two degrees of) a reference orientation. [0064]. Haptic magnitude can also increase (or decrease) based on how long alignment with a reference orientation is maintained. [0049], [0067]. Welch, ¶79.

Another technique, “Variable Magnitude Alignment Sensation,” causes a haptic effect when the compass is oriented within 10 degrees of a reference orientation, and increases the effect’s magnitude as the compass’s orientation approaches the reference orientation. [0069]. Welch, ¶80. Rosenberg also describes a “Variable Frequency Alignment Sensation” technique that is similar except the haptic effect’s frequency, rather than its magnitude, varies depending on angular proximity to the reference orientation. [0070]-[0071]. Further embodiments vary both magnitude and frequency based on alignment proximity. [0072]. Welch, ¶80.

2. Claim 1

- a. **[1PRE]: “A non-transitory computer-readable medium having instructions stored thereon that, when executed by a processor, cause the processor to generate a haptic effect, the generating the haptic effect comprising:”**

Rosenberg’s device has “local *memory* 122, such as RAM and/or ROM... coupled to microprocessor 110 to *store instructions* for microprocessor 110....” [0051]. *See also* Fig. 3, [0060], [0076]-[0078], claim 22 (“memory coupled to the processor”). RAM and ROM are among the examples of non-transitory computer-readable media in the ’546 patent itself. EX1001, 2:55-59, 3:2-7. Memory 122 thus is a “*non-transitory computer-readable medium having instructions stored thereon,*” as claimed. Welch, ¶¶82-84.

Rosenberg's device includes "*microprocessor* 110." [0051], Fig. 3; *see also* [0050] ("[M]*icroprocessor* 110 can process inputted sensor signals to determine appropriate output actuator signals by following *stored instructions*."), [0062] ("software running upon the *microprocessor*"), [0064] (same), claim 22 ("memory coupled to the *processor*"). Microprocessor 110 is a "*processor*" that "*execute[s]*" "*instructions*" stored in Rosenberg's memory, as claimed. Welch, ¶85.

Rosenberg's processor executes "software routines that read orientational data from one or more geospatial sensors on board the portable computing device 100 and in response to changes in the data command a tactile sensation upon the user that corresponds with one or more geospatial orientations...called Haptic Compassing Routines." [0033]; *see also* [0043], [0050] (quoted in previous paragraph). "Haptic Compassing Routines" are used to "selectively activate[]" "haptic actuators" so the "user feels a tactile sensation." [0034]; *see also* [0043] ("[P]rocessor 110 is configured to...provide signals to actuator 18 in accordance with the Haptic Compassing Routines."), [0046] ("[U]nder the control of the Haptic Compassing Routines, processor 110 is operative to selectively control one or more actuators 18 by sending a haptic control signal to actuator electronics 116."), [0062] ("[S]oftware running upon the microprocessor...may...control the actuator (or actuators) to impart a sensation upon the user...."), [0073]-[0079], Fig. 5, Abstract ("processor controlled tactile feedback sensations"). Welch, ¶86.

Thus, Rosenberg's Haptic Compassing Routines are "*instructions*" that, when executed by processor 110, cause it to generate (by commanding an actuator) "haptic sensations" ([0006], [0012]-[0013], [0028], [0032]-[0034], [0050]-[0051]), *i.e.*, a "*haptic effect*," as claimed. The Haptic Compassing Routines are stored in Rosenberg's memory, as claimed. [0051], [0060] ("Haptic Compassing Routines select...tactile sensations....For example, different types of tactile sensations may be associated *in memory*...with Cardinal Directions..."). Welch, ¶87.

- b. [1A]: "receiving input from a sensor, wherein the input comprises extra-sensory information, wherein the input further comprises one or more interaction parameters, and wherein each interaction parameter comprises a value;"

When executed by processor 110, the instructions in Rosenberg's memory cause the processor to generate haptic feedback by "*receiving input from a sensor, wherein the input comprises extra-sensory information, wherein the input further comprises one or more interaction parameters, and wherein each interaction parameter comprises a value*," as claimed.

Rosenberg's processor "*receive[s] signals from sensor 112*," which it uses to produce actuator command signals. [0043], Fig. 3; *see also* [0046] ("Under the control of the Haptic Compassing Routines, *processor* 110 is operative to read orientational data from *sensors* 112...."), [0076] ("[T]he geospatial orientation *sensors* on board the portable computing device [are] read by the *processor*...."),

Fig. 5 (step 502). **Sensor** 112 can be a “magnetometer” which “provide[s] orientational data with respect to the physical world.” [0043]; *see also* [0023]-[0026], [0039], [0076], claim 2. Rosenberg’s processor thus “*receiv[es] input from a sensor,*” as claimed. Welch, ¶¶88-89.

The “orientational data” that processor 110 receives from sensor 112 comprise “*extra-sensory information,*” as claimed, because the data are, *e.g.*, the output of “a **magnetometer** that detects orientation with respect to the earth’s magnetic field” ([0023]-[0024], [0046], [0076]). The ’546 patent itself identifies “a magnetometer configured to detect electromagnetic fields” as a sensor “configured to detect extra-sensory information.” EX1001, 6:40-45; *see also* EX1001, 2:13-20, 7:30-31, 8:23-31, 9:18-19, 10:35-42, 15:23-25, 16:19-23. Welch, ¶90.

The “orientational data” the processor receives from the sensor comprise “*one or more interaction parameters,*” as claimed, because orientational data are parameters that are based on a user’s interaction with a device (*i.e.*, the compass). A “parameter” is a measurable factor that helps define a system’s behavior or operation, like Rosenberg’s orientation angle. EX1015, EX1016. Welch, ¶¶91-92. Although the ’546 patent never defines “interaction parameter,” Patent Owner agreed in IPR2016-01372, involving another of its patents with haptic effects driven by user interaction (EX1028), that an interaction parameter is simply a parameter “based on a user’s interaction with a device.” EX1017, 7. Welch, ¶¶91-93.

Rosenberg’s “orientational data” include “an angle A that indicates the clockwise rotary orientation in degrees away from geographic NORTH,” toward which the device points. [0076]. Angle A is a measurable factor that helps define the device’s haptic behavior (*i.e.*, a “*parameter*” as claimed), the value of which depends on a user’s interaction with the device, *i.e.*, in what direction she “aimed [it] at the moment the data was read by the processor.” [0076]; *see also* Abstract (“*[A] user may perform a manual scanning operation wherein they **manipulate the portable navigation device** through a range of physical orientations and find a desired geospatial target orientation based upon their sense of touch.*”), [0013], claim 17 (“a handheld casing to be ***pointed in a direction by a user***...repeatedly determining a current geospatial pointing orientation...”).

The “orientational data” (angle value), *i.e.*, the claimed “*input from a sensor*,” thus comprise “*one or more interaction parameters*,” as claimed. Angle A can be any “angle value from 0.0 degrees to 360.0 degrees.” [0076]. Angle A thus also “*comprises a value*,” as claimed. Welch, ¶94.

c. [1B]: “mapping the received input to a haptic signal; and”

When executed, the instructions in Rosenberg’s memory cause the processor to generate haptic feedback by “*mapping the received input to a haptic signal*,” as claimed.

Rosenberg explains that “portable computing device 100 is equipped with one [or] more haptic actuators.” [0032]; *see also* [0033]-[0038] (describing suitable haptic actuators), [0050]-[0052], [0060], [0062], [0064], Fig. 3. The haptic actuators provide “tactile sensations” to users, including “vibrations, a single jolt, or a texture sensation.” [0050]. Welch, ¶95.

“Routines running upon the processor...select and impart sensations by sending *appropriate signals*...to one or more actuators...” [0033]; *see also* [0043] (“[P]rocessor 110 is configured to...provide *signals* to actuator 18 in accordance with the Haptic Compassing Routines.”), [0046] (“[U]nder the control of the Haptic Compassing Routines, processor 110 is operative to selectively control one or more actuators 18 by sending *a haptic control signal* to actuator electronics 116....Based upon the timing and form of *haptic control signals*...tactile sensations are selectively produced.”), [0052], [0054] (“Actuator 18 transmits forces to the housing of the portable computing device in response to *signals* received from microprocessor 110.”). These signals are the claimed “*haptic signal*.” Welch, ¶96.

These signals are mapped from “*received input*,” as claimed. *E.g.*, [0050] (“The microprocessor 110 can *process inputted sensor signals to determine appropriate output actuator signals* by following stored instructions.”), [0033]. Welch, ¶97.

Rosenberg discloses various ways that its processor maps “*received input*” (*i.e.*, orientation data) to “*haptic signal[s]*,” and all meet limitation [1B]. Rosenberg even repeatedly uses the word “***mapping***.” For example, in the “Variable Magnitude Alignment Sensation” embodiment, Rosenberg explains:

[T]actile sensation is not produced unless the portable computing device orientation comes within 10 degrees of the geospatial reference orientation (clockwise or counter clockwise). Once within that angular threshold, the magnitude of the sensation...increase[s] from 25% to 75% as an inversely linear function of angular proximity. Thus when the angular distance between the portable computing device orientation and the geospatial reference orientation is 10 degrees, the magnitude is 25%. And as the angular distance between the portable computing device orientation and the geospatial reference orientation goes to 0, the magnitude rises to 75%. The ***mapping*** can be linear. The ***mapping*** may also be non-linear.

[0069]. *See also* [0071] (describing “***mapping***” for “Variable Frequency Alignment Sensation” in which the effect’s frequency, rather than magnitude, varies).

In these embodiments, the “*received input*” (*i.e.*, orientation data or angle value indicating angular proximity to a reference orientation) is mapped to a “*haptic signal*” providing a sensation, the magnitude and/or frequency of which changes as the received sensor input changes. Welch, ¶98.

The “alignment” technique works similarly:

The software running upon the microprocessor...may be configured to control the actuator (or actuators) to impart a sensation upon the user when it is determined that a reference orientation within the portable computing device (or an aimable portion thereof) is...aligned (or substantially aligned) along a geospatial reference orientation...for more than some threshold amount of time....The range might be, for example, plus or minus two degrees of the reference orientation.

[0064].

The particular haptic effect can be selected based on the direction with which the compass is aligned. [0064]. *See also* [0060]. Thus, the “*received input*” (*i.e.*, the angle value the processor evaluates for substantial alignment with a reference orientation for a threshold time period) is mapped to the “*haptic signal*” providing a haptic effect. [0064]. Welch, ¶¶99-100.

In the “pass-through” approach, a haptic effect is generated when the device passes through a reference orientation, *i.e.*, the device “begins on one side of the geospatial reference orientation and moves to the other side.” [0062]. The particular haptic effect can be selected based on the passed-through direction. [0060], [0062]. Thus, the “*received input*” (*i.e.*, the angle value the processor evaluates for pass-through) is mapped to the “*haptic signal*” providing a haptic effect. Welch, ¶101.

Accordingly, Rosenberg’s processor generates haptic feedback by “*mapping the received input to a haptic signal*,” as claimed. Welch, ¶102.

d. [1C]: “sending the haptic signal to an actuator to generate the haptic effect;”

When executed, the instructions in Rosenberg’s memory cause the processor to generate haptic feedback by “*sending the haptic signal to an actuator to generate the haptic effect,*” as claimed.

Rosenberg’s “portable computing device 100 is equipped with one [or] more haptic actuators.” [0032]; *see also* [0033]-[0038], [0036] (actuator can be an “electro-active polymer and/or piezoceramic”). The haptic actuators provide “tactile sensations” to users, including “vibrations, a single jolt, or a texture sensation.” [0050]. The “tactile sensations” are a “*haptic effect,*” as claimed. [0006]. *See also* EX1001, 1:11-14 (“haptic effect[]” encompasses “tactile” feedback), 2:29-41. Welch, ¶103.

Rosenberg’s processor uses a command signal to instruct the actuators to produce tactile sensations. [0052] (“Actuator 18 transmits forces to the housing...in response to *signals received from microprocessor 110.*”); *see also* [0033], [0043] (“*processor 110* is configured to...*provide signals to actuator 18 in accordance with the Haptic Compassing Routines...*”), [0046], [0050]-[0051], [0054]-[0055], [0058], [0062], [0064]. As demonstrated for [1B] (§IX.A.2.c), this signal is the claimed “*haptic signal.*” Welch, ¶¶104-106.

Rosenberg’s processor thus generates haptic feedback by “*sending the haptic signal to an actuator to generate the haptic effect,*” as claimed. Welch, ¶104.

- e. [1D]: “the mapping the received input to the haptic signal further comprising modulating the haptic signal when new input is received, wherein the new received input comprises an update of at least one value of at least one interaction parameter of the received input; and”

Rosenberg’s instructions, in causing the processor to generate haptic feedback “*mapping the received input to a haptic signal*” as claimed (§IX.A.2.c), also cause the processor to “*modulat[e] the haptic signal when new input is received, wherein the new received input comprises an update of at least one value of at least one interaction parameter of the received input,*” as claimed.

(1) Potential Constructions of “*modulating the haptic signal when new input is received*”

The phrase “*modulating the haptic signal when new input is received*” could be construed two ways. The Board need not decide the issue, however, because Rosenberg’s embodiments all meet or render obvious limitation [1D] under both potential constructions.

The first potential construction flows from language in the specification and an argument by the applicants during prosecution. In the specification, the phrase “modulating the haptic signal” appears exclusively in embodiments in which the “mapping” step involves “*continuously* modulating the haptic signal based on a *continuous* updating of the value of at least one interaction parameter.” EX1001, 9:32-35, 15:41-44. *See also* EX1001, 7:62-8:3 (similar).

When responding to claim rejections during prosecution, the applicants emphasized the phrase “continuously modulated” in paragraph [0041] of the application-as-filed, which describes a “*continuously modulated*” haptic signal mapped from sensor input by “mathematically transforming the received sensor input into a corresponding...haptic signal.” EX1002, 152; EX1001, 7:62-8:3 (same paragraph). Thus, a first potential construction would require continuously mapping successive sensor inputs, one after the other, to modulated haptic signals.

On the other hand, the applicants omitted “continuously” from the claims. Original dependent claim 3 recited “*continuously* modulating the haptic signal based on a *continuous* updating of the value of at least one interaction parameter.” EX1002, 44. In the above-discussed response, the applicants incorporated claim 3’s substance into independent claim 1 but deleted “continuously” and “continuous.” EX1002, 141-142. Thus, a second potential construction would not require the “new input” mapping to the modulated haptic signal to be received immediately after earlier input that was mapped to a haptic signal; under the second construction, claim 1 would cover a scenario in which one sensor input is mapped to a haptic signal, after which, for some period of time, new/updated sensor inputs are *not* mapped to any haptic signal, and then a further new/updated sensor input *is* mapped to a modulated haptic signal.

Rosenberg’s “Variable Magnitude Alignment Sensation” and “Variable Frequency Alignment Sensation” embodiments satisfy both potential constructions. Rosenberg’s “pass-through” and “alignment” embodiments satisfy the second potential construction and render limitation [1D] obvious under the first one. These embodiments are discussed below.

First, as an initial matter, it should be noted that, in all embodiments, Rosenberg’s processor receives “*repeated* data samples of the sensor...at a rapid rate.” [0080]; *see also* [0033] (in both the “alignment” and “pass-through” embodiments, “the processor...*repeatedly reads* one or more geospatial orientational sensors”), [0068]-[0070] (tactile sensations can change as compass “hone[s] in” on a reference orientation, which also requires repeated sampling, *see* Welch, ¶108), [0086] (explaining that software repeats steps 502-505 in Figure 5)), claim 17 (“*repeatedly* determining a current...orientation”). Rosenberg’s processor 110 thus receives updated orientation data from sensor 112, including an updated “angle value.” [0076]. As noted for limitation [1A] (§IX.A.2.b), the updated angle value is an “*interaction parameter*” with a “*value*.” The processor thus receives “*new received input*” that “*comprises an update of at least one value of at least one interaction parameter of the received input*,” as claimed. Welch, ¶¶108-109.

(2) The Variable Magnitude/Frequency Alignment Sensation Embodiments Meet Both

(i) First Potential Construction

Rosenberg's "Variable Magnitude Alignment Sensation" and "Variable Frequency Alignment Sensation" embodiments both satisfy limitation [1D] under the first potential construction of "*modulating the haptic signal when new input is received.*" In these embodiments, once users point the compass within 10° of a reference orientation, the haptic effect's magnitude and/or frequency increases as the "angular proximity of the geospatial reference orientation...is reduced," *i.e.*, as the compass points closer to the reference orientation. [0068]-[0071]. The changing magnitude and/or frequency "allows the user to sweep the device around and hone in upon the active reference orientation." [0068], [0070]. These embodiments satisfy the first potential construction because, as users point the compass closer to a reference orientation (each new angle value being "*new input*" the processor receives from the sensor), the haptic effect is continuously modulated (*i.e.*, its magnitude and/or frequency change continuously based on each successive new sensor input), which means the haptic signal that produces the effect is also continuously modulated based on each successive new sensor input. Indeed, both embodiments involve continuous mathematical transformations of successive sensor inputs into haptic signals. [0069] ("The mapping can be linear. The mapping can also be non-linear."), [0071] (same). Welch, ¶110.

(ii) Second Potential Construction

Because Rosenberg’s Variable Magnitude Alignment Sensation and Variable Frequency Alignment Sensation embodiments both meet the first potential construction requiring *continuous* modulation of the haptic signal, *supra* p. 24, *a fortiori* they also meet [1D] under the second potential construction, which does not require that a first haptic signal and a second haptic signal (modulated relative to the first haptic signal) result from mappings based on successive sensor inputs received from the sensor immediately after one another. Welch, ¶111.

(3) The Pass-Through Embodiment Meets or Renders Obvious Both Constructions

(i) Second Potential Construction

In the “pass-through” embodiment, a haptic effect is generated when new sensor input (orientation angle), compared to prior input, shows the device passed through a reference orientation. [0062]. The haptic effect’s magnitude, frequency and duration depend on the passed-through direction. [0062]. If new input later shows the device passed through a different reference orientation, the haptic effect is modulated. [0062]. The haptic signal—which causes the haptic effect—is also modulated, thus satisfying [1D] under the second potential construction, which does not require *continuous* modulation of the haptic signal for successive sensor inputs received one immediately after the other. Welch, ¶¶112-113.

(ii) First Potential Construction

Under the first potential construction of “*modulating the haptic signal when new input is received*,” Rosenberg’s “pass-through” embodiment renders [1D] obvious. Some sensor inputs indicate a pass-through has occurred; others do not. There are just two approaches to the latter type of input: either no haptic signal is sent, or the input is mapped to a haptic signal instructing the actuator to do nothing. Both would be obvious, but POSAs would recognize benefits in the latter’s simplicity since all inputs would map to haptic signals. The two types of haptic signals—one instructing the actuator to produce a haptic effect, another instructing the actuator to do nothing—mapped from successive sensor inputs, would be “modulated” relative to one another (as would the resulting effects), thus satisfying [1D] under the first potential construction. In one obvious scenario, a first sensor input indicating a “pass-through” is mapped to a haptic signal instructing the actuator to produce a haptic effect. [0062]. Immediately thereafter, the next sensor input does not indicate that a haptic-producing event is occurring, so it is mapped to a haptic signal instructing the actuator to do nothing. The latter signal has been “modulated” relative to the first one since doing nothing is different from producing a haptic effect. This obvious scenario satisfies [1D] under the first potential construction. Welch, ¶¶112, 114.

(4) The Alignment Embodiment Meets or Renders Obvious Both Constructions

(i) Second Potential Construction

In the “alignment” embodiment, “current and historical sensor values”—the “current” one being a “*new input*” as claimed—are used to determine if a device is aligned with a reference orientation for more than a threshold time. [0064]. If so, a haptic effect is produced which depends on direction. [0064]. If new sensor input later shows alignment with another direction, the haptic effect is modulated. [0064]. The haptic signal—which causes the haptic effect—is also modulated, thus meeting [1D] under the second potential construction, which does not require *continuous* modulation of the haptic signal for successive sensor inputs. Welch, ¶115.

(ii) First Potential Construction

Under the first potential construction of [1D], Rosenberg’s “alignment” embodiment renders it obvious for the same reasons as the “pass-through” embodiment. Some sensor inputs indicate alignment; others do not. There are just two approaches to the latter type of input: either no haptic signal is sent, or the input is mapped to a haptic signal instructing the actuator to do nothing. Both would be obvious, but POSAs would recognize the latter’s simplicity since all inputs would map to haptic signals. The two types of haptic signals, mapped from successive sensor inputs, are “modulated” relative to one another (as are the resulting effects), thus satisfying [1D] under the first potential construction. Welch, ¶116.

- f. [1E]: “the sending the haptic signal to the actuator to generate the haptic effect further comprising sending the modulated haptic signal to the actuator to modulate the generated haptic effect.”

As discussed for [1C], when executed, the instructions stored in Rosenberg’s memory cause the processor to generate haptic feedback by “*sending the haptic signal to an actuator to generate the haptic effect*,” as claimed. *Supra* §IX.A.2.d. As discussed for [1D], the Variable Magnitude / Frequency Alignment Sensation embodiments satisfy “*modulating the haptic signal when new input is received*” under both potential constructions, while the “pass-through” and “alignment” embodiments satisfy it under the second potential construction and render it obvious under the first potential construction. *Supra* §IX.A.2.e. For the same reasons Rosenberg’s embodiments all meet or render obvious “*modulating the haptic signal when new input is received*” in [1D] (and hence they all also modulate the haptic effect generated at the actuator) and “*sending the haptic signal to an actuator to generate the haptic effect*” in [1C], they also meet [1E]. *Supra* §IX.A.2.d.; [0052], [0033], [0043] (“**processor 110** is configured to...**provide signals to actuator 18 in accordance with the Haptic Compassing Routines**...”), [0046], [0050]-[0051], [0054]-[0055], [0058], [0062], [0064]. Welch, ¶¶117-118.

3. Claim 2: “The non-transitory computer-readable medium of claim 1, the mapping the received input to the haptic signal further comprising generating the haptic signal when the value of at least one interaction parameter exceeds a specified value.”

In the Variable Magnitude / Frequency Alignment Sensation embodiments, “the tactile sensation is not produced unless the portable computing device orientation comes within 10 degrees of the geospatial reference orientation....” [0069], [0071]. The processor thus generates a haptic signal only when the angle value it receives from sensor 113 is within 10° of the reference orientation. Welch, ¶125. The “angle value” is “from 0.0 degrees to 360.0 degrees,” representing “the clockwise angle away from NORTH.” [0076]. If north is chosen as the reference orientation, the processor generates a haptic signal when the device is oriented between 350.0° and 360.0°, *i.e.*, when the angle value exceeds 350.0° (or, depending on the meaning of “within” in [0069]-[0071], when the angle exceeds the next-highest value below 350.0°, *e.g.*, 349.9°). Welch, ¶125. If the reference orientation is 350.0°, the processor generates a haptic control signal when the device is oriented between 340.0° and 360.0°, *i.e.*, when the angle value exceeds 340.0° (or, depending on the meaning of “within” in [0069]-[0071], when the angle exceeds the next-highest value below 340.0°, *e.g.*, 339.9°). These embodiments satisfy claim 2. Welch, ¶119.

In the “alignment” embodiment, the haptic signal is generated when the device is “within...plus or minus two degrees of the reference orientation” for “more than some threshold amount of time.” [0064]. This satisfies claim 2 for the same reasons as the preceding embodiments. For example, if the reference orientation is 358.0°, the haptic signal is generated when the device is oriented between 356.0° and 360.0°, *i.e.*, when the angle value exceeds 356.0° (or, depending on the meaning of “within” in [0064], when the angle exceeds the next-highest value below 356.0°, *e.g.*, 355.9°). Welch, ¶120.

In the “pass-through” embodiment, a haptic signal is generated when the device passes through a reference orientation. *Supra* §§IX.A.2.cIX.A.2.d. If the user turns the device clockwise, the angle must increase beyond the reference orientation angle. For example, if the reference angle is 300°, the haptic signal will be generated once the angle exceeds 300°, thus satisfying claim 2. Welch, ¶121.

4. Claim 3: “The non-transitory computer-readable medium of claim 1, wherein the actuator comprises a vibration actuator, and wherein the haptic effect generated by the vibration actuator comprises a vibration haptic effect.”

As discussed for limitation [1C] (§IX.A.2.d), Rosenberg’s “*actuator*” is a haptic actuator providing “tactile sensations” including vibrations. [0050]; *see also* [0032]-[0038].

Rosenberg discloses actuators that impart “inertially induced *vibrations* that are transmitted to the user through the casing of the portable computing device 100.” [0034]; *see also* [0028], [0032] (“In many embodiments the actuators...induc[e] *vibration* forces...”), [0034], [0049]-[0050], [0062]-[0064] (“pass-through” and “alignment” embodiments can provide sinusoidal or saw-tooth *vibrations*), [0069]-[0071] (Variable Magnitude / Frequency Alignment Sensation embodiments can provide sine wave *vibrations*), claims 1, 8 (“a haptic actuator...to provide...a *vibration* sensation”). Rosenberg thus discloses a “*vibration actuator*,” as claimed, which generates a “*vibration haptic effect*,” as claimed. Welch, ¶¶122-123.

5. Claim 4: “The non-transitory computer-readable medium of claim 1, wherein the actuator comprises a deformation actuator, and wherein the haptic effect generated by the deformation actuator comprises a deformation haptic effect”

Rosenberg discloses that its device provides a “tactile sensation” in each of the “alignment,” “pass-through,” and Variable Magnitude / Frequency Alignment Sensation embodiments. [0062], [0064], [0068]-[0072]. Rosenberg explains that “different types of actuators” are suitable. [0036]. For example, “a surface of the portable computing device itself may be comprised of a [sic] electronically responsive material such as electro-active polymer [EAP] and/or piezoceramic that can be controlled to produce tactile sensations felt by a user holding the device.” [0036]; *see also* [0050]. Rosenberg thus discloses, among other options, using EAP to produce “tactile sensations” for all its embodiments. Welch, ¶¶124.

POSAs would have understood that, if a surface of Rosenberg's device comprises "electronically responsive material such as electro-active polymer and/or piezoceramic," [0036], that material constitutes a "*deformation actuator*," as claimed. Indeed, the '546 patent itself identifies an "electroactive polymer ('EAP') actuator" as a deformation actuator. EX1001, 3:46 ('546 patent abbreviating "electroactive polymer" as "EAP"), 5:65-6:3 ("EAPs may be used to form one or more actuators...for shape changing..."), 6:6-13 ("[P]atterns can then be applied to the flexible surface of device 300 using a *deformation* mechanism. A haptic substrate that includes a plurality of *actuators* can be applied to the surface to enact or form the patterns. *EAPs*, for example, can be employed..."). See also EX1018, 3 (active polymer can "change its volume by swelling or shrinking more than 90%"). Welch, ¶¶125-126.

Further, Rosenberg's "tactile sensation" ([0036], [0062], [0064], [0068]-[0072]) can be "texture sensation." [0050] ("[V]ibrations, a single jolt, or a *texture sensation* are all considered *tactile sensations*."). Welch, ¶127. Texture sensation is an additional "*deformation haptic effect*," as claimed. EX1001, 6:6-13, 9:52-61 ('546 patent admitting that a "*change in [] texture*" is a deformation haptic effect caused by a deformation actuator), 16:2-8 ("deformation haptic effect" includes changing "a texture of the device"), claim 18 (same). POSAs would understand that texture sensation is caused by a "*deformation actuator*." Welch, ¶127.

If Patent Owner contends, despite the above disclosures, that Rosenberg fails to explicitly disclose using a deformation actuator to produce deformation haptic effects, implementing Rosenberg with a deformation actuator to produce tactile/texture sensations ([0036], [0050]) would have been an obvious combination of prior-art elements according to known methods to yield predictable results. *KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 421 (2007). Welch, ¶128.

As the Examiner found, and the applicants did not dispute, deformation actuators outputting deformation haptic effects were conventional in the prior art, and their use would “yield a predictable result.” EX1002, 123-124 (per examiner, U.S. Publ. 2006/0103634 (“Kim,” EX1010) discloses deformable haptic effects), 154 (applicants conceding Kim discloses deformable EAP); *see also* EX1002, 120 (per examiner, U.S. Publications 2009/0189746 (“Ullrich ’746,” EX1011) and 2010/0253525 (“Engel,” EX1012) disclose deformation actuators), 124 (taking official notice that “the deformation haptic effect of a haptic simulation which having texture effect, for example, for skin sensation are well known in the art”); EX1013 (prior art reference cited by ’546 patent (6:30-33) as providing “details of devices capable of producing shape changing or deformation haptic effects”). *See also* EX1018. Welch, ¶129. Claim 4 would have been obvious over Rosenberg in view of POSAs’ knowledge about well-known deformation actuators, as evidenced by the foregoing corroborating references. Welch, ¶129.

6. Claim 5

Claim 5 recites a “*method for generating a haptic effect*” that claim 1’s “*instructions*” cause a processor to perform. Rosenberg thus meets claim 5 for the same reasons it meets claim 1. *Supra* §IX.A.2. Welch, ¶¶130-131.

7. Claim 6

Claim 6 (depending from claim 5) recites a “*method for generating a haptic effect*” that the “*instructions*” recited in claim 2 cause a processor to perform. Rosenberg thus meets claim 6 for the same reasons it meets claims 2 and 5. *Supra* §IX.A.3. Welch, ¶¶132-133.

8. Claim 7

Claim 7 (depending from claim 5) limits claim 5’s method to one used with the vibration actuator of claim 3. Rosenberg thus meets claim 7 for the same reasons it meets claims 3 and 5. *Supra* §IX.A.4. Welch, ¶¶134-135.

9. Claim 8

Claim 8 (depending from claim 5) limits claim 5’s method to one used with the deformation actuator of claim 4. Rosenberg (or an obvious implementation of its teachings) meets or renders obvious claim 8 for the same reasons it meets or renders obvious claims 4 and 5. *Supra* §IX.A.5. Welch, ¶¶136-137.

10. Claim 9

a. [9PRE]: “A haptic representation system comprising:”

Rosenberg discloses a “*haptic representation system*,” as claimed. Rosenberg discloses a “portable computing device” with a “geospatial haptic compass” that allows it to provide “tactile feedback to a user corresponding to a direction of orientation of the portable computing device.” [0002]; *see also* [0007]. Rosenberg explains that “portable computing device 100 is equipped with one [or] more haptic actuators.” [0032]; *see also* [0033]-[0038] (describing suitable actuators), [0036] (actuator can be an EAP). The haptic actuators provide “tactile sensations” including “vibrations, a single jolt, or a texture sensation.” [0050]. Welch, ¶138.

An exemplary device is shown in Figure 1 and its “computational architecture,” including one or more sensors, processor, and actuator, is depicted in Figure 3. [0043].

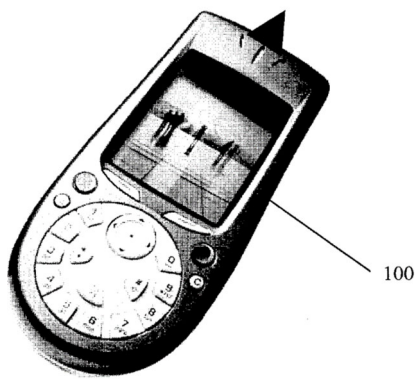


FIG. 1

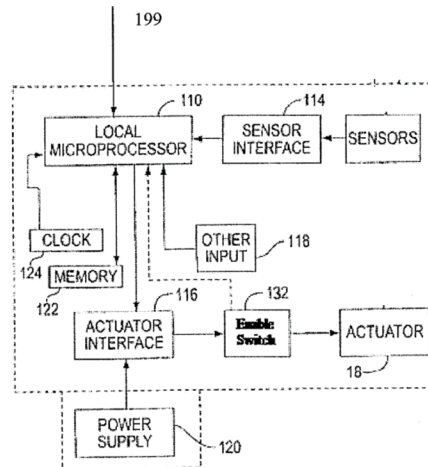


FIG. 3

The '546 patent explains that “a haptic representation system,” shown in its Figure 1, including sensor(s), a processor and an actuator, “represent[s] the sensor input as haptic output.” EX1001, 2:40-45, 4:16-19, Fig. 1. Rosenberg’s device represents geospatial sensor input as haptic output using components similar to those in the '546 patent’s haptic representation system (*e.g.*, sensor, processor, actuator), and thus has a “*haptic representation system*,” as claimed. Welch, ¶¶139-140.

b. [9A]: “a memory configured to store a haptic representation module;”

As discussed for [1PRE] (§IX.A.2.a), Rosenberg’s device includes “local *memory* 122...coupled to microprocessor 110 to store instructions for microprocessor 110 and store temporary and other data.” [0051]; *see also* Fig. 3, [0060], [0076]-[0078]; claim 22 (“*memory* coupled to the processor”). Rosenberg’s memory is a “*memory*,” as claimed. Welch, ¶141.

The '546 patent explains that a “*haptic representation module*” is “software” that “generates a haptic effect that represents received input.” EX1001, 3:8-15.

That is the function of Rosenberg’s Haptic Compassing Routine software. *Supra* §IX.A.2.a; *see also* [0033] (“[T]he **software routines** that read orientational data from one or more geospatial sensors on board the portable computing device 100 and in response to changes in the data command a tactile sensation upon the user that corresponds with one or more geospatial orientations, are called Haptic Compassing Routines.”), [0034] (“Haptic Compassing Routines” are used to “selectively activate[]” actuators so the “user feels a tactile sensation”), [0046] (“[U]nder the control of the Haptic Compassing Routines, processor 110 is operative to selectively control one or more actuators 18 by sending a haptic control signal to actuator electronics 116.”), [0062], [0073]-[0079]; Fig. 5. Welch, ¶¶142-143.

The Haptic Compassing Routines are stored in Rosenberg’s memory. [0051], [0060] (“Haptic Compassing Routines select...tactile sensations....For example, different types of tactile sensations may be associated ***in memory***...with Cardinal Directions....”); *supra* §IX.A.2.a. Thus, Rosenberg’s memory is “*configured to store a haptic representation module*,” as claimed. Welch, ¶¶144-145.

c. [9B]: “a processor configured to execute the haptic representation module stored on the memory; and”

As discussed for [1PRE] (§IX.A.2.a), Rosenberg’s device includes “*microprocessor* 110.” [0051], FIG. 3; *see also* [0022] (“[D]evice 100 may include a computer *processor*....”), [0050] (“*[M]icroprocessor* 110 can process inputted sensor signals to determine appropriate output actuator signals by following stored instructions.”), [0062] (describing “software running upon the *microprocessor*”); [0064] (same), claim 22 (“a memory coupled to [a] *processor*”). Welch, ¶146.

Rosenberg’s processor executes the Haptic Compassing Routines, discussed above for [9A] (§IX.A.10.b). [0033], [0043] (“[D]evice 100 includes a *processor* 110 for running the Haptic Compassing Routines.”), [0046] (“[U]nder the control of the Haptic Compassing Routines, *processor* 110 is operative to selectively control one or more actuators 18 by sending a haptic control signal to actuator electronics 116.”), [0050], [0062]. Welch, ¶147.

Processor 110 is thus a “*processor configured to execute the haptic representation module,*” *i.e.*, Rosenberg’s Haptic Compassing Routines, “*stored on the memory,*” as claimed. Welch, ¶148.

d. [9C]: “an actuator configured to output one or more haptic effects;”

Rosenberg meets [9C] for the same reasons it meets [1C]. *Supra* §IX.A.2.d. Welch, ¶149.

e. [9D]-[9H]

Limitations [9D]-[9H] require the “*haptic representation module*” of [9A] to be configured to perform the steps in limitations [1A]-[1E]. Rosenberg thus discloses limitations [9D]-[9H] for the same reasons it discloses limitations [1A]-[1E]. *Supra* §§IX.A.2.b-IX.A.2.f. Welch, ¶150.

11. Claim 10

Claim 10 requires claim 9’s “*haptic representation module*” to be configured to perform the functionality of claim 2. Rosenberg thus meets claim 10 for the same reasons it meets claims 2 and 9. *Supra* §IX.A.3. Welch, ¶151.

12. Claim 11

Claim 11 requires claim 9’s “*haptic representation system*” to be used with the vibration actuator of claim 3. Rosenberg thus meets claim 11 for the same reasons it meets claims 3 and 9. *Supra* §IX.A.4. Welch, ¶152.

13. Claim 12

Claim 12 requires claim 9’s “*haptic representation system*” to be used with the deformation actuator of claim 4. Rosenberg (or an obvious implementation of its teachings) meets or renders obvious claim 12 for the same reasons it meets or renders obvious claims 4 and 9. *Supra* §IX.A.5. Welch, ¶153.

14. Claims 13, 21, 26

Independent claims 13, 21, and 26 largely mirror independent claims 1, 5, and 9. For example, limitations [13B]-[13C] and [13F]-[13G] are identical to limitations [1B]-[1E]. Limitations [21B]-[21C] and [21F]-[21G] are identical to limitations [5B]-[5E]. Limitations [26A]-[26C], [26E]-[26F], and [26I]-[26J] are identical to limitations [9A]-[9C] and [9E]-[9H]. Welch, ¶154.

The only distinctions between the two sets of independent claims are:

- (a) the “*input*” received from a “*sensor*” in limitations [13A], [21A], and [26D] is not limited to “*extra-sensory information*” (ESI) as in limitations [1A], [5A], and [9D]; and
- (b) the “*haptic signal*” and “*haptic effect*” in limitations [13D]-[13E], [21D]-[21E], and [26G]-[26H] are limited to “*at least one of a force haptic signal[/effect], a deformation haptic signal[/effect], or an impedance haptic signal[/effect],*” whereas claims 1, 5, and 9 recite simply a “*haptic signal*” and “*haptic effect.*”

Welch, ¶155.

Claims 13, 21, and 26 are thus broader than claims 1, 5, and 9 in sense (a) but narrower in sense (b). Welch, ¶156.

Claims 13, 21, and 26, though not limited to ESI sensor input, cover it. Thus, Rosenberg’s ESI “orientational data” is “*input from a sensor*” in claims 13, 21, and 26. *Supra* §IX.A.2.b (discussing limitation [1A]’s “*input*”). Welch, ¶157.

As explained for claim 4, Rosenberg discloses, and renders obvious, using a deformation actuator to generate deformation haptic effects. *Supra* §IX.A.5. When Rosenberg (or an obvious implementation thereof) uses a deformation actuator, its “haptic control signal” is a “*deformation haptic signal*” producing a “*deformation haptic effect*,” as recited in limitations [13D]-[13E], [21D]-[21E], and [26G]-[26H]. *Supra* §IX.A.2.c (discussing limitation [1B]’s “*haptic signal*”), §IX.A.5 (discussing claim 4’s “*deformation actuator*” and “*deformation haptic effect*”). Welch, ¶158.

As explained for claims 15, 23, and 28, Rosenberg discloses a “*force haptic effect*,” as claimed. *Infra* §IX.A.16. When providing a force haptic effect, Rosenberg’s command signal is a “*force haptic signal*,” as claimed. Welch, ¶158.

Because the remaining limitations of claims 13, 21, and 26 mirror those of claims 1, 5, and 9, Rosenberg meets them for the same reasons it meets corresponding limitations of claims 1, 5, and 9. Welch, ¶159.

15. Claims 14, 22, 27

Claims 14, 22, and 27 limit the “*input*” of their respective independent claims to ESI. Rosenberg meets these claims for the same reasons it meets limitations [1A], [5A], and [9D]. *Supra* §IX.A.2.b, §IX.A.6, §IX.A.10.e. Welch, ¶160.

16. Claims 15, 23, 28

Claims 15, 23, and 28 limit the “*haptic effect*” of their respective independent claims to a “*force haptic effect*” that “*causes a device to apply a force to a user.*” As previously noted, each embodiment relied upon herein provides a “tactile sensation.” [0062], [0064], [0068]-[0072]; *supra* §IX.A.5. Rosenberg discloses that its available “tactile sensations” include a “single force” such as a “single jolt.” [0050]. A “jolt,” like the ’546 patent’s “jerk sensation,” EX1001, 5:52, is a “*force haptic*” that causes Rosenberg’s device to “*apply a force to a user,*” as claimed. Welch, ¶161.

17. Claim 16

Claim 16 limits the “*force haptic effect*” of claim 15 to one that “*causes the device to apply pressure to the user’s body.*” Pressure is simply force per unit area. EX1019; EX1020. Welch, ¶162. Rosenberg meets claim 16 for the same reason it meets claim 15. *Supra* §IX.A.16. *See also* [0036]. Welch, ¶162.

18. Claims 17, 24, 29

Claims 17, 24, and 29 limit the “*deformation haptic effect*” of their respective independent claims to one that “*causes a device to deform.*” As discussed above, Rosenberg (or an obvious implementation thereof) discloses that a “surface of the...device” may comprise an EAP, which deforms. [0036]. *Supra* §IX.A.5. Rosenberg thus meets or renders obvious claims 17, 24, and 29. Welch, ¶163.

19. Claim 18

Claim 18 limits claim 17 by requiring that “*the deformation haptic effect causes the device to modify at least one of a macro-shape of the device or a texture of the device, and wherein the deformation of the devices comprises at least one of a visual deformation, a haptic deformation, a quasi-static deformation, or a dynamic deformation.*” Rosenberg (or an obvious implementation thereof) discloses that the device’s surface may comprise an EAP. [0036]. EAPs deform, including by changing their volume/shape, *i.e.*, a “*haptic deformation.*” *Supra* §IX.A.5. Welch, ¶164. Rosenberg also discloses that its “tactile sensation” can be a “texture sensation.” [0050]. Rosenberg thus meets or renders obvious claim 18. Welch, ¶164.

B. Ground 2: Brock Anticipates and/or Renders Obvious Claims 1-3, 5-7, 9-11, 13-16, 21-23, and 26-28

1. Brock (EX1008)³

Brock discloses a system enabling a surgeon to perceive locations of certain anatomical structures (*e.g.*, nerves or blood vessels) while controlling an instrument inside a patient's body, to avoid cutting those structures unintentionally. [0006], [0020]-[0021], [0026]-[0031]. The instrument has, or has a connection to, a "manipulator" (*e.g.*, handle or telerobotic interface) used to control the instrument. A sensor can be located at the instrument's tip to detect a "non-visible" parameter, *e.g.*, an electric field surrounding a nerve. [0029], [0059]-[0067], [0073]-[0075], [0078]-[0082], Figs. 1-6, claims 29-40. The system includes a controller which generates a haptic effect in the manipulator based on the sensed non-visible parameter. For instance, the system can produce tactile feedback like force or vibration in the manipulator when the field is sensed, alerting the surgeon that the instrument is approaching something the surgeon should avoid cutting. Abstract, [0026]-[0031], [0035]-[0039], [0042]-[0043], [0048]-[0049], [0054]-[0056], [0059]-[0067], [0069], [0089]-[0101], [0132]-[0136]. The system modulates the haptic effect based on changes in the sensed non-visible parameter. [0056], [0084], [0089], [0094], [0134]. Welch, ¶¶165-168.

³ Unless otherwise noted, citations in Section IX.B.1 are to Brock.

Figure 1 depicts an embodiment in the context of a telerobotic surgical instrument:

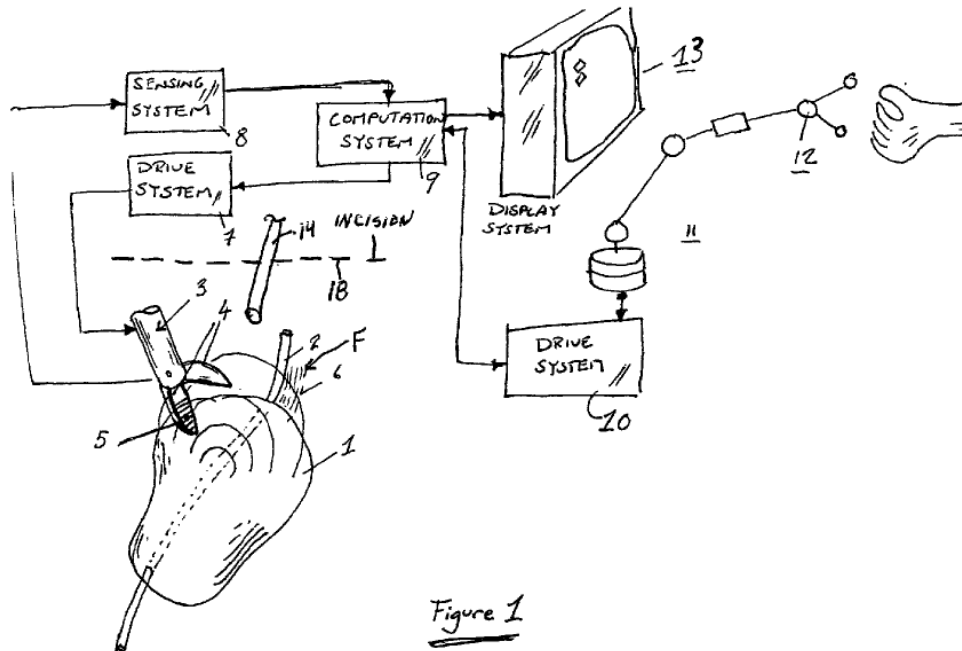


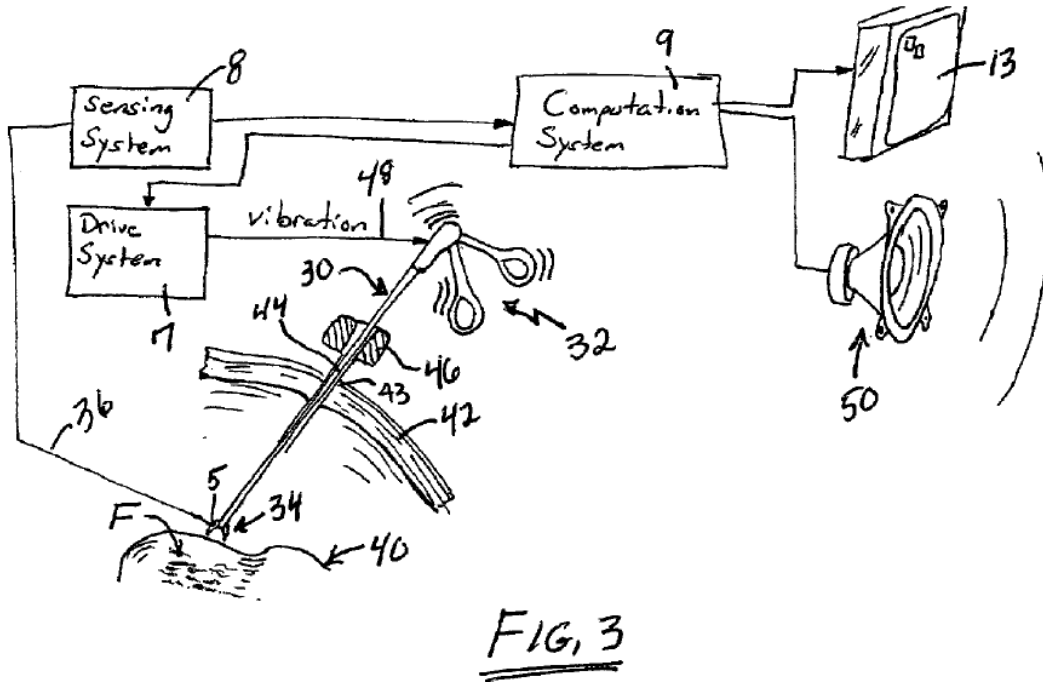
Fig. 1, [0059], [0026], [0085].

Figure 1 shows a surgical instrument 3, including tool 4, inside a patient, proximate tissue 1. [0077]-[0078]. Figure 1 also shows a sensor 5 at the tip of instrument 3. [0080]. The output from sensor 5 couples to sensing system 8, which in turn couples to computation system 9. [0080]. Drive system 7 is coupled between computation system 9 and instrument 3 for controlling the instrument. [0080]. Another drive system 10 is coupled between computation system 9 and haptic interface 11, which includes handle 12. [0081]. Using haptic interface 11, the surgeon can control instrument 3 via the drive systems. [0082]. Welch, ¶¶169-170.

Brock further discloses that the system may “provide feedback to the haptic interface 11.” [0089]. Sensor 5 can sense a “non-visible field” associated with an anatomical structure, such as an electric field or a thermal, radioactive, infra-red, or other non-visible field. [0025], [0053], [0074], [0079], [0011]-[0014] (explaining that nerves produce electric fields, blood vessels produce thermal variations, lymph nodes can be radioactively tagged). The tactile feedback provided through the haptic interface can be based on the detected field’s strength, signaling that the instrument is approaching an anatomical structure that should be avoided. [0056], [0094], [0089]. Welch, ¶171.

Figure 1, for instance, shows nerve 2 near the surgical instrument. [0079]. Brock explains that an electric field F is associated with the nerve. [0039], [0068]-[0070], [0079]. Brock also explains that, “as the sensor 5 gets closer to the nerve 2, the field strength increases.” [0089]. “This measured strength, sensed by the sensor, is coupled by way of the sensing system 8 to the computation system 9, and from there to drive system 10 and haptic interface 11.” [0089]. The sensor data can be used to generate haptic effects in handle 12 such as vibration or force feedback, “signal[ing] to the surgeon that he is in the vicinity of a nerve and must be careful.” [0090]. “This control is on a real-time basis.” [0089]. Welch, ¶172.

Figure 3 depicts essentially the same haptic-feedback system in the context of a manual (non-robotic) instrument. The surgeon manipulates hand-held instrument 30 using operating handle 32, implemented as a haptic interface. [0092]. Sensor 5 is included at end effector 34 of instrument 30. [0092]. Welch, ¶173.



Drive system 7 generates, and provides to operating handle 32, “a vibration signal as an indication to the surgeon at the handle 32 that the end effector [34] is coming into close proximity to a sensed non-visible field F.” [0094]. This causes vibration at handle 32. [0094]. “The magnitude of the vibration may be a function of the proximity of the end effector to the field.” [0094]. The vibration “provide[s] the surgeon with tactile...feedback based upon sensed non-visible parameter.” [0096]. Welch, ¶174.

Brock's system includes a "controller, intercoupling the sensing device and the manipulator," with "a mapping component for translating the characteristics of the sensed field signal into a tactile feedback signal to the manipulator to warn the surgeon that he is approaching" a sensitive structure. Abstract. *See also* [0028], [0036] ("Also included is a controller coupled from the sensor, responsive to the magnitude of the field, for feeding back to the master station a control signal to the surgeon interface so as to provide a tactile response to the surgeon based upon the magnitude of the detected field."), [0038] ("The medical device includes...a controller coupled from and responsive to the sensor for providing at the handle a tactile indication to the surgeon based on a predetermined parameter of the field."), [0048], [0067] ("With a controller, the digital signal can be mapped to, for example, a tactile feedback (palpable hardness or vibration sense) provided at a surgeon's tactile (haptic) interface."), [0101] ("The controller(s) also control feedback to the haptic interface 140, such as from the sensors...."), [0108] ("[T]he controller provides a force feedback signal to the manipulator, or haptic interface 140 illustrated in FIG. 5....Preferably, the feedback signal is a signal that the surgeon 'feels' (tactile) at the haptic interface...."), [0133]-[0136]. Welch, ¶175.

Figure 5 depicts a controller 136 that receives input from various sensors. It controls, *inter alia*, haptic interface 140, for example providing a signal causing a “tactile” haptic response. [0099], [0101], [0108], [0132]-[0134]. The tactile feedback is “carried out preferably in ‘real time’.” [0134]. *See also* [0026]-[0027], [0075], [0089], [0099], claims 33, 39. Welch, ¶176.

Although Figure 1 is described as “illustrating an embodiment” ([0059]) and Figure 3 is described as depicting “an alternative embodiment” ([0092]), the primary difference between them is the instrument type. In Figure 1, a robotic instrument is controlled remotely. [0080]-[0082]. In Figure 3, the instrument is “hand-held” ([0061]); the surgeon controls it directly. [0094]. Brock’s thrust is providing haptic feedback to surgeons in both situations. [0026], claims 29, 32, 35, 38. Welch, ¶177. Brock explains that its controller maps sensed field strength to haptic feedback at the haptic interface. Although not shown in Figures 1 or 3, the controller is a common element of Brock’s embodiments, [0063] (Figure 5 shows “relationships between sensed parameters, transformed data and signals, and applied outputs, *according to various embodiments*”)—and maps sensor input to haptic output. *Supra* p. 48. Welch, ¶177. Thus, Figures 1, 3, and 5, and their descriptions, are properly considered together. *CSR, PLC v. Skullcandy, Inc.*, 594 F. App’x 672, 680 (Fed. Cir. 2014) (Board properly combined “interchangeable” figures for anticipation).

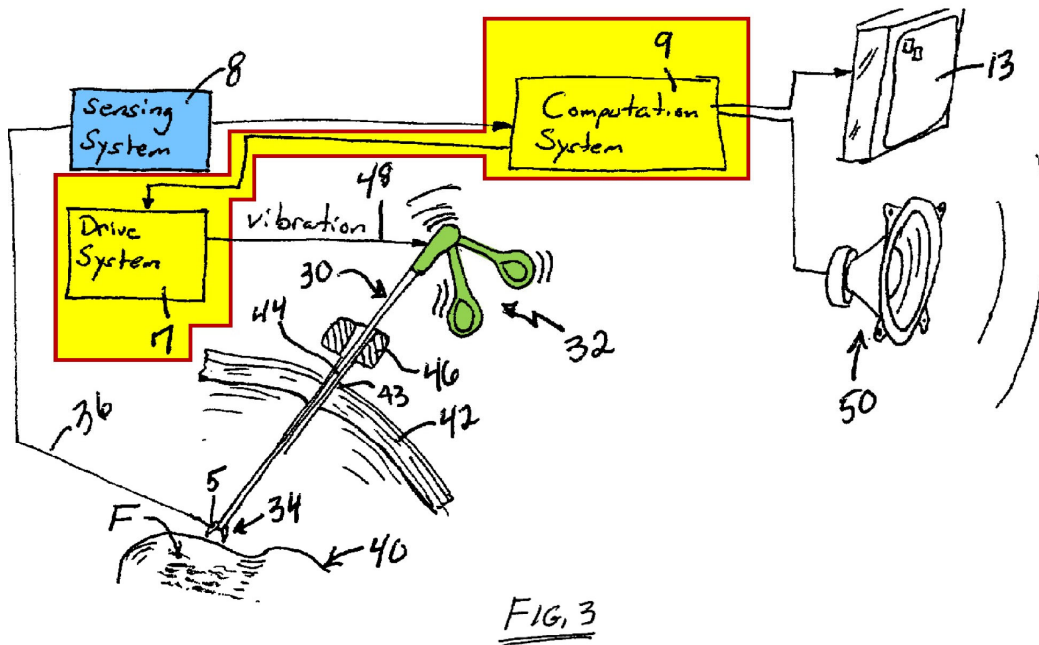
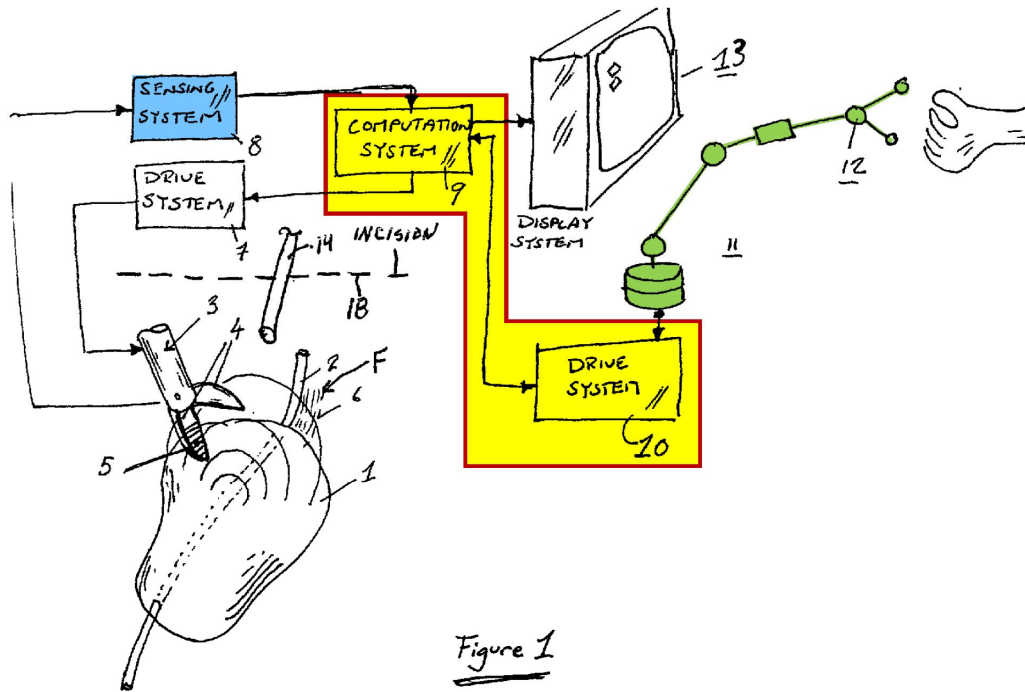
As explained below, Brock meets or renders obvious claims 1-3, 5-7, 9-11, 13-16, 21-23, and 26-28. Welch, ¶178.

2. Claim 1

- a. [1PRE]: “A non-transitory computer-readable medium having instructions stored thereon that, when executed by a processor, cause the processor to generate a haptic effect, the generating the haptic effect comprising:”

Brock’s haptic feedback system includes a “computation system” and a “drive system” coupled to a handle. Figs. 1, 3, [0077]-[0094]. In connection with Figure 3, Brock explains, “the computation system 9 along with drive system 7 causes a signal on line 48 to create a vibration at the handle 32” ([0094]), making handle 32 a “***haptic*** interface” ([0092]). The vibration is a “***haptic effect***,” as claimed. Similarly, in connection with Figure 1, Brock explains that computation system 9 and drive system 10 are connected to “***haptic*** interface 11” including “handle 12” ([0081]), and provide “feedback...at the handle 12” including “vibration” ([0089]-[0090]). In particular, Brock’s “controller” maps a sensed field signal to a “tactile feedback signal to the manipulator.” Abstract; *see also supra* p. 48. Thus, Brock discloses generating a “***haptic effect***,” as claimed. Welch, ¶179. *See also* [0020]-[0023], [0025]-[0030], [0035], [0043], [0067], [0073]-[0075].

Below, Figures 1 and 3 are color-coded to show how the computation system and haptic drive system (yellow) are situated between the sensing system 8 (blue) and the device exhibiting the haptic effect (green). Welch, ¶180.



As noted above, Brock’s controller 136 (shown in Fig. 5) provides “signal mapping” and “control[s] feedback to the haptic interface.” [0101]; *see also* Fig. 5, Abstract, [0028], [0035]-[0038], [0052]-[0055], [0067], [0099]-[0102], [0108], [0133]. POSAs would have understood that Brock’s controller is in the computation system or drive system. [0036], [0094], [0133], [0136]; Welch, ¶181. Based on the controller’s functionality, and conventional use of the term “controller,” POSAs would have understood that it comprises a processor that executes instructions stored on a non-transitory computer-readable medium to generate a haptic effect. For example, Pratt (EX1021), filed March 29, 2012 and prior art under pre-AIA 35 U.S.C. §102(e), demonstrates POSAs’ knowledge regarding devices, like Brock’s, employing haptic effects like vibration, with a “UI controller” that receives sensor inputs and generates corresponding haptic commands. Pratt, [0025]; *see also* Abstract, [0014]. The “controller” comprises processor 112 and memory 114. Pratt, Fig. 1(a), [0015], [0017]. Memory 114 “may be provided as a non-volatile memory, a volatile memory such as random access memory (RAM), or a combination thereof” and stores instructions, executed by the processor, to “control the operations of the UI controller.” Pratt, [0017]. Pratt thus corroborates that POSAs understood the term “controller”—including a “controller” used to generate haptic effects—typically described a component comprising a processor that executes instructions stored on a non-transitory computer-readable medium. Welch, ¶¶181-184.

Ullrich '182 (EX1022), filed December 7, 2010 and thus prior art under pre-AIA 35 U.S.C. §102(e), provides similar corroboration. It discloses a surgical tool that generates haptic effects. The device has a “control system 112” that receives input from sensors 140 and sends output to haptic feedback system 120. Ullrich '182, Fig. 2, [0028]. “Control system 112” comprises a processor 116 and tactile mapping logic 118, which “may be associated with a memory device...for storing...instructions.” Ullrich '182, Fig. 2, [0026]. The memory device may be RAM or ROM, and may store “logical instructions, commands, and/or code executed by tactile mapping logic 118,” which “outputs control signals to haptic feedback system 120.” Ullrich '182, [0026]-[0027]. Ullrich '182 thus further corroborates that POSAs understood control systems such as Brock’s “controller” to comprise a processor that executes instructions stored on a non-transitory computer-readable medium. Welch, ¶185.

In the alternative, if the Board found that Brock’s controller does not disclose a “processor” and a non-transitory computer-readable medium storing instructions for execution by the processor, POSAs would have recognized that Brock’s controller renders those features obvious for the reasons discussed immediately below. Welch, ¶186.

With respect to the non-transitory computer-readable medium: RAM and/or ROM—the same memories described in the ’546 patent (EX1001, 2:55-59)—were ubiquitous in the prior art for storing instructions in similar contexts. Rosenberg is one example. *Supra* §IX.A.2.a. Other corroboratory examples include Ramstein (EX1014), directed to a surgical tool with a sensor and a system providing haptic feedback in response to a sensor signal. Ramstein, Abstract. Just like the ’546 patent, Ramstein discloses RAM or ROM to store instructions for execution by a processor, which instructions control an actuator providing a haptic effect. Ramstein, [0019]-[0021]. *See also* Pratt, [0017]; Ullrich ’182, [0026]-[0027]. In short, based on POSAs’ knowledge, it would have been obvious to store instructions for generating Brock’s haptic effect on a non-transitory computer-readable medium. Welch, ¶187.

With respect to the processor, it would have been obvious to POSAs to use a processor to execute instructions to generate a haptic effect as described in Brock, as was ubiquitous in the prior art. Rosenberg is one example. *Supra* §IX.A.2.a. Other corroboratory examples include Ramstein (EX1014), which discloses a processor 22 for processing instructions to control an actuator to provide haptic effects. Ramstein, [0019]-[0021]. *See also* Pratt, Fig. 1(a), [0015], [0017]; Ullrich ’182, Fig. 2, [0026]-[0027]. Welch, ¶188.

Accordingly, claim 1's preamble is satisfied by Brock's controller, which POSAs would have understood to comprise a processor and a non-transitory, computer-readable medium containing instructions that, when executed by the processor, generate haptic effects. Further, because use of such a processor and memory in Brock's system would have been obvious, the preamble is obvious over Brock in view of POSAs' knowledge. Welch, ¶189.

- b. [1A]: “receiving input from a sensor, wherein the input comprises extra-sensory information, wherein the input further comprises one or more interaction parameters, and wherein each interaction parameter comprises a value;”

In connection with Figures 1 and 3, Brock discloses a sensor 5 at or near the medical instrument's tip. [0080], [0092], Figs. 1, 3. It senses a “non-visible field” described generally as “field F.” [0079], [0094]. Welch, ¶190.

Non-visible fields are “not observable...by the naked eye.” [0029]. This matches the '546 patent's “*extra-sensory information*,” described as “information that cannot normally be perceived by a human being.” EX1001, 2:17-19. As examples of non-visible fields sensed by its sensor, Brock lists electromagnetic (e.g., electric), thermal, infra-red, and radioactive fields. [0025], [0029], [0053], [0065], [0079]. These closely match the examples of “*extra-sensory information*” in the '546 patent: “electromagnetic field, infra-red light, ultraviolet light, radiation, or subtle changes in temperature.” EX1001, 2:17-20. Welch, ¶191.

Brock's sensor 5 is connected, via sensing system 8, to computation system 9 and a drive system. [0080], [0092]-[0094], Figs. 1, 3. The non-visible field information sensed by sensor 5 is provided as input to computation system 9 and the drive system. [0089] ("This measured strength, sensed by the sensor, is coupled by way of the sensing system 8 to the computation system 9, and from there to drive system 10 and haptic interface 11."). *See also* [0020], [0022], [0086]. In particular, the sensor input is provided to Brock's "controller," which POSAs would have understood is in the computation system or the drive system. Abstract, [0028], [0036], [0038], [0048]. Therefore, Brock meets the claim language "*receiving input from a sensor, wherein the input comprises extra-sensory information.*" Welch, ¶192.

The "non-visible data" that Brock's computation system and drive system receive as input from sensor 5 comprise "*one or more interaction parameters,*" as claimed. Brock says the input comprises a "*parameter.*" [0025], [0028], [0096]. That parameter is an "*interaction parameter,*" as claimed, because it is based on the user's interaction with the surgical device (e.g., interaction with the "manipulator" to control and move the instrument, [0133]-[0134]). For example, "as the sensor 5 gets closer to the nerve 2, the field strength increases. This measured strength, sensed by the sensor, is coupled by way of the sensing system 8 to the computation system 9, and from there to drive system 10 and haptic interface 11." [0089].

Because the “measured strength” varies based on how close the surgeon moves the sensor to the nerve, it is based on the surgeon’s interaction with the device and thus meets the claimed “*interaction parameter*.” *See also* [0025] (non-visible data are “*parameters*”), [0028] (“a feedback signal which is a function of a sensed *parameter* of the non-visible field...fed back to the haptic interface...”), [0094], [0096] (“The control may also include feedback to the haptic interface...based upon sensed non-visible *parameter*:”), [0134] (“A feedback occurs...indicating that the instrument is now at a location that corresponds with a certain field intensity.”). Welch, ¶193.

The field’s “measured strength” also “*comprises a value*” because a field “strength” has a value (*e.g.*, a magnitude). Brock teaches that “the sensed or predetermined *parameter* may comprise a *magnitude* of the field” ([0031]) and such sensed “*values*” of “non-visible *parameters*” can be stored ([0075]). For instance, the sensor measuring field strength can be a “voltmeter” ([0080]), which POSAs knew measures electric field strength in values of, *e.g.*, volts. Welch, ¶194. *See also* [0029] (“A ‘field’ may also be identified as...sensory information which constructs a data set of *values*.”), [0036] (Brock provides “a tactile response to the surgeon based upon the *magnitude* of the detected field”), [0084] (“As the instrument/sensor is moved, different voltages are sensed...”), [0086] (“[O]ne can establish intensity levels for all sensed locations.”), [0092], [0098]. Welch, ¶¶194-195.

c. [1B]: “mapping the received input to a haptic signal; and”

Brock’s controller, which receives input from the sensor as explained for limitation [1A] (§IX.B.2.b), “includes a *mapping* component for translating characteristics of the sensed field signal into a tactile feedback signal to the manipulator to warn the surgeon that he is approaching this structure with the implement.” Abstract. *See also* [0028], [0035], [0036] (“a controller coupled from the sensor, responsive to the magnitude of the field, for feeding back to the master station a control signal to the surgeon interface so as to provide a tactile response to the surgeon based upon the magnitude of the detected field”), [0038], [0089], [0094], [0100]-[0101], [0132] (“*Mapping* Non-Visible Field to Haptic Interface”), [0133] (“A controller intercouple the surgical implement, manipulator and sensing device and includes a *mapping* block for translating predetermined characteristics of the non-visible field from the sensing device into a signal for controlling actions at the manipulator. The signal for controlling actions usually controls a tactile feedback to the operator.”), [0135] (“*Mapping* Non-Visible Field to Vibration”), [0136] (“A controller...includes a *mapping* block for translating predetermined characteristics of the non-visible field from the sensing device into a vibration signal coupled to the manipulator.”). In short, the “signal” transmitted by the controller to the manipulator is a “*haptic signal*” to which the received sensor input is “*mapp[ed]*,” as claimed. Welch, ¶196.

d. [1C]: “sending the haptic signal to an actuator to generate the haptic effect;”

Brock explains that its controller sends a tactile feedback signal, such as a vibration signal, to the manipulator. Abstract (controller sends a “*tactile feedback signal to the manipulator* to warn the surgeon that he is approaching this structure with the implement”), [0094], [0133] (“A controller intercouple the surgical implement, manipulator and sensing device and includes a mapping block for translating predetermined characteristics of the non-visible field from the sensing device into a *signal for controlling actions at the manipulator*. The signal...usually *controls a tactile feedback to the operator*.”), [0136] (“A controller is provided intercoupling the surgical implement, manipulator and sensing device and includes a mapping block for translating predetermined characteristics of the non-visible field from the sensing device into *a vibration signal coupled to the manipulator*.”). The “manipulator,” which receives the signal, may be Figure 1’s haptic interface 11 or Figure 3’s handle 32. [0112], [0114]. Vibration and tactile effects are haptic effects. [0094], [0136]; *see also* EX1001, 1:11-14 (“Haptics is a tactile...technology” and vibrations are “haptic effects”), 4:42-43 (vibration is a “haptic effect[]”). When Brock’s controller sends a “tactile feedback signal to the manipulator,” it is “*sending the haptic signal*,” as claimed. Welch, ¶197.

While Brock does not use the word “actuator,” POSAs would have understood that an actuator is simply a device that actuates (*i.e.*, moves) something. EX1023; EX1024. Welch, ¶198. For example, the ’546 patent describes a device that causes vibration as a “vibration actuator” and a device that generates force as a “force actuator.” EX1001, 2:29-34. POSAs would have understood that Brock’s “manipulator”—which receives the claimed “*haptic signal*” from Brock’s controller as discussed above and comprises an instrument or haptic interface that produces a haptic effect, [0043], [0048], [0054], [0133] [0136]—comprises an “*actuator*,” as claimed. Welch, ¶198.

Further, use of an actuator would have been obvious, as actuators were ubiquitous in the prior art for creating haptic effects. Rosenberg is one example. *Supra* §IX.A.2.d. Indeed, Brock says handle 32 is a “haptic interface,” [0092], and POSAs knew that a typical implementation of a “haptic” device with a vibrating part includes an actuator. *E.g.*, Ramstein, [0019] (“Actuator 28 is a haptic device that generates a vibration on handle 16.”); Pratt, [0027] (“haptics actuator” produces “haptic effect”), Ullrich ’182, [0028] (“haptic actuator” produces “haptic feedback to the operator”); EX1025, [0016] (“Actuator 18 is a haptic device that generates a vibration on telephone 10.”). Based on POSAs’ knowledge, it would have been obvious to implement Brock’s sending a “tactile feedback signal to the manipulator” (Abstract) by sending the signal to an actuator in the manipulator. Welch, ¶199.

- e. [1D]: “the mapping the received input to the haptic signal further comprising modulating the haptic signal when new input is received, wherein the new received input comprises an update of at least one value of at least one interaction parameter of the received input; and”

As explained above for limitation [1B] (§IX.B.2.c), Brock’s mapping functionality, in Brock’s controller, maps non-visible field input from the sensor to a signal causing a haptic effect. Welch, ¶200.

Brock’s mapping functionality “*further compris[es] modulating the haptic signal when new input is received,*” as claimed. Per Brock, the “magnitude of the vibration may be a *function of the proximity* of the end effector to the field.” [0094]. See also [0069] (“*[D]iffering electrical forces and dipoles* can be mapped and then provided to the surgeon as *different degrees of hardness/softness, or vibration.*”). Thus, based on “measured strength, sensed by the sensor,” Brock’s system provides “feedback” that “can be used to indicate at the handle 12 that the distal end of the instrument 3 is *approaching* an area where there is a nerve.” [0089]. “This control is on a *real-time basis.*” [0089]. See also [0075], [0099] (line 130 in Fig. 5 depicts “*real time*” sensed data to control a haptic interface), [0134] (the “tactile feedback is carried out preferably in ‘*real time*’.”), claims 29, 39. The measured field strengths, received from the sensor in “real time,” are “*new input[s],*” as claimed, and haptic effects are modulated based on them, as described above in this paragraph. Welch, ¶201.

POSAs would have understood that, since the magnitude of the haptic effect (e.g., vibration) is modulated based on sensed field strength, Brock’s control signal is also modulated, since the control signal is what controls the magnitude of the haptic effect. E.g., [0056] (“The signal for controlling actions may control a vibration level at the manipulator...”). Accordingly, Brock discloses “*modulating the haptic signal when new input is received,*” as claimed. Welch, ¶202.

The received input data comprise “*interaction parameter[s]*” that comprise “*at least one value*” for the reasons discussed with respect to limitation [1A] (§IX.B.2.b). The “*new received input*” (e.g., measured field strength from the sensor, as the device moves, on a real-time basis) “*comprises an update of at least one value of at least one interaction parameter of the received input,*” as claimed, because each field-strength measurement provided by the sensor updates the prior measurement. [0084] (“As the instrument/sensor is moved, different voltages are sensed...as the end effector is moved...”). See also [0029], [0031], [0036], [0075]. Welch, ¶203.

Brock meets [1D] under both constructions discussed *supra* §IX.A.2.e. Brock provides “real-time” control via mathematical transformation, just like the ’546 patent (EX1001, 7:62-8:3), and Brock’s haptic feedback “may be a *function* of the proximity of the end effector to the field.” [0094]. This satisfies the first construction since successive sensor inputs are mapped to haptic signals, and the second construction which does not require “continuous” modulation. Welch, ¶204.

- f. [1E]: “the sending the haptic signal to the actuator to generate the haptic effect further comprising sending the modulated haptic signal to the actuator to modulate the generated haptic effect.”

As explained above for limitation [1C] (§IX.B.2.d), Brock discloses, and renders obvious, “*sending the haptic signal to the actuator to generate the haptic effect.*”

Brock also discloses “*modulating the haptic signal.*” *Supra* §IX.B.2.e (limitation [1D]).

Because Brock’s haptic signal is modulated to modulate the haptic effect (*see* limitation [1D]), and Brock’s haptic signal is sent (or was obvious to send) to the actuator (*see* limitation [1C]), it follows that Brock’s modulated haptic signal is sent “*to the actuator to modulate the generated haptic effect,*” as claimed. *Supra* §IX.B.2.e. *See also* [0094] (the “magnitude of the vibration may be ***a function of the proximity*** of the end effector to the field.” Welch, ¶205-207.

For the above reasons, Brock meets claim 1, and in view of POSAs’ knowledge, also renders claim 1 obvious. Welch, ¶208.

3. Claim 2: “The non-transitory computer-readable medium of claim 1, the mapping the received input to the haptic signal further comprising generating the haptic signal when the value of at least one interaction parameter exceeds a specified value.”

As noted above, Brock discloses providing haptic feedback, *e.g.*, vibration, when an instrument tip approaches a nerve, and discloses that this “control may be exercised using *threshold levels*.” [0090]. POSAs would have understood this to mean the haptic effect (and hence the haptic signal causing it) are generated when a threshold (*e.g.*, threshold field strength) is exceeded. Elsewhere, Brock says an “audible signal may be generated only when the force signal *exceeds a preselected threshold*.” [0051]. As Figure 5 shows, audible device 144 and haptic interface 140 are alternative recipients of a control signal from controller 136. Fig. 5. POSAs would have understood that when paragraph [0090] refers to exercising control through haptic feedback “using threshold levels,” it likewise means that haptic feedback is only produced when a threshold (*e.g.*, threshold field strength) is exceeded. Brock thus meets claim 2. Welch, ¶¶209-212. Further, it was well-known in the art to implement haptic feedback based on threshold sensed levels. *E.g.*, Ullrich ’182, [0042] (“Haptic feedback will be provided to users as force measurements pass through several thresholds.”); Pratt, [0039] (haptic feedback based on finger’s threshold distance or time). Brock, in view of POSAs’ knowledge, thus also renders claim 2 obvious. Welch, ¶213.

4. Claim 3: “The non-transitory computer-readable medium of claim 1, wherein the actuator comprises a vibration actuator, and wherein the haptic effect generated by the vibration actuator comprises a vibration haptic effect.”

Brock focuses heavily on generating a vibration haptic effect. *E.g.*, [0048] (Brocks’s system provides “a signal for controlling *vibration* at the manipulator”), [0054] (similar), [0056], [0067], [0069], [0073]-[0075], [0090] (“Thus, as the surgeon manipulates the handle 12, if the instrument tip gets close to a nerve 2, there will be a feedback...to provide...a *vibration* to the handle 12....”), [0094] (a purpose of the system is “to create a *vibration* at the handle 32”), [0100], [0135]-[0136], Fig. 3 (showing vibration of handle 32). Welch, ¶214.

Thus, Brock meets or renders obvious claim 3 for the same reasons it meets or renders obvious [1C], concerning “*sending the haptic signal to an actuator.*” *Supra* §IX.B.2.d. Welch, ¶215.

5. Claim 5

Claim 5 recites a “*method for generating a haptic effect*” that claim 1’s “*instructions*” cause a processor to perform. Brock thus meets or renders obvious claim 5 for the same reasons it meets or renders obvious claim 1. *Supra* §IX.B.2. Welch, ¶216.

6. Claim 6

Claim 6 (depending from claim 5) recites a “*method for generating a haptic effect*” that the “*instructions*” of claim 2 cause a processor to perform. Brock thus renders claim 6 obvious for the same reasons it renders claims 2 and 5 obvious. *Supra* §IX.B.3. Welch, ¶¶217.

7. Claim 7

Claim 7 (depending from claim 5) limits claim 5’s method to one used with the vibration actuator of claim 3. Brock thus renders claim 7 obvious for the same reasons it renders claims 3 and 5 obvious. *Supra* §IX.B.4. Welch, ¶¶218-219.

8. Claim 9

a. [9PRE]: “A haptic representation system comprising:”

Brock discloses a “*haptic representation system*,” as claimed.

As discussed previously, Brock discloses a controller which generates a haptic effect in a manipulator based on a sensed non-visible parameter. *Supra* §IX.B.1. The manipulator (*e.g.*, haptic interface 11 in Figure 1 or handle 32 in Figure 3) includes, and also renders obvious the use of, an actuator for creating a haptic effect. *Supra* §IX.B.2.d.

The '546 patent explains that a “*haptic representation system*” can be part of a “device” with the haptic representation system “represent[ing] the sensor input as haptic output.” EX1001, 2:42-45, 4:16-19, Fig. 1. Brock’s controller and manipulator, including an obvious actuator, collectively represent non-visible sensor input as haptic output (tactile sensations from haptic actuators) and thus are a “*haptic representation system*,” as claimed. Welch, ¶¶220-222.

b. [9A]: “a memory configured to store a haptic representation module;”

The '546 patent explains that a “haptic representation module” is “software” that “generates a haptic effect that represents received input.” EX1001, 3:8-15.

As discussed above for limitation [1PRE], POSAs would have understood that Brock’s “controller” comprises a processor that executes instructions stored in memory to generate haptic effects. Alternatively, POSAs would have recognized that Brock’s controller renders obvious the use of instructions stored in memory to generate haptic effects. *Supra* §IX.B.2.a. Thus, Brock meets, or renders obvious in view of POSAs’ knowledge, limitation [9A]. Welch, ¶¶223-224.

c. [9B]: “a processor configured to execute the haptic representation module stored on the memory; and”

As discussed above for [1PRE], POSAs would have understood that Brock’s “controller” comprises a processor that executes instructions stored in memory to generate a haptic effect. Alternatively, POSAs would have recognized that Brock’s controller renders obvious the use of such a processor. *Supra* §IX.B.2.a. Thus, Brock meets, or renders obvious in view of POSAs’ knowledge, limitation [9B]. Welch, ¶225.

d. [9C]: “an actuator configured to output one or more haptic effects;”

As discussed above for limitation [1C], POSAs would have understood that Brock’s manipulator comprises an actuator to create a haptic effect. Further, use of an actuator would have been obvious, as actuators were ubiquitous in the prior art for creating haptic effects like vibration. *Supra* §IX.B.2.d. Thus, Brock meets, or renders obvious in view of POSAs’ knowledge, limitation [9C]. Welch, ¶226.

e. [9D]-[9H]

Limitations [9D]-[9H] require the “*haptic representation module*” of limitation [9A] to be configured to perform the steps recited in limitations [1A]-[1E]. Brock thus discloses limitations [9D]-[9H] for the same reasons it discloses limitations [1A]-[1E]. *Supra* §§IX.B.2.bIX.B.2.f. Welch, ¶227.

9. Claim 10

Claim 10 requires claim 9's "*haptic representation module*" to be configured to perform the functionality of claim 2. Brock thus renders claim 10 obvious for the same reasons it renders obvious claims 2 and 9. *Supra* §IX.B.3. Welch, ¶228.

10. Claim 11

Claim 11 requires claim 9's "*haptic representation system*" to be used with the vibration actuator of claim 3. Brock thus renders claim 11 obvious for the same reasons it renders obvious claims 3 and 9. *Supra* §IX.B.4. Welch, ¶229.

11. Claims 13, 21, 26

Independent claims 13, 21, and 26 largely mirror independent claims 1, 5, and 9. *Supra* §IX.A.14. Welch, ¶230. The only distinctions between the two claim sets are: (a) the "*input*" received from a "*sensor*" in limitations [13A], [21A], and [26D] is not limited to "*extra-sensory information*" (ESI) as in limitations [1A], [5A], and [9D], but (b) the "*haptic signal*" and "*haptic effect*" in limitations [13D]-[13E], [21D]-[21E], and [26G]-[26H] are limited to "*at least one of a force haptic signal[/effect], a deformation haptic signal[/effect], or an impedance haptic signal[/effect],*" whereas claims 1, 5, and 9 recite simply a "*haptic signal*" and "*haptic effect.*" Claims 13, 21, and 26 are thus broader than claims 1, 5, and 9 in sense (a) but narrower in sense (b). Welch, ¶230.

Claims 13, 21, and 26, though not limited to ESI sensor input, cover it. Thus, Brock’s “non-visible field” is “*input from a sensor*,” as recited in claims 13, 21, and 26. *Supra* §IX.B.2.b (discussing “*input*” for limitation [1A]). Welch, ¶231.

Brock discloses using a force haptic effect as an alternative to a vibration haptic effect. *E.g.*, [0025] (“The response parameters include...a vibratory device and ***force feedback*** to a haptic interface.”), [0075] (“[R]eference has been made to the sensing of certain non-visible parameters for the purpose of providing real-time ***force*** or vibration ***feedback*** to the haptic interface.”), [0090] (discussing providing “a ***force feedback*** to the handle 12”), [0100] (“a haptic interface which has the ability of receiving tactile (***force*** or vibration) ***feedback*** signals”), Fig. 5, element 140 (“***Force Feedback***”), claims 30 and 36 (“wherein the tactile signal is at least one of ***force*** and vibration”). When Brock employs “force feedback,” its control signal is a “*force haptic signal*” producing a “*force haptic effect*” as recited in limitations [13D]-[13E], [21D]-[21E], and [26G]-[26H]. *Supra* §IX.B.2.c (discussing [1B]’s “haptic signal”). Welch, ¶232.

Because the remaining elements of claims 13, 21, and 26 mirror those of claims 1, 5, and 9, Brock meets them for the same reasons it meets corresponding limitations of claims 1, 5, and 9. Welch, ¶233.

12. Claims 14, 22, 27

Claims 14, 22, and 27 limit the “*input*” of their respective independent claims to ESI. Brock meets these claims for the same reasons it meets limitations [1A], [5A], and [9D]. *Supra* §IX.B.2.b, §IX.B.2.b, §IX.B.2.b. Welch, ¶234.

13. Claims 15, 23, 28

Claims 15, 23, and 28 limit the “*haptic effect*” of their respective independent claims to a “*force haptic effect*” that “*causes a device to apply a force to a user.*” POSAs would have understood that Brock’s “force feedback” applies force to a user; thus, Brock renders obvious these claims for the same reason it renders obvious claims 13, 21 and 26. *Supra* §IX.B.11. Welch, ¶235.

14. Claim 16

Claim 16 limits the “*force haptic effect*” of claim 15 to one that “*causes the device to apply pressure to the user’s body.*” Pressure is simply force per unit area. EX1019; EX1020. Welch, ¶236. Brock meets claim 16 for the same reason it meets claim 15. *Supra* §IX.B.13. Welch, ¶236.

X. NO BASIS FOR DISCRETIONARY DENIAL

A. Fintiv

Under the Director’s Interim Procedure for Discretionary Denials, “the PTAB will not deny institution based on *Fintiv*⁴ if there is compelling evidence of unpatentability,” which this Petition provides. That should conclude the *Fintiv* analysis. *Nokia of Am. Corp. v. TQ Delta, LLC*, IPR2022-00471, Paper 11 at 19-21 (Aug. 18, 2022). Regardless, the *Fintiv* factors weigh against discretionary denial.

1. Potential for Stay

Petitioner will seek a pre-institution stay, but without “specific evidence” how the court will rule, this factor is neutral. *Sand Revolution II, LLC v. Cont’l Intermodal Grp.–Trucking LLC*, IPR2019-01393, Paper 24 at 7 (June 16, 2020) (informative).

2. Timing of Trial

Though June 2025 is the trial-ready date (EX1007), the Board considers median time-to-trial—27 months in Western District of Washington (EX1026, 76), putting trial in August 2025, likely shortly *after* a FWD herein. *Sony Interactive Ent. v. Quantum Imaging LLC*, IPR2023-00954, Paper 11 at 26 (Dec. 11, 2023) (trial four months *before* FWD “weighs *against* discretionary denial”).

⁴ *Apple Inc. v. Fintiv, Inc.*, IPR2020-00019, Paper 11 (Mar. 20, 2020) (precedential).

Moreover, Petitioner filed this Petition diligently, just three months after receiving Patent Owner’s list of asserted claims in the litigation and more than three and a half months before the Section 315(b) deadline. EX1005; EX1027. Factor 2 thus weighs against denial. *Fintiv*, Paper 11 at 11 (“expeditiously” filed petitions “weigh[] against [denial]”); *Dish Network LLC v. Broadband iTV, Inc.*, IPR2020-01332, Paper 14, 29 (Jan. 27, 2021) (granting institution and finding reasonable diligence where petition was filed less than three months after identification of asserted claims); *Intel Corp. v. ParkerVision, Inc.*, IPR2021-00346, Paper 12, 34 (July 22, 2021) (similar where petition was filed five months after infringement contentions).

3. Litigation Investment

Other than initial motion practice and preliminary contentions, the parties have invested little in the litigation, weighing against denial. *Samsung Elecs. Co. v. Netlist, Inc.*, IPR2022-00063, Paper 13 at 8 (May 5, 2022) (instituting IPR where no “claim construction and merits determinations” had occurred in litigation); *ExtractionTek Sales LLC v. Gene Pool Techs., Inc.*, IPR2022-00832, Paper 15, 10-11 (Oct. 31, 2022).

4. Overlap of Issues

Patent Owner does not assert challenged claims 4, 8-18, 21-24, or 26-29. EX1005. This IPR will address claims the district court will not, weighing against denial. *Markforged Inc. v. Continuous Composites, Inc.*, IPR2022-00679, Paper 7 at 32-33 (Oct. 25, 2022).

5. Litigation Defendants

Petitioner is the litigation defendant, which “is far from an unusual circumstance.” *Sand Revolution II*, Paper 24 at 12-13. This factor is neutral.

B. Section 325(d)

Neither Rosenberg nor Brock was cited during prosecution. Discretionary denial under Section 325(d) is improper.

XI. CONCLUSION

The Board should institute IPR against the challenged claims.

Dated: 01-30-2024

Respectfully,

Valve Corporation,

By: /Elisabeth Hunt/
Elisabeth H. Hunt, Reg. No. 67,336
WOLF, GREENFIELD & SACKS, P.C.

CERTIFICATE OF SERVICE UNDER 37 C.F.R. §42.6(e)(4)

I certify that on January 30, 2024, I will cause a copy of the foregoing document, including any exhibits or appendices filed therewith, to be served via Overnight FedEx at the following correspondence address of record for the patent:

Immersion / Kilpatrick Townsend and Stockton
Mailstop: IP Docketing – 22
1100 Peachtree Street
Suite 2800
Atlanta, GA 30309

Date: January 30, 2024

/MacAulay Rush/
MacAulay Rush
Paralegal
WOLF, GREENFIELD & SACKS, P.C.

CERTIFICATE OF WORD COUNT

Pursuant to 37 C.F.R. §42.24, the undersigned certifies that the foregoing Petition for *Inter Partes* Review contains 14,000 words excluding a table of contents, a table of authorities, Mandatory Notices under §42.8, a certificate of service or word count, or appendix of exhibits or claim listing. Petitioners have relied on the word count feature of the word processing system used to create this paper in making this certification.

Date: January 30, 2024

/MacAulay Rush/
MacAulay Rush
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WOLF, GREENFIELD & SACKS, P.C.

XII. CLAIM LISTING

The following claim listing assigns labels (e.g., [1PRE], [1A], [1B], etc.) to limitations of certain claims for clarity.

Claim 1
[1PRE] A non-transitory computer-readable medium having instructions stored thereon that, when executed by a processor, cause the processor to generate a haptic effect, the generating the haptic effect comprising:
[1A] receiving input from a sensor, wherein the input comprises extra-sensory information, wherein the input further comprises one or more interaction parameters, and wherein each interaction parameter comprises a value;
[1B] mapping the received input to a haptic signal; and
[1C] sending the haptic signal to an actuator to generate the haptic effect;
[1D] the mapping the received input to the haptic signal further comprising modulating the haptic signal when new input is received, wherein the new received input comprises an update of at least one value of at least one interaction parameter of the received input; and
[1E] the sending the haptic signal to the actuator to generate the haptic effect further comprising sending the modulated haptic signal to the actuator to modulate the generated haptic effect.
Claim 2
The non-transitory computer-readable medium of claim 1, the mapping the received input to the haptic signal further comprising generating the haptic signal when the value of at least one interaction parameter exceeds a specified value.
Claim 3
The non-transitory computer-readable medium of claim 1, wherein the actuator comprises a vibration actuator, and wherein the haptic effect generated by the vibration actuator comprises a vibration haptic effect.
Claim 4
The non-transitory computer-readable medium of claim 1, wherein the actuator comprises a deformation actuator, and wherein the haptic effect generated by the deformation actuator comprises a deformation haptic effect.

Claim 5
[5PRE] A computer-implemented method for generating a haptic effect, the computer-implemented method comprising:
[5A] receiving input from a sensor, wherein the input comprises extra-sensory information, wherein the input further comprises one or more interaction parameters, and wherein each interaction parameter comprises a value;
[5B] mapping the received input to a haptic signal; and
[5C] sending the haptic signal to an actuator to generate the haptic effect;
[5D] the mapping the received input to the haptic signal further comprising modulating the haptic signal when new input is received, wherein the new received input comprises an update of at least one value of at least one interaction parameter of the received input; and
[5E] the sending the haptic signal to the actuator to generate the haptic effect further comprising sending the modulated haptic signal to the actuator to modulate the generated haptic effect.
Claim 6
The computer-implemented method of claim 5, the mapping the received input to the haptic signal further comprising generating the haptic signal when the value of at least one interaction parameter exceeds a specified value.
Claim 7
The computer-implemented method of claim 5, wherein the actuator comprises a vibration actuator, and wherein the haptic effect generated by the vibration actuator comprises a vibration haptic effect.
Claim 8
The computer-implemented method of claim 5, wherein the actuator comprises a deformation actuator, and wherein the haptic effect generated by the deformation actuator comprises a deformation haptic effect.

Claim 9
[9PRE] A haptic representation system comprising:
[9A] a memory configured to store a haptic representation module;
[9B] a processor configured to execute the haptic representation module stored on the memory; and
[9C] an actuator configured to output one or more haptic effects;
[9D] wherein the haptic representation module is configured to receive input from a sensor, wherein the input comprises extra-sensory information, wherein the input further comprises one or more interaction parameters, and wherein each interaction parameter comprises a value;
[9E] wherein the haptic representation module is further configured to map the received input to a haptic signal;
[9F] wherein the haptic representation module is further configured to send the haptic signal to an actuator to generate the haptic effect;
[9G] wherein the haptic representation module is further configured to modulate the haptic signal when new input is received, wherein the new input comprises an update of at least one value of at least one interaction parameter of the received input; and
[9H] wherein the haptic representation module is further configured to send the modulated haptic signal to the actuator to modulate the generated haptic effect.
Claim 10
The haptic representation system of claim 9, wherein the haptic representation module is further configured to generate the haptic signal when the value of at least one interaction parameter exceeds a specified value.
Claim 11
The haptic representation system of claim 9, wherein the actuator comprises a vibration actuator, and wherein the haptic effect generated by the vibration actuator comprises a vibration haptic effect.
Claim 12
The haptic representation system of claim 9, wherein the actuator comprises a deformation actuator, and wherein the haptic effect generated by the deformation actuator comprises a deformation haptic effect.

Claim 13
[13PRE] A non-transitory computer-readable medium having instructions stored thereon that, when executed by a processor, cause the processor to generate a haptic effect, the generating the haptic effect comprising:
[13A] receiving input from a sensor, wherein the input further comprises one or more interaction parameters, and wherein each interaction parameter comprises a value;
[13B] mapping the received input to a haptic signal; and
[13C] sending the haptic signal to an actuator to generate the haptic effect;
[13D] wherein the haptic signal is at least one of a force haptic signal, a deformation haptic signal, or an impedance haptic signal;
[13E] wherein the haptic effect is at least one of a force haptic effect, a deformation haptic effect, or an impedance haptic effect;
[13F] the mapping the received input to the haptic signal further comprising modulating the haptic signal when new input is received, wherein the new received input comprises an update of at least one value of at least one interaction parameter of the received input; and
[13G] the sending the haptic signal to the actuator to generate the haptic effect further comprising sending the modulated haptic signal to the actuator to modulate the generated haptic effect.
Claim 14
The non-transitory computer-readable medium of claim 13, wherein the input comprises extra-sensory information.
Claim 15
The non-transitory computer-readable medium of claim 13, wherein the haptic effect is a force haptic effect, and wherein the force haptic effect causes a device to apply a force to a user.
Claim 16
The non-transitory computer-readable medium of claim 15, wherein the force haptic effect causes the device to apply pressure to the user's body.
Claim 17
The non-transitory computer-readable medium of claim 13, wherein the haptic effect is a deformation haptic effect, and wherein the deformation haptic effect causes a device to deform.

Claim 18
The non-transitory computer-readable medium of claim 17, wherein the deformation haptic effect causes the device to modify at least one of a macro-shape of the device or a texture of the device, and wherein the deformation of the devices comprises at least one of a visual deformation, a haptic deformation, a quasi-static deformation, or a dynamic deformation.
Claim 21
[21PRE] A computer-implemented method for generating a haptic effect, the computer-implemented method comprising:
[21A] receiving input from a sensor, wherein the input further comprises one or more interaction parameters, and wherein each interaction parameter comprises a value;
[21B] mapping the received input to a haptic signal; and
[21C] sending the haptic signal to an actuator to generate the haptic effect;
[21D] wherein the haptic signal is at least one of a force haptic signal, a deformation haptic signal, or an impedance haptic signal;
[21E] wherein the haptic effect is at least one of a force haptic effect, a deformation haptic effect, or an impedance haptic effect;
[21F] the mapping the received input to the haptic signal further comprising modulating the haptic signal when new input is received, wherein the new received input comprises an update of at least one value of at least one interaction parameter of the received input; and
[21G] the sending the haptic signal to the actuator to generate the haptic effect further comprising sending the modulated haptic signal to the actuator to modulate the generated haptic effect.
Claim 22
The computer-implemented method of claim 21, wherein the input comprises extra-sensory information.
Claim 23
The computer-implemented method of claim 21, wherein the haptic effect is a force haptic effect, and wherein the force haptic effect causes a device to apply a force to a user.

Claim 24
The computer-implemented method of claim 21, wherein the haptic effect is a deformation haptic effect, and wherein the deformation haptic effect causes a device to deform.
Claim 26
[26PRE] A haptic representation system comprising:
[26A] a memory configured to store a haptic representation module;
[26B] a processor configured to execute the haptic representation module stored on the memory; and
[26C] an actuator configured to output one or more haptic effects;
[26D] wherein the haptic representation module is configured to receive input from a sensor, wherein the input further comprises one or more interaction parameters, and wherein each interaction parameter comprises a value;
[26E] wherein the haptic representation module is further configured to map the received input to a haptic signal;
[26F] wherein the haptic representation module is further configured to send the haptic signal to an actuator to generate the haptic effect;
[26G] wherein the haptic signal is at least one of a force haptic signal, a deformation haptic signal, or an impedance haptic signal;
[26H] wherein the haptic effect is at least one of a force haptic effect, a deformation haptic effect, or an impedance haptic effect;
[26I] wherein the haptic representation module is further configured to modulate the haptic signal when new input is received, wherein the new input comprises an update of at least one value of at least one interaction parameter of the received input; and
[26J] wherein the haptic representation module is further configured to send the modulated haptic signal to the actuator to modulate the generated haptic effect.
Claim 27
The haptic representation system of claim 26, wherein the input comprises extra-sensory information.
Claim 28
The haptic representation system of claim 26, wherein the haptic effect is a force haptic effect, and wherein the force haptic effect causes a device to apply a force to a user.

Claim 29

The haptic representation system of claim 26, wherein the haptic effect is a deformation haptic effect, and wherein the deformation haptic effect causes a device to deform.